Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Northern Region/Lolo National Forest

September 2023

# Revised Assessment

## Lolo National Forest Land Management Plan

# Revised Assessment

## Lolo National Forest Land Management Plan

Mineral, Missoula, Sanders, Granite, Powell, Lewis and Clark, and Flathead counties

**Lead Agency:** USDA Forest Service

**Responsible Official:** Carolyn Upton
Forest Supervisor
24 Fort Missoula Road
Missoula, MT 59804
406-329-3750

**For Information Contact:** Land Management Plan Revision Team
SM.FS.LNFRevision@usda.gov
or mail to:
Attn: Amanda Milburn-Lolo Plan Revision
Lolo National Forest All Units
24 Fort Missoula Rd., Missoula, MT, 59804
406-329-3430

**Cover photo:** Rolling hills of arrowleaf balsamroot taken by Maureen Essen.

The Forest Service values public participation. Communications from the public regarding this project, including commenters' names and contact information, will become part of the public record. Comments, including anonymous comments, will be accepted at any time. However, comments posted after the close of a designated comment period may not be able to be given full consideration. Anonymous comments and comments submitted after the close of the final designated comment period will not provide the commenter standing for administrative review. Comments, or in some cases other expressions of interest, along with respondent's contact information, submitted during the comment period may be necessary to establish a respondent's eligibility to participate in an administrative review for this proposed action. Interested members of the public should review the proposal's information to determine the applicable administrative review process and the eligibility requirements for that process.

# Table of Contents

# List of Tables

# List of Figures

# Chapter 1: Overview and Assessment Background

## 1.1 Document Structure

The Lolo National Forest is embarking on the process to revise its land management plan under the 2012 Planning Rule (36 CFR 219.19). This assessment is a rapid evaluation of relevant existing conditions, status, and trends on the Lolo National Forest and represents the first stage in the plan revision process. This assessment is organized into three chapters and six appendices:

- Chapter 1: Overview and Assessment Background
- Chapter 2: Assessment Findings: Biophysical Elements
- Chapter 3: Assessment Findings: Socioeconomic Elements and Multiple Uses
- Appendices:
    - ♦ Appendix 1: Maps
    - ♦ Appendix 2: Carbon Assessment
    - ♦ Appendix 3: Natural Range of Variation Methods and Results
    - ♦ Appendix 4: Evaluation of Forest Health Monitoring Data to support Lolo National Forest Plan Revision
    - ♦ Appendix 5: Data Sources and Adjustments Used to Estimate Forest Attributes
    - ♦ Appendix 6: Scenery Management System Inventory Overview

**Cross-references** to tables, figures, and maps are located throughout the document. Tables and figures located within the main body of the assessment are referenced as “table” or “figure.” References to maps located in appendix 1 are listed as “figure” with an “A1” prefix before the number (e.g., see figure A1-01).

**Data Disclaimer:** The USDA Forest Service makes no warranty, expressed or implied, including the warranties of merchantability and fitness for a particular purpose, nor assumes any legal liability or responsibility for the accuracy, reliability, completeness, or utility of these geospatial data, or for the improper or incorrect use of these geospatial data. These geospatial data and related maps or graphics are not legal documents and are not intended to be used as such. The data and maps may not be used to determine title, ownership, legal descriptions or boundaries, legal jurisdiction, or restrictions that may be in place on either public or private land. Natural hazards may or may not be depicted on the data and maps, and land users should exercise due caution. The data are dynamic and may change over time. The user is responsible to verify the limitations of the geospatial data and to use the data accordingly.

**Map Disclaimer:** These maps are intended to depict physical features as they generally appear on the ground and may not be used to determine title, ownership, legal boundaries, legal jurisdiction, including jurisdiction over roads or trails, or access restrictions that may be in place on either public or private land. Obtain permission before entering private lands and check with appropriate government offices for restrictions that may apply to public lands. Lands, roads, and trails within the boundaries of the national forest may be subject to restrictions on motor vehicle use. Obtain a Motor Vehicle Use Map or inquire at a local Forest Service office for motor vehicle access information. Natural hazards may or may not be depicted on the map, and land users should exercise due caution. These maps may not be suitable for navigation.

## 1.2 Purpose of the Assessment

The National Forest Management Act (NFMA) of 1976 requires every national forest or grassland managed by the Forest Service to develop and maintain an effective land management plan (commonly known as a forest plan) and to amend or revise the plan when conditions significantly change. The process for the development and revision of plans, along with the required content of plans, is outlined in planning regulations often referred to as the planning rule. The current rule is the 2012 National Forest System land management planning rule.

The Lolo National Forest is beginning the first phase of the planning process to revise its plan, which was signed in 1986. As stated in the 2012 planning rule, planning for a national forest is an iterative process that includes three phases which are complementary and may overlap. The intent of the planning framework is to create a responsive process that informs integrated resources management and allows the Forest Service to adapt to changing conditions, including climate change, and improve management based on new information and monitoring. The planning process consists of the following phases:

- Assessment phase. The evaluation of existing information, such as relevant ecological, economic, and social conditions, trends, and sustainability, and its relationship to the land management plan within the context of the broader landscape.
- Revision phase. The updating of information, including identification of 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.
- Monitoring phase. The continuous observation and collection of feedback for the planning cycle that is used to test relevant assumptions, track relevant conditions over time, and measure management effectiveness.

This document provides a summary for the assessment phase. The purpose of the assessment is to provide and evaluate existing information about relevant ecological, economic, and social conditions; trends and sustainability; and relationships to the land management plan. The assessment is not a decision-making document, it provides current information on topics relevant to the plan area. The assessment does describe expected future trends under the current management framework; however, it does not speculate or determine how future management may change in the revised plan. This assessment contributes to the planning process by—

- Providing information to help identify the need for change in the land management planning process;
- Identifying and evaluating a solid base of existing information relevant to the land management plan;
- Building a common understanding of that information with the public and other interested parties before starting the land management planning process;
- Developing relationships with interested parties, government entities, American Indian tribes, private landowners, and other partners; and

- Developing an understanding of the complex topics across landscapes that are relevant to planning.

During this phase, the Responsible Official manages the process by setting the scale, scope and timing of the assessment as well as identifying the topics to be analyzed in depth and ensuring that the most important, relevant information is synthesized. The Responsible Official must also engage the public and government entities early in this process and make the report available to the public.

The assessment sets the stage for the integrated approach to be taken in land management planning, as emphasized in the planning regulations. Integrated resource management is defined as multiple use management that recognizes the interdependence of ecological resources and is based on the need for integrated consideration of ecological, social, and economic factors (36 CFR 219.19). For this reason, the assessment findings outline key connections between social, economic, and ecological sustainability.

# 1.3 The Assessment Process

The Lolo National Forest issued a Notice of Intent to Prepare an Assessment and Initiate Plan Revision on 3/16/2023. Beginning in January of 2023, revision team staff and Forest leadership held an array of public engagement activities designed to gather early public input on the assessment (refer to Section 1.8). The Draft Assessment was prepared by the Northern Region Land Management Plan Revision Team, using input and review from Lolo National Forest staff and leadership, and public input. This Revised Assessment was published in September 2023 following a formal comment period (see section 1.3.3 for summary of changes between the Draft and Revised Assessment.

## 1.3.1 Best Available Scientific Information

The 2012 Planning Rule requires the responsible official to use the best available scientific information to inform the development of a revised plan. The foundation of scientific information from which the plan components will be developed is provided by this assessment. The best available scientific information is represented by the collective body of information used and is reflected in the literature cited section.

The 2012 Planning Rule acknowledges that the best available scientific information may include expert opinions, inventories, or observation data prepared and managed by the Forest Service or other agencies, universities, reputable scientific organizations, and data from public 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; information obtained via participation; local information; workshops and collaborations; and information received from public engagement. This information was used to evaluate conditions, trends, and risks.

Chapters 2 and 3 discuss science contradictions and areas lacking information. Ecosystems and social and economic conditions are complex and contain an enormous number of known and unknown factors that interact with each other, often in unpredictable ways. As such, there are gaps in the scientific information available. The level of uncertainty with the findings associated with each element assessed in this document varies and is addressed in each section.

Moving forward, additional information will be gathered as it becomes available; therefore, additional scientific information may be added to the environmental impact statement and the planning record prior to the record of decision. Information submitted by the public will continue to be considered. Section 1.3.3, below, describes the comments we received on the Draft Assessment related to best available scientific information. The documentation of the ongoing literature review and rationale for responses to literature submitted will be summarized in the draft environmental impact statement.

### 1.3.2 Scope, Scale, and Timing

The responsible official has established the scope, scale, and timing of the assessment process. The geographic scope of this assessment includes all lands within the administrative boundary of the Lolo National Forest, as well as consideration for 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. As such, it has been prepared prior to the identification of the need to change to ensure the relevant information is gathered that will inform the plan development process. The timeframe considered in the assessment includes the status and trends that have occurred under the existing 1986 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.

The key topics of the assessment include the fifteen topical areas presented in the land management planning handbook (FSH 1909.12.10 (11)(b). Each topical area was considered, and the information relevant to the Lolo National Forest compiled in this assessment. In addition, relevant information regarding relevant land management plans on surround landscapes was considered.

- Terrestrial ecosystems, aquatic ecosystems, and watersheds.
- Air, soil, and water resources and quality.
- 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.
- Areas of tribal importance.
- Cultural and historical resources and uses.
- Land status and ownership, use, and access patterns.
- Existing designated areas located in the plan area including wilderness and wild and scenic rivers and potential need and opportunity for additional designated areas.

### 1.3.3 Changes between the Draft and Revised Assessment

The Revised Assessment includes updates based on the information submitted by the public; refer to section 1.8.1 for a description of the public comment period and process. A separate document titled

Summary of Public Comments: Draft Assessment and Potential Species of Conservation Concern is available on the Lolo National Forest Web Hub and describes the public comments received in further detail. A broad range of comments and perspectives were received on the Draft Assessment and the Potential Species of Conservation Concern lists. Six major themes of public comments were identified. The following sections describe each theme, the general response, and if and where edits were made to the Draft Assessment.

### Public comment theme 1: Comments not Relevant to this Planning Stage

The first theme includes comments asking for considerations in the revised plan (the proposed action), or for analysis considerations relevant to the development of alternatives or the draft environmental impact statement analysis. These issues are not directly relevant to the assessment or potential species of conservation concern but do present important issues and considerations that the team will consider in later steps in the planning process. Many different topics and resource areas were included in these comments. These comments and issues are not addressed in this revised assessment. However, they may be used later to develop alternatives or in the effects analysis of the draft environmental impact statement.

### Public comment theme 2: Process and Coordination

These comments were related to the plan revision process and how the planning team works with other agencies and partners such as the counties; Montana Fish, Wildlife and Parks; Montana Department of Natural Resources and Conservation; the Bureau of Land Management, and private entities such as The Nature Conservancy and Five Valleys Land Trust that manage adjacent lands. There were also comments asking for clarity about the role of the assessment in the planning process. One comment pointed to a need to clarify the influence of litigation on forest management projects. Finally, multiple commenters pointed to the importance of tribal outreach, involvement, and consultation, including the inclusion of indigenous tribal ecological knowledge. Specific tribes that were mentioned include the Confederated Salish and Kootenai Tribes and the Nez Perce Tribe.

The planning team expanded the discussions of process and coordination in the revised assessment with other agencies, tribal governments, and private entities in Chapter 1 and the Executive Summary. Coordination with other agencies and partners is a crucial element of the revision process. Moving forward, the planning team will continue to emphasize the importance of partnerships and coordination in the plan development process.

### Public comment theme 3: Best Available Scientific Information

Across all the comment themes, commenters provided scientific citations and references to inform the plan revision. Some of the information provided is more relevant to the plan development or environmental analysis stages of the process. Other comments addressed the issue of using the scientific information more broadly. Several comments explicitly requested that the plan revision process include an independent science review. Some requested to include more information and literature that the public has previously provided to project planning efforts on the Lolo, such as the Wildfire Adapted Missoula project. We received several comments suggesting that the assessment needs to include more monitoring information and results of monitoring from the 1986 Forest Plan, and a concern that the Lolo National Forest does not adequately accomplish monitoring requirements.

The citations and references submitted were reviewed by specialists to inform the Revised Assessment. Additional information has been incorporated or acknowledged in the relevant resource sections, as described for themes 4, 5, and 6, below. All attached publications and those for which a complete citation was provided have been filed for continued review for applicability during the revision process. Those comments that provided context and rationale for the use of the literature were more easily addressed than those that did not. Some references were not presented with a full citation or were presented using website links that are outdated; the team is attempting to locate these items, but it was not possible to give them all full consideration for the revised assessment.

Monitoring is an important topic to provide context for trends, as well as to illuminate potential needs for change in the revised planning process. Some aspects of monitoring that were brought up in comments, such as whether required monitoring has been accomplished in the past, is a plan implementation issue; however, the team will consider that information moving forward as context to ensure that the revised plan includes a monitoring program that is both robust and achievable. Where commenters pointed to specific conclusions that they felt were not accurate based on monitoring, the team reviewed information and adjusted if needed. The team will continue to consider monitoring information as the preliminary need to change document is developed with public input.

The assessment phase identifies and evaluates information relevant to the issues that will be considered later in the development of plan components and other plan content. The revised assessment reflects the science the team has identified as most relevant to this stage of the process, as cited in this document and listed in the bibliography. The request for an independent science review is being given careful consideration moving forward. Some of the issues and the related body of science presented by commenters are large, complex, and represent competing scientific perspectives; the Forest Service recognizes these important issues and will continue working through the conversation on best available scientific information with the public.

### Public comment theme 4: Distinctive Roles and Contributions

We received an array of comments asking for additional information and clarification in the description of the distinctive roles and contributions of the geographic areas on the Lolo National Forest. Some commenters provided detailed descriptions of elements such as the history and culture of rural communities, the history and role of the logging industry, the economic importance of landscapes, the conservation values of landscapes, and requests to clarify and emphasize the importance of the Lolo for landscape connectivity as well as native plant and animal species diversity. There were also comments that provided specific information on geological, topographical, and recreational values. The planning team has incorporated much of the suggested information and provide more detailed descriptions of distinctive roles and contributions in this revised assessment (section 1.5).

### Public comment theme 5: Potential Species of Conservation Concern

Many comments were related to the Potential Species of Conservation Concern List and Rationale. Some comments included concerns on the process itself. Others identified specific species that the commenter felt warranted additional consideration as a species of conservation concern, and some provided specific information or literature to support their rationale. The comments covered a wide range of species.

For species that are currently listed as proposed, candidate, threatened, or endangered under the Endangered Species Act (e.g., grizzly bear, Canada lynx, whitebark pine, and bull trout), the regulations do not allow for them to also be considered for species of conservation concern listing; however, the revised plan will include plan components to support provide ecological  these species as appropriate. Over time, if the federally listed species change, the species of conservation concern list may be revisited as needed. No edits were made to the potential species of conservation concern list for these species.

For other species identified, the planning team and Regional Office biologists are reviewing the comments and rationale provided in the context of species of conservation concern requirements. This review will be used by the Regional Forester, Leanne Marten, to establish the species of conservation concern list that the Lolo National Forest will use for plan development. This list is not yet available at the writing of this revised assessment. The revised plan must provide for the persistence of all native species in the plan area. It is possible that some species may not meet the criteria for a species of conservation concern but may warrant specific plan components to support their persistence, or to address other concerns, threats, or public interests. All species will be further evaluated in this context during plan development and the subsequent environmental analysis.

### Public comment theme 6: Resource-Specific Input

This theme encompasses the many comments that provided input, science, content suggestions, and concerns about the assessment for specific resource topics listed below. Many commenters requested additional information or corrections to the analysis, incorporation of additional scientific information, and inclusion of conflicting viewpoints. Others commented that the conditions, status, and trends of the resource were either inadequately or incorrectly described in the Draft Assessment. Many commentors were particularly concerned about the influence of climate change and increasing human pressures as drivers and stressors that need to be addressed in the revised plan. The planning team has incorporated updates to the Revised Assessment where necessary. There are some complex and wide-reaching issues that cannot be fully explored or resolved at the assessment stage; rather, in some cases this revised assessment acknowledges areas of conflict and uncertainty and identifies where additional work and review is needed to address the issue moving forward in the planning process.

The subthemes and assessment sections that include updates for this theme include:

- Air quality (section 2.9)
- Aquatic, wetland, and riparian ecosystems (section 2.3)
- At-risk wildlife and hunting, fishing, and wildlife viewing (section 2.6.2 and section 3.10.5)
- Climate change (section 2.1.1)
- Cultural, historical, and tribal topics (section 3.4)
- Designated areas (wilderness section 3.9.1)
- Energy and minerals (section 3.10.4)
- Fire, fuels, and fire management (sections 2.1.2 and 3.3)
- Fish and other aquatic wildlife (section 2.6.3)
- Forest vegetation management (sections 2.1.9)
- Infrastructure and lands (sections 3.8 and 3.7)
- Landscape pattern and connectivity (section 2.5)
- Livestock grazing (sections 2.1.8 and 3.10.3)
- Public information, interpretation, and education (section 3.2)
- Sustainable recreation (section 3.5)
- Terrestrial wildlife species: grizzly bear and wolverine (section 2.6.2)
- Social and economic considerations (section 3.1)
- Soils and geology (section 2.8)

- Watershed condition and water uses (section 2.7 and 3.10.6)

## 1.4 The Lolo National Forest Setting

The Lolo National Forest is located west of the Continental Divide in the Northern Rocky Mountains of western Montana. It includes over 2 million acres of public land. The Forest Supervisor's office is in Missoula, Montana, with five Ranger District offices in Missoula, Superior, Plains, Ninemile Valley, and Seeley Lake. The Forest surrounds the growing urban community of Missoula and adjoins many rural communities in western Montana. The planning area is defined as all National Forest System lands within the administrative boundary of the Lolo National Forest. This planning area is surrounded by seven other National forests, borders the Flathead Indian Reservation on three sides, and includes inholdings of private land, state, and land managed by other federal agencies. Given its juxtaposition with lands managed by these entities, the management context of for the Lolo is complex. There are eight major landscape areas, or geographic areas, identified to help capture the diversity of conditions across the landscape (Table 1, Figure 1, and figure A1-02).

**Table 1—Geographic areas that comprise the Lolo planning area**

| Geographic area | Ranger District(s) | Total Acres | NFS Lands | Non-NFS Lands |
|---|---|---|---|---|
| Clearwater Upper Blackfoot | Seeley Lake | 596,187 | 347,697 | 246,314 |
| Greater Missoula | Missoula | 313,865 | 158,906 | 154,953 |
| Lolo Creek | Missoula | 174,178 | 154,248 | 19,930 |
| Lower Clark Fork | Plains/Thompson Falls | 816,475 | 490,092 | 325,589 |
| Middle Clark Fork | Ninemile and Superior | 538,712 | 419,520 | 118,203 |
| Ninemile/Petty Creek | Ninemile | 286,738 | 212,534 | 74,204 |
| Rock Creek | Missoula | 267,631 | 245,729 | 21,887 |
| Saint Regis | Superior | 249,966 | 229,067 | 20,899 |
| | **Total** | **3,243,752** | **2,257,793** | **981,979** |


**Figure 1—Geographic areas on the Lolo National Forest**

The Lolo National Forest is influenced by both continental and maritime climates. These climate conditions, combined with a variety of soil types and topography, provide for a range of environmental gradients that support forests, grasslands, and shrublands of high ecosystem diversity and connectivity. Ecosystems on the Forest range from dry ponderosa pine and moist western red cedar in the valley bottoms to cold high elevation alpine mountaintops above the timberline. Most of the species that occur in the northwest United States are represented here, including some threatened and endangered species. The geographic location of the Forest provides connectivity between large blocks of undeveloped land.

Clean air, clean water, beautiful scenery, a variety of environments to recreate in, and a place to make a living are just some of the ecosystem services important to people provided by the Lolo National Forest. Multiple tribes have retained treaty rights to hunt, fish and gather resources on land the tribes ceded to the U.S. government, as well as on land they retained. People continue to be drawn to this area as they have been for centuries in part because of the proximity of public land to communities and opportunities. For people who seek solitude, the Lolo also offers remote lakes and trails, four designated wilderness areas, and a National Recreation Area. People are also drawn here to make a living from the forest resources. From forest products to services such as outfitting and guiding, people depend on the health and sustainability of the Forest.

## 1.5 Distinctive Roles and Contributions

The 2012 planning rule (36 CFR 219.7(1(ii)) and associated handbook (FSH 1909.12.22.32) require that revised plans describe the plan area's distinctive roles and contributions within the broader landscape. This content describes roles for which the plan area is best suited, considering the Agency's mission, the unit's unique capabilities, and the resources and management of other lands in the vicinity. These considerations should be described early in the planning phase to provide focus or context and aid in developing plan components to help provide an all-lands approach and provide a foundation for desired conditions and objectives. This section describes preliminary distinctive roles and contributions of the plan area within the broader region identified by the revision team with input from the public. The major ecosystem services and other benefits described here are topics that we expect the plan area to provide.

Early in 2023, public workshops were held in Missoula, Paradise, Seeley Lake, and Superior to gather preliminary input on distinctive roles, contributions, and ecosystem services. For each of the items mentioned below, there was substantial discussion and participants shared a range of detailed and knowledgeable perspectives. More detailed meeting notes and perspectives of participants are available in the planning record, and on the Lolo Revision Webhub. In brief, some common themes identified during these sessions included the following:

- Access for recreation and the opportunity for everyone to enjoy recreation activities, scenery, and cultural resources and maintain a healthy quality of life. The proximity of these opportunities to local communities is important and unique. Many participants expressed close connections between people and landscapes, and that lands on the Lolo National Forest are a source of pride for communities. Recreational uses highlighted included hiking, skiing, snow shoeing, enjoyment of quiet places and opportunities for solitude, snowmobiling, motorized recreation, non-motorized uses including on lakes, rock climbing, equestrian uses, boating and swimming, scenic driving, huckleberry picking, foraging, camping, hunting, fishing, photography, and mountain biking.
- Participants expressed an interest in providing for ecological health and biological elements on the landscape such as supporting the diversity of plants and animals, healthy vegetation and restoration of fire-adapted ecosystems given the influences of climate change, carbon sequestration, habitat connectivity, clean water, and healthy streams. Adequate consideration of climate change and associated scientific information and resource trends was emphasized. Perspectives and values on un-managed and undisturbed natural landscapes were shared.
- We heard an emphasis on the provision of economic opportunities and support for rural communities, including examples such as supporting local timber industry, grazing, and tourism, and the incorporation of active management opportunities to provide economic inputs and

ecosystem health. Input included desires for management activities such as prescribed burning and timber harvest to promote desired conditions, provide wildfire mitigation, and protect values at risk. The provision of other multiple uses such as firewood gathering, huckleberry, and mushroom picking was also important.

Distinctive roles are further discussed at two scales in this document: forestwide and for each geographic area. It is not known at this time if the revised plan will develop plan components for geographic areas, management areas, or both. The distinctive roles and contributions will become part of the revised plan, and as such will continue to be revised and updated based on internal and external input throughout the process. Work is currently ongoing with tribes to provide additional description and understanding of the areas of tribal importance for each geographic area.

## 1.5.1 Forestwide Ecological Characteristics

The Lolo National Forest 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 western Montana between ecosystems and habitats for many species. For example, the Lolo National Forest provides corridors between three of the identified grizzly bear recovery ecosystems: the Northern Continental Divide Ecosystem, the Cabinet Yaak Ecosystem, and the Bitterroot Ecosystem. The Lolo National Forest connects to lands managed by seven other national forests, the Flathead Reservation, as well as lands managed by State agencies, the Bureau of Land Management, and private landowners.

The range of growing conditions varies from warm, moist, and dry valley bottoms to cold, steep, non-forested ecosystems. Disturbance processes such as wildfire, insects, disease, and aboriginal burning have played the primary role in the development of forest and grassland ecosystems over long time periods. Historically, wildfire was a major system driver that maintained the capacity of ecological systems to provide the various renewable resources in certain amounts in perpetuity. More recently, logging and vegetation management has also influenced ecosystem conditions. Notable forest communities include western white pine and whitebark pine, both of which have been impacted by white pine blister rust, as well as western larch, ponderosa pine, western red cedar bottomlands, and limited populations of subalpine larch. The Lolo also hosts a variety of research natural areas and special botanical areas designated to preserve and study representative and unique plant communities and supports several tree improvement areas critical to the Northern Region’s reforestation and tree improvement programs.

The Lolo National Forest supplies high-quality water that supports a variety of uses throughout the Clark Fork basin. The Forest represents a hub of several major watersheds that are important for fisheries; these watersheds are known as the “five valleys.” Cold water fisheries are particularly important for the conservation of bull trout, a federally listed at-risk species, as well as many other plants and animals. Riparian ecosystems, including habitat conditions created by beaver, are also key features of the ecosystems on the Lolo.

The Lolo National Forest is home for 17 conifer and five hardwood tree species, over 200 bird species, at least 20 species of fish, over 60 mammal species, and an estimated 1,500 plant species including 250 non-native plant species. The Lolo supports large areas of habitat that have been relatively undisturbed by humans over the last century, such as those lands found in inventoried roadless and wilderness areas, as well as areas that have been influenced by active management that provide valuable habitat conditions. These and similar habitats on adjacent ownerships are valuable for wildlife, especially wide-ranging carnivores. The presence of large, undeveloped areas is one reason that nearly all the terrestrial and aquatic species that were present when Lewis and Clark journeyed through 200 years ago persist today.

Nevertheless, several species on the Forest are listed as threatened, candidate, or proposed under the Endangered Species Act. Due to its landform and juxtaposition on the landscape, the Lolo National Forest plays an important role in connectivity between ecosystems for many species across western Montana.

## 1.5.2 Forestwide Cultural and Historic Characteristics

The Lolo National Forest encompasses an area with a long and rich historic and pre-contact cultural record. Near the end of the Pleistocene ice age the lower reaches of the Clark Fork, Bitterroot, and Flathead River valleys were inundated with waters from Glacial Lake Missoula. The earliest evidence of human occupation in the area occurs after the lake drained for the last time, around15,000-13,000 years ago. Many Indigenous groups traveled through or permanently resided in western Montana and helped shape these ecosystems. Members of the Salish, Nez Perce, Coeur d'Alene, Kalispel, Kootenai, Blackfeet, and Shoshone groups used or passed through this area. In historic times, only the Salish, Kalispel, and Kootenai permanently occupied the area now encompassed by the Lolo National Forest. The Forest borders three sides on what is now the Flathead Indian Reservation. A portion of the Forest has a deep connection to the Nez Perce. The 1877 flight of the Nez Perce from their homelands to their current reservation took place on the most southern end of the Forest: creating the Nee Mee Poo National Historic Trail. Congress passed the National Trails System Act in 1968, establishing a framework for a nationwide system of scenic, recreational, and historic trails.

Shortly after the early explorers arrived, the fur trade brought both trappers and traders who traveled along the Clark Fork River and its tributaries. The first settlers in western Montana arrived in the 1850s. In the 1860s through the turn of the century, gold strikes throughout southwestern Montana caused an influx of miners. The first reports of mineral deposits in western Montana date to the mid to late-1850s when gold placers were reported. After the initial rush, lode mining quickly replaced placer mining as the dominant and more economically proficient mining method. By the 1860s, the natural resources of the land were attracting settlers to pursue farming, ranching, and logging. The construction of the Northern Pacific Railroad, and later the Chicago Milwaukee Railroad, played an important role in the settlement and development of this region. Logging and the forest products industry has historically played a significant role in forest management since the early 1800s. The first known sawmill was built in the nearby Bitterroot Valley in 1845. Portions of the Lewis and Clark National Historic Trail is also located on the Forest.

In the early 1900s, the Forest Service began its work in the area to build trail and road systems, oversee timber harvests, livestock grazing, mining activities, and suppressing forest fires. The historic Savenac tree nursery, the Ninemile Remount Depot, and Camp Paxson are three examples of important historic Forest Service sites that have been preserved. The Lolo National Forest has established an active heritage resource program that has focused on identifying, protecting, and interpreting the most significant heritage properties. Patrol cabins in the Bob Marshall and Great Bear wildernesses are examples of early Forest Service history that have been protected and are eligible for listing on the National Register of Historic Places. Multiple properties located on the forest are listed on the National Register of Historic Places. Numerous other historic and areas of traditional use have been identified. Evaluation, protection, and interpretation of these properties are important responsibilities for the Lolo National Forest to uphold.

The Lolo National Forest has a rich history of providing forest products to meet local and national needs, as well as supporting livestock grazing and mineral exploration. The culture of the rural communities that arose around these activities has greatly influenced ecosystems and lifestyles in western Montana. Missoula was the center of a flourishing forest products industry whose jobs and products were a dominant feature of the local economy for nearly a century. This continued after World War II as the Lolo contributed forest products to an expanding national economy. Beginning in the mid-1960s, stronger environmental laws, changing public desires, increasing foreign imports, and changing mill technology resulted in a loss of employment related to logging, mills, and related fields, and an associated decline in the economic stability of communities dependent on the forest products industry. Other factors, such as increased mechanization and efficiency, also contributed to the loss of jobs in this industry. Livestock grazing permits on the Forest supported ranches that were located on the valley floor and lower foothills of the Clark Fork valley.

### 1.5.3 Forestwide Social and Economic Characteristics

There are several social and economic characteristics distinctive for the Lolo, including recreation opportunities and designated areas, the forest products industry, livestock grazing, mining, municipal watersheds, the presence of large acreages of land recently acquired by private landowners, and the expanse of the wildland-urban interface.

The Lolo National Forest offers many recreational opportunities that are unique by virtue of their close proximity to communities. Landscapes rich in history with abundant wildlife and accessible wildlands provide a backdrop for diverse day-use recreation. A wide range of developed and dispersed recreation opportunities are available. Designated wilderness areas and other undeveloped lands offer primitive experiences of such things as hiking, fishing, camping, horseback riding, or photography. In Missoula, the University of Montana’s student population adds another layer of recreation users. Smaller communities in western Montana such as Seeley Lake, Superior, St. Regis, Plains, and Thompson Falls also have National Forest System land at their doorsteps which adds to their residents’ quality of life. The road and trail system provides a recreational connection between people and their national forest. Unroaded areas are also prominent; the Lolo National Forest overlaps several congressionally designated wilderness areas. In addition to primitive recreation, designated wilderness provides opportunities to study ecosystems that have been relatively undisturbed by non-indigenous humans, although tribes may have been burning or otherwise managing these lands in pre-colonial times. They provide reference conditions for vegetation, watersheds, and wildlife, and provide secluded habitat. Additional administratively designated areas include inventoried roadless areas, research natural areas, and special interest areas which also provide primitive and semi-primitive recreation opportunities and conservation of biodiversity.

The bulk of the road system was constructed in the decades following World War II when demand for building materials was high and the Lolo National Forest had a large timber sale program. The forest products industry and the Forest’s contribution to the supply of raw materials remain important contributors to the diversity of the regional economy, and especially to the local economics of Seeley Lake, St. Regis, Superior, and Thompson Falls where wood processing facilities are located. It is also an integral part of the rural culture of many communities, connecting people to the forest. Logging infrastructure, present within and supported by materials from the Lolo National Forest, support forest management and restoration activities across the State. Sanders, Mineral, Powell, and Granite counties include large areas of National Forest System land and are dependent on the contribution of those lands to their economies. In addition to commercial timber products, the Lolo National Forest has always been a place where residents and tribes could harvest non-timber forest products such as firewood, berries, or mushrooms.

Livestock grazing and mining are less prominent uses on the Lolo but are of high importance to some communities and individuals. Much of the livestock grazing occurs on small grassland areas, under sparse forest canopies, along roadsides, and on transitory rangelands created by timber harvesting. Although grazing has steadily declined since the 1950s, active cattle allotments are still present. Most of the open rangelands today are in big game winter range and riparian areas, and steep, forested terrain is not conducive to grazing. The bulk of the production from small to moderate-sized mines in or near the Lolo

National Forest (especially near Superior) has been from lead, silver, and zinc. Some areas on the Forest have a moderate to high occurrence and development potentials for metallic minerals. Most areas of the forest are open to mineral entry. Areas withdrawn from mineral entry include designated wilderness areas and administrative and recreation sites with an investment in facilities. While there have been no economic discoveries of oil and gas resources west of the Continental Divide in Montana, the areas underlying and immediately adjacent to the west flanks of the Glacier Park and Swan ranges have been recognized as an area with a high potential for the occurrence of oil and gas resources.

Several municipal watersheds are found on the Lolo National Forest, including Ashley Creek which serves Thompson Falls and Rattlesnake Creek which serves the communities near Missoula; providing the needed quantity of clean water is an important ecosystem service supported on the Forest in these areas.

Since 1986, the Lolo National Forest has acquired over 200,000 acres of lands previously held by other landowners, including private timber companies. These parcels occur on a variety of sites with a range of ecological conditions as well as established uses and infrastructure. The scope and scale of these lands is distinctive, as is the need to develop a management framework for these lands.

The wildland-urban interface is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. This term describes an area within or adjacent to private and public property where mitigation actions can prevent damage or loss from wildfire. The Lolo National Forest currently has the largest number of wildland-urban interface acres on National Forest System lands in western Montana, most of which were historically influenced by low intensity, non-lethal understory fire regimes.

## 1.5.4 Distinctive Roles by Geographic Area

### Clearwater Upper Blackfoot

The Clearwater Upper Blackfoot geographic area is comprised of the Seeley Ranger District. It is generally rural with the town of Seeley Lake being the largest community. The area is a year-round recreation destination and supports a tourism-based economy and boasts remarkable scenery. The natural settings provide for high-quality recreation opportunities from summer water-based activities to winter snow play. The area is a regionally known destination for snowmobiling, cross-country skiing, and dog-sled racing. Adjacent lands are in a variety of other ownerships including industrial forest lands, state lands, and other private lands. Specific unique recreation opportunities found in this geographic area include: The chain of lakes linked by the Clearwater River (Seeley Lake, Salmon Lake, Lake Inez, Lake Alva, Rainy Lake, and Summit Lake), with associated cabin rentals and recreation sites; hundreds of miles of trail popular in both winter and summer; the Clearwater Canoe Trail; and the Scapegoat Wilderness within the larger Bob Marshall Wilderness Complex.

The area is a stronghold for species such as grizzly bear, Canada lynx, loons, and bull trout. There is an adfluvial bull trout fish population that migrates upstream from Salmon Lake, Seeley Lake, Lake Inez, and Lake Alva. The location of this geographic area is important for habitat connectivity of many species of wide-ranging wildlife. Unique ecological characteristics present in this area include the national champion western larch tree in the Girard Grove; the Blackfoot-Clearwater Wildlife Management Area; the Seeley Lake Game Preserve; and the Pyramid Peak Research Natural Area.

The forest management industry has played an important economic role for the communities of this geographic area. Pyramid Mountain Lumber was established in 1949 in Seeley Lake and is the oldest surviving family-owned mill in Montana. More recently, extensive land acquisition has occurred; past activities on these lands emphasized production of wood fiber with high road densities. The Scapegoat Wilderness and adjoining inventoried roadless areas are buffered by largely undeveloped lands to the south. Local communities and organizations have worked together to protect and expand wildland qualities through acquisition of land and conservation easements.

### Greater Missoula

The Greater Missoula area is one of three geographic areas on the Missoula Ranger District. It is characterized by its close proximity to the City of Missoula. Missoula is home to a large and growing population which frequently visits and recreates on the Lolo National Forest. The area boasts several prominent “backdoor” recreation areas, including the only national recreation area in the Northern Region of the Forest Service. The proximity of Rattlesnake Wilderness to urban communities is unique. The recreational-urban interface of this geographic area is extensive and public lands are easily accessible from the city. Residents and visitors enjoy the trails that wind through the city limits, the surrounding foothills and the adjacent backcountry and wilderness. The Missoula area offers float fishing on the Blackfoot, Bitterroot, and Clark Fork rivers as well as opportunities for frisbee golf, mountain biking, and alpine skiing. The area east of Highway 93 includes a large portion of intermixed lands where recreational activities are emphasized, and substantial land acquisitions have occurred. Notable social and ecosystem characteristics found in this geographic area include the Rattlesnake National Recreation Area, Upper Rattlesnake Lakes, Montana Snowbowl alpine ski area, Blue Mountain Recreation Area, Pattee Canyon Recreation Area, Rattlesnake Creek municipal watershed, and the Rattlesnake Wilderness. Several forest products businesses exist in the Greater Missoula area that provide essential services and employment opportunities and support the management of federal and state lands.

Ecological characteristics of note in the Greater Missoula area include several research natural areas (Sheep Mountain Bog, Shoofly Meadows, Council Grove, and Plant Creek).

### Lolo Creek

The Lolo Creek geographic area is located on the western side of the Missoula Ranger District. The southeast portion of this geographic area is mainly non-motorized, backcountry lands without roads, including proximity the Selway-Bitterroot Wilderness and an area recommended as wilderness in the 1986 Forest Plan. The western half of this geographic area has been managed primarily as timber lands with a large part of the upper watershed in checkerboard ownership. Much of the checkerboard private timberlands have been recently acquired by the Lolo National Forest. The corridor directly adjacent to U.S. Highway 12, from the town of Lolo west to Lolo Pass, has several developed campgrounds, picnic areas, interpretive sites, dispersed camping sites and national historic trails. Other unique characteristics found on the Lolo Creek geographic area include the Lolo Pass recreation area and visitor center and Lolo Peak. Portions of the Nez Perce and the Lewis and Clark National Historic Trails are located in this area.

Ecological characteristics of note in the Lolo Creek area include the Mary’s Frog Pond Botanical Area, the Carlton Ridge Research Natural Area as well as unique subalpine and whitebark pine ecosystems in the Carlton Lake Basin.

### Lower Clark Fork

The Lower Clark Fork area is made up of the Plains and Thompson Falls Ranger District. It encompasses the scenic mountains and valleys of the lower Clark Fork River and its major tributaries, the Flathead and Thompson rivers, and Prospect Creek. Private lands on the open valley bottoms and lower mountain slopes are mainly rural, agriculture, or industrial forest lands. This geographic area has a rural character.

Recreation is an increasingly important part of the local economy, including floating and fishing, and the area boasts high scenic quality. Large portions of the Thompson River drainage are in mixed ownership, primarily a checkerboard pattern of industrial timberlands ownership that support a wide range of industrial and recreational uses. Murr Creek Canyon, which flows into the Thompson River, is a deep canyon feature that retains a semi-primitive setting in an area of intermingled ownership that has been heavily roaded. The main Prospect Creek drainage includes a paved highway, several high-voltage utility lines, a petroleum pipeline, and an increasing number of private developments. Other unique characteristics found in this area include the Clark Fork River, Noxon and Thompson reservoirs; the St. Regis-Paradise (Highway 135) National Scenic Byway; the Prospect Creek scenic route and recreation connection to north Idaho; the Thompson River Road scenic route, working forests with high recreational use, bull trout and grizzly bear habitats; the Ashley Creek municipal watershed; and the Plains Tree Improvement Area. Forest industry businesses are also present and important to the economies of rural communities, as well as providing the critical infrastructure needed for forest management and restoration work.

The Cube Iron-Silcox Big Hole Peak and Fishtrap areas north and east of Thompson Falls are part of the Cabinet-Yaak grizzly bear recovery area. The geographic area is also home to a large, easily viewable population of bighorn sheep. Prospect Creek and Thompson River and its tributaries are considered bull trout strongholds for the lower Clark Fork watershed. Other prominent ecological characteristics include Glacial Lake Missoula features, whitebark pine forest communities, bighorn sheep wildlife viewing opportunities along the Clark Fork and Thompson River, and the Barktable Ridge and Ferry Landing Research Natural Areas.

### Middle Clark Fork

The Middle Clark Fork area contains portions of both the Superior and Ninemile Ranger Districts, and boasts a variety of recreation opportunities, including, but not limited to, fishing, floating, and mountain biking, and an array of notable historic resources. Most of the area has been managed with a timber emphasis for many decades. The area has a well-developed road system, contains several inventoried roadless areas that offer non-motorized recreation opportunities and quality habitat for fish and wildlife. There are approximately forty alpine lakes found in scenic glacial cirque basins, many with catchable populations of trout. Specific social and economic contributions found in this geographic area include the Clark Fork River Alberton Gorge; the Fish Creek State Park (the largest state park in western Montana); the Great Burn proposed wilderness; the Bonneville Power Administration 500 KV powerline; the Stateline Trail, which provides beautiful scenery and unique recreational opportunities; and the Clearwater Crossing Trailhead, which contains exceptional pack stock facilities.

Ecological features of note in this area include the Cedar Creek Zoological Area; a uniquely high concentration of high-elevation lakes along the Montana-Idaho state line, and the Montana State record ponderosa pine.

Placer mining operations were common in valley bottoms in the late nineteenth and early twentieth century. Intact sections of the historic Mullan Military Road (a National Historic Engineering Landmark designated by the American Society of Civil Engineers) are present, as is the Cedar Creek drainage Historic Mining District.

### Ninemile/Petty Creek

The Ninemile/Petty Creek is located on the Ninemile Ranger District. The Interstate 90 (I-90) corridor, which roughly parallels the Clark Fork River, bisects this area. The communities of Alberton, Ninemile, Huson, and Frenchtown constitute one of the fastest growing areas in Missoula County. Abandoned mine sites in the mid- to upper Ninemile drainage are contributing to watershed degradation and have been the focus of extensive reclamation efforts in recent years. Specific unique characteristics found in the Ninemile/Petty Creek area include the Reservation Divide Trail, which has superb views into Ninemile and as far north as Glacier National Park.

Ecological features of note in this area include the Petty Creek Research Natural Area, and the Ninemile Demographic Connectivity Area, which is intended to improve connectivity between the Northern Continental Divide Ecosystem and the Bitterroot Ecosystem. In addition, both the Ninemile and Petty Creek watersheds are important producers of native fish including bull trout and westslope cutthroat trout.

This area hosts a prominent array of historic features, including the Ninemile Ranger Station which is on National Historic Register; the Forest Service working ranch at Ninemile; the Northern Region Pack Train, winter boarding program, and Ninemile Wildlands Training Center; the historic Civilian Conservation Corps Camp; a historic mining district; the Remount Depot National Historic Site; and Cha-paa-qn Peak.

### Rock Creek

The Rock Creek geographic area is located on the southeastern portion of the Missoula Ranger District, approximately 20 miles from Missoula, MT. This National Forest System land comprises 80 percent of the Rock Creek drainage and is administered by the Beaverhead-Deerlodge and Lolo National Forests. Most of this area is comprised of lands of primitive character, including the Welcome Creek Wilderness and other large roadless expanses. The area along the Clark Fork valley and the upper slopes of the Sapphire Divide has been managed for forest products and is in a checkerboard ownership pattern. Much of the private land in these sections is industrial timberland. The middle and upper reaches of Rock Creek are composed of private lands and National Forest System lands administered by the Beaverhead–Deerlodge National Forest.

The Rock Creek drainage lies in the central portion of the Northern Rocky Mountains and drains into the Clark Fork of the Columbia River. Rock Creek is distinguished from other areas on the Lolo National Forest by its unique steep, rugged terrain, talus slopes, and dry vegetation types. This area supports a trophy bighorn sheep herd, and a unique bunch grass big game winter range. Rock Creek also provides important cold-water habitat. The area also supports sensitive summer range areas, including wet meadows, high-elevation basins, and dense stands of security cover. There are several historic cabins located in this geographic area.

Rock Creek is an outstanding fishery that has national recognition for fishing quality and fish production. The Montana Department of Fish, Wildlife and Parks has classified the lower 51.3 miles of Rock Creek as a Blue Ribbon Trout Stream. Rock Creek is the only Blue Ribbon Trout Stream where National Forest System land comprises the majority of the watershed and streambanks. This classification is based primarily upon Rock Creek's productivity for fishing. Other considerations are the stream's availability, aesthetics, and use. An issue specific to Rock Creek was identified by both Forests in 1986: "how can the Forests continue to protect the fishery, wildlife, and recreational values in the Rock Creek Blue Ribbon Trout Stream?" In total, there are approximately 280 miles of fishable streams exist in the drainage. Other values and use in the area include wilderness, recreation, timber harvest, livestock grazing, big-game winter range, and oil and gas leasing.

### St. Regis

The St. Regis geographic area is located on the western side of the Superior Ranger District and supports a blend of forest product and tourism-based economies and contains a notable array of cold-water streams important for aquatic habitat. The area is a regionally known destination for snowmobiling and draws many Washington and Idaho users in addition to Montana residents. The area offers year-round motorized and non-motorized recreation opportunities. While summer recreation continues to grow, road and area closures have dramatically reduced winter recreation. Other social and economic characteristics found in the St. Regis area include Lookout Alpine Ski Area and Resort, St. Regis Basin, the St. Regis-Paradise National Scenic Byway, the Route of the Hiawatha Trail (part of the Rails-to-Trails program), the Ward Eagle Inventoried Roadless Area, the Taft sub-station for the Bonneville Power Administration 500 Kv powerline, and a portion of the Stateline Trail is also present here. In addition, there are several businesses in Mineral County that are important to the economies of rural communities and provide critical infrastructure needed to support forest management and restoration activities. This area supports high-elevation lakes; and the Little Joe Slide Geologic Area which displays notable geologic features. The Historic Savenac Tree Nursery and Visitor Center is found in this geographic area.

## 1.6 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. The major drivers and stressors on the Lolo National Forest include:

- Climate change and drought,
- Wildland fire, including shifting regimes, the impacts of fire suppression and exclusion,
- Insects and disease, including shifts in natural population dynamics due to climate change,
- Water resources and conditions influenced by loss of keystone species such as beaver as well as dams and water diversions, flooding, and stream flows,
- Invasive species, including invasive plants, diseases, and aquatic species,
- Roads, with respect to sediment delivery as well as habitat security and fragmentation,
- Effects of past and present mining, livestock grazing, and vegetation management activities, and
- Population growth and associated increases in recreation pressures and the expansion of the wildland-urban interface.

## 1.7 Current Management Constraints and Opportunities

The current Lolo National Forest Plan was signed in 1986, and there are over forty amendments to the plan that have been incorporated to keep pace with updated law, regulation, policy, and environmental conditions. The management areas associated with the 1986 plan, as amended, are displayed in figure A1-01.

The goals outlined in the 1986 plan include providing a sustained yield of timber; providing habitats for all indigenous wildlife and increasing populations of big-game animals; providing dispersed recreation and a pleasing environment including clean air, clean water, and diverse ecosystems; conserving energy resources; being a "good host" to the public; contributing to the recovery of federally listed species; and meeting or exceeding State water quality standards.

Over the last thirty-five plus years, the environmental and regulatory context for the Lolo National Forest has changed in ways that were not foreseen or addressed in the planning efforts conducted in 1986. Broad changes that have altered the context of forest planning, and that present both challenges and opportunities for management include:

- Legal frameworks, policy, science, social conditions (such as values and stressors),
- Influences of ecosystem drivers and stressors such as climate change,
- Over 200,000 acres of land acquisitions,
- Local economies and evolving social expectations for ecosystem services,
- Changes in the ways that people use and recreate on the Forest, and
- New information related to managing ecosystem and socioeconomic sustainability provided by best available scientific information and monitoring.

# 1.8 Public Engagement, Cooperation, and Coordination

The Lolo National Forest and the plan revision team began public engagement for the assessment in December of 2022. The cornerstone of this engagement has been a public engagement and participation strategy. The goal of public engagement during the assessment phase has been to set a tone of broad and transparent engagement, in recognition of the wide array of interests involved in plan revision. Agency staff have been using engagement strategies designed to meet people where they are. The following broad outcomes are desired from public engagement:

- Meet the requirements of the 2012 planning rule and other relevant regulations,
- Result in a well-informed and comprehensive land management plan, and
- Maintain and build relationships that carry forward to plan implementation and monitoring.

The 2012 planning rule requires public participation during the assessment, plan development, and monitoring phases of land management planning. Input opportunities are required for a variety of specific topics. During the assessment phase, informal input opportunities were offered for the development of the public engagement strategy and the assessment. These engagements included the invitation to provide input into the distinctive roles and contributions and to help identify the best available scientific information. In addition, formal comment periods were offered for the Preliminary Wild and Scenic Rivers Inventory, Draft Wilderness Inventory, and the Draft Assessment. Engagement events during development of the assessment also set the foundation for reviewing the potential species of conservation concern. A comment period on the potential species of conservation concern also occurred concurrently with the draft assessment.

## 1.8.1 Assessment Public Engagement and Participation

### Plan Revision Public Engagement and Participation Strategy

The Lolo plan revision process is coordinated by a plan revision team in the Northern Regional Office and the staff on the Lolo National Forest. Public engagement responsibilities emphasized for the regional revision team include providing education, outreach tools and materials, facilitating, building relationships with Lolo staff and the public, managing revision processes, and conducting analysis. The Lolo National Forest leadership and staff inform the engagement strategy and support processes with local knowledge, maintain and build relationships, and participate in engagements. We asked interested stakeholders; members of the public; state, local, and federal agencies; and Indian tribes to help guide engagement opportunities that meet their interests and abilities while sharing the following principles:

- Be respectful and accountable; listen and respect divergent views.
- Share knowledge and information; be honest.
- Value each other’s time; provide timely feedback and keep the process moving forward.
- Be inclusive of all stakeholders.
- Be grounded in the best available scientific information and indigenous traditional ecological knowledge.
- Be flexible and adaptive; think innovatively and creatively.
- Focus on interests rather than positions.

The public engagement strategy includes diverse opportunities for interested parties to be involved. The Rule includes requirements for outreach to specific groups, and the strategy is designed to ensure that all members of the public have access to information and equitable opportunities to provide input. The following groups were identified in the engagement strategy:

- Federally Recognized Indian Tribes
- Local and State Governments and other Federal Agencies
- Youth
- Underserved communities, Low-income, and Minority Populations
- Collaborative Groups and Resource Advisory Committees
- User Groups
- Economic interests (individuals, groups, and communities)
- Non-governmental conservation and advocacy organizations
- Local communities
- Other interested parties

## Draft Assessment Public Engagement and Outreach

To engage the diverse array of interested parties, the Lolo staff and revision team employed a variety of tools and strategies to achieve goals ranging from informing, involving, consulting, and collaborating. Information tools for engagement have included the development of a robust and interactive website that houses a library of informational documents, recorded webinar content, and a calendar of events. In addition, the team compiled a list of contacts and provides frequent email updates using the GovDelivery email platform. Social media accounts are used weekly to provide information, and newsletters are distributed to community locations for posting. Press releases were also utilized to inform the public of milestones during the assessment phase, including the opportunity to provide input on the draft engagement strategy and participate in engagement events for the development of the assessment. To involve, consult, and collaborate with the public, the staff hosted a variety of events that included several educational webinars per month, monthly ranger chat and revision team office hours, and several in person and online workshop events.

Since December of 2022, our mailing list has grown from roughly 500 to approximately 830 contacts. Engagement opportunities have reached a variety of interested parties from December 2022 to April 2023, the Assessment phase, as listed below.

- Educational Webinars: 9 hosted, with an estimated 248 participants total.
- In person Ranger Chats: 25 hosted, with an estimated 267 participants total.
- Revision Team Office Hours: 5 hosted, with an estimated 31 participants total.
- Assessment Workshop (“Common Ground in the Lolo): 4 sessions hosted online and in person, with an estimate 126 participants total.
- Draft Wild and Scenic Rivers Inventory Workshop: 3 online sessions hosted, with an estimated 34 participants total.

- Draft Wilderness Inventory Workshop: 3 in-person and 1 online session hosted, with an estimated 45 participants total.
- Interagency Governmental Working Group Meeting: 1 meeting hosted, with an estimated 20 participants total.
- In support of the public engagement strategy, a variety of innovative communication tools have been used, including GovDelivery email updates, press releases, social media posts, continual website updates, and a variety of education materials posted on that website such as a frequently asked question library, recordings of webinar presentations, and other resources. To ensure transparency, meeting notes and summaries for all engagement events are documented and posted to public files available through the plan revision website. The website also hosts a geospatial library of information.
- During the informal comment period for the draft public engagement strategy (December 2022), we received approximately 20 comments through our Revision email address. These comments were used to refine the engagement strategy. We also received over 125 comments on the draft wild and scenic rivers and wilderness inventories, through the formal comment database and an online Talking Points Collaborative mapping tool. These inventories will provide the foundation for the evaluation phases of the wild and scenic rivers and wilderness recommendation processes. The evaluation process for these topics will commence following completion of the assessment.
- Engagement events thus far have reached a diverse audience, and interest in the Lolo Plan Revision continues to grow. The team continues to incorporate feedback to refine the engagement strategy.

### Draft Assessment Comment Period

An opportunity to submit comments on the Draft Assessment and Potential Species Of Conservation Concern List and Rational was provided for 30 days from June 9, 2023, through July 8, 2023. The comment period was advertised with a press release on May 17, 2023, four email announcements to over 800 self-subscribed recipients (on May 1, 2023; May 16, 2023; June 1, 2023; and June 9, 2023), multiple social media posts, and with postings on the Lolo National Forest Plan Revision Web Hub. Forest Service staff also provided verbal invitations and reminders at all public engagements in May and June. Options to submit comments included the online Content Analysis and Response Application (CARA), postal mail, and email (SM.FS.LNFRevision@usda.gov). The review documents and supporting information were posted to the Web Hub on the day the comment period opened.

During the comment period, the planning team continued to host virtual “Open Office Hours”, and a second Interagency Governmental Working Group was held in June. In addition, Forest Supervisor Carolyn Upton hosted a “Draft Assessment Roundtable Discussion” engagement event in Missoula on June 14, 2023, shortly after the start of the comment period. Based on this engagement, the planning team provided an additional potential species of conservation concern-focused Office Hours session (June 27, 2023) to address concerns and provide additional information about the process.

Several requests to extend the 30-day comment period were received, both verbally during engagement events and in writing through the email or the CARA platform. The Forest Supervisor decided not to extend this comment period and provided her rationale in a letter to the public posted to the Lolo Web Hub on June 29, 2023.

Approximately 87 comments were received on the Draft Assessment. Approximately 10 of these were duplicates submitted to more than one commenting platform. Approximately eight comments were form letters (the exact same content as another commenter). Therefore, approximately 69 unique comment letters were received. The number of comments received were distributed across the available commenting platforms as follows:

- CARA: Forty-eight comments were received directly through this platform, available from the revision website. Some individuals submitted multiple unique comments.
- Email: Thirty-seven emails with comments were received, several of which were duplicated in CARA.
- Postal mail: Two hardcopy letters were received in the mail, one of which was duplicated in CARA.

As stated in the planning rule directives, "*the public will have further opportunities throughout the plan development or revision phase and NEPA scoping to provide comment on information in the assessment or provide new information as it relates to the proposed action and other possible alternatives*." Accordingly, the planning team continues to receive and consider input related to the assessment. To date, approximately nine comments have been received outside of the comment period. These comments are included in the revision of the assessment. Additional input and comments that are received will also be given consideration to the extent possible but may not be timely to reflect in the revised assessment.

All comments submitted via email or hardcopy were uploaded into CARA. Every letter was reviewed, and each unique issue or subject within the letter was identified. Similar issues and comments across all letters were grouped up into themes to facilitate an efficient review and response. A "Summary of Public Comments" document was posted to the Web Hub on August 14, 2023, to describe the comments received and the responses to each theme. A GovDelivery email was also sent on August 14, 2023, to all subscribers announcing the posting of this document.

Section 1.3.3, above, describes the changes that were made to produce this revised assessment based on the public comments received.

### 1.8.2 Indian Tribes and Intertribal Organizations

American Indian tribes are sovereign nations. As such, they are entities with which the Forest Service maintains a government-to-government relationship. Through treaties, tribes have reserved rights and privileges for their tribal members on off-reservation lands ceded to the U.S. Government. The Forest Service manages some of the off-reservation lands ceded in the treaties. The agency has legal responsibilities to American Indian tribes that are clarified in statutes, executive orders, and case law enacted and interpreted for the protection and benefit of the tribes. In meeting these responsibilities, the Forest Service consults with tribes whenever our proposed policies or management actions may affect their interests. Each tribe is different and is recognized as part of a separate and unique government. There are differences in treaty rights from one tribe to another, significant cultural differences between tribes, and there are differences in the historic relationships between tribes and the lands on and near their ancestral homelands. In some cases, several tribes may each have legitimate interests in the same lands because they each may have occupied or otherwise used those lands during different historic periods. Because of the treaty rights of American Indian tribes, tribal members retain rights to use national forest lands in ways that are not allowed to the general public.

Forest Service leadership and staff approached federally recognized Indian Tribes with a potential interest in the Lolo plan revision early in the pre-assessment phase and are committed to ensuring that the agency's trust responsibilities are a key focus of the revision process, and to ensure that indigenous traditional ecological knowledge is incorporated into the planning process. Based on the Tribal consultation that occurred with the previous plan revision effort (in the early 2000s), the current 1986 plan does not fully address issues and concerns that have been raised by the Tribes.

Federally recognized Indian Tribes that have expressed interest in the management of the Lolo National Forest include the Confederated Salish and Kootenai Tribes, the Blackfeet Tribe, the Coeur d'Alene Tribe, the Nez Perce Tribe, and the Shoshone-Bannock Tribe. Members of the Salish, Nez Perce, Coeur d'Alene, Kalispel, Kootenai, Blackfeet, and Shoshone groups used or passed through this area. In historic times, the Salish, Kalispel, and Kootenai permanently occupied the area now encompassed by the Lolo National Forest. The Forest borders three sides on what is now the Flathead Indian Reservation. The Lolo National Forest contains landscapes that are important spiritually to the Tribes for cultural activities and also supports key trust resources such as fish, wildlife, and plants.

Personal contacts (emails and phone calls) were made with each Tribe in the spring and summer of 2022. Formal letters of introduction to the process were sent to each Tribe in the winter of 2022-2023. In-person introductions to the process were held with the Confederated Salish and Kootenai Tribes in the summer of 2022, and with the Nez Perce Tribe in spring of 2023. The Confederated Salish and Kootenai Tribes requested and have been granted cooperating agency status for the Lolo Plan Revision process. Forest Service staff and Confederated Salish and Kootenai Tribes' staff began working together to develop a memorandum of understanding in December of 2022, and the Forest Supervisor met with the Tribal Council in March of 2023 to formalize and initiate the memorandum of understanding. Starting in May of 2023, Confederated Salish and Kootenai Tribal representatives have attended monthly interdisciplinary team meetings, and the Tribal Heritage Protection Officer and the Forest Heritage Program Manager also meet monthly to work on codeveloped products for plan revision. The Tribe provided comments to the Draft Assessment during these meetings, and these edits have been incorporated into this document. In addition, Forest Service and Tribal staffs have been meeting directly on the topic of potential species of conservation concern and other species of cultural importance. Outreach is also occurring to other tribal members, including presentations to the Tribal Elder's Councils and a field trip with tribal youth on the topic of culturally important plant species.

The Nez Perce Tribe has also expressed an interest to be involved in the process. Staff began correspondence in the spring and summer of 2022, and the Forest Supervisor and other staff met with the Nez Perce Tribe in April of 2023 to introduce the revision process. Review and comment on the Draft Assessment and Potential Species of Conservation Concern List and Rational was also invited from this Tribe. In July of 2023, Nez Perce staff visited Lolo National Forest leadership and staff in Missoula to present a tribal treaty rights and historical background training. In summer of 2023, correspondence went out to both the Confederated Salish and Kootenai Tribes and the Nez Perce Tribe offering to establish quarterly government-to-government updates on plan revision. Monthly email correspondence occurs with all tribes offering to meet and discuss the process. In addition, several representatives from the Coeur d' Alene Tribe attended the first Interagency Governmental Working Group meeting in the spring of 2023.

Based on the extensive consultation that occurred with the most recent plan revision effort (2003-2006), we recognize that tribal issues often occur at a scope beyond forest plan revision, that each tribe may identify different issues, and that there is a need for the Forest Service to support public education on the agency's treaty obligations to the tribes, including the legal rights of tribal members to access and use National Forest System lands. Issues that have been previously raised by the tribes relative to federal land management on the Lolo National Forest include, but are not limited to:

- Visible acknowledgement of American Indian issues and the Forest Service trust responsibilities.
- A systematic approach to protection of traditional cultural properties and other important American Indian interests on National Forest System lands.

- Road and trail access for traditional and other uses protected by treaty rights, as well as other occupancy and use rights protected by treaties.
- Restoration, protection, and monitoring of habitat for culturally significant species.
- Designated areas of culturally significant forest products.
- Use of traditional Indian place names.
- Consideration of proclaimed aboriginal territory.
- Attention to water rights and hunting rights.
- Address conflicts between gray wolf and sheep.

### 1.8.3 Cooperation with States, Local Governments, Federal Agencies, and other landowners

Due to its central geographic location, the Lolo National Forest overlaps or is adjacent to a variety of other agency and governmental jurisdictions. The Lolo National Forest and its management affect a variety of agencies and governments, including the State of Montana (notably the departments of Fish, Wildlife and Parks, Department of Environmental Quality, Department of Natural Resources and Conservation, Montana Natural Heritage Program, and Montana State Historic Preservation Office), the Bureau of Land Management, the US Fish and Wildlife Service, Indian Reservations, the Bureau of Indian Affairs, the U.S. Environmental Protection Agency, the Bonneville Power Administration, the U.S. Natural Resource Conservation Service, the U.S. Bureau of Reclamation, several Indian Tribes as well numerous counties and associated community councils. The plan area specifically overlaps 9 counties, but the preliminary economic area of influence includes 27 counties in western Montana and northern Idaho. The Lolo also shares borders with seven other national forests (Flathead, Helena-Lewis and Clark, Beaverhead-Deerlodge, Bitterroot, Nez Perce Clearwater, Idaho Panhandle, and Kootenai).

The services that the resources of the Lolo National Forest provide to other agencies and governments and their constituents include, but are not limited to, water provisioning, spiritual values and quality of life, forest products, wildlife habitat, and tourism related activities such as recreation. Common resource management issues and concerns include, but are not limited to, wildfire risk and safety, climate change mitigation and ecosystem resilience, species diversity, and economic sustainability of communities.

To involve and cooperate with all relevant agencies, an Interagency Governmental Working Group has been formed as part of the public engagement strategy. The purpose of this group is two-fold: first, to encourage interagency understanding and dialogue to foster an all-lands approach; and second, to ensure all impacted agencies have the information needed to provide meaningful comment to the revision process. Representatives from over 70 agencies and governments, including local, state, and federal elected officials, were invited to participate in this group using the GovDelivery platform followed by personal one-on-one contacts. Informal input was gathered at the first meeting of this group in March of 2023. Attendance at this first meeting included representatives from the following agencies:

- Coeur d’Alene Tribe
- Montana Department of Natural Resources and Conservation
- Montana Department of Fish, Wildlife, and Parks
- US Bureau of Land Management
- US Fish and Wildlife Service

- US Environmental Protection Agency
- Office of Congressman Ryan Zinke
- Office of Senator Testor
- Office of Senator Daines
- Missoula County
- Bonneville Power Administration
- City of Missoula

Many of the members of this group also routinely participated in other public engagement events.

The planning team encourages agencies and governments to request cooperating agency status; it is at the purview of those agencies to request the status based on their interest and capacity. Several county and State agencies and one tribal government have requested cooperating agency status for the Lolo plan revision process thus far. This status is relevant to the NEPA process for plan revision. Memorandums of understanding have been developed with each agency to identify the areas of specialized expertise they will provide to the revision process. To date, the cooperating agencies for the Lolo Plan Revision include:

- Confederated Salish and Kootenai Tribes
- Mineral County
- Montana Department of Natural Resources and Conservation
- Montana Department of Fish, Wildlife and Parks
- Missoula County has requested cooperating agency status, and development of a memorandum of understanding is currently underway at the writing of this revised assessment.

Representatives from cooperating agencies attend monthly interdisciplinary team meetings and were provided with pre-release materials for the Draft Assessment and Potential Species of Conservation Concern Lists and Rational. Additional staff meetings are also held regularly to discuss specific planning elements.

### Land Management Planning Across the Broader Landscape

The 2012 Planning Rule places focus on coordination, cooperation, and collaboration between governmental interests and the Forest Service as they work together to fulfill their missions. The Rule requires that the Forest Service coordinate land management planning with the planning efforts of other agencies and governments. Coordination helps ensure that management is consistent across ecosystems and jurisdictions and achieves mutual goals where possible. To achieve this goal, the Forest Service must review relevant state, local, and tribal land use plans and policies, and assess their interrelated impacts.

Many of the agencies affected by the management of the Lolo National Forest have management plans for lands and natural resources. Common objectives and issues found in these plans include providing for health and human safety as well as for ecological and economic sustainability. The following management plans were identified and reviewed during development of the assessment. Additional plans may be identified as we proceed through the planning process.

- The Montana Forest Action Plan (Montana Department of Natural Resources and Conservation)
- Montana Statewide Comprehensive Outdoor Recreation Plan (Montana State Parks)

- Montana Wildlife Action Plan (Montana Department of Fish, Wildlife and Parks)
- Resource Management Plan (Bureau of Land Management Missoula Field Office)
- county wildfire protection plans
- county growth policies and resource use plans
- The Confederated Salish and Kootenai Tribes Resource Management Plan
- U.S. Fish and Wildlife Service recovery plans for bull trout, grizzly bear, and Canada lynx.
- Surrounding national forest land management plans (Flathead, Helena-Lewis & Clark, Beaverhead-Deerlodge, Bitterroot, Nez Perce Clearwater, Idaho-Panhandle, Kootenai)

Detailed information on each of these plans is not required content for the Draft Assessment; at this phase, we conducted a broad review and established a process for considering relevant themes from these plans. As described in preceding sections, we also engaged early with our agency partners and continue to build relationships and provide a framework for working together. Additional consideration and more detailed documentation concerning how these plans are used to inform the plan development process will be available in the draft environmental impact statement later in the process.

Key areas of interest and opportunities to align objectives with other agency plans include the extent and condition of the wildland urban interface and appropriate wildfire management response, efforts to support management on private lands, the impacts to rural communities and economics, supporting the recovery of listed species, seeking edge-matching and consistency in management across other national forests, and support of tribal rights, interests, and concerns.

There are several key planning efforts or unique conditions on lands adjacent to the Lolo managed by other agencies that provide important context for planning and present an opportunity for seeking consistent objectives where appropriate. For example, the Bureau of Land Management is currently conducting a large ecosystem analysis at the watershed scale on lands it recently acquired in the Clearwater Upper Blackfoot geographic area to inform future project-level planning. In addition, Montana Fish, Wildlife and Parks is working with the University of Montana to create the Fish Creek Watershed Recreation Management Plan on its newly acquired Fish Creek Wildlife Management Area that is also adjacent to the Lolo National Forest. This agency also manages the Blackfoot-Clearwater Wildlife Management Area and the Seeley Lake Game Preserve. A close partnership with Montana Fish, Wildlife and Parks is also crucial to align species management goals and objectives. There are also high-use recreation areas managed by the county that are adjacent to National Forest System lands, such as Mt. Dean Stone, Mt. Sentinel, Mt. Jumbo, Seeley Lake trails, parts of the Marshall Mountain area (Missoula County), and Murphy Creek Trails (Mineral County), where cross-boundary coordination of recreation opportunities and issues is particularly important. Montana Department of Natural Resources and Conservation also manages state lands intermixed with federal lands, and of particular importance is the objectives outlined in the Montana Forest Action Plan, implementing the Good Neighbor Authority, and responding to the Wildfire Crisis Strategy.

In addition, county planning (such as county wildfire protection plans, growth policies, and resource use plans) sets important context for how the Forest can support the objectives of county agencies. The Lolo is a neighbor for many private landowners, ranging from individual homeowners to large corporations. For example, the Nature Conservancy has acquired substantial acres of former corporate timber lands in the Blackfoot Valley and slowly selling those lands to the USFS, Bureau of Land Management, State of Montana, and private conservation buyers. Five Valleys Land Trust also owns and manages lands in the vicinity of the Lolo National Forest, including the Marshall Mountain area. There are also many communities and individual homeowners that have land adjacent to the Lolo National Forest, and the wildland-urban interface is growing. The management of these lands and seeking opportunities to foster an all-lands approach to management, such as restoration activities and fire mitigation, is also important context to recognize for planning.

# Chapter 2: Assessment Findings: Biophysical Elements

This chapter presents the key findings for biophysical elements. We first present a broad overview of the primary ecosystem drivers and stressors that influence all biophysical elements of the Lolo National Forest. Following the ecosystem drivers and stressors overview there is a section for each of the primary biophysical elements. In these sections, we present key takeaways, a summary that provides 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. In some cases, there are appendices that provide more detailed information (Arno and Fiedler 2005).

## 2.1 Ecosystem Drivers and Stressors

Broadly, ecosystem drivers are the dominant ecological or human-influenced processes that shape the ecosystem. For the purposes of land management planning, stressors are those factors that may directly or indirectly degrade or impair ecosystem composition, structure, or ecological process in a manner that may impair its ecological integrity (36 CFR 219.19). Some factors can be either a driver or a stressor depending on the conditions and context under which it is operating. This section provides an overview of the primary drivers and stressors that influence conditions on the Lolo National Forest. More detailed discussion disclosing the effects that these drivers and stressors have on specific ecosystem conditions is found throughout this chapter.

### 2.1.1 Climate Change

Historical and projected climate and best available scientific information on climate change and climate change impacts for the Lolo National Forest are presented by The Northern Rockies Adaptation Partnership (Halofsky et al. 2018b;a). This effort was part of a broader evaluation of resource vulnerability on Forest Service Northern Region national forests and adjacent jurisdictions. Here we summarize some key findings of the Northern Rockies Adaptation Partnership synthesis and provide a high-level summary of climate change impacts for key resources and ecosystem services of the Lolo National Forest. While climate change is expected to be a major ecosystem stressor in the coming decades, it is also acknowledged that there is an incomplete understanding of both climate change and its potential impact to forests and ecosystems. General consequences of projected climate change impacts are briefly summarized, with more detail provided in each resource section. For a more complete discussion of climate and climate change impacts on the Lolo National Forest, see The Northern Rockies Adaptation Partnership (Halofsky et al. 2018b;a) and references therein.

The Lolo National Forest is dominated by an inland mountain climate. Air masses that develop over the Pacific Ocean release moisture in the Cascade Range and over the mountains of northern Idaho. West-central Montana occupies the rain-shadow area, which receives dried-out Pacific air and little moisture in the valley bottoms—about 13 inches annually (Lackschewitz 1991). Humidity is high in this region, except during the summer months, and winters are cold and moist. Microclimate also has a big effect on the distribution, abundance, and productivity of vegetation. For example, steep south-facing slopes with low retention of snow and soil moisture in summer are generally less productive and have different species composition than north-facing slopes. Finklin (1988) provides detailed description of the area's climate.

The Lolo National Forest is part of the Central Rockies subregion identified by The Northern Rockies Adaptation Partnership. The annual mean monthly minimum temperature increased by about 2.6 °F over the historical period of record (1895–2012), while the annual mean monthly maximum temperature increased by about 1.3 °F (Figure 2). By 2100, temperature is projected to increase 6 to 12 °F for the annual mean monthly minimum, and 5 to 11 °F for the annual mean monthly maximum (Figure 2). Mean monthly minimum and maximum temperatures are projected to increase for all seasons. The mean monthly minimum temperature (spring and autumn) and the mean monthly maximum temperature (winter) may rise above freezing. In contrast to temperature, there is a high degree of uncertainty in how precipitation patterns will change. Seasonal precipitation is projected to be slightly higher in winter and spring and slightly lower in summer than during the historical period of record (Figure 2). Changes in climate affecting mountain snowpack will have important hydrologic implications. Climatic extremes are difficult to project, but they will probably be more common, driving biophysical changes in terrestrial and aquatic ecosystems. Droughts of increasing frequency and magnitude are expected in the future, promoting an increase in wildfires, insect outbreaks, and nonnative species. These periodic disturbances, will rapidly alter productivity and structure of vegetation, potentially altering the distribution and abundance of dominant plant species and animal habitat.

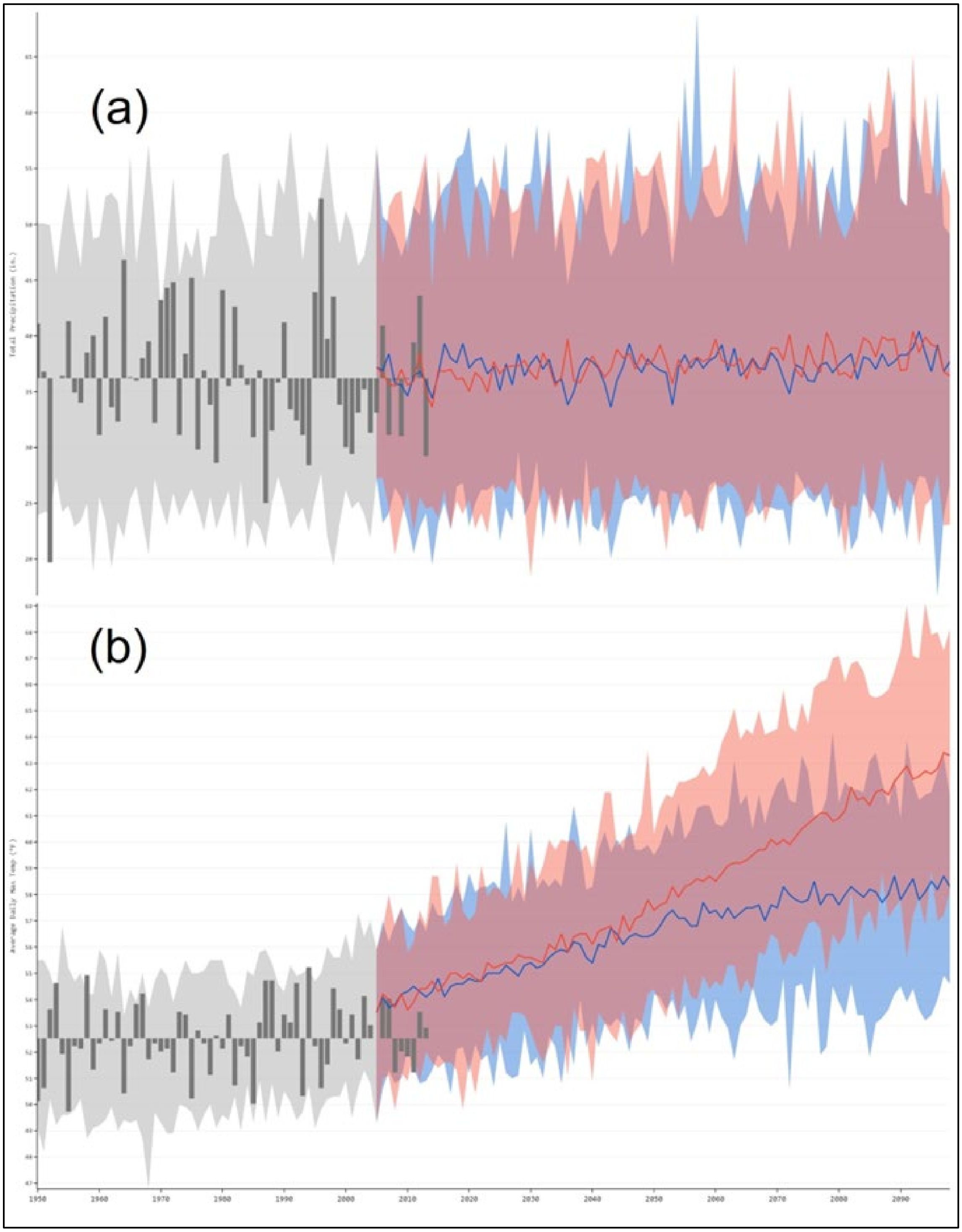


**Figure 2—Observed and projected trends in total precipitation (a) and average daily maximum temperature (b) projections for the Clark Fork Valley and Mountains Ecoregion. Observed history is indicated by grey bars. Modeled history is shown by shaded grey area. Two possible futures are shown: one in which humans drastically reduce and stabilize global emissions of heat-trapping gases (blue line, also known as RCP4.5), and one in which we continue increasing emissions through the end of the 21st century (red line, also known as RCP8.5). Station data for temperature and precipitation were interpolated and stored as a gridded observational dataset. Data are available via Data.gov.**

There is a great deal of uncertainty about the magnitude and rate of climate change, especially as projections are made at more local scales or for longer time periods (Ryan and Vose 2012). Despite the uncertainty in downscaled projections, scientists expect the earliest changes will be at ecotones between lifeforms (e.g., upper and lower treelines). There is also general agreement that ecological disturbance – rather than the direct effects of climate on individuals or species – will likely be the primary facilitator of environmental change. Nevertheless, increased temperatures are expected to result in a reduction in water available to trees and understory plants. Trees will respond to reduced water availability, higher temperatures, and changes in growing season length in diverse manners. Changes in vegetation composition and structure will be the result of changes in both the life cycle processes and responses of a plant to disturbance.

Effects of climate change on wildfire is a primary vulnerability for the Lolo National Forest. Large and severe wildfires occurring more frequently are being driven by warmer and drier fire seasons (Running 2006, Abatzoglou and Williams 2016, Higuera and Abatzoglou 2021). Wildfires are also accelerating transitions to non-forest, with growing evidence of conifer tree recruitment failure due to environmental constraints on seedling survival (Stevens-Rumann et al. 2018, Davis et al. 2019), and limited seed dispersal and positive feedbacks to frequent reburning (Prichard et al. 2017, Parks et al. 2019).Warmer temperatures will likely result in increased fire frequency and intensity, creating more favorable conditions for invasive species, which may decrease overall forage quantity, quality and biodiversity.

One of the clearest signals from climate and streamflow models is that seasonal shifts in precipitation and increased temperature will likely result in lower summer flows and, in lower elevation streams, earlier and potentially higher and more frequent peak flows (Mantua et al. 2010, Wu et al. 2012). Earlier streamflow timing has already been recorded across western North America (Stewart et al. 2005). By the 2040s, spring snow water equivalent is projected to decline by 22-35% in the Columbia Basin (Littell et al. 2010). Decreasing snowpack and declining summer flows will alter timing and availability of water supply, affecting agricultural, municipal, and public uses in and downstream from national forests, and affecting other forest uses such as livestock, wildlife, recreation, firefighting, road maintenance, and instream fishery flows. Declining summer low flows will affect water availability during late summer, the period of peak demand (e.g., for irrigation and power supply). Increased magnitude of peak stream flows may damage roads near perennial streams, ranging from minor erosion to extensive damage, thus affecting public safety, access for resource management, water quality, and aquatic habitat. Bridges, campgrounds, and national forest facilities near streams and floodplains will be especially vulnerable, reducing access by the public.

Climate change introduces additional uncertainty about how forests—and forest carbon sequestration and storage—may change in the future. Climate change causes many direct alterations of the local environment, such as changes in temperature and precipitation, and it has indirect effects on a wide range of ecosystem processes (Vose et al. 2012). Further, disturbance rates are projected to increase with climate change (Vose et al. 2018) making it challenging to use past trends to project the effects of disturbance and aging on forest carbon dynamics. 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 carbon dioxide 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.

The Lolo National Forest produced an assessment specific to watershed vulnerability with focus on water supply, bull trout, western pearlshell mussel, and infrastructure risks along with specific management implications (Wade et al. 2016). This Watershed Climate Change Vulnerability Assessment for the Lolo National Forest was the lattermost assessment of a broader national effort (Furniss et al. 2000) and provides the following key findings:

- Bull trout: Populations are projected to be more exposed to changes in flow than to increased temperatures. Because the rankings are relative across watersheds within the Forest, this does not necessarily indicate that bull trout are expected to be more impacted by flow than by temperature, only that relative to other areas in the Forest, temperature increases were not expected to be as great in bull trout local populations as in watersheds not inside a bull trout local population area. Bull trout generally occupy higher elevation streams which represent some of the best remaining thermally suitable areas, and higher elevation streams are projected to warm less quickly than lower elevation streams. However, bull trout local populations are also situated in areas that are projected to have some of the greatest increases in winter flows, particularly in the western half of the study area. Further, the higher elevation headwater streams favored by bull trout currently have lower flow and may be particularly susceptible to projected reductions in summer flows.
- Water Supply: Lower summer flows are predicted with higher elevation headwater streams exhibit higher vulnerability except for Rock Creek. On streams with water diversions and withdrawals, projections are likely underestimate issues and vulnerability because these factors exacerbate or override lower base flows because of climate change.
- Infrastructure: Winter flooding is expected to increase on recreation sites, trails, and roads with greatest exposure at lower elevations and relatively less exposure at higher elevations. Vulnerability increases where infrastructure is in floodplains or areas of high geologic hazard. Forty-four percent of the 12th code hydrologic unit code watersheds in the study area had roads in the highly vulnerable category of high combined exposure and sensitivity. The high vulnerability areas are scattered throughout the forest and are generally concentrated in lower elevations.

Across the Lolo National Forest, the number of intermittent streams is expected to increase with issues exacerbated by human activities, such as water diversions and withdrawals (Acuna et al. 2014). Groundwater, seeps, and springs are expected to decrease in volume and presence, which is expected to negatively affect water availability for domestic water sources, as well as various terrestrial, semi-aquatic, and aquatic species.

In summary, the Northern Rockies Adaptation Partnership (Halofsky et al. 2018b;a) and Lolo Watershed Climate Change Vulnerability Assessment (Wade et al. 2016) indicate that a warming climate will rarely be the direct agent of change for ecosystems on the Lolo National Forest. Rather, most of the changes will likely result from responses to climate change-induced disturbance or to some combination of other climate-exacerbated stressors. Whether it is changes in precipitation and runoff volumes and timing, invasive species (such as, white pine blister rust), drought, uncharacteristic wildfires, elevated native insect and disease levels, lower summer flows or higher peak flows, the most significant effect of climate change is likely to be further exacerbating these stressors and “stress complexes” (McKenzie et al. 2009). In turn, these stressors could have negative consequences on infrastructure resilience (campgrounds, roads and trails) and ecosystem services including water supplies, air quality, forage, wildlife and fisheries, and wood supplies. Although the exact timing and magnitude of climate change driven ecosystem change is uncertain, it will clearly be one of the most important ecosystem stressors in the coming decades.

## 2.1.2 Fire

The Northern Rocky Mountain ecosystems are often referred to as fire-driven systems. This acknowledges fire as the major disturbance process that shapes the forests and shrublands of this area. The Northern Rocky Mountains experience summertime thunderstorms. Monsoonal moisture from the southwest moves up from the Great Basin and produces intense, dry lightning storms. Storms can produce thousands of lightning strikes, but only when the conditions are ideal for ignition would a wildfire start. Fire is a natural process and many fires on the Lolo National Forest are started by lightning. However, humans have also been a source of fire on the landscape for centuries, and intentional or not, have influenced vegetation successional dynamics. Fire plays innumerable ecological functions, including driving species structure and composition, carbon and nutrient recycling, snag and tree cavity creation, and stimulating seeding and sprouting of vegetation.

### Historical Fire Regimes

A fire regime represents the periodicity and pattern of naturally occurring fires, described by frequency, biological severity, and aerial extent (Anderson 1982). The historical fire regime is a classification of the role fire would play in the absence of modern human intervention but including the influence of aboriginal fire use based on the average number of years between fires (fire frequency or mean fire interval) combined with severity (the amount of vegetation replacement) and its effects to the dominant vegetation (Agee 1993, Lentile et al. 2006). A spatially explicit map of historical fire regimes available from the LANDFIRE project (https://landfire.gov/fireregime.php) was used to assess historical fire frequencies and severities for the Lolo National Forest. These data were mapped to 30-meter pixels and assigned values from the Fire Regime Group theme. Each fire regime group describes a range of historical fire frequencies and historical fire severities. Based on the Fire Regime Group Description field in the database, six Fire Frequency Classes were assigned to each pixel on the map. Table 2 shows the distribution of the six Fire Frequency Classes across all ownerships on the Lolo National Forest.

**Table 2—Distribution of the LANDFIRE Fire Frequency Classes based on Fire Regime Groups across the Lolo National Forest analysis area (all ownerships)**

| Frequency Class | Acres |
|---|---:|
| Very frequent (6-15 years) | 200,621 |
| Frequent (16-35 years) | 1,244,591 |
| Moderately frequent (36-100 years) | 863,551 |
| Infrequent (101-200 years) | 890,907 |
| Very Infrequent (201-500 years) | 15,007 |
| Rock, Water, Other | 29,075 |
| **Total** | **3,243,752** |

Based on the range of mean fire return intervals defined for each class in Table 2, we can estimate the minimum and maximum amount of fire that occurred historically on a yearly basis for each fire regime class. To calculate historical area burned, one, divided by minimum and maximum mean fire return interval is the maximum and minimum percent of the class burned per year. Table 3 shows the estimated extent of Lolo National Forest burned annually by fire regime class based on the LANDFIRE Fire Regime Group map.

**Table 3— Estimated historical annual fire by fire frequency class based on minimum and maximum Mean Fire return Intervals (MFRI) for the Lolo National Forest**

| Frequency Class | Max MFRI | Min percent per year | Min acres per year | Min MFRI | Max percent per year | Max acres per year |
|---|---|---|---|---|---|---|
| A: Very frequent (6-15 years) | 15 | 7 | 14,043 | 6 | 17 | 34,106 |
| B: Frequent (16-35 years) | 35 | 3 | 37,338 | 16 | 6 | 74,675 |
| C: Moderately frequent (36-100 years) | 100 | 1 | 8,636 | 36 | 3 | 25,907 |
| D: Infrequent (101-200 years) | 200 | 1 | 4,455 | 101 | 1 | 8,909 |
| E: Very Infrequent (201-500 years) | 500 | 0 | 30 | 201 | 1 | 750 |
| Rock, Water, Other | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **n/a** | **n/a** | **64,501** | **n/a** | **n/a** | **144,347** |

## Current Fire Regimes

The extent of recent fire on the Lolo National Forest was estimated using a fire atlas developed for the entire Northern Rockies (https://www.fs.usda.gov/rds/archive/Catalog/RDS-2009-0006). Using atlases to identify recent fire occurrence by year takes advantage of their strengths, including extensive mapping of known fires, while minimizing the influence of their limitations including that the locations of perimeters may be inaccurate and may include unburned areas, and small fires may not be recorded (Morgan et al. 2008). The Lolo National Forest portion of a fire atlas for the northern Rockies recently compiled to identify and map years of recent extensive fires between 1889 and 2003 was used. In addition, we compiled acres of fire on a yearly basis using the most recent Monitoring Trends in Fire Severity (https://www.mtbs.gov) data to map fire extent between 2004 and 2020. According to these data, 1,505,120 acres of fire have occurred on the Lolo National Forest between 1889 and 2020 (Figure 3).

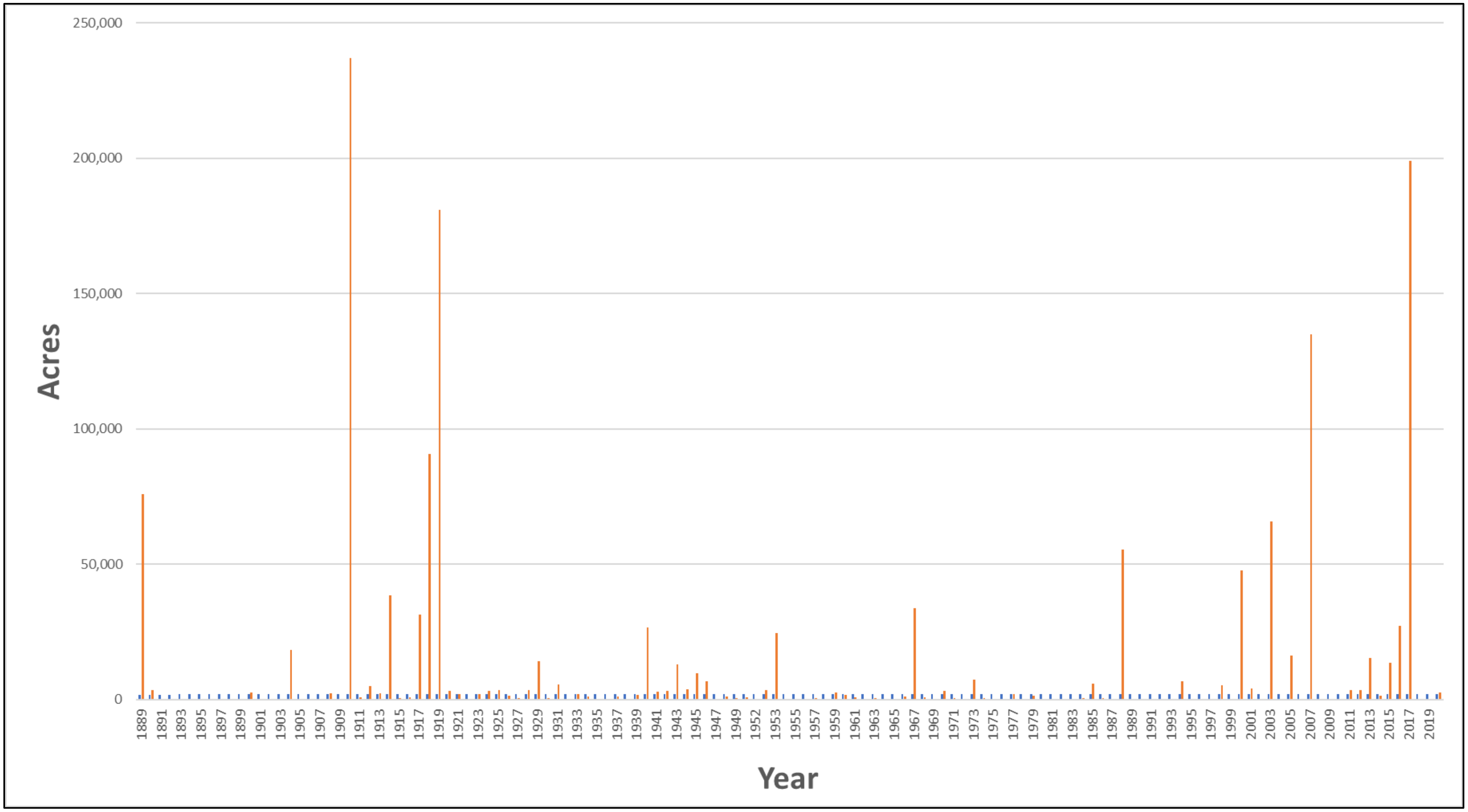


**Figure 3—Recent acres burned by fire by year on the Lolo National Forest (1889 through 2020)**

Recent research using historical fire atlases in adjacent areas of British Columbia, Canada in similar forest types identified distinct phases of wildfire regimes from 1919 to 2019 (Baron et al. 2022). The fire atlas data on the Lolo National Forest suggests a similar trend but with slightly different years. It is apparent on the Lolo National Forest that fire was active up until 1939 with frequent and large fire events. Fire activity decreased in 1920, coinciding with effective fire suppression influenced by a mild climatic period. In 1985, the combined effects of fire exclusion and accelerated climate change fueled a shift in fire regimes of various forest types, with increases in area burned through 2020.

## Changes from Historical Fire to Current Fire

We mapped the distribution of the more recent fire events shown in Figure 3 across the LANDFIRE Fire Frequency Classes and compared those to the estimates of eighty years of historical minimum and maximum acres of fire and show the results of that mapping analysis below in Table 4. Table 4 quantifies recent fire in two different phases of wildfire regimes shown in column two and column three. In column two, the acres of wildfire between 1940 and 2020 are tabulated across the historical fire frequency classes. In column three, the acres of wildfire between 1985 and 2020 are tabulated across the historical fire frequency classes. The Infrequent and Very Infrequent frequency classes are the only classes where recent fire approaches minimum levels of historical fire. Recent fire in the Moderately Frequent, Frequent, and Very Frequent classes has not approached the minimum amount of historical burning.

**Table 4—Comparison of the more recent fire events shown in Figure 3 across the LANDFIRE Fire Frequency Classes to the estimates of eighty years of historical minimum and maximum acres of fire.**

| LANDFIRE Historical Fire Frequency Class | Total acres | Acres burned from 1940 to 2020 | Acres burned from 1985 to 2020 | Minimum estimate of acres for 80 years of historical fire | Maximum estimate of acres for 80 years of historical fire |
|---|---|---|---|---|---|
| A: Very frequent (6-15 years) | 200,471 | 56,300 | 25,268 | 1,122,640 | 2,726,412 |
| B: Frequent (16-35 years) | 1,243,665 | 285,024 | 216,869 | 2,984,796 | 5,969,592 |
| C: Moderately frequent (36-100 years) | 862,908 | 171,940 | 126,546 | 690,326 | 2,070,978 |
| D: Infrequent (101-200 years) | 890,244 | 335,721 | 268,070 | 356,098 | 712,195 |
| E: Very Infrequent (201-500 years) | 14,996 | 2,561 | 1,956 | 2,399 | 59,985 |

## Fire in Riparian Areas

Fire in and near riparian areas is an important disturbance element driving ecosystem processes, such as large woody debris recruitment to stream channels, reducing conifer encroachment, and increasing deciduous vegetation; all of which can enhance filtering and flow modulation roles of riparian areas and provide the basis for beaver colonization, among other benefits (Bisson et al. 2003). Riparian areas frequently differ from adjacent uplands in attributes influencing fire regime: vegetative composition and structure, geomorphology, hydrology, microclimate, and fuel characteristics (Dwire and Kauffman 2003). Although these features, combined with land management, may contribute to different fire frequency, severity, behavior, and extent fire remains a critical driver of ecological processes in riparian areas (Bisson et al. 2003). Riparian areas may contribute to limiting the extent and severity of wildfire by altering burn patterns, providing unburned refugia, and filtering ash and silt from post-wildfire debris flow. Beaver occupancy can reduce the wildfire severity by expanding the lateral extent of the aquatic ecosystem, serving as a natural fuel break, especially for ground fire (Fairfax and Whittle 2020). The ability of riparian areas to support unburned refugia and filter post-debris flow can be impacted by high-severity wildfires.

Some riparian plant species, such as aspen, cottonwood, green ash, chokecherry, or coyote willow possess natural defense mechanisms to some stressors, having the ability to sprout after fire or flood (Hansen et al. 1995). These adaptations to disturbances facilitate survival and reestablishment following fires, thus contributing to the rapid recovery of many streamside and seep habitats.

## 2.1.3 Insects and Disease

Conditions on the Lolo National Forest are conducive to insect infestations, based on climatic conditions and widespread susceptibility of forests across most of the area (density, composition, and age/size class within cover types) following nearly a century of disturbance exclusion. Hot-dry summer conditions have re-occurred since multidecadal dry cycle initiated in 2000 and are promoting forest vulnerability that has increased the probability of insect eruptions and potential for compounding disturbances (see appendix 4 for more information). Novel instances of secondary insect pests causing damage, exotic insect colonization, and pests occurring in new geographic locations are being promoted by multidecadal summer dry cycle and warmer temperatures (see appendix 4 for more information). Forest insects and disease have had a major impact on the composition and structure and this trend is expected to continue (Byler and Hagle 2000). See appendix 4 for more information.

### Insects

Insect eruptions often cause most damage within homogenized forest conditions that are susceptible (density, age and size class, composition) to insect-attack during prolonged dry periods when weather and climatic exposure enhances vulnerability in susceptible stands.  Hot-dry conditions promote physiological stress that reduced natural tree defenses and directly impacting insect phenology, including the number of generations produced per year (Fettig et al. 2022). Currently, most of the Lolo National Forest cover types are susceptible to insect-attack and have been exposed to hot-dry summer conditions that have progressively caused reduced soil moisture and drying across the western U.S. (Krist et al. 2015, Williams et al. 2020). Insect pest damages have been elevated during this dry cycle with active Douglas-fir beetle, fir engraver, Douglas-fir tussock moth, western spruce budworm, mountain & western pine beetles, pine engraver, twig beetles, black pineleaf scale, and wood boring beetle damages noted within Forest Health Protection ground visits and Aerial Detection Surveys (Hicke et al. 2020). Multiple instances of 'novel' damages caused by insects not considered as primary agents are occurring, including:

- Pine engraver causing pine mortality in large-diameter (20-30" diameter at breast height) ponderosa pines beyond their typical 10" diameter at breast height host size in conjunction with unprecedented summer of 2021 heat event.
- Black pineleaf scale causing severe (up to 80%) ponderosa pine mortality and stand failure in infested stands along the Frenchtown Face and other locations.
- The exotic balsam wooly adelgid causing true fir dieback and mortality.
- Douglas-fir tussock moth erupting in novel locations like the Missoula valley.
- Douglas-fir beetle progressing from fire-injured tree colonization to outbreaks in vulnerable, adjacent stands following fire-injured tree colonization in the Rice Ridge wildfire perimeter.

Insect eruptions and damages are expected to increase into the near future if the current multidecadal summer dry cycle persists. This includes continued Douglas-fir beetle-caused mortality in mesic mixed conifer and dry Douglas-fir cover types, increased bark beetle and twig beetle activity impacting ponderosa pine cover types, increased balsam wooly adelgid spread in mesic-mixed conifer and spruce/fir cover types, further Douglas-fir tussock moth and western spruce budworm defoliation outbreaks in dry Douglas-fir and mesic mixed-conifer cover types, and increased potential for bark beetle eruptions following wildfire and blowdown across all cover types as probability for compounding disturbances is enhanced by dry conditions. The risk of these events would be temporarily reduced with a transition to a multidecadal wet cycle; however, as temperature increases are projected to be continuous, insect damages are anticipated to be more severe after that wet cycle during the next dry cycle unless forest susceptibility conditions change.

## Disease

Increasing temperatures and unprecedented summer dry conditions increase a tree's susceptibility to tree diseases including root diseases, one of the most impactive types of forest disease in the region. Root disease infections cause years of slowed growth ending in wind-throw or death of the impacted tree by other interacting factors such as bark beetles. This can contribute to a cycle of suppressed regeneration, unsuccessful recruitment, and increased fuel loadings while impacting long-term site productivity. In Region 1, root diseases impact mesic-adapted conifer species such as Douglas-fir and true firs more severely than more drought-tolerant species such as pines and larch. If dry cycle conditions persist, mesic mixed conifer stands can be expected to be increasingly maladapted which will increase their susceptibility to root diseases, increasing the impacts of these diseases on the landscape (Kim et al. 2021). Forest Inventory and Analysis data shows that approximately half of plots in the mixed mesic conifer cover type on the Lolo National Forest have root disease. As mixed mesic conifer cover type is the most common cover type on the Lolo, we expect root disease to continue with impacts worsening across infected sites, often in tandem with insect-caused mortality, primarily during periods when high temperatures interact with dry summer conditions as climate continues to change.

Continuing hot and dry conditions can also be expected to exacerbate pre-existing stressors to trees, making conditions such as subalpine fir decline more severe (Lalande et al. 2020) and worsening the impact of dwarf mistletoes (Kliejunas 2011) and opportunistic diseases. Ponderosa pine in western Montana has been showing increasing crown symptoms in response to hot and dry summers and a combination of Diplodia shoot blight and western gall rust. Diplodia shoot blight is known to interact with water stress (Sherwood et al. 2015) and together with western gall rust, the crown dieback in these trees in western Montana has been significant.

Disease spread and impacts are expected to vary in future years with long-term wet and dry cycles. A return to wet cycle conditions may ameliorate physiological stress of drought and decrease tree susceptibility to disease, however, many fungal pathogens depend on seasonal moisture for reproduction and spread. Increased moisture could cause increases in needle diseases and further promote the spread of the invasive rust fungus white-pine blister rust (Sturrock et al. 2011). Sporulation of the white pine blister rust fungus *Cronartium ribicola* depends on 48 hour periods of 100% humidity (Sturrock et al. 2011). Increases in moisture could increase the frequency of wave years of this invasive pathogen, enhancing its ability to disperse far distances. Wet-cycle conditions also support the growth and establishment of mesic-adapted conifers such as Douglas-fir and true firs which are more susceptible to root diseases generally. Although dry conditions are expected to increase the susceptibility of trees to root disease, a return to wet cycle conditions could cause an increase in the overall abundance of these pathogens even though the impact on individual trees may be reduced.

## 2.1.4 Beaver

Beavers are a keystone species that historically were responsible for some of the greatest biodiversity and ecological systems on the Lolo National Forest. Beavers were likely as formative of a disturbance agent as wildfires and floods for valley bottom ecosystems. Although beaver populations are rebounding, levels are far below potential. Consequently, valley bottoms and the extent of riparian vegetation are departed from potential ecological conditions and services. Because beavers are a very large, but mostly missing, disturbance agent on the landscape, understanding beaver habitat potential along with potential riparian habitat is essential in management considerations of valley bottom ecosystems and stream corridors.

### Beavers as an Ecosystem Driver

Over the past thirty years, research has highlighted the role of beavers as a keystone ecosystem species and improved our understanding of the cascading effects of beaver presence on landscape processes. One of the greatest changes to disturbance regimes in valley bottoms is the lack of beaver activity. In most of the temperate Northern Hemisphere, beavers historically altered low-gradient, small-stream ecosystems by constructing series of dams in suitable habitat. Beaver dams numbered in the tens to hundreds of millions across the Northern Hemisphere historically. Almost every northern temperate ecosystem that had trees or shrubs growing along streams also once had beaver dams (Pollock et al. 2015). Beaver populations have declined significantly largely because in the 19th century they were trapped for fur or oil or to create hay and agricultural fields instead of wetlands and wet meadows (Halley et al. 2012). More recently there has been widespread recognition that beaver dams play a vital role in maintaining and diversifying stream and riparian habitat (Pollock et al. 2015).

Beavers are ecosystem engineers (Naiman et al. 1988, Pollock et al. 2015). Beavers, through dam building and vegetation harvest, exert profound influence on the habitats they occupy and drastically modify hydrologic, geomorphic, and biologic processes across spatial and temporal scales. In the types of stream systems found across much of Montana, the effects of beaver activity are mostly positive, resulting in:

- Increased landscape-scale water storage (Naiman et al. 1986, Naiman et al. 1988, Westbrook et al. 2006, Jin et al. 2009, Nyssen et al. 2011, Majerova et al. 2015).
- Reconnection of stream channels to their floodplains (Westbrook et al. 2006, Polvi and Wohl 2012;2013, Pollock et al. 2014, Majerova et al. 2015).
- Water quality improvements, including sediment retention and nutrient cycling, reducing suspended sediments, improving nutrient cycling, and removing and storing contaminants (Castro et al. 2017).
- Attenuation of flood events (Puttock et al. 2021).
- Bolstered landscape resilience to disturbances such as fire and drought (Fairfax and Small 2018, Silverman et al. 2019, Fairfax and Whittle 2020).
- Enhanced biodiversity (Naiman et al. 1988, Russell et al. 1999, Wright et al. 2002, Cooke and Zack 2008, Bartel et al. 2010, Kivinen et al. 2020),
- Creation of diverse fish habitat, including overwintering, spawning, and rearing areas (Jakober 1998, Collen and Gibson 2001). Most research suggests that the increased complexity of habitat created by beaver dams is beneficial to many fish species (Schlosser and Kallemeyn 2000, Collen and Gibson 2001, Pollock et al. 2003, Benda et al. 2004, Kemp et al. 2012, Pollock et al. 2012).

- Baseflow and groundwater recharge. Beaver dams can play a critical role in replenishing alluvial aquifers by trapping and storing water and redirecting surface water (Pollock et al. 2015). Stream rehabilitation and subsequent beaver colonization on the Lolo increased baseflow by at least 0.5 cubic feet per second per mile (Brissette 2016).
- Creation of habitat for wildlife species. The list of waterfowl and overall birds that use beaver ponds is long and varies by region. Beaver habitats provide numerous species and abundance of aquatic insects. The diverse cover provides numerous nesting, forage, refuge, and isolated opportunities for breeding pairs. Many amphibians and reptiles not only thrive in beaver environments but are highly dependent on the wetlands and habitat niches they create. Beaver canals can be important movement corridors and overwintering habitat. By diversifying the landscape with different sizes and ages of ponds, streams can significantly increase the biodiversity of amphibians.

Beaver have a disproportionately large effect on their environment relative to their abundance (Pollock et al. 2015). One Montana study found 200% higher aquatic invertebrate emergence rates, 60% higher abundance of spiders, and 75% higher deer mice in stream segments with beaver (McCaffery and Eby 2016). Abundant literature exists on beaver impacts on biodiversity and ecological importance, especially in drought conditions. Beaver's ability to produce wetlands is especially important in the west where riparian and wetland habitats make less than 2 percent of the landscape yet provide habitat for more than 80 percent of wildlife species (Hansen et al. 1995).

Land use changes, and ecosystem degradation have caused summer water temperatures and rivers to frequently exceed levels suitable for aquatic life (Kaushal et al. 2010). Climate change models predict that water temperatures are warming, and summer maximums are often the single most limiting factor in fish species (Rieman and Isaak 2010). In many regions, systemic effects of beaver have the ability to lower stream temperatures (Pollock et al. 2015). Beaver damming can increase local stream temperature on the surface layer (McCaffery 2009) but decrease temperature in bottom layer thermal ranges (Bobst 2019) and lower overall stream temperature on larger system scales. Stream temperatures were lowered on a stream segment after beaver dam analogue rehabilitation on Teepee Creek, Lolo National Forest (McDowell et al. n.d.).

The notion that beaver dams block fish passage is largely unsupported by the literature. The literature suggests that beaver dams may act as temporary barriers, especially during low-flow periods. As flows increase, dams typically become more easily passable by both juvenile and adult fish, with a diversity of flow paths over, through, under, and around these permeable structures (e.g., via side channels formed from lateral overland flow) (Schlosser 1995, Pollock et al. 2014). Flow paths continually change with beaver maintenance, construction, and abandonment and with fluctuations in discharge (Lokteff et al. 2013). Dams might even provide a competitive advantage to certain native fish species relative to non-natives (Powers and Orsborn 1985, Lokteff et al. 2013). Lokteff et al. (2013) studied the effects of beaver dams on the movement of one native trout species and two non-native species in two northern Utah streams. The authors found that all three species were able to pass through beaver dams, but the native trout passed dams more frequently than either of the non-native species.

### Beaver Status and Associated Departures from Historic Conditions

The Lolo has assessed the following items to improve understanding and assist future forest stewardship of ecological services supported by beaver and beaver habitat:

- Riparian vegetation presence and departure from likely historic spatial extents.

- Wetland presence and departure from likely historic spatial extents.
- Developed an informal technical paper displaying reference beaver conditions when beaver populations are allowed to exist to more natural levels (Sylte 2020).
- Beaver habitat suitability mapping (i.e., potential land area in the Lolo's valley bottoms that beaver could occupy if favorable conditions existed to maintain populations).
- Exploration of restoration options for beaver, wetlands, and riparian vegetation.
- Review of wildlife Montana Species of Concern, for important beaver influences on sensitive fish, amphibians, reptiles, mammals, or birds (see planning record exhibit R01-003).

Fifty-four animal species (40 percent) listed as Montana species of concern are rated as not having associated habitat, habitat needs, minor overlap, unknown, or not detriment/beneficial to beaver. This leaves 75 animal species (almost 60 percent) listed as Montana species of concern that are directly impacted by beaver with both positive and negative impacts.

Recent assessment on the extent of existing riparian vegetation versus the potential riparian footprint, has been conducted. Contrasting the current extent of riparian acreage with the acres of potential riparian footprint provides an estimate of how much the presence of riparian vegetation may be departed from potential conditions, and intact riparian and valley bottom ecosystems. The extent of riparian vegetation is far below potential, which coincides with our awareness with lack of beavers as one of several disturbance agents that are needed in valley bottom ecosystems (see section 2.3).

In addition, wetlands are a distinct and important feature of riparian habitat types and ecology in valley bottoms (wet-river corridors). The current number and acreage of wetlands influenced and/or maintained by beavers on the Lolo National Forest are shown in Table 5. These values provide additional perspective at the lack of beaver presence currently and at the great departure from historic conditions. These values also provide management perspective on the recovery that is possible, which also provides stewardship challenges in determining the means and approaches to achieve the highest ecological potential.

**Table 5—Wetlands influenced by beavers on the Lolo National Forest**

| Number of national wetland inventory wetlands | Number of beaver-influenced wetlands | Percent of wetlands that are beaver influenced (by occurrence) | Acreage of all national wetland inventory wetlands | Beaver-influenced wetland area (acres) | Percent of wetland area that is beaver influenced |
|---|---|---|---|---|---|
| 20,150 | 398 | 2.6 | 52,801 | 271 | 0.5 |

The extent of the valley or drainage bottom area that beaver and beaver dams likely historically influenced can be labeled a "Beaver Influence Area". A beaver influence area can be approximated by the streamside areas that are inundated by a large flood (i.e., 50–100-year flood magnitude) because any elevations that could not be accessed by large floods likely would also not be influenced by beaver. In contrast, areas that are low enough that a large flood could access could very well be influenced by beaver historically when they were unconstrained, and dams existed across entire valley bottoms. Beaver influence areas are also known to occupy hillsides up to 12% gradient (Sylte 2020).

Various models can be used to approximate a reasonable potential beaver influence area. For this assessment, the beaver influence area was approximated by aggregating three distinct valley/wetland mapping approaches: 1) floodplain mapping from the Lolo's climate change vulnerability assessment (Wade et al. 2016); 2) the National riparian areas base map (see planning record exhibit L-001); and 3) the

National Wetlands Inventory. Each of the models produce a different floodprone area layout and represent an area that could reasonably be inundated by flooding (Figure 4). If we assume that beaver were able to occupy valley bottoms from margin to margin (except where second-level terraces curve in and out), then an aggregate of the greatest area approximated by floodplain modeling may be the best estimate of the beaver influence area.

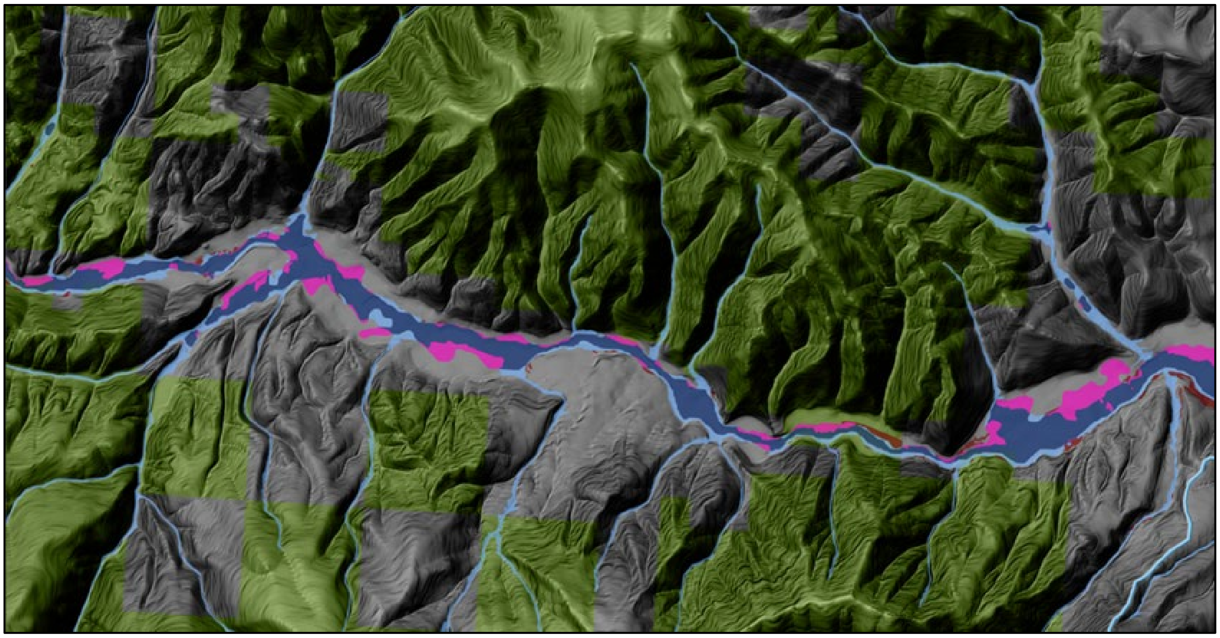

**Figure 4—Lolo Creek example of floodprone areas on the Lolo National Forest. Green indicates National Forest System lands. Dark blue, pink, and brown are the combination of mapping that represents the likely floodprone/beaver extent area.**

These modeled projections are supported by empirical data in Colorado, Montana, and Alaska (Sylte 2020). This work demonstrated that the extent of riparian vegetation is grossly different between the two scenarios of riparian vegetation-beaver present versus riparian vegetation-beaver absent. The presence of beaver equates to riparian vegetation existence that is valley wall to valley wall in these scenarios, which provides empirical evidence of what riparian vegetation and wetland presence could be. Although beaver prefer low gradient terrain, when the populations are unconstrained (i.e., allowed to persist for significant time periods and rich high abundance), beaver are known to also occupy steeper intermittent drainages and areas of hillside seeps and springs (see planning record exhibit R01-001).

Addressing beaver and beaver habitat recovery is one of the approaches to recovering the ecological potential of the riparian systems on the Lolo. Beginning in 2013, the Clark Fork Coalition received funding from the Forest to develop a model that accurately describes beaver habitat potential. With the long-term goal of supporting beaver habitat restoration and use of beavers to enhance watershed health, this assessment identified sites able to support beaver after habitat conditions are improved to support beaver populations and transplants. A revised Habitat Suitability Index model was developed in 2015. Since this time, the Beaver Restoration Assessment Tool model has been developed and used to project suitable habitats for beaver damming activity across the state of Montana.

Because model validation is important, the Clark Fork Coalition, supported by a Forest Service citizen science program, embarked on a substantive effort to validate initial beaver habitat suitability model predictions (Leach 2020). This work concluded that the NetMap model over-predicts beaver habitat in larger order streams but may capture segments on larger channels where beavers are able to make use of side channels in broad floodplains. They also found that the GIS overlay model over-predicts habitat in very small headwater streams, largely due to a lack of data for perennial stream flow and, finally, that the GIS overlay model lined up well with ground-truthing for beaver habitat presence and habitat (current or historic). On the stream reaches visited by the Clark Fork Coalition field crew, they noted that beaver activity was highest where log jams were present or larger streams had side channels. They surmised that beaver had difficulty establishing in simplified, single channels without wood jams. Selection of sites for restoration depend on multiple other restoration and management considerations. Multiple restoration opportunities also exist on private lands. A story map of the assessment can be found at: https://storymaps.arcgis.com/stories/5a23afa0d6c94d5099fc21cf91fca9f1

## 2.1.5 Flooding, Stream Flows, and Groundwater

National Forest System lands contribute much of the surface flows to the headwater streams and rivers of Western Montana. The relationship between mountainous areas, snowpack accumulation, and runoff cause National Forest System lands to function like reservoirs for downstream communities, ecosystems, and economies. Research suggests that climate change may shift the timing of snowmelt and peak flows to earlier in the year in Western Montana Watersheds. Local gage data suggests that a shift toward earlier runoff and peak flows may already be occurring on Lolo National Forest. As timing of stream flow shifts due to climate change, water scarcity may become an issue for maintaining stream flows to support aquatic life and for the communities surrounding the Lolo (Wade et al. 2016). Promoting watershed health and resilience is critical to provide ecosystem services relating to stream flows and ground water.

Streams, rivers, wetlands and meadows throughout the Lolo National Forest provide essential ecosystem benefits by serving as key components of the hydrologic cycle and biodiversity hot spots. Mountainous watersheds receive up to three times the precipitation compared to adjacent valley bottoms, where the higher density population centers are located. Water originating in the headwater catchments ultimately provides surface and subsurface water for users in Western Montana to sustain their communities and economies. Healthy watersheds provide more, higher quality water than degraded watersheds.

Historical land use has affected the function of some watersheds, in some instances degrading water quality and decreasing useable water amounts for downstream users. Historical anthropogenic degradation of freshwater, riparian and wetland ecosystems has contributed to the decline and extirpation of native species from our watersheds. Increased climatic variability looking into the near future adds additional stress to already impaired watershed function and ecosystems. Restoring headwater watersheds on the Lolo can help to mitigate the negative effects of historical land use, improve resilience and watersheds function into the future, promote ecological integrity, and enhance water resource security.

### Flooding and Stream Flow

Flow regimes are challenging to predict because they are a function of multiple variables. Climate, geology, topographic conditions, and other factors play into flow characteristics. Past efforts to map flow regime were inaccurate, especially in headwater drainages; however, as this field continues to advance, modeling efforts to predict flow patterns will likely produce more accurate maps.

The Lolo National Forest and adjacent National Forest System lands are a significant contributor of water locally and nationally (National Forest Contributions to Streamflow | US Forest Service Research and Development (usda.gov). National Forest System lands contribute 72 percent of the discharge of the Blackfoot River (943 out of 1,320 thousand-acre-feet per year), 74 percent of the Clark Fork River just above its confluence with the Bitterroot River (2,140 out of 2,910 thousand-acre-feet per year), 93 percent of the Bitterroot River (2,090 out of 2,250 thousand-acre-feet per year), 73 percent of the Clark Fork River at Cabinet Gorge Reservoir (13,300 out of 18,400 thousand-acre-feet per year), and 98 percent of the St. Regis River (524 out of 536 thousand-acre-feet per year). These headwater streams are the lifeblood of local ecosystems, communities, and economies while also being crucial contributors to the Columbia River and major population centers downstream. The Columbia River discharges the most water out of any river in the country at its mouth, from this location 44 percent of the discharge originates in watersheds on National Forest System lands (80,100 out of 183,000 thousand-acre-feet per year).

As of 2023, there are 29 operational in-situ meteorological stations deployed on or near Lolo National Forest. 15 are situated on lands managed by the Forest Service. Stations range in elevation from 2380’ to 7905’. Most stations are at low-elevation sites and high elevation instrumentation lacks some basic meteorological sensors (such as wind and radiation). Elevation is the largest predictor of annual precipitation on the Forest; however, long-term monitoring also indicates that the West Zone of the forest receives more precipitation than the East Zone (figure A1-07).

Watershed hydrology of the Lolo National Forest is snowmelt dominant. Annual peak flows typically occurred between the end of April and the beginning of June with May 20th being the mean date of peak flow at all gages on Lolo National Forest between 1950 - 2022.  The summer months can bring convective thunderstorms, occasionally producing peak flows on small catchments that are orders of magnitude greater than spring runoff. Rain-on-snow events can produce large run-off events at atypical times and can be magnified by ice jams; this is illustrated by the outlier values on the St. Regis River and Prospect Creek for Jan 16, 1974 (Figure 5) when a major rain-on-snow event caused January flooding throughout Northwestern Montana. Research suggests that climate change may shift the timing of snowmelt and peak flows to earlier in the year in western Montana watersheds (Gillan et al. 2010) and throughout the western U.S., with some suggesting that a shift is already occurring (Hamlet and Lettenmaier 2007).  Local gage data suggests that a shift toward earlier runoff and peak flows may already be occurring on Lolo National Forest - every gage site, except the Bitterroot near Missoula, shows a tendency toward earlier peak flow since 1950 (Figure 5). The Climate Change Watershed Vulnerability Assessment (Wade et al. 2016) found that flow in watershed along the Montana-Idaho boarders are expected to be 22 to 40 days earlier by the 2040s and 28 to 68 days earlier by the 2080s. Climate change may impact the frequency of flooding in the Western U.S. (Hamlet and Lettenmaier 2007).

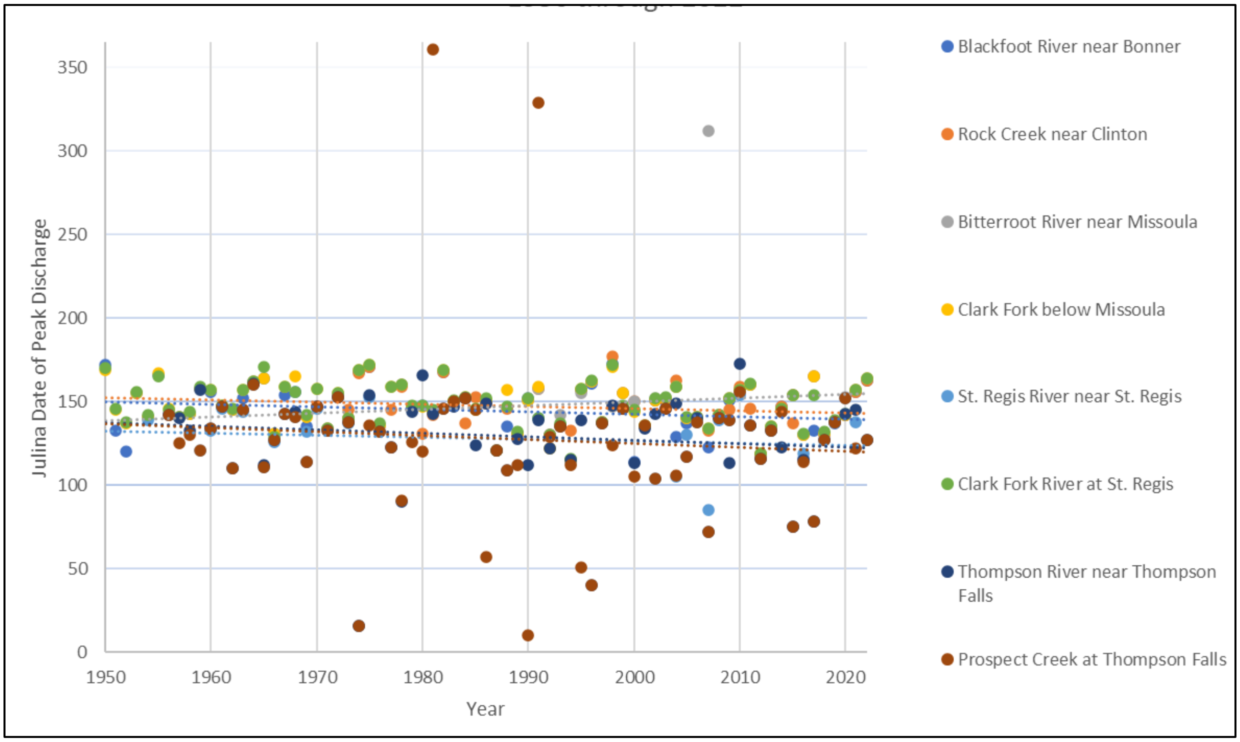


**Figure 5—Date of peak flow, expressed as Julian date, on Lolo National Forest gaged streams and rivers, 1950-2022. Trend lines are dotted lines.**

Through implementation of a water compact between the Forest Service and State of Montana since 2007, the Lolo National Forest has acquired 12 instream flow water rights. These junior water rights set a minimum flow rate necessary to support native fisheries and aquatic ecosystems. The Forest has collected data to acquire instream flow water rights on 78 discreet stream reaches; as of 2023, 31 of those water rights have been issued by Montana Department of Natural Resources and Conservation.

As timing of stream flow shifts due to climate change, water scarcity may become an issue for the communities surrounding Forest, especially those that rely on waters originating in the watersheds along the Montana-Idaho border and the higher tributaries of the Blackfoot River (Wade et al. 2016). There are 83 6th code hydrologic unit watersheds in basins that are legislatively closed to new water rights (figures A1-32 and A1-32a); however, most of watersheds (approximately 83 percent) remain open for new water right acquisition. The basins which remain open are concentrated in the areas that were identified as most vulnerable to water scarcity (ibid).

As of 2023, there are 3,144 active non-Forest Service claims (where the Forest Service is not the sole owner) with points-of-diversion on National Forest System land (Table 6).

**Table 6—Range of water rights by type on the Lolo National Forest**

| Purpose | Number of Water Rights |
|---|---:|
| Agricultural spraying | 1 |
| Commercial | 55 |
| Domestic | 1,567 |
| Fire protection | 7 |
| Fish and wildlife (consumptive) | 53 |
| Fishery (non-consumptive) | 10 |
| Industrial | 21 |
| Institutional | 3 |
| Irrigation | 601 |
| Lawn and garden | 82 |
| Mining | 100 |
| Multiple domestic | 65 |
| Municipal | 14 |
| Other purpose or unknown | 17 |
| Power generation | 18 |
| Recreation | 25 |
| Stock | 505 |
| **Total** | **3,144** |

Adjudication for water rights with a priority date earlier than July 1, 1973, is ongoing for most of the basins within the Lolo National Forest (Table 7).

**Table 7—Adjudication status of basins in the Lolo National Forest**

| Basin Name | Adjudication Status |
|---|---|
| Rock Creek | Still in case consolidation/resolution phase |
| Clark Fork above Blackfoot River | Preliminary decree/objection period projected for 2023 |
| Bitterroot River, North End Subbasin | Preliminary decree/objection period projected for 2025 |
| Flathead River below Flathead Lake | Preliminary decree/objection period projected for end of 2023 |
| Clark Fork between Blackfoot River and Flathead River | Preliminary decree/objection period projected for 2023 |
| Clark Fork below Flathead River | Preliminary decree/objection period projected for 2023 |
| Blackfoot River | Awaiting final decree |

## Groundwater

The underlying geology of the Lolo is dominated by Belt supergroup Precambrian rock, and streams have formed in fissures or fractures in this material. Granitic intrusions from the Idaho Batholith are present in isolated areas. Valley bottoms are composed of glacial till and unconsolidated alluvial deposits of tertiary and quaternary ages. These deposits are porous and readily store and transport groundwater. Elevations below approximately 4,200-feet have been influenced by repeated fills and drains of Glacial Lake Missoula (12,000-15,000 years ago), as evidenced by lacustrine and flood deposits.

More than half of Montanans depend on groundwater for their primary water supply. Current withdrawal represents a small percent of the available groundwater, recognizing that the amount of available groundwater far exceeds that of available surface water. According to the Montana Groundwater Atlas provided by the Montana Natural Resource Information Service, groundwater provides 94 percent of Montana's rural domestic water supply and 39 percent of the public water supply (https://docs.msl.mt.gov/geoinfo/WIS/pdf/gwatlas/mtgwa.pdf). Montana uses over 188 million gallons of groundwater per day for domestic use, public water supplies, irrigation, livestock, and industry (Hutson et al. 2005).

Considering orographic effects on precipitation and the contribution of National Forest System lands to surface streamflow, National Forest System lands have similar significance in discharge contribution to surface aquifers due to their inherent connection with streamflow. Surface aquifers in western Montana valleys are often associated with tertiary or quaternary glacial and alluvial deposits that make up the valley floors typical in basin and range type geology. Currently there is not enough data to numerically differentiate snowmelt recharge events from the Lolo versus deeper groundwater resources and which of those two has a larger impact on aquifers. However, hydrogeologic assessments (English and Marvin 2000, Marvin 2000, Schmechel 2015) indicate that in proximity to surface water some springs and wells may be under direct influence of surface water recharge driven by snowpack accumulation and precipitation. Groundwater recharge to shallow aquifer systems (hyporheic zones) has substantial importance to stream and river flow during base-flow, in some cases being critically important for surface water quantity, water quality, and/or thermal buffering for aquatic biota. Another key gap in understanding stems from confined aquifers with "older" water and their hydrologic connection with (and this recharge potential) to surface waters or surficial aquifers.

It is incorrect to assume that groundwater extraction and changes in land use cannot significantly alter aquifer levels. Groundwater level drawdown occurs when outflows exceed inflows. Comparing monitoring results of groundwater levels in areas of high residential and commercial development (that were historically agricultural lands), current agricultural lands, and reference conditions that are like pre-European settlement conditions would help quantify the complex interactions between land management actions (both on and off National Forest System lands), hydrology, geology, and groundwater levels. The interactions between surface water and groundwater (in confined, semi-confined and unconfined aquifers) are inherently complex because the number of variables at play in modeling such behavior and the difficulty and cost associated with monitoring water that flows underground. Groundwater contamination caused by industry exists in the following locations and has both groundwater and surface water effects:

- Silver Bow Creek/Upper Clark Fork River, headwaters of the Clark Fork River, is a current superfund remediation site.
- Flint Creek, tributary to the Clark Fork River.
- Mikehorse Dam, headwaters of the Blackfoot River.
- Milltown Dam, at the confluence of the Clark Fork and Blackfoot Rivers, Completed Superfund site immediately upstream of Missoula with onsite repository.
- Stone Container, Clark Fork River just downstream of Missoula.
- Previous Superfund Cleanup Sites on the Lolo (Tarbox, Nancy Lee, St. Louis Creek, Kennedy Creek).
- Flat Creek Current Superfund Cleanup Site.

While the Lolo National Forest cannot control surface and groundwater use in the valley bottoms of larger valleys and river systems adjacent to forest lands (i.e., Missoula Valley, Bitterroot Valley, Clark Fork Valley, etc.) it can promote watershed health in the headwaters where most precipitation falls. Restoration projects aimed at floodplain connectivity, wet meadow restoration, wetland restoration, and beaver reintroduction in the smaller headwater valley bottoms on National Forest System lands promote groundwater recharge and runoff flow attenuation (Powers et al. 2018, Bobst et al. 2022). Pre-European colonization, the bottoms of many broad alluvial valleys in the American West were river-wetland complexes that were highly adapted to local disturbance regimes and served as hubs of biodiversity (Wohl et al. 2021). In such ecosystems there is a high degree of connection between surface and groundwater. In certain settings, water deposited underground into surface aquifers during runoff could be withdrawn during the late-summer and fall as stream flow for transport to the valley bottoms of larger valleys. Restoring and utilizing mountainous watersheds to realize the water quality and quantity benefits they provide is not a novel concept but necessitates a holistic mindset that recognizes the inherent ties between watersheds, freshwater ecosystems, and downstream water users.

Land management activities the Lolo conducts pertaining to fire prevention, timber extraction, and vegetation management affect the water cycle in watersheds and thus water yield to downstream systems. Annual water yield is defined as the total volume of water flowing out of a watershed in a given year, including both surface and subsurface flows (Vigerstol et al. 2021). Assuming no long-term storage, water yield in a watershed is the difference between precipitation and evapotranspiration. A long-held assumption is that there is an adverse relationship between forest cover and water yield. However, more recent reviews of research indicate that post disturbance (i.e. timber harvest or forest fires) that decrease forest cover may increase, decrease, or cause no significant change to water yield in a watershed (Goeking and Tarboton 2020). The relationship between forest cover in mountainous watersheds and water yield is complicated by variables like aspect, elevation, latitude, seasonal snowpack accumulation and prevailing wind direction (ibid). Additionally, climate variability over water years may dominate forest cover as the primary driver for water yield (Kurzweil et al. 2021). Land management activities that affect forest cover may significantly change water yield in a watershed, but effects must be analyzed on a case-by-case basis while recognizing that complex interactions of many variables drive water yield.

Surface and Ground water provide municipal water supply to both residents and municipalities. At times of municipal water scarcity, the topic of increasing stream flows for water yield through additional forest harvest has gained political and media attention (see section 3.10.5: Municipal Watersheds). There are four stream diversions to irrigation canals where the diversion structure is on the Lolo National Forest: Quast ditch from Rattlesnake Creek, Dunham ditch from Dunham Creek (and possibly Shoup Creek), an unnamed ditch from Cottonwood Creek (near the confluence with Little Shanley Creek), and the Alder Creek ditch which has inter-watershed transfer of water from Alder Creek to the Dry Fork Creek in the Little Bitterroot watershed. Additionally, there are seven irrigation diversion canals that convey water across approximately 11 miles of National Forest System land.

## 2.1.6 Invasive Species

A species is invasive if it meets two criteria: (1) it is a nonnative organism to the ecosystem under consideration, and (2) its introduction causes, or is likely to cause economic or environmental harm, or harm to human, animal, or health (Obama 2016). Invasive species includes all taxa, including plants (such as state and county designated noxious weeds), vertebrates, invertebrates (such as emerald ash borer, non-native mussel larvae, New Zealand mudsnail), and pathogens (such as blister rust). Invasive forest insects and pathogens are addressed in section 2.1.6. Invasive species tend to spread aggressively because they lack the natural controls, such as predatory insects and disease, which may have evolved within their native ranges. As a result, they can displace native species, change hydrology and microclimatic features, increase soil erosion, alter wildfire intensity and frequency, and generally disrupt natural processes and reduce overall native community diversity. The 2012 Planning Rule identifies invasive species as a stressor to natural processes.

### Invasive Plants

Invasive plants are one of the most immediate and disruptive threats to ecosystem function and integrity. Invasive weed infestations can substantially change biological diversity by affecting the amount and distribution of native plants and animals. They can also have negative effects on forest regeneration, wildlife and livestock forage, native plants associated with tribal rights, landscape and soil productivity, fire cycles, nutrient cycling, riparian and hydrologic function, water quality, and human recreational activities (Miniat et al. 2021). Non-native plants have either accidentally or deliberately been introduced into the Northwest mountain ecoregions as a result of historical and current land uses based on livestock ranching, farming, and timber harvesting (Parks et al. 2005). Many of these species arrived in the Northwest between 1850 and 1920 and have spread to surrounding native ecosystems.

Invasive plant management prioritization on the Lolo National Forest relies heavily on the official Montana Noxious Weed lists, the Aquatic Invasive Species list, and pertinent county noxious weed lists (Montana Natural Heritage Program 2023a). A noxious weed is defined by Montana code annotated (MCA 7-22-2101, 2014) as "any exotic plant species established or that may be introduced in the state that may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities". The Lolo National Forest is continually collecting and updating spatial inventory data of invasive plants, but many areas have not yet been inventoried. Information is regularly shared with the Montana Heritage Program which maintains a statewide species occurrence database. The Forest has successfully implemented weed management activities as reported in the 2021 Biennial Monitoring and Evaluation Report. On a yearly average, the Forest treated 5,772 acres between 2018 and 2020, compared to an annual average of 2,859 acres between 2000 and 2001. However, the report cites a lack of inventory and monitoring leading to an increased potential of new invaders to take hold on the forest and existing infestations to grow in size and severity.

As of March 2023, the Montana Natural Heritage Program database records 44 state or county listed invasive plant species occurring on the Lolo National Forest. Some of them are common and widespread, such as spotted knapweed (*Centaurea stoebe*), oxeye daisy (*Leucanthemum vulgare*), common St. John's-wort (*Hypericum perforatum*), leafy spurge (*Euphorbia virgata*), and cheatgrass (*Bromus tectorum*). Other species, such as yellow starthistle (*Centaurea solstitialis*), Japanese knotweed (*Polygonum cuspidatum*), medusahead (*Taeniatherum caput-medusae*) and ventenata (*Ventenata dubia*) are only known from a handful of locations but are a high priority for eradication or containment due to their potential to invade native ecosystems and interrupt ecological processes. Several other high priority weeds are known to be present in the vicinity of the Lolo National Forest but have not yet been recorded in the plan area. These include dyers woad (*Isatis tinctoria*), purple loosestrife (*Lythrum salicaria*), and Rush Skeletonweed (*Chondrilla juncea*) (Lesica 2012, Montana Natural Heritage Program 2023a). Aquatic invasive plants recorded within or adjacent to Lolo National Forest are fragrant waterlily (*Nymphaea odorata*), flowering rush (*Butomus umbellatus*), yellowflag iris (*Iris pseudacorus*), eurasian water-milfoil (*Myriophyllum spicatum*), and curly-leaf pondweed (*Potamogeton crispus*).

According to the Natural Resources Manager database queried in 2023, mapped invasive plants occupy a footprint of 74,464 acres or 3.3% of the plan area but are not evenly distributed across the Forest. About 44% of the mapped invasive plant footprint is located within a 100-foot corridor of roads. Invasive plant species are also more commonly recorded in the non-forested and warm dry broad potential vegetation types compared to those in cooler habitats and higher elevation (Table 8). This is partly explained by uneven survey efforts between easily accessible road-side areas versus backcountry and wilderness. However, it is well documented that transportation routes provide corridors for mid to long-distance invasive plant dispersal (Tyser and Worley 1992, Gelbard and Belnap 2003, Mortensen et al. 2009, McDougall et al. 2018). A systematic study of roadside vegetation in the Wallowa Mountains of eastern Oregon showed decreased non-native species abundance with increased canopies and higher elevations (Averett et al. 2016). The authors suggest that the high canopy closures of mid-elevation forests provide barriers to non-native species establishment and act as buffers to upper subalpine and alpine ecosystems.

**Table 8—Mapped invasive plant species on the Lolo National Forest by broad potential vegetation type (broad potential vegetation type)**

| Broad Potential Vegetation Type | Mapped Acres (Footprint) | Broad Potential Vegetation Type (percent) |
|---|---:|---:|
| Non-Forested | 5,244 | 9.9 |
| Wetlands/Riparian/Water | 1,507 | 6.3 |
| Warm Dry | 45,985 | 6.7 |
| Warm Moist | 9,331 | 2.5 |
| Cool Moist | 11,335 | 1.5 |
| Cold | 1,059 | 0.3 |

Parks et al. (2005) explored the relationship between vegetation type, elevation, and disturbance on the presence of non-native plants and found an overwhelming importance of disturbance in facilitating non-native plant establishment. Altered riparian ecosystems and low elevation disturbed shrub steppe, grassland and pine forests are especially vulnerable to plant invasion, but many non-native plants are generalists and less limited by environmental gradients than native species (Parks et al. 2005). Broadly adapted species such as Dalmation toadflax (*Linaria dalmatica*) appear to be more restricted by properties of the native community than climatic conditions (Pollnac and Rew 2014).

Disturbances may include natural events such as floods, windstorms or wildfire which create opportunities for invasive plant establishment by decreasing vegetation cover and increasing light levels. Disturbances resulting from human activities are the cause of most of today's problems with invasive species (Hobbs and Humphries 1995). At local scales, the number of invasive species and their abundance are generally highest in and around disturbed patches, corridors, and edges such as riparian corridors, transportation corridors, skid trails and haul routes associated with timber harvest, and fuel treatments (Benninger-Traux et al. 1992, Buckley et al. 2003, Gelbard and Belnap 2003, Larson 2003).

In western Montana ponderosa pine forests, restoration treatments were found to increase non-native species cover; the combination of thinning and subsequent burning resulted in higher increases than either thinning or burning alone (Metlen and Fiedler 2006). Many of the non-native species of recently treated ponderosa pine forests, such as common mullein (*Verbascum thapsus*) and prickly lettuce (*Lactuca serriola*), are considered transient members of the understory and do not pose a threat to native plant communities (Martinson et al. 2008). However, a long-term study in the Bitterroot Valley showed some invasive plants persisting for decades, albeit at low covers (Jang et al. 2021). Species present 23 years after treatment included spotted knapweed (*Centaurea stoebe*) and meadow hawkweed (*Hieracium caespitosum*).

In grass-, shrub-, and woodland ecosystems, chronic ungulate grazing by wildlife and livestock increase the potential for exotic plant invasion, especially when coupled with disturbances such as wildfire (Vavra et al. 2007). A study of western Montana grasslands in 2011 to 2014 determined that the three most impactful exotic species at that time were cheatgrass (*Bromus tectorum*), spotted knapweed (*Centaurea stoebe*) and leafy spurge (*Euphorbia virgata*) (Pearson et al. 2016). The invasion of spotted knapweed into native bunchgrass communities has lowered forage availability to elk during late winter and early spring (Rice et al. 1997). Annual grasses such as cheatgrass (*Bromus tectorum*) and ventenata (*Ventenata dubia*) cure early in the season compared to perennial grasses, and ventenata is not considered palatable to livestock because of its high silica content. Grasslands invaded by these species do not provide dependable forage for wildlife or livestock (Pellant 1996, Hart and Mealor 2021). While ventenata has only been recorded in few locations on the Lolo National Forest, it is widespread in many Montana counties. This species has rapidly invaded the Pacific Northwest bunchgrass prairie and spread into shrublands, scablands, woodlands and forest mosaics in eastern Oregon and adjacent Idaho within the last two decades (Averett et al. 2016, Jones et al. 2018, Averett et al. 2020).

Increasing dominance of invasive annual grasses has altered fire regimes in many ecoregions of the United States (Fusco et al. 2019). Frequent fire is often followed by increased abundance of invasive grasses which further creates fuel conditions that facilitate combustion, resulting in a "grass-fire cycle (D'antonio and Vitousek 1992). This feedback cycle is well documented for arid and semiarid ecosystems, but invasion by ventenata (*Ventenata dubia*) may also pose a threat to forested environments (Kerns et al. 2020).

The response of non-native plants to climate change in the northern Rocky Mountains will likely vary depending on the specific ecological amplitude and life history strategy of individual species (Loehman et al. 2018). However, for the Lolo National Forest, bioclimatic modeling indicates increased invasion risk for yellow starthistle (*Centaurea solstitialis*), cheatgrass (*Bromus tectorum*) and tamarisk (*Tamarix* spp.) but decreased suitability for leafy spurge (*Euphorbia virgata*) (Bradley et al. n.d.), (Adhikari et al. 2020). In a warming climate, broadly adapted invaders of higher elevation ecosystems may have the capacity to spread into subalpine and alpine environments (Pollnac and Rew 2014).

Aquatic invasive plants can severely alter environmental conditions, ecosystem processes, plant and animal communities, and human uses of water bodies. Freshwater aquatic habitats appear to be disproportionately vulnerable to and negatively affected by invasive species compared to terrestrial habitats (Moorhouse and Macdonald 2014) because of the wide range of potential pathways for spreading live organisms, such as, boats, ballast water, and the aquarium trade and the susceptibility of aquatic systems to hydrologic, nutrient, and other disturbances (Lodge et al. 1998, Zedler and Kercher 2004). Aquatic invasive plants not only drive alteration of habitats but also benefit from habitat degradation in response to anthropogenic stressors and disturbances (MacDougall and Turkington 2005).

The extent to which invasive plants impair aquatic habitats and can be effectively controlled depends on a variety of factors, including site conditions, detection and response times, and management decisions. Thick dense mats of Eurasian watermilfoil reduce light penetration and water movement, deplete oxygen levels, and affect water temperatures with adverse effects on native aquatic vegetation. Similarly, fragrant waterlily can reduce light, increase water temperature and encourage algal growth which impacts water quality and wildlife habitat (King County 2010). Flowering rush can form dense stands in previously unvegetated shallow fringes of lakes. If left unchecked, potential impacts such as changes in water temperature regimes, nutrient transfers, and altered sediment transport, deposition, and accretion rates are likely to increase. These dense stands can also provide habitat for snails as vectors for pathogens and non-native fish, such as, northern pike that predate cutthroat trout (*Oncorhynchus clarkii)*, bull trout (*Salvelinus confluentus*), and juvenile anadromous salmonid (*Oncorhynchus*) species (Area 2019).

## Terrestrial Invasive Invertebrates and Vertebrates

As of March 2023, there are no known populations of Montana high priority terrestrial invasive invertebrates or vertebrates within Lolo National Forest boundaries according to Montana Natural Heritage Program data. The Montana Natural Heritage Program identifies two high priority species in Montana with a high potential to expand in Montana through human activities: eastern heath snail and feral swine.

**Eastern heath snail** *(Xerolenta obvia)* is listed as a high priority snail in a preliminary risk assessment of alien non-marine snails and slugs of priority quarantine importance in the United States (Cowie et al. 2009). The overall USDA qualitative pest risk is medium and was recommended for delimitation, containment, and eventual eradication. The expansion of eastern heath snail populations locally in Montana and in Michigan and in Ontario, Canada indicates it is not significantly impeded by climate. The adaptations that allow this species to survive adverse temperatures and low humidity protects it from extreme winter temperatures and weather (Forsyth et al. 2015). The climate matching model produced by the US Fish and Wildlife Service demonstrated the central Montana region was a close climate match for eastern heath snail. The overlap between the predicted range of eastern heath snail and grain, pulse, and brassica growing regions is extensive.

Eastern heath snail negatively impacts Montana's agricultural, recreational, and environmental resources. Cattle may reject pasture and cut forage contaminated with snail mucus (Baker 2002, Grains Research and Development Corporation 2003). The Melissa blue butterfly, *Plebejus melissa* (Edwards), feeds on *Lupinus perennis* (sundial lupine), which is preferred forage for eastern heath snails. The western subspecies, *P. melissa melissa,* Melissa blue, also feeds on *Astragalus alpinus* L. (alpine milkvetch), *Glycyrrhiza lepidota* Pursh. (American licorice), *Lotus corniculatus* L. (bird' s-foot trefoil), *Lupinus x-alpestris* A. Nelson (Great Basin lupine), and *Medicago lupulina* L. (black medick), so it is likely not threatened by either habitat loss or feeding by eastern heath snail (Lotts and Naberhaus 2021). The eastern subspecies of this butterfly, the Karner blue, *P.melissa samuelis,* is threatened by habitat loss and loss of its single host plant and is considered critically endangered by U.S. Fish and Wildlife Service. Eastern heath snail can carry tapeworms and roundworms which is a concern for bighorn sheep and reintroduction efforts. Eastern heath snail has the potential to displace several native mountain snails (*Oreohelix* sp.) listed by the Montana Natural Heritage Program as Species of Concern. Eastern heath snail attaches to surfaces including wood, metal, knapweed, chokecherry, hollyhocks, roses, and grasses (Montana Department of Agriculture 2014). Eastern heath snails have been transported outside of the Belt, Montana area by attaching to and moving on hard surfaces (e.g., gardening pots, pallets) and natural materials (e.g., hay, soil, firewood, gravel). Eastern heath snail was transported in gravel to Monarch, Montana adjacent to Helena-Lewis & Clark National Forest; this population expanded into the National Forest (ibid).

**Feral swine** were first brought into the United States in the 1500s by early explorers and settlers as a source of food. Their geographic range species is rapidly expanding, and its populations are increasing across North America because of their highly adaptable nature and reproductive efficiency. The growing population of feral swine in Alberta and Saskatchewan, Canada is likely to colonize northern Montana (U. S. Department of Agriculture 2021). Their range has also been expanded through the illegal translocation of swine by humans and escapes from enclosures; the highest potential pathway into Lolo National Forest is through these pathways. Feral swine have not been confirmed in Montana; however, the Montana Board of Livestock receives frequent reports of feral swine, yet no reports have led to a positive identification of feral swine. The state's goal is to remove the animals before the population becomes established, damage increases, and the swine become more difficult and expensive to eradicate (U. S. Department of Agriculture 2021).

In Montana, feral swine are defined as a hog, boar, or pig that appears to be untamed, undomesticated, or in a wild state or appears to be contained for commercial hunting or trapping (MCA §81-29-101). Montana's laws defining feral swine do not include a genotypic definition because domestic swine species can revert to a feral state in just a few generations. Individuals may not import, transport, possess, intentionally feed, expand the range, or profit from the release, hunting, trapping, or killing of feral swine (MCA §81-29-104). In addition, individuals may not intentionally, knowingly, or negligently allow swine to live in a feral state (MCA §81-29-104).

Feral swine compete with native wildlife for food, habitat, and water. Feral swine diets overlap with those of native wildlife, such as bear, deer, and turkey, which results in competition for important and limited natural food supplies. Feral swine activity will often deter other species from living in an area, resulting in competition over prime habitat. Feral swine wallow in mud to maintain proper body temperature where they can monopolize and contaminate limited water sources. Feral swine also prey directly on the nests, eggs, and young of native ground nesting birds and reptiles. Feral swine have been documented killing and eating deer fawns, and actively hunting small mammals, frogs, lizards, and snakes (USDA-APHIS 2021). Feral swine can carry 30 viral and bacterial diseases, and nearly 40 parasites that may affect humans, pets, domestic livestock, and wildlife species (Ruiz-Fons et al. 2008, Meng et al. 2009). Feral swine can also harbor the causative agents of important foodborne diseases such as Escherichia coli (E. coli), Salmonella spp. and Trichinella spiralis (Brown et al. 2018). Feral swine can also transmit many of these diseases to pets, including pseudorabies.

## Aquatic Invasive Invertebrates

Aquatic invasive invertebrates can displace native species, clog waterways, impact irrigation and power systems, degrade ecosystems, threaten recreational fishing opportunities, and can cause wildlife and public health problems. Since most systems experience multiple invaders (Kuebbing et al. 2013), understanding the additive and interactive effects of invaders, including invasional meltdown is key to understanding overall invader impacts. For example, the ecological effects of dreissenid mussels are considered the one of the most extensive, causing local extinction of many native mollusks, modifying the food chain and fish assemblages, and contributing to the collapse of valuable sport fish populations (Pimentel et al. 2005, Strayer 2010). Once established, these mussels commonly reach densities more than 100,000 individuals per square foot (Higgins and Vander Zanden 2010), clogging pipelines and water intakes and disrupting operations at hydroelectric power plants, municipal water supply facilities, and irrigation systems. Recreational boaters will incur costs from removing mussels on hulls, engines, and steering components. Beaches could become encrusted with sharp shells. A recent study (Nelson 2019), reported the potential economic damages of dreissenid mussels were to colonize all waterbodies in Montana totaled $72.4 to $121.9 million in mitigation costs, $23.9 to $112.1 million in lost revenue, and $288.5 to $497.4 million in property value losses. According to the Montana Natural Heritage Program database, as of March 2023 there are three aquatic invertebrates found within the Lolo National Forest geographic area are faucet snails (*Bithynia tentaculata)*, virile crayfish, and New Zealand mudsnail.

**Faucet snails** are found in Upsata and Browns Lakes; the popularity of these lakes in proximity to Lolo National Forest increases the potential risk of introduction to waterbodies on the Forest. Faucet snails have the potential to have major ecological and economic impacts. The snail is an intermediate host for four species of trematode parasites that can be lethal to waterfowl when snails are ingested (Huffman and Roscoe 1986, Hoeve and Scott 1988, Roy et al. 2016). During the Spring of 2006, approximately 22,000–26,000 migrating waterfowl were killed by ingesting faucet snails infected with trematodes in the Upper Mississippi River National Wildlife and Fish Refuge (Sauer et al. 2007). Faucet snails may also alter aquatic ecosystems by grazing on biofilms or filter feeding from the water column, which likely gives them a competitive advantage over native snails and may enhance the faucet snail's survival in eutrophic habitats (Schock et al. 2019). Faucet snails could incidentally become entrapped and survive on the dry surfaces of small fisheries gear (e.g., dip nets, boots, or small seines) for several hours to several days. If it not disinfected (every faucet snail killed), transport of the gear may be a pathway for expansion of the faucet snail's range (Mitchell and Cole 2008).

**Virile crayfish** *(Faxonius virilis)* is native to eastern Montana but has been transported by human activity west over Continental Divide the last 30 years according to the Montana Natural Heritage Program. It is an omnivorous scavenger that shreds and consumes large pieces of organic matter. Virile crayfish shredding can have substantial effects on the food web by providing smaller organic materials to invertebrates and fishes feeding lower and smaller on the food chain and may compete for food resources with other shredders. Virile crayfish are a vector of a pathogen that causes lesions to develop on the crayfish; researchers uncertain what pathogen causes these lesions. Greater than 90% of the virile crayfish collected in Placid (Lolo National Forest) and Tally (Flathead National Forest) Lakes had lesions. Lesions were more severe and more prevalent on virile crayfish west of the divide (non-native) compared to east (native in some sites). The conservation impacts of this invader as a vector of an unknown pathogen could potentially be significant.

**New Zealand mud snail** (*Potamopyrgus antipodarum*) is found in Beavertail Pond in Missoula County and Mitchell Slough and Skalkaho Creek in Ravalli County, based on the Montana Natural Heritage Database as of 2023. This species is a successful invader because of its opportunistic traits and tolerance of broad ranges of environmental conditions. Optimal conditions for successful New Zealand mud snail establishment are stable hydrology, slow water velocity (or refugia in waters with high velocities), high specific conductivity, and moderate salinity (Hall et al. 2006, Geist et al. 2022). As detritivore-herbivores, they impact multiple compartments of aquatic ecosystems and their functioning. They can become extremely abundant and has one of the greatest secondary-production rates reported for any stream-benthic invertebrate (Hall et al. 2006). Minimal genetic variation within and among invasive populations and minimal predation and parasitism suggest environmental factors constrain populations. New Zealand mud snail alter invertebrate and algal communities and can resist digestion by many fish species. This lack of digestion combined with expanding New Zealand mud snail populations suggest that snail-eating fish are unlikely to regulate New Zealand mud snail populations and may aid in local range expansion. Morphological and life history traits facilitate more highly effective transport of the species and difficulty detecting it, such as, small body size, a parthenogenic reproduction strategy that allows a single individual to establish a new population, resistant and operculate shell allows this species to tolerate desiccation and passage through digestive tracts of some other organisms, and broad environmental tolerances as listed above (Levri et al. 2007, Loo et al. 2007, Butkus and Vaitonis 2019). Water-based human recreation has the highest potential to move this species longer distances between watershed followed by fish and wildlife; it can attach to waterfowl and be ingested by fish who then transport it. Downstream drift is probably the most significant means of transport once a population is established in flowing waters (Geist et al. 2022). Aquatic systems with favorable conditions may be more susceptible to not only the invasion of New Zealand mud snail, but also to larger ecological impacts by facilitating rapid population growth and dominance over the resident community and resources (Geist et al. 2022).

### Aquatic Invasive Vertebrates

Aquatic invasive vertebrates in the plan area include several non-native fish species that can be categorized as cold-water species and cool-water species. Warm-water species such as largemouth bass (*Micropterus salmoides*), pumpkinseed (*Lepomis gibbosus*), and yellow perch (*Perca flavescens*) are also present in the assessment area but are mostly restricted to lakes and fishing ponds either because of their habitat requirements for lake-like conditions and/or warmer temperatures. These species pose little threat to native fisheries. Other invasive vertebrate species include American bullfrogs and snapping turtles.

The **cold-water category of non-native fish** primarily include brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and rainbow trout (*Oncorhynchus mykiss*). These species were introduced to western Montana by management agencies to provide increased recreational angling opportunities in the early- to mid-1900s. This practice was discontinued in the 1970s after research showed this was harmful to native fish communities. Because stream conditions in western Montana are ideal for introduced cold-water species, they reproduce naturally and have become a permanent component of the fish community. They now greatly outnumber native trout species in many systems. Brook, brown, and rainbow trout, while still sought after by anglers, threaten native fish through a variety of mechanisms (see section 2.6.2). Although brook trout and rainbow trout populations appear to be stable in number and distribution, brown trout numbers are declining in many western Montana systems for unknown reasons. Brown trout are still expanding their range on the Lolo National Forest as they have a slightly warmer water preference than other trout so climate change appears to be increasing their suitable habitat. Lake trout (*Salvelinus namaycush*) are another non-native, cold-water fish found in many western Montana watersheds, but are currently only found on the far western edge of the assessment area (Noxon Reservoir). This reservoir is primarily downstream of the Lolo National Forest on the Clark Fork River such that the hydropower dam in Thompson Falls prevents lake trout from moving upstream into Lolo watersheds; fish ladder technicians at Thompson Falls Dam ensure no lake trout are allowed to pass upstream.

The **cool-water category of non-native fish** in the plan area primarily include northern pike (*Esox lucious*) and smallmouth bass (*Micropterus dolomieu*). These species were likely introduced illegally by the public in the early 1990s to provide recreational opportunities. Although these species have also been able to reproduce naturally in some areas, they are not as abundant as the non-native cold-water trout species.

Northern pike generally require slower water with abundant aquatic vegetation to spawn; these conditions do not occur often on the Lolo National Forest. Exceptions include the natural chain of lakes in the Clearwater River system near Seeley Lake and the unnaturally occurring reservoirs created by dams (ex. Thompson Falls Reservoir). Northern pike numbers in the Clark Fork River portion of the area were substantially reduced after the Milltown Dam east of Missoula was removed in 2011 but now appear to be stable in both abundance and distribution.

The illegal introduction of smallmouth bass may have occurred later than northern pike as they are not as widely distributed in the plan area despite being more accustomed to flowing waters. The largest concentration of smallmouth bass on the Forest currently is in the Clark Fork River between Thompson Falls and Paradise and upstream into the Flathead River. This portion of the Clark Fork appears to be somewhat of a transportation corridor for smallmouth bass that are more abundant in the Noxon Reservoir downstream of the plan area and large sections of the Flathead River to the north. In fact, Montana Fish, Wildlife, and Parks and other management partners have allowed smallmouth bass to be passed upstream of the Thompson Falls dam via the fish ladder in recent years because they are already ubiquitous above and below the dam. Smallmouth bass do not seem to continue upstream in the Clark Fork River and into other Lolo National Forest watersheds in detectable numbers for reasons that are unclear. However, smallmouth bass are becoming increasingly established in the Clearwater chain of lakes to include Salmon and Seeley lakes. With sizable source populations now on either side of the plan area and suitable habitat in between, it is likely that smallmouth bass will increase in number and distribution in coming years. Walleye (*Sander vitrieus*) are another cool-water species that often becomes established in western Montana watersheds but are currently restricted to the Noxon Reservoir by the Thompson Falls Dam. Fish ladder technicians ensure no walleye are passed upstream into other Lolo National Forest watersheds.

**American Bullfrogs** (*Lithobates catesbeianus*) are known to occur on the Lolo National Forest along the Clark Fork and Bitterroot Rivers and adjacent private ponds, based on the Montana Natural Heritage Program database in 2023. One inductive model (Montana Natural Heritage Program and Parks 2023) that predicts the current distribution and relative suitability of general year-round habitat for American Bullfrog at large spatial scales across the entire state of Montana, predicted medium and high suitable habitat mostly along the Clark Fork and Bitterroot Rivers with some low suitability habitat along the tributaries within Lolo National Forest.

**Snapping turtles** are non-native and invasive to Western Montana. They have been recorded on Rattlesnake Creek (pet released) and backwaters of the Clark Fork River near Milltown. One model from the Montana Natural Heritage Program predicts the current distribution and relative suitability of general year-round habitat for snapping turtles at large spatial scales across the entire state of Montana, identified moderate suitable habitat along the Clark Fork River and low suitable habitat in some of the creeks within Lolo National Forest. Typically, snapping turtles spend most of their time under the water buried in mud, only coming to the surface to breathe and find nesting sites (Montana Fish Wildlife and Parks 2022b). They prefer muddy or sandy bottom aquatic habitats with ample vegetation or debris, like those of sloughs, backwaters, and ponds (Reichel 1995). The western Montana population dispersal pathway is most likely human introduction, walking from one waterbody to another, and along riparian corridors (Montana Fish Wildlife and Parks 2022b). Snapping turtles are resilient and voracious predators that can overtake a pond or lake ecosystem and severely impact native populations of fish, waterfowl, amphibians, and possibly native turtles (Moldowan et al. 2015); however, their very low recruitment rate (Montana Fish Wildlife and Parks 2022b) and heavy predation to their nests combined with other threats to their young may reduce their threat to native species and habitat. The Montana Fish, Wildlife and Parks received (Montana Fish Wildlife and Parks 2022b) only three reports of juvenile snapping turtles during the 2022 trapping effort in the Swan Lake area and no juveniles were trapped. It was also recommended that monitoring, trapping, and public education continue.

## 2.1.7 Mining

The Lolo National Forest has a long history of mining and mineral development across and adjacent to the administrative boundary. Legacy mining has resulted in a cascade of environmental impacts across the forest that now comprises an important component of the forest's program of rehabilitation work involving substantial partner cooperation and coordination. Current and forecasted interest in mineral development across the forest is relatively limited. The current regulatory framework in tandem with 1986 forest plan direction has provided an effective framework for managing mining requests and mitigating or avoiding legacy effects at the scope and scale seen historically. This section focuses on the influence of mining as an ecosystem stressor; refer to section 3.10.4 for more information on mineral resources and mining as a multiple use on the Lolo National Forest.

There has been a history of mining on the Lolo National Forest dating from the 1860s to the turn of the 20$^{th}$ century. Early mining activities began with the discover of placer gold deposits, generally focused on precious metals. Although hard-rock mining has occurred, the most significant mineral deposits currently being worked are associated with placer mines. Some areas on the Forest have a moderate to high occurrence and development potentials for metallic minerals. While there have been no economic discoveries of oil and gas resources west of the Continental Divide, the areas underlying and immediately adjacent to the west flanks of the Glacier Park and Swan Ranges have been recognized as having high potential for the occurrence of oil and gas. Coal bearing units also exist, either at the surface or at depth, west of Missoula near Frenchtown and in the Ninemile valley area. There is low potential for geothermal development on the Lolo National Forest.

Legacy mining effects on land productivity and water quality form the focus of the Forest's restoration program of work. Impacts include direct effects from mining across National Forest lands and indirect effects from mining on adjacent or nearby private lands. Many streams across the Forest are 303(d) listed for impairment related to past mining and multiple mainstem and tributary streams have been designated as Superfund sites under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. A variety of projects across the Forest are ongoing to address environmental damage in coordination with the Environmental Protection Agency and the Montana Department of Environmental Quality. Nancy Lee, Tarbox, St. Louis Creek, Kennedy Creek, and Flat Creek are all recent (within 20 years) or current superfund and CERCLA cleanup sites.

The Ninemile watershed is one example of legacy mining impacts and rehabilitation work. The Total Maximum Daily Load process completed by Montana Department of Environmental Quality in 2006 identified probable causes and sources of impairment. Sedimentation, low flow alterations, and habitat alterations were identified as impairments in the mainstem or selected tributaries. In the mainstem Ninemile valley bottom, dredging straightened over five miles of Ninemile Creek and left linear waste rock piles that impaired aquatic habitat, reduced baseflows, and created long-term water quality issues. Starting in 2015, the Lolo National Forest partnered with Trout Unlimited, Montana Fish Wildlife and Parks, Missoula County, Montana Department of Natural Resources and Conservation and Department of Environmental Quality to address mining impacts. Since that time, over $7,000,000 as of 2023 have been spent to remove waste rock and restore channel and floodplain systems. Over five miles of channel or valley bottom rehabilitation have been completed in the mainstem and tributaries, yielding measured improvements in baseflow, water quality, and aquatic habitat by reducing land loss and sedimentation. The highest sediment loading in the basin had placer mining origins that as of 2022 have been remediated.

The Montana Bureau of Mines and Geology, in coordination with the Forest, inventoried and conducted a preliminary characterization of abandoned and inactive mines in the administrative boundary. This inventory included an assessment of human health and environmental risks at each site. Methods and findings of this effort were documented in Montana Bureau of Mines and Geology Open File Report 476 (Hargrave et al. 2003). In total, 109 sites were visited and existing or potential water quality exceedances were noted at 19 of them (ibid). This report represents the best available information regarding current mine-related water quality exceedances across the Forest. Another iteration of water quality characterization may be warranted at these sites to better inform management needs.

Considering the existing portfolio of mine-related water and aquatic restoration work and the continued backlog of restoration needs across the Forest, mine-related restoration is likely to continue in coming years. Administration of mining activity under the 1986 plan in tandem with other relevant regulatory authorities has limited the magnitude and extent of resource adverse resource effects compared to mining administered prior to 1986. Cumulative effects of small mining operations continue to be evaluated.

## 2.1.8 Livestock Grazing

This section provides an overview of the influence of livestock grazing as an ecosystem stressor; refer to section 3.10.2 for information on livestock grazing as a multiple use. Capable and suitable rangelands are limited on the Lolo National Forest. Challenges to managing livestock include rangeland conversion to other land uses and maintaining resilient productive rangeland ecosystems with associated multiple-uses and climate variables. Since the 1950s, grazing use has generally been declining. Current grazing uses consist of 11 cattle grazing allotments (figure A1-26); there are no active allotments for sheep or goats.

A considerable amount of the literature has focused on assessing the environmental and ecological impacts of grazing federally managed public land (Runge et al. 2018). Literature suggests that grazing has substantial environmental impacts, both beneficial and harmful to some conservation goals (Krueger and Sheley 2002). The Rocky Mountain Research Station GTR374 (McKelvey and Buotte 2018) provides reference that generally U.S. rangelands are not improperly grazed to the point of degradation, and improper grazing is not the normal condition across rangelands in the Northern Region.

Unwise use by livestock can be a common cause of deteriorated riparian zones in western rangelands (Knopf and Cannon 1981). Improper livestock grazing can have numerous direct and indirect effects on soil infiltration by trampling, compaction, and loss of vegetation cover on both upland and riparian sites. Impacts are often greater in riparian zones because livestock seek shade, water, and succulent vegetation in which these areas provide (Andrew et al. 2004). Overuse by livestock in riparian zones can reduce bank stability through vegetation removal and bank trampling, increase soil compaction and sedimentation, cause stream widening or down cutting, and can change vegetation composition (Platt 1991). Other ecological challenges that may arise in grazing allotments can include the spread of noxious weeds and the presence of nonnative invasive forage species. Additional information found in the invasive species section (section 2.1.6).

A Columbia River Basin analysis and evaluation of stream attributes included streams in reference and managed areas, which included areas within portions of the Lolo NF. The data used to determine the status and trends of stream conditions in reference and managed stream reaches were collected as part of a large-scale stream reach monitoring program within the Interior Columbia River Basin. The literature indicated the general status and trend of stream conditions were improving within the study area (Roper et al. 2019). All allotments and site-specific streams within the Lolo NF may not be reflected by the study area and was a broadscale approach within the Columbia River Basin to assess trend.

To address the potential resource impacts of livestock grazing, the 1986 Plan incorporated grazing standards. Adaptive management practices used in allotment management plans include deferment and rest from grazing, cultural and mechanical vegetation treatments, infrastructure to control livestock, and conservation measures to protect federally listed plants and animal species. Current management of grazing seeks to maintain the ecological integrity of rangeland ecosystems. The reduction in upland grass and herbaceous fuels caused by grazing may be a positive management objective in some places. Disturbances can impact grazing practices; for example, areas affected by drought or burned by wildfire may need to be rested from grazing while the vegetation recovers.

Adaptive strategies for managing livestock and the greatest success with ecosystem resilience may be achieved by managing within the carrying capacity, adjusting stocking rates to allow plant recovery, adjusting season of use, deferred grazing systems, and increasing the time or rest between periods of grazing.

According to the 2021 Biennial Monitoring Report for the Lolo National Forest, livestock use is being managed with the carrying capacity of the existing allotments and that the Lolo National Forest has been successful with managing and updating the existing permits and achieving forest plan direction. Impacts have and continue to occur in some wetlands and stream segments; future monitoring is planned to improve our understanding, and impacts will be further addressed with appropriate remedial actions.

## 2.1.9 Forest Vegetation Management

Forest vegetation management includes activities such as timber harvest, prescribed fire and other fuel reduction treatments, reforestation activities, and other stand tending activities such as precommercial thinning. These actions are drivers of vegetation change and have the potential to influence vegetation conditions trends at both the stand-level and landscape-scale depending on the type of treatment, the spatial extent and placement of those treatments. Timber harvest on the Lolo National Forest had the greatest role in influencing forest conditions during from 1920 to the 1990s which corresponded with a moister climate and fire suppression that limited the influence of other ecosystem drivers such as wildfire and insects. Since the 1800s, the timber-harvest industry has played a major role in the development of rural communities and culture, and helped establish the infrastructure needed to accomplish forest management activities which remain important today.

Forest vegetation management activities that are focused on improving resilience or resistance to natural disturbances may include mechanical harvest or fuels manipulations such as hand thinning and piling, prescribed fire, or a combination of activities. Typical outcomes of activities may include: 1) reducing overall stand densities; 2) reducing canopy fuels, heavy surface fuels, and ladder fuels; 3) increasing the mean diameter of trees in stands, and 4) shifting composition toward the more drought- and fire- tolerant species as appropriate for the site. The application of prescribed fire is also important to achieve other ecological objectives in fire-adapted ecosystems including but not limited to nutrient cycling, fire hardening of certain tree species for long-term snag retention, creation of seedbeds for reforestation, and reducing accumulated fuel loading while stimulating understory vegetation response.

Timber harvest is a tool used not only to provide timber products and contribute to the local economy but also to achieve multiple resource objectives. The objective of any timber harvest project varies depending on the location and local landscape conditions, but objectives may include reducing insect or disease impacts, improving wildlife habitat, altering vegetation conditions to enhance forest resiliency, reducing fuel loadings and fire risk, increasing tree growth rates, and improving timber productivity. Timber harvest especially in conjunction with prescribed fire will continue to be a valuable tool in the future to maintain ecological integrity as evidence suggests that proactive management can prepare many landscapes for future wildfires and the maintenance work they can provide (Hessburg et al. 2021).

Regeneration harvest refers to any removal of trees intended to assist in the regeneration of a new age class or to make regeneration of a new age class possible (Forest Service Handbook 1909.12.60). Regeneration harvest may include even-aged, two-aged, and uneven aged methods. In particular, even- or two-aged regeneration harvests that remove most existing mature trees and establish a new forest dominated by seedlings are important methods to adjust species composition, increase forest structural diversity across landscapes, and establish early successional plant communities. An intermediate harvest entry modifies an existing stand and does not promote the establishment of regeneration. Intermediate harvest is a collective term for any treatment or tending designed to enhance growth, quality, vigor, and composition of the stand after establishment or regeneration and prior to final harvest (Forest Service Manual 2470). There are many possible purposes for intermediate harvest, including modification of species composition and structure for a variety of objectives such as improved resiliency to disturbances, as well as enhancing the quality, growth, or commercial value of trees. Variants of intermediate cuttings include commercial thinning, improvement harvest, sanitation, salvage, and liberation harvest. Reforestation and other non-commercial stand tend treatments (such as pre-commercial thinning) are often conducted to meet objectives or maintain desired conditions in harvested stands over time.

Following harvest, treatment of ground fuels, surface fuels and ladder fuels is often necessary to meet desired conditions with respect to fire resilience and fuel loadings. There is increasing scientific evidence that thinning stands without dealing with the fuels that is generated by the thinning activity can increase the intensity of subsequent wildfires in the short-term (North et al. 2007, Ager et al. 2010, Kalies and Yocom Kent 2016), and that the combination of mechanical treatment followed by fire is the best approach to achieve fuels reduction and improve fire resilience and ecological function. Prescribed fire is the primary technique for dealing with slash, small residual trees, surface and ladder fuels, and some ground fuels (litter and duff). Prescribed fire may take the form of underburning, broadcast burning, or burning fuel concentrations, such as jackpot burning and the burning of hand piles. The type of fire applications applied is dependent on the objectives of treatment, such as desired levels of fuel consumption and tree mortality. Mechanical forms of fuel treatment, such as mastication, may be an alternative where fire cannot be used. Prescribed fire and fuel reduction activities are also used without harvest activities, as stand-alone management tools to achieve desired vegetation conditions. In many areas, the application of prescribed fire is the best or only tool to influence vegetation condition.

Table 9 shows the acres of regeneration harvest, intermediate harvest, and fuels treatments that occurred from 2018-2021 as reported in the 2021 Biennial Monitoring Evaluation Report for the Lolo National Forest(U.S. Department of Agriculture 2022a).

**Table 9—Vegetation treatment summary 2018-2021. Data source: FACTS**

| Activity | 2018 Accomplished Acres | 2019 Accomplished Acres | 2020 Accomplished Acres |
|---|---|---|---|
| Acres regeneration and removal harvests | 5,023 | 3,061 | 3,828 |
| Acres planting prior regeneration harvests | 126 | 37 | 167 |
| Acres intermediate harvest to reduce forest density | 264 | 918 | 3,593 |
| Acres stand improvement activities | 1,763 | 403 | 1,366 |
| Acres mechanical fuels treatments not related to timber harvest | 9,295 | 3,610 | 5,035 |
| Acres of prescribed burning | 9,674 | 7,727 | 1,909 |
| Acres planting following wildfire | 977 | 1,244 | 2,427 |
| **Total** | **27,122** | **17,000** | **18,325** |

Forest vegetation management practices are used to meet multiple resource objectives including providing for jobs and wood products to communities; improving forest health, vigor, and productivity; and providing for vegetation diversity. In recent decades, management practices are primarily used to assist in restoration of ecosystem processes, improve resilience, promote certain wildlife habitats, to reduce or alter fuels to modify or change fire behavior, or to meet a combination of these objectives. Relative to other ecosystem drivers and stressors such as insects and disease or wildfire, vegetation management has a relatively small footprint on the Lolo National Forest. Nevertheless, forest management practices have influenced ecosystem conditions in many areas. Vegetation management remains an extremely effective tool for achieving desired vegetation conditions in key areas such as the wildland urban interface and can have meaningful landscape-scale restoration impacts when designed and implemented strategically (Ager 2013, Hessburg et al. 2021). Many factors, such as law, policy, regulations, public expectations, and litigation affect the scope and scale of the role that vegetation management plays on the landscape.

### 2.1.10 Recreation

Recreation opportunities across the Lolo National Forest provide a wide variety of activities and settings to connect people to the land and add value to the quality of life for visitors and local communities. Trends in uses and additional information regarding recreation are detailed in section 3.4. This section focuses on recreation as a stressor on forest resources and ecosystems.

While some recreational uses create very little impact on forest and aquatic ecosystems, other uses can be very impactful and present challenges if unmanaged. Dispersed camping is a common ecosystem stressor associated with recreation on National Forest system lands. This involves camping in areas that do not provide infrastructure or facilities to support use and are not managed as developed recreation site or campgrounds. When unmanaged dispersed camping areas receive high and frequent use, health and safety issues and resource issues, such as sanitation, compaction, vegetation impacts, and erosion, can result. As use continues, additional infrastructure and recreation management may be needed to reduce resource impacts and manage these uses. Management approaches, including, but not limited to, site hardening, installing barriers to manage parking and concentrate use areas, and installing toilet and garbage collection facilities. Additionally, management often emphasizes visitor education and enforcement of Leave No Trace principles and pack-in pack-out policies to reduce resource impacts.

Instream wood is an essential ecosystem component serving many purposes with primary functions of flood energy dissipation and fisheries habitat. Most valley bottom streams are significantly lacking in wood as compared to historic conditions, and more wood is needed in most stream systems to improve the health of theses ecosystems. Concurrently, large instream wood and wood jams can be inconvenient or even hazardous to recreationists in terms of blocking passage to floaters and entrapment. This challenge presents a situation where public safety directly conflicts with ecological needs in these riparian systems. Various agency officials, professional outfitters and guides, and members of the public have discussed this challenge on several occasions on rivers such as the Bitterroot River, Clark Fork, and Rock Creek. With an increase of boating, rafting, and floating on rivers across the Forest, further conversations in meeting both resource needs and supporting safety will be needed.

In some cases, developed recreation opportunities are operated and maintained through special use authorizations, such as developed ski areas. For these operations, the construction and maintenance of roads, access routes, pipelines, power lines, water wells, diversions, storage tanks, reservoirs, and other facilities can encroach directly on drainages and flood prone areas, alter water yield and runoff regimes, cause erosion/land loss and sediment delivery to streams (Burt and Rice 2009, David et al. 2009). As with all development, facilities such as buildings, parking lots, and sanitary systems can also contribute pollutants to water quality.

As the level of development of recreation opportunities increase, so does the infrastructure required to support those areas. The ability of the forest to maintain those features varies as staffing and budgets fluctuate. Public health and safety are prioritized, followed closely by reducing resource impacts. In recent years, additional funding sources and partnerships have allowed the forest to address backlog maintenance at developed recreation sites. Information regarding additional Great American Outdoors Act funding is found under section 3.4.

## 2.1.11 Infrastructure

Infrastructure on the Lolo National Forest includes roads, trails, recreation infrastructure, administrative facilities, bridges, utilities, and dams. Roads, trails, and recreation infrastructure provide mechanisms for people to access and enjoy the National Forest. In addition, the road network facilitates land management activities such as timber harvest, hazardous fuels reduction, and restoration activities. Refer to section 3.7 for more detailed information on the conditions, status, and trends of infrastructure on the Lolo National Forest. This section focuses on the role of infrastructure as a stressor for ecosystems.

Transportation corridors are one of the most prominent threats to watersheds and aquatic ecosystems. Stressors on systems are singular and/or cumulative depending on the resource impacted and variety of scenarios such as location, condition, quantity, and/or sensitivity to climate change impacts. Examples of stressors are barriers to aquatic organism passage (e.g. fish passage) such as roads and diversion dams, water quality issues cause by erosion and sedimentation, encroachment on stream/floodplain structure and functions, large wood loss, shade loss, vegetation trampling, among many others.

Transportation system location, use, and maintenance can affect forest and aquatic ecosystems. Poorly maintained roads and trails can extend channel networks via interception and routing of water, increase sediment delivery, reduce stream access to floodplains, and interfere with woody debris and other nutrient cycles. Roads can also impact wildlife habitat connectivity by creating barriers to both aquatic organism passage and wildlife habitat passage at road/stream crossings where structures are not sufficiently sized or poorly located. Stream crossings are often located in lower gradient stream segments where fish would typically spawn, which the structure presence can either preclude spawning, or in the case of a stream ford, trample fisheries eggs and fry. A properly installed stream crossing structure reduces new streambed substrate disturbance; however, the approaches to these crossings are still likely to be sources of fine-grained soil delivered to the stream, adding to the level above base rates. The aquatic biota of intermittent streams is also sensitive to these activities (Mullins et al. 2005). Poorly located trails and roads that run along streams are also impactful, especially if the stream begins running down the road or trail or is captured completely. Infrastructure higher in watersheds can likewise fragment movement corridors for terrestrial species, disturb native plant species, lead to introductions of non-native plant species, and threaten soil and archeological resources. To the degree that they facilitate human presence and disturbance, roads, trails, and recreational developments and can impact organisms that require undisturbed habitat or seclusion.

There are approximately 3,165 miles of road open for public use either seasonally or year-round. There are also “undetermined roads” across the Forest which are not managed as part of the transportation system. Many of these routes are legacies of past management that are discovered during project planning and implementation activities and have not been evaluated with respect to their inclusion in the transportation system. Nearly half of known undetermined roads are located on recently acquired lands.

In general, most forest roads, developed recreation sites, and trails are clear of floodplains, alluvial fans, and wetlands such that they do not generally impact aquatic systems. However, the Lolo contains many miles of roads within 100 feet of waterbodies where roads can impair the natural function of riparian and aquatic ecosystems. Sections 2.7.2 and 3.7 describe management efforts and trend of road decommissioning, which has resulted in removal of undersized culverts that were fish barriers. Efforts have removed hundreds of miles not needed for the long-term transportation system, reduced maintenance costs, and improved impacted wildlife, fish, and water quality. The Lolo National Forest implements Best Management Practices along with many other project design features and resource protection measures when implementing management projects. Routine road maintenance is performed, including actions such as culvert cleaning. These efforts collectively contribute to ameliorating the negative impacts of the road network and associated impacts to resources and result in an overall trend of improvement.

Unauthorized off-road and off-trail use by motorized and non-motorized vehicles creates another unmanaged recreation challenge. In addition to the impacts resulting from transportation systems as previously described, these unauthorized uses result in damage to sensitive ecosystems, resources, and disturb wildlife. Evidence of off-road vehicle activity is readily apparent in riparian areas. In moderately used areas, this may consist of visible tracks, while in heavily used areas vegetation may be completely denuded. As pressure on forest infrastructure increases and new uses are developed, existing forest infrastructure should be managed to support these uses and encourage visitor to stay on managed and authorized road and trail systems.

The Lolo National Forest also manages dam infrastructure under various management scenarios depending on the dam type and usage. Dams range from small diversion dams associated with water rights, to lake elevation control, to large dam complexes within the Rattlesnake Wilderness Area. The dam complexes in the Rattlesnake Wilderness area are not owned by the Forest; they are operated and managed through a special use authorization. These dams have not been used for water delivery in more than 30 years, suffer from a lengthy maintenance backlog, and are largely non-operational.

# 2.2 Terrestrial Ecosystems

## 2.2.1 Introduction

In this section, status and trends of ecological integrity are described for terrestrial ecosystems. The analysis for terrestrial ecosystems provides results for the National Forest System lands on the Lolo National Forest. However, ecosystem conditions and trends do not follow administrative boundaries. It is important to understand the broader context of the landscape to provide a comprehensive understanding of ecosystems and foster an "all-lands approach". Therefore, vegetation data and modeling processes were applied across all lands within and immediately adjacent to the Lolo National Forest. In appendix 5, detailed tables of conditions across all lands provide results for both National Forest System lands and lands of other ownerships in the analysis area. Appendix 3 provides more information on the natural range of variation analysis.

### Information Sources

This analysis draws on the best available scientific information relevant to the ecosystems on the Lolo National Forest. Literature sources that were the most recent, peer-reviewed, and local in scope or directly applicable to the local ecosystem were selected and cited. Uncertainty and conflicting literature is acknowledged and interpreted when applicable.

- Forest Activity Tracking System: The Forest Activity Tracking System is the activity tracking database used to record management and natural events on National Forest System lands. Information in this database is used to quantify the extent and type of management actions that have occurred or are planned to occur. Spatial and tabular information is required when activities occur. This database is the newest of several databases developed over the years and used by the Forest Service in the Northern Region; older records from previous systems are incorporated. The earliest activity records date back to the 1940s or 1950s, when activity tracking protocols were adopted. Older records are likely not as accurate due to improvements in modern record keeping. Site-specific records of harvest activities during the initial settlement of the area are not available but are addressed qualitatively using other information sources such as boundary reports compiled when National Forest Reserves were proposed.
- Northern Region Existing Vegetation Database: Mapping of current vegetation is based on the USDA Forest Service Northern Region vegetation database (VMap). VMap is a geospatial dataset developed using the Northern Region existing vegetation classification system (Barber et al. 2011). It is a remotely sensed product derived from satellite imagery, airborne acquired imagery, field sampling and verification. Detailed metadata for this database can be found in the project file. The VMap data used for this analysis was developed in 2016 and updated with major disturbances though 2022. Accuracy of the VMap data varies depending on the particular attribute (Ahl and Brown 2017).
- Forest Inventory and Analysis and the Northern Region Summary Database: This analysis draws on measurements collected on spatially balanced forest inventory and analysis (FIA) grid plots. The forest inventory and analysis grid is a nationwide grid which includes 363 plots on the Lolo National Forest. This dataset is used to display estimates because it spatially represents all National Forest System lands. Forest inventory and analysis plot data is summarized in the Northern Region summary database, which includes statistical reporting functions and derived attributes (Bush and Reyes 2015, Bush et al. 2016).

Forest Inventory and Analysis and VMap are distinctly different data sources used to estimate current vegetation conditions. Each dataset has advantages and disadvantages; depending on the application, both datasets are used in this assessment. Because Forest Inventory and Analysis data is spatially balanced and measured at regular intervals using the same methods, it is ideal for broad scale assessment and monitoring. However, because there is only approximately one plot per 6,000 acres, this data is less useful at finer spatial scales. Forest Inventory and Analysis data is essentially nonspatial and cannot be used to understand how attributes vary across space or at finer spatial scales such as potential vegetation types. While VMap data is spatial and offers wall-to-wall coverage for a suite of forest attributes, it is based on image classification models (not direct measurements) and can only be used to estimate stand-level averages for characteristics such as stand size, density or dominance type. See Appendix 5 for a description of the datasets, an analysis of their differences, and potential causes underlying them.

## Defining Terrestrial Ecosystems: Potential Vegetation Types

Potential vegetation was used as the primary means of defining and mapping terrestrial ecosystems. Potential vegetation represents the plant community expected under historical climatic conditions in the absence of significant natural or human-caused disturbance (Pfister and Arno 1980). Potential vegetation provides a basis for understanding ecological dynamics including successional development (Arno et al. 1985), fire regimes (Fischer and Bradley 1987, Barrett 1988, Morgan et al. 2001) and site productivity (Milner 1992). While there are theoretical and practical limitations to the use of potential vegetation types (Chiarucci et al. 2010), the framework is powerful when used correctly and key assumptions are understood (Somodi et al. 2012).

The Forest Service's Northern Region has identified potential vegetation groups called Broad Potential Vegetation Types that are recommended for use at broad spatial scales to facilitate consistent analysis and monitoring (Milburn et al. 2015, Roberts 2022). Each R1 Broad Potential Vegetation Type is assessed as an ecosystem – a spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and elements of the abiotic environment within its boundaries (36 CFR 219.19). Each ecosystem, in turn, can be described in terms of its structure, composition and function – both in terms of natural range of variation and the current condition. In contrast to potential vegetation, existing vegetation describes what *currently* exists on a particular site. The characteristics of existing plant communities can be highly variable over time and space within a potential vegetation type. The existing conditions reflect a particular site's unique disturbance history, landscape setting and biophysical characteristics.

Figure A1-27 and Table 10 show the approximate distribution and extent of the Broad Potential Vegetation Types on the Lolo National Forest. Warm Dry and Cool Moist Forests are the most common.

**Table 10—Broad potential vegetation types found on the Lolo National Forest**

| Broad potential vegetation types | Plan area (percentage estimate) | Plan area (estimated acres) |
|---|---:|---:|
| Alpine | <1 | 3,116 |
| Mesic Grassland | <1 | 12,442 |
| Not Classified | <1 | 18,064 |
| Sparse | 1 | 27,999 |
| Riparian Wetland | <1 | 4,674 |
| Xeric Grassland | <1 | 12,442 |
| Warm Dry Forest | 41 | 928,407 |
| Cool Moist Forest | 35 | 788,432 |
| Cold Forest | 10 | 225,486 |
| Warm Moist Forest | 10 | 236,889 |

Note: Data source is Forest Inventory and Analysis data. These estimates are based on Forest Inventory Analysis plot data and do not match the distribution of mapped potential vegetation types.

## Assessing Ecological Integrity

As required by the 2012 Planning Rule, terrestrial ecosystems are assessed using the concept of ecological integrity as a guiding framework. The rule defines ecological integrity as the quality or condition of an ecosystem when its dominant ecological characteristics (for example, composition, structure, function and connectivity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence (36 CFR 219.19). By capturing the ability of ecosystems to "withstand and recover from most perturbations," this definition describes resilience as a fundamental component. Moreover, the 2012 Planning Rule explicitly puts the natural range of variation at the core of assessing ecological integrity. As the definition suggests, it is assumed that maintaining ecosystems within the natural range of variation will provide resilience. Ecological integrity forms a crucial part of the plan's ecosystem-based approach for a conservation strategy—for example, a habitat-based approach, versus species-specific management (Hunter et al. 1988). A key assumption of this approach is that intact ecological conditions mean habitats, and the species dependent on them, persist (Agee 2003). It is assumed that by maintaining these conditions, critical ecological and evolutionary processes such as nutrient cycling and sediment transport, biotic interactions, dispersal, gene flow and disturbance regimes, will also be maintained and provide the necessary environmental conditions for climate adaptation (Beier and Brost 2010).

Wurtzebach et al. (2016) outline some key characteristics and assumptions associated with the ecological integrity framework. They note that ecological integrity:

- Emphasizes the importance of ecological processes such as natural disturbance regimes that provide the structures and functions upon which the full complement of species in an ecosystem or landscape depends.
- Assumes that ecological systems that retain their native species and natural processes are more resistant and resilient to natural and anthropogenic stresses over time (including climate change).
- Emphasizes the intrinsic value of native biodiversity of ecosystems, beyond its functional role in supporting the renewal and reorganization of ecosystem function and structure over time.

- Uses the natural range of variation as a reference point for promoting resilience (the capacity to reorganize while undergoing change to still retain essentially the same function, structure, identity, and feedbacks).
- Ecosystem integrity is typically assessed by considering dominant ecosystem components including function, composition, structure and connectivity *(Andreasen et al. 2001)*. Composition refers to attributes associated with the species within an ecosystem, such as species dominance, richness, or evenness. Structure generally refers to physical features, such as stand density or tree size. Function encompasses ecological processes such as herbivory, succession, and fire. Connectivity denotes the degree to which the landscape facilitates or impedes movement among resource patches.

Specific key ecosystem characteristics representing ecological function, composition, structure, and connectivity have been identified. Key ecosystem characteristics are measurable (for example, quantitative or qualitatively) and there is data or means to distinguish and describe them. Estimated changes in key ecosystem characteristics over time serve as the basis for evaluation of ecological sustainability and forest resilience. In this section, we assess elements of composition and structure across all forested ecosystems. Functional characteristics are addressed in section 2.1; connectivity is discussed in section 2.4. Key ecosystem characteristics used for these elements of terrestrial ecosystems include:

- Composition: cover type
- Structure: size class, large-tree structure, density class, vertical structure, old growth, and snags
- Function: wildfires, insects and disease, climate change, and other drivers and stressors.

Each ecosystem is assigned a level of integrity based on the following criteria:

- **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 identify 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 identify 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.

## 2.2.2 Summary of Terrestrial Ecosystems

Eighteen ecosystems on the Lolo National Forest have been assessed (Table 11); some of these ecosystems overlap with each other. Many ecosystems are at moderate or high integrity; however, eight ecosystems are estimated have a low or poor level of ecosystem integrity. Ecosystems with low or poor integrity may require actions to improve and change their expected trend, while management in ecosystems with higher integrity may emphasis maintenance of existing conditions and trends.

**Table 11—Summary of terrestrial ecosystem integrity on the Lolo National Forest**

| Terrestrial Ecosystem | Ecological Integrity | Restoration Potential | Confidence |
|---|---|---|---|
| Warm dry forest, lower elevation | Low | High | High |
| Warm dry forest, upper elevation | Moderate | High | High |
| Warm moist forest | Low | High | Moderate |
| Cool moist forest | Moderate | Moderate | High |
| Cold forest, lower elevation | Moderate | Low | Moderate |
| Cold forest, upper elevation | Low | Moderate | Moderate |
| Whitebark pine parklands | Poor | Low | Moderate |
| Western redcedar bottomlands | Moderate | Moderate | Moderate |
| Subalpine larch | Low | Moderate | Moderate |
| Aspen stands | Moderate | Moderate | High |
| Cottonwood forest | Low | Low | High |
| Xeric grasslands | Low | Moderate | High |
| Mesic grasslands, lower elevation | Low | Moderate | High |
| Mesic grasslands, upper elevation | Moderate | Moderate | High |
| Xeric shrublands | Moderate | Moderate | Moderate |
| Mesic shrublands | Moderate | Moderate | Moderate |
| Alpine and sparse, high elevation | High | Low | Moderate |
| Sparse, low elevation | Moderate | Moderate | Moderate |

## 2.2.3 Coniferous Forest Ecosystems

Coniferous forests are defined as the land area occurring on habitat types (sensu Pfister et al. 1977) classified as "forested" types by the Northern Region (U.S. Department of Agriculture 2005). For management and analysis, the Northern Region has hierarchically grouped individual forested habitat types in to meso-scale vegetation classes known as habitat type groups (Roberts 2022) and to coarse-scale vegetation groupings known as broad potential vegetation types (Milburn et al. 2015). Each entity in each classification scale of potential vegetation types can be defined as an ecosystem – a spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and elements of the abiotic environment within its boundaries (36 CFR 219.19). Here, we assess ecosystem integrity and characteristics at two scales: across all forested ecosystems of the Lolo National Forest and separately within each forested Broad Potential Vegetation Type.

### Key Ecosystem Characteristics Forestwide

The **species composition** of existing vegetation in forested ecosystems is characterized by cover types, which describe the species making up the plurality of vegetation (Barber et al. 2011, Milburn et al. 2015). Dominance types describe the most common plant species present. Region 1 Cover Types are groupings of dominance types that are used to simplify analysis for broad scale analysis (figure A1-27). Table 12 displays the approximate distribution of Region 1 Cover Types across geographic areas within the plan area. More information on the natural range of variation of cover types as it compares to existing conditions is provided for each potential vegetation type in subsequent sections of this assessment.

**Table 12—Distribution of Region 1 Cover Types (Milburn et al. 2015) across geographic areas of the Lolo National Forest. Data source: VMap**

| Cover type | Greater Missoula (%) | Lolo Creek (%) | Lower Clark Fork (%) | Middle Clark Fork (%) | Ninemile/ Petty Creek (%) | Rock Creek (%) | Saint Regis River (%) | Upper Blackfoot-Clearwater (%) |
|---|---|---|---|---|---|---|---|---|
| Grass/Shrub/ Forb | 19 | 25 | 16 | 16 | 7 | 21 | <5 | 36 |
| Larch Mixed Conifer | 11 | 5 | 9 | 6 | 9 | <5 | <5 | 9 |
| Lodgepole | 14 | 32 | 18 | 16 | 14 | 20 | 17 | 9 |
| Mixed Mesic Conifer | 22 | 15 | 43 | 25 | 29 | 38 | 57 | 27 |
| Ponderosa pine | 19 | 14 | 9 | 18 | 26 | 16 | 5 | <5 |
| Spruce/ Fir | 14 | 8 | <5 | 19 | 15 | <5 | 13 | 18 |
| Whitebark | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |

Unlike potential vegetation, the relative abundance of individual species and dominance types is constantly in transition. Without disturbance, species dominance would slowly transition from early seral, shade intolerant species to late seral, shade tolerant species. However, disturbances may intervene at any point in the successional trajectory. The exclusion of fire since modern settlement has resulted in a higher proportion of late seral, shade tolerant species at the expense of shade-intolerant types, a trend which mirrors that of the larger Northern Rocky Mountain ecoregion (U.S. Department of Agriculture 2003).

This is most evident in types where high frequency, low severity fires would have been common, such as the hot dry and warm dry habitat type groups. On many of these sites, Douglas-fir has become dominant over early seral species such as ponderosa pine. On more mesic sites, Douglas-fir can act like an early seral species, giving way to subalpine fir or spruce with no disturbance.

Feedbacks between composition, structure and function interact in ways that are important consequences for ecological integrity. For example, as species shift on a site, so do functional traits that influence interactions with fire (such as stand density, canopy fuels, and canopy base heights as well as tree species characteristics that include bark thickness, root depth, and retention of lower limbs, bark thickness or needle shape) which, in turn, has important consequences for populations (such as reproduction or germination strategies) with associated effects on wildlife habitat and other ecosystem services (Laughlin et al. 2016, Hagmann et al. 2021). Moreover, loss of heterogeneity in species composition and associated structural conditions leads the landscape more vulnerable to contagious processes such as insect outbreaks and disease epidemics and uncharacteristic wildfire (Agee 1994, Hessburg et al. 1994, Hessburg and Smith 1999, Jenkins et al. 2014).

Results of the natural range of variation modeling for the Lolo National Forest (appendix 3) are consistent with the trends seem across the interior west (Hessburg et al. 1999a, Stine et al. 2014, Hagmann et al. 2021). At lower elevations, where frequent fire regimes are most disrupted, forests have experienced a shift from early seral, fire-dependent species such as larch and ponderosa pine, to more shade tolerant and less fire-resistant species such as *Abies sp*. and Douglas-fir. In addition, the foundational ecological role of whitebark pine and western white pine have been severely compromised due to an invasive fungal pathogen that causes white pine blister rust disease (Hines 2013). The combined effects of blister rust and the loss of low- and patchy, mixed-severity fire has led to a species composition that is generally less fire tolerant, economically valuable, and more vulnerable to insects and disease. In some areas, these shifts in species composition have impacted ecological integrity, thereby compromising the ability of the Lolo to provide important cultural, regulating, and provisioning services (ibid).

**Forest density** is a measure of the area occupied by trees. The density of trees can influence tree growth and vigor; susceptibility to drought, insects and diseases, wildfires, and windthrow; and the rate of forest succession as well as other attributes such as vertical structure. These factors in turn affect whether the stand is suitable habitat for certain wildlife species. For this analysis, tree canopy cover is used as the measure of density. Canopy cover is the percentage of ground covered by a vertical projection of the outermost perimeter of the tree crowns, considering trees of all heights. Three canopy cover classes are considered here: open (10-40% canopy cover), medium (40-60% canopy cover) and closed (>60% canopy cover). Stands in a forested potential vegetation type with less than 10% canopy cover of trees is considered (currently) nonforested.

Canopy cover is low when the stand is in the earliest stage of succession and dominated by seedlings. As trees grow, crowns expand to fill up growing space, and canopy cover gradually increases. Growth of understory trees over time also adds to the canopy cover and vertical structure as the forest grows into the later successional stages. Disturbances and competition-based mortality can limit tree density. Site productivity also affects canopy cover, with more productive, moist sites supporting higher densities, and harsh sites with poor soils supporting lower densities. Frequent fire, particularly in the Warm Dry potential vegetation type, can maintain low canopy covers at all stages of forest succession.

Forest density influences wildlife habitat, forest resilience, timber productivity, and fire hazard. More open densities tend to be more resilient to fire as well as insects and diseases and promote the growth of large trees. Moderate densities tend to maximize timber production. Higher densities provide valuable wildlife habitat particularly in the more productive forest types with less frequent fire return intervals. Density also influences tree species composition and vice versa. For example, ponderosa pine and lodgepole pine are intolerant of shade and cannot survive in the lower canopy layers. Shade tolerant species, such as subalpine fir and spruce can prosper in dense stand conditions with limited light. Unless a disturbance reduces competition from shade tolerant species, intolerant species will die out. Some cover types, such as lodgepole pine, naturally grow at high density. Others, such as ponderosa pine, typically grow at more open densities with natural disturbance regimes.

Maintaining appropriate amounts and spatial distribution of high-density forest is a critical component of ecological integrity as these conditions provide cover and forage for wildlife. However, when high-density forest is too abundant or too spatially aggregated, the resistance and resilience of large landscapes may be at risk. In general, high-density forest has a greater likelihood of supporting a fast-moving intense crown fire due to greater fuel quantities and the vertical and horizontal continuity of fuels. Lower forest densities are therefore desired near communities or other values at risk from fire. In addition, as the density increases, individual tree growth slows, a deficit of soil moisture develops and trees lose their ability to withstand attacks by insects, pathogens, and parasites (Safranyik et al. 1998). Shifts towards lower-density forests would likely increase the large tree size classes and concentrations described above.

Figure 6 displays current forest-wide proportions of density classes and the natural range of variation. A density class distribution with the natural range of variation would contribute to ecological integrity. Currently, the open density class is below the natural range of variation, while the closed class is over-represented. Figure A1-30 displays a map of existing density classes.

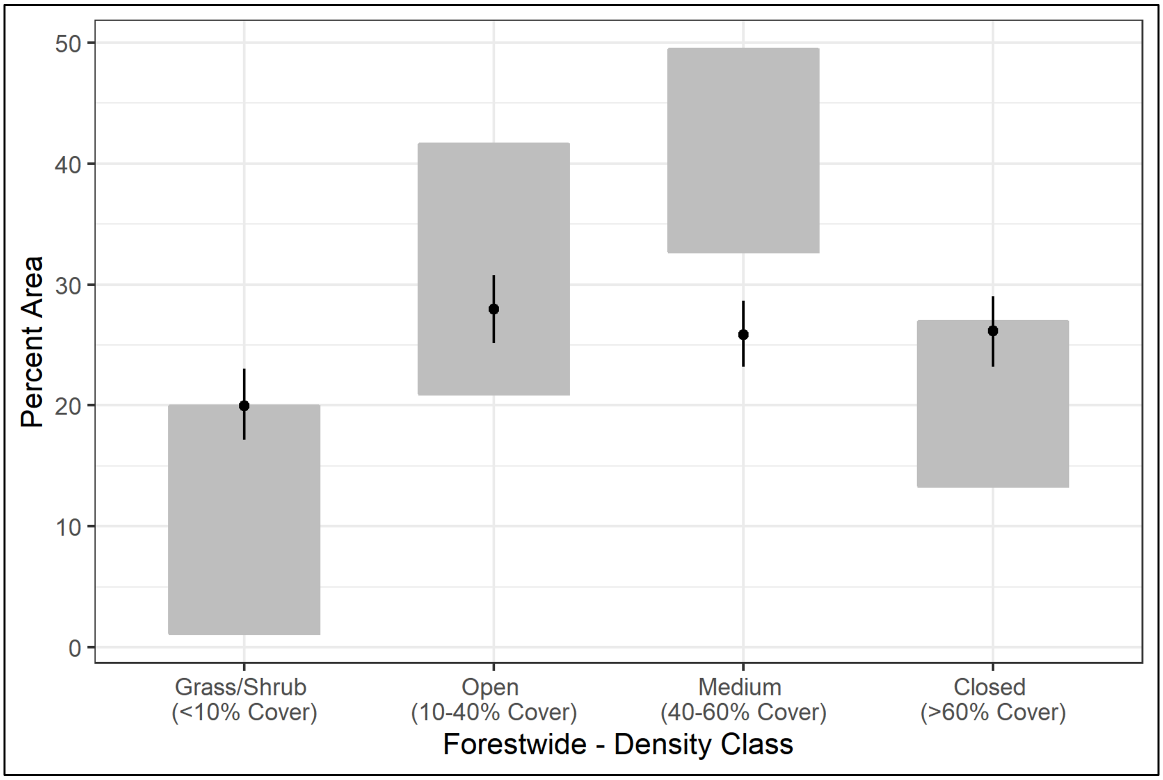


**Figure 6—Natural range of variability (grey bars) and current condition estimate (black points; error bars represent 90% CI) for the distribution of density classes across the forested area of the Lolo National Forest. Current condition estimates are based on Forest Inventory and Analysis data.**

**Size class.** Tree size is an indicator of the successional stage and age of forests. Forest size classes are defined based on the predominant tree diameter in the stand; it is expressed here as the mean basal area weighted average diameter. Basal area weighted average diameter is the average diameter of the live trees weighted by their basal area. Basal area weighted average diameter is less influenced by small trees than other methods of calculating a stand's average diameter such as quadratic mean diameter. Since management questions typically are concerned with the larger, dominant and co-dominant trees in a setting, and basal area-weighted average diameter is influenced, to a greater extent, by larger trees, it was selected by the Northern Region Vegetation Council to be used in the Northern Region existing vegetation classification system. Details on how forests are classified by size are described by Barber et al. (2011).

A stand with a small or medium size class (5-10" or 10-15" diameter at breast height) may still have an ecologically significant representation of large trees (>15" diameter at breast height) providing important structural element in forested ecosystems. For example, based on Forest Inventory and Analysis data, approximately 11% of stands in the pole size class (5-10") and 48% of stands in medium size class (10-15") contain at least 10 trees per acre greater than 15". This large tree structure in small or medium size classes is important wildlife habitat and confers and element of resilience as these trees are generally more fire resistant and fecund. A general association of the size class with tree age and forest successional stage is made based upon knowledge of the successional patterns on the Lolo National Forest. Figure 7 shows that compared to the natural range of variation, pole-sized forests have become more prevalent and very large forests are less common than they were historically. Figure A1-29 displays a map of existing size classes.

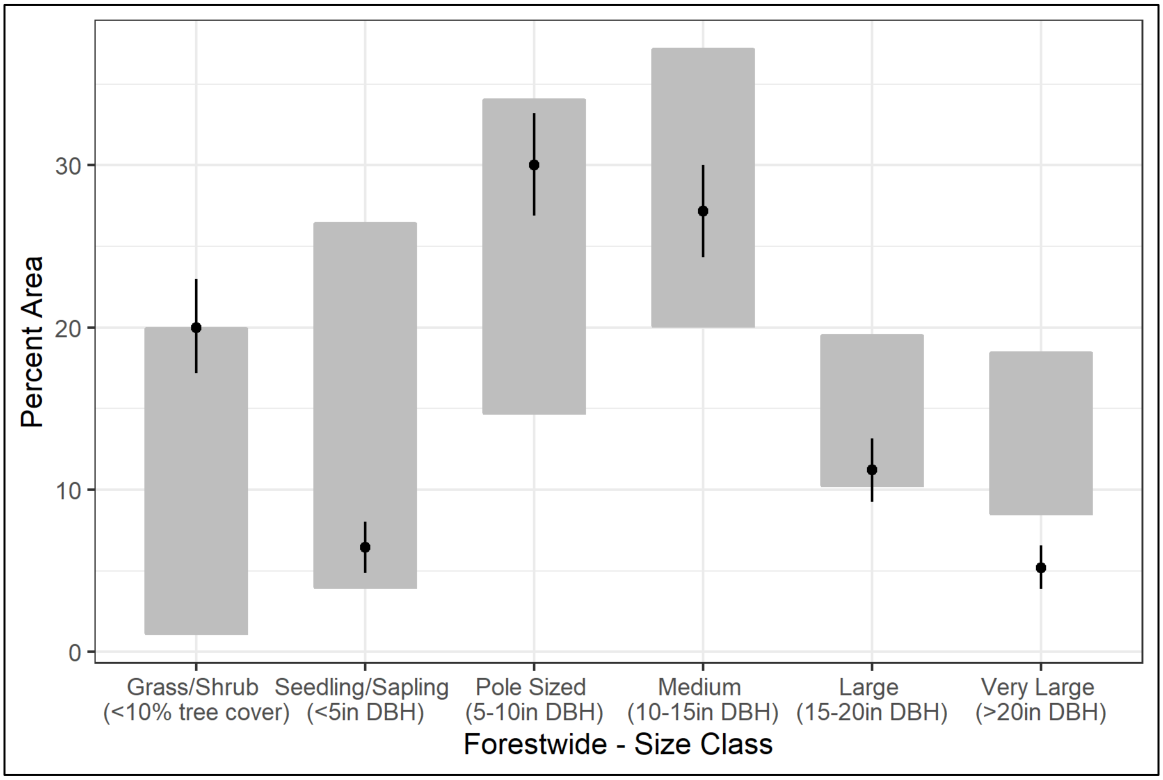


**Figure 7—Natural range of variability (grey bars) and current condition estimate (black points; error bars represent 90% CI) for the distribution of size classes across the forested area of the Lolo National Forest. Current condition estimates are based on Forest Inventory and Analysis data.**

**Old-growth and mature forests** are ecosystem characteristics of conservation concern recently highlighted by Executive Order 14072 (Biden 2022). This order emphasizes fostering resilience in an era of rapidly changing climate and recognizes the critical role forests play in slowing the pace of climate change and conserving biodiversity as well as their importance to local communities, providing forest products, and subsistence and cultural uses (U.S. Department of Agriculture and U.S. Department of the Interior 2023). The Executive order calls attention to the importance of old-growth and mature forests on Federal lands. These forests are at risk from climate-related stressors and disturbances, potentially requiring climate-informed interventions to reduce these risks (ibid).

Old-growth forest represents a relatively small amount of total forested area at broad scales yet comprises a large fraction of forest wood volume, biomass, and carbon stocks and disproportionately influence the rate and pattern of tree regeneration and forest succession (Lutz et al. 2012). Old-growth is of value to many wildlife species and is an important component of biological diversity (Thomas et al. 1988). These forests contain biological legacies and seed sources that contribute to landscape resilience. The concept of old growth involves not only the age of a forest but also other characteristics, such as snags, downed woody material, and canopy layers (Johnson et al. 1995, Green et al. 2011). Though old-growth ecosystems are typically distinguished by old trees, these stands are not necessarily in a late successional condition nor free from anthropogenic disturbance (Foster et al. 1996).

On April 20, 2023, the USDA issued a technical report in fulfillment of Biden Executive Order 14072, Section 2(b) (U.S. Department of Agriculture and U.S. Department of the Interior 2023). This report provides definitions for mature and old-growth forests and an initial inventory of these conditions on lands managed by the Forest Service and Bureau of Land Management. This report presents the finding that Forest Service and Bureau of Land Management lands combined contain 32.7 +/- 0.4 million acres of old-growth and 80.1 +/- 0.5 million acres of mature forest, representing 18 percent and 45 percent of all forested land managed by the two agencies respectively. To provide the initial inventory, the department provided narrative and quantitative working definitions of both old growth and mature forest for each Region. The narrative definitions are as follows:

- Old-growth forests are dynamic systems distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics, which may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function. In addition to their ecological attributes, old-growth forests are distinguished by their ecosystem services and social, cultural, and economic values. Old-growth forests have place-based meanings tied to cultural identity and heritage; local economies and ways of life; traditional and subsistence uses; aesthetic, spiritual, and recreational experiences; and Tribal and Indigenous histories, cultures, and practices. Dialogue with stakeholders and Tribal Nations and integration of local and Indigenous Knowledge with evolving scientific understanding are critical in identifying and stewarding old-growth forests.
- Mature forests are delineated ecologically as the stage of forest development immediately before old growth. Mature forests exhibit structural characteristics that are lacking in earlier stages of forest development and may contain some but not all the structural attributes in old-growth forests. The mature stage of stand development generally begins when a forest stand moves beyond self-thinning, starts to diversify in height and structure, and/or the understory begins to reinitiate. Structural characteristics that mark the transition from an immature to mature forest are unique to each forest type; they may include but are not limited to abundance of large trees, large tree stem diameter, stem diameter diversity, horizontal canopy openings or patchiness, aboveground biomass accumulation, stand height, presence of standing and/or downed boles, vertical canopy layers, or a combination of these attributes. Mature forests vary widely in character with age, geographic location, climate, site productivity, relative sense of awe, characteristic disturbance regime, and the values people attribute to or receive from them. Dialogue with stakeholders and Tribal Nations and integration of local and Indigenous Knowledge with evolving scientific understanding are critical in effectively managing mature forests.

To estimate old growth, the authors of the technical report utilized Old Growth Forest Types of the Northern Region (Green et al. 2011) which has been used to define old growth in the Northern Region for decades. These old-growth definitions are specific to forest type and habitat type group. Key attributes include minimum thresholds of age, numbers, and diameter of the old tree component in the stand, and the stand density. Associated characteristics are also described for each old-growth type such as probabilities of downed woody material, number of canopy layers, and number of snags over nine inches diameter at breast height. There are no specific criteria for minimum patch size. Based on Forest Inventory and Analysis plot data on the Lolo National Forest as summarized in the R1 Summary Database, old growth on the Lolo National Forest currently represents about 8% of the forested area and is distributed across potential vegetation types as shown in Figure 8.

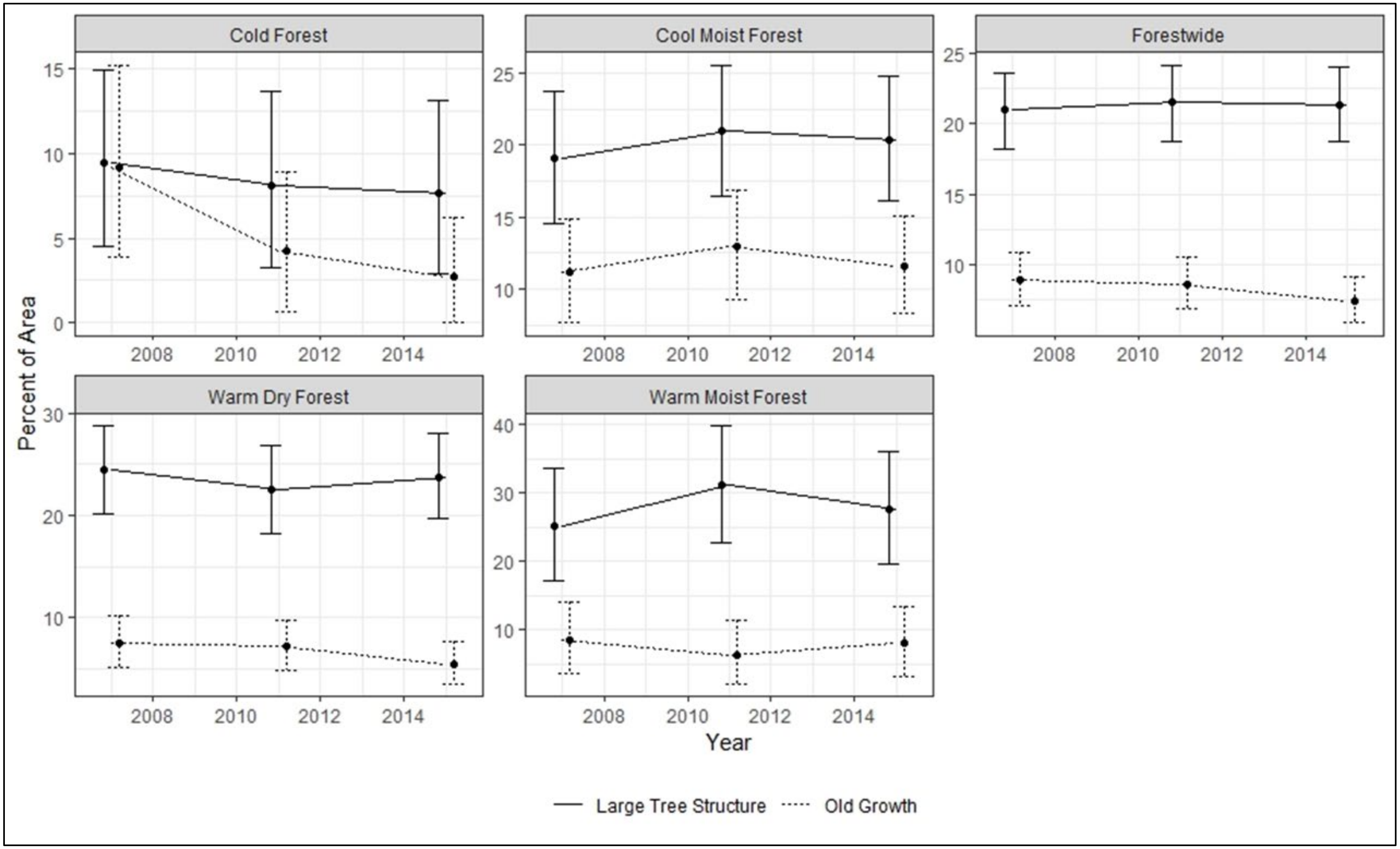


**Figure 8—Estimates of Large Tree Structure (Milburn et al. 2019) and Old Growth (Green et al. 2011) across R1 Broad Potential Vegetation Groups and the Lolo National Forest. Data source: Forest Inventory and Analysis**

Prior to the mature and old growth report produced in response to President Biden’s Executive Order (U.S. Department of Agriculture and U.S. Department of the Interior 2023), there was not a consistent definition of “mature forest”. The working definition of mature forest presented in this report for the Northern Region is based on the narrative framework from the national inventory (U.S. Department of Agriculture and U.S. Department of the Interior 2023). We do not have a precise estimate of mature forest on the Lolo National Forest using this definition. As mentioned in the "Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management", the working definitions developed for the national inventory may need “further refinement… to apply working definitions at local scales due to diverse ecology, forest types, site characteristics, and varied management contexts” (ibid).

The later stage states of succession represented by mature and old-growth forest are not static and as these stands age and die, they are replaced by younger forests. The location, proportion, and distribution of old-growth and mature forest across the landscape therefore changes over time. These forests are vulnerable to moderate or high severity fire, as well as insects and disease. Fire exclusion, particularly in low-elevation warmer sites, has altered vegetation structure and composition in some old-growth forests. In many areas, increasing tree densities and canopy layers have increased tree stress and vulnerability to mortality from insects, disease, and fire.

There is no quantitative estimate of the natural range of variation of the abundance or distribution of old growth. This is because the specific tree-level information required to classify any given stand as old-growth or large tree structure cannot be estimated with the model used, which provides stand-level averages of size and age. Based on the body of science and other information, including the condition of forest size class discussed in the preceding section, it is likely that old growth is less abundant than it was historically, while the amount of mature forest may be similar or higher.

The 2021 Biennial Monitoring Report for the Lolo National Forest (U.S. Department of Agriculture 2022f) found that the most current Forest Inventory and Analysis dataset (Hybrid 2015, with data representing 2006-2015) as compared to the most recent prior dataset (Hybrid 2011, representing 2003-2011), shows a reduction of approximately 18,000 acres of old growth. This reduction is attributed to natural disturbances, including fire and insect and disease activity, and not a result of management activities. Timber harvesting and prescribed burning do currently occur in old growth stands on the Lolo National Forest, but management prescriptions and resource protection measures ensure that activities do not reduce stand characteristics below the minimum criteria identified in Green et al. (2011). In areas that are close to meeting the minimum criteria but are lacking one of the components (usually age), prescriptions typically are designed to provide for succession to meet old growth in the future across the Forest, which is aligned with the goals stated in 1986 Forest Plan Management Area 21.

Because of the influences of multiple ecosystem drivers and stressors, including climate change and altered wildfire regimes especially in low elevation forests, the overall trend of old-growth forest abundance may be declining because the pace of losses of existing old-growth and mature forest through disturbances may be occurring at a faster rate than the natural successional processes that give rise to old-growth. Most scientists agree that old forests and large trees are key components of resilient forests ecosystems that should be a priority for conservation (Franklin and Spies 1991, Spies 2004, Lutz et al. 2012, Hessburg et al. 2015, Lutz et al. 2018, DellaSala et al. 2022, Barnett et al. 2023). The ability of forest management practices to alter trends in old-growth and mature forest trends would be related to site-specific and landscape level actions designed to increase forest resilience to major drivers and stressors, including a consideration for the natural range of variation of composition, size, and density.

**Large trees.** Even if they are not necessarily old, large diameter live trees, long-lived fire tolerant ponderosa pine, western larch, and Douglas-fir, are uniquely valuable ecologically due to their disproportionate contribution to resilience in dry and mixed mesic conifer forests (Lutz et al. 2012, Hessburg et al. 2015). These trees can survive low to moderate fire, contributing to the recovery of the forest after disturbance, promoting resilience, and providing long-term structural diversity. Where present in sufficient numbers they contribute to late successional forest and, in some cases, old growth. They also provide important wildlife habitat, both as live trees and when they die as snags and downed wood. The decay and snag traits of these species are conducive to cavity formation and long-term snag persistence. In addition to their ecological value, large old trees are also an important part of our combined cultural heritage, providing people with aesthetic, symbolic, and spiritual value.

In the Northern Region, a forest size class describes an averaged, stand-level diameter, calculated as the basal area weighted mean diameter at breast height of all trees in a stand (Barber et al. 2011). Because it accounts for all trees, size class may be strongly influenced by a large number of small trees in given stand which lower the overall average diameter. However, individual large trees often occur in stands dominated by smaller trees. In these situations, the stand may have a relatively small average diameter, but the presence of large trees provides important and unique ecological functions.

To characterize stands or plots where large- and very large-trees occur at certain minimum densities an attribute has been developed for analysis and monitoring in Region 1: *Large-tree Structure*. The criteria for defining large tree structure are based, in part, on analysis of old-growth found in Green et al. (2011) and are designed to indicate thresholds of ecological importance. The methods and definitions for the minimum requirements for large tree structure are described in detail by Milburn et al. (2019) but, in general, stands must have at least 10 trees per acre greater than 15” to classify as large tree structure. Unlike old growth, there is no minimum age requirement in the classification of large tree structure. Stands with large tree structure commonly occur in forests classified into smaller size classes.

Based on Forest Inventory and Analysis data, approximately 11% of stands in the pole size class (5-10”) and 48% of stands in medium size class (10-15”) are classified as having large tree structure. Forestwide, the proportion of forested land classified as large tree structure has been steady at approximately 21% since 2007. Figure 8 provides estimates of large-tree structure by potential vegetation type.

**Tree snags** (standing dead trees) are critically important. The ecological conditions created by high severity fire events, as well as the general level of snags and down wood are all elements of healthy, productive, and biologically diverse forests (Bull et al. 1997, Hutto 2006;2008). Numerous species depend on snags and down wood for foraging, denning, roosting, and nesting habitat. After snags fall, they also store nutrients and moisture and aid in soil development. See the Soils section for more discussion and assessment of coarse woody debris.

The amounts of snags and down wood and the amount of forest that has recently experienced severe fire can all affect the sustainability of animal and plant species. Some species are restricted in their habitat distribution to standing dead forests created by stand replacement fires (Hutto 1995). Snags are also the major source of down wood in both upland and riparian areas. Different amounts, ages, species, and sizes of snags typically exist throughout the forest landscape because of various disturbance agents and competition-related mortality. At any given point in time, the quantity and extent of snag habitat conditions will vary, but will be greatest following disturbance events, such as wildfire, wind events, and insect and disease outbreaks. Snags and down wood density tend to be higher in riparian areas.

A report on snag conditions in western Montana forests was completed by Bollenbacher and others (Bollenbacher et al. 2009) using forest inventory and analysis data. Updated data tables were produced in

2021. Medium snags are the most prevalent; relatively few large or very large are present. Large snags tend to occur in the Cool Moist broad potential vegetation group. In areas dominated by lodgepole pine, early seral stands have the most snags due to a greater proportion of stand-replacing fires and species intolerance to fire. The Warm Dry broad potential vegetation group often has a more even distribution of snags into later seral stages because of a more frequent, less severe fire regime. All broad potential vegetation groups show fewer mid-seral stage snags as snags transition to downed wood. Snags occur in a clumpy manner, and in all groups the larger the snag the less common it is. This is due to: 1) fewer trees living to an old age; 2) as trees age, they grow slower, not commonly reaching large diameters; and 3) the inability of systems to contain large old trees and snags due to various types of disturbances (Bollenbacher et al. 2009).

Figure 9 displays the natural range of variation and existing conditions for average snag densities (Figure 9a) and distribution of snags (Figure 9b), defined as the percent of the area containing at least one snag of a given size class. We assume that the best indication of the natural range of variation is the abundance of snags found in wilderness and roadless areas, where natural processes have by and large been allowed to occur (Bollenbacher et al. 2009). The analysis area for snags is Forestwide by snag analysis group. Snag analysis groups are consistent with Northern Region broad potential vegetation groups, except areas dominated by lodgepole pine are addressed separately. This is important for the snag analysis because lodgepole pine is relatively short lived, generally smaller in diameter than other species, and subject to stand replacing disturbances which result in unique snag conditions and dynamics.

The 2021 Biennial Monitoring Report concluded that the 1986 Lolo Forest Plan emphasizes the need for snags as an important habitat component, and that given the series of wildfires over the years across the Forest, there is an abundance of snags where wildfire has resulted in tree mortality, particularly in areas with more recent wildfire such as the 2017 and 2021 wildfires. Wildfire burns across a spectrum of intensity and can result in diverse patterns of severity within varying tree species mix and age classes, thus creating a variety of snag abundances to accommodate several species' snag habitat needs.

Snag conditions at a forestwide scale are similar to conditions expected under natural regimes and are generally within the natural range of variation. At smaller scales of analysis, timber harvest and human access can have substantial impacts on snag density, distribution and longevity (Wisdom and Bate 2008). Presence of localized disturbances could also influence on snag conditions at smaller scales.

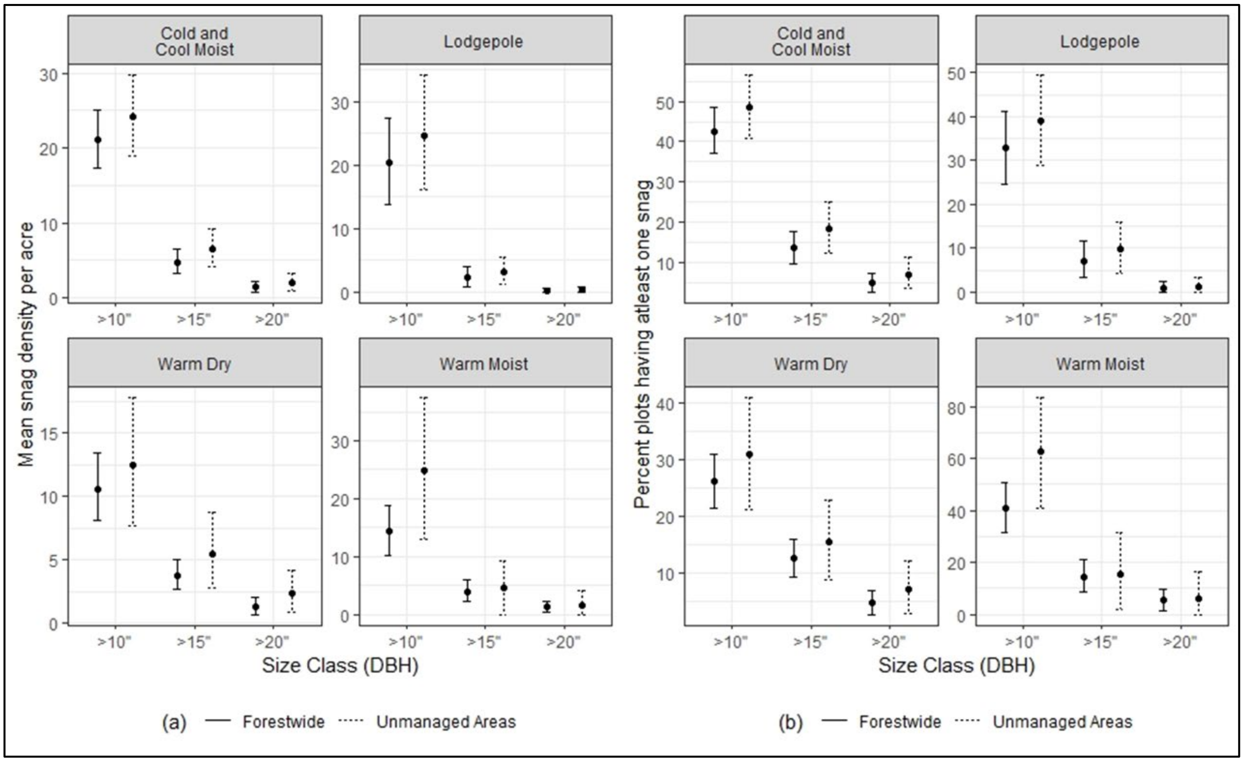


**Figure 9—(a) Estimates of snags per acre densities and (b) percent of plots having at least one snag on plot with 90% confidence intervals by diameter thresholds, inside and outside of wilderness/roadless areas by Snag Analysis Groups for Region One. See Bollenbacher et al. (2009) for additional detail. Data source: Forest Inventory and Analysis**

## Warm Dry Forest

The **key takeaways** of warm dry forests are:

- At lower elevations (ecotonal, lower 5% of Warm Dry Forest), the ecological integrity of the warm dry forest ecosystem is rated as **low**. At lower tree line, there is potential for conversion to nonforest due to the combined effects of exotic species and reduced natural tree regeneration as the climate gets warmer and drier. At lower elevations, the introduction of invasive species has compromised the provision of wildlife habitat including big game winter range.
- At higher elevations with more productive forest types, ecological integrity is classified as **moderate**. Here, the reduced frequency of low severity fires and management legacies have led to denser forests with fewer large trees and a more shade-tolerant species composition. These changes have led to forests that are less resilient and more prone to large, stand-replacing disturbance events. However, natural regeneration is less of a concern here compared to lower tree line communities.
- Across the Warm Dry Forest, the potential to increase ecological integrity through active management is **high** due to the potential to effectively implement treatments to achieve restoration goals.

**Summary.** The Warm Dry Forest ecosystem occurs on approximately 928,000 acres or 41% of the Lolo National Forest based on Forest Inventory and Analysis data. This ecosystem generally occurs below 5,500' but is found at higher elevation on southerly and westerly aspects. The Warm Dry Forest ecosystem is well-distributed (figure A1-27) and occurs in places that are water-limited and often subject to late summer drought or water stress. When western larch is present it is always an early successional species (dominant after disturbance). Grand fir, when it occurs in Warm Dry forests, is a late-successional species and more shade-tolerant than ponderosa pine and western larch. Ponderosa pine and Douglas-fir can play both late- and early successional roles, depending on the potential vegetation type (Pfister et al. 1977). Table 13 displays the current distribution of dominance types across Warm Dry Forests.

**Table 13—Current distribution of Region 1 cover types (Milburn et al. 2015) across the warm dry forest ecosystem. Based on Vmap data**

| Ecosystem | Grass/Shrub (percent) | Lodgepole Pine (percent) | Mixed Mesic Conifer (percent) | Ponderosa pine (percent) | Western Larch Mixed Conifer (percent) |
|---|---|---|---|---|---|
| Warm Dry Forest | 15 | 9 | 42 | 27 | 7% |

The Warm Dry Forest ecosystem can be divided into two types: a lower-ecotone zone with a grass-dominated understory and widely scattered, variably spaced trees (e.g. Douglas-fir-bluebunch wheatgrass), and a higher elevation zone characterized by a shrubby understory and higher productivity (e.g. Douglas-fir-ninebark). At the xeric ecotone, usually a belt of climax ponderosa pine forest separates grassland from climax Douglas-fir forests. Where tree cover is present, it is ordinarily composed of open-grown park-like stands of mature, large diameter ponderosa pine at low stocking levels, with occasional pockets of Douglas-fir and a bunchgrass understory. Trees tend to be clumped where soil development is adequate (Larson and Churchill 2012, Churchill et al. 2013). In areas just above the elevational or cold tolerance of ponderosa pine, Douglas-fir dominated stands also occur with similar, widely spaced stand structure and bluebunch wheatgrass and arrowleaf balsamroot or Idaho fescue understory. These grass and forb dominated habitat types, such as ponderosa pine-bluebunch wheatgrass or Douglas-fir-bluebunch wheatgrass form the low-elevation tree line and are somewhat rare on the Lolo (<5% of Warm Dry forests).

At higher elevations or in areas with more available soil moisture, Douglas-fir -ninebark is the most common habitat type, representing about 40% of Warm Dry forests based on Forest Inventory and Analysis data. Ponderosa pine, western larch, and lodgepole pine are seral components of many stands; however, Douglas-fir is usually the dominant tree species in all stages of succession here (Pfister et al. 1977). Nine bark or oceanspray form a dense shrubby layer that dominates the undergrowth. Common snowberry, white spirea, pinegrass, heartleaf arnica, and elk sedge are also well represented on Douglas-fir -ninebark. Douglas-fir -blue huckleberry is also a common habitat type representing approximately 12% of the Warm Dry forests according to Forest Inventory and Analysis data. Here, huckleberry is well represented in undergrowth throughout the habitat type and most stands have a mat of pinegrass and elk sedge. Grand fir habitat types represent about 10% of Warm Dry forests and often form the boundary between the drier Douglas-fir sites and the cooler subalpine fir sites. Douglas-fir is usually a major component of seral stands while undergrowth is typified by numerous moist-site forbs and a diverse mixture of shrub species which may gain temporary dominance during early successional stages.

**Status and trends.** Warm Dry forests provide ecosystem services including recreation, timber, and wildlife habitat. Nearly all big game winter range occurs here. Historically, this system was shaped and maintained by frequent fire including native burning and management techniques (Kimmerer and Kanawha Lake 2001). Since European settlement in the nineteenth century, Warm Dry forests have been affected by logging, grazing, roadbuilding, and fire suppression (Hessburg et al. 2015, Hagmann et al. 2021). Early logging practices that removed the largest diameter trees fire-intolerant species coupled with fire suppression altered the structure of forests (particularly by increasing stand density), reduced their ecological integrity, and increased their susceptibility to uncharacteristic, high-severity disturbances. However, more modern vegetation treatments designed to retain large trees, establish fire intolerant species, and promoting more open stand densities can improve both stand- and landscape-level resiliency to disturbances.

Prior to Euro–American settlement, both accidental and intentional low- or mixed-severity fires burned approximately every 5 to 25 years in Warm Dry forests (Arno 1976, Arno and Gruell 1983, Heyerdahl et al. 2008). Fires ignited by lightning and by American Indian Tribes played a dominant role in shaping forest structure and processes (Barrett and Arno 1982, Kimmerer and Kanawha Lake 2001) These frequent surface fires maintained low and variable tree densities, light and patchy ground fuels, simplified forest structure, influenced species composition of grass/forb layer, and favored large, fire-tolerant trees (Davis et al. 1980, Hessburg et al. 2005).

Frequent surface fires also favored patchy regeneration by periodically exposing patches of mineral soil. At the stand level, tree patterns in these forests were sometimes characterized by an uneven-aged mosaic of individual trees, clumps ranging from 2 to more than 20 trees, and large, sinuous openings that persisted for centuries in a dynamic system of fine-scale, gap-phase replacement (Agee 1993, Larson and Churchill 2012). Surface fires also reduced the long-term threat of running crown fires by reducing the fuel bed and metering out individual tree and group torching, and they reduced competition for site resources among surviving trees, shrubs, and herbs. At the broader scales (multi-stand), the patterns of dry forest structure and composition that resulted from frequent fires reinforced the occurrence of low- or mixed-severity fires and spatially isolated conditions that supported high-severity fires. Consequently, Warm dry forests were long-lived, relatively resilient to disturbances (fire, insect, and disease) and rarely affected by severe disturbance events (Harvey 1994).

Warm Dry Forests have been significantly modified from their historical structure, composition, and function (Brown et al. 2004, Hessburg et al. 2005, Hagmann et al. 2021). Above the xeric ecotone, these forests support much higher tree density than historically, primarily due to the combined effects of fire suppression and grazing by domestic livestock (Figure 10) (Franklin and Agee 2003, Graham and Jain 2005). Moreover, these denser forests are often composed of more shade-tolerant and less-fire resistant species (Hagmann et al. 2021). Current conditions increase susceptibility to drought and related insect disturbances (Hessburg et al. 1999a, Franklin et al. 2013) and dramatically increase the potential for large, stand-replacing events and consequent losses of important forest values such as wildlife habitat and watershed protection, as well as threats to human infrastructure and communities (Davis et al. 1980, Ager et al. 2010). Notably, about 45% of Warm Dry forests on the Lolo are in the wildland urban interface as identified by Community Wildfire Protection Plans and the Healthy Forest Restoration Act.

In contrast to the higher elevations of the Warm Dry Forests, at the xeric ecotone, the primary stressor is not greater competitive stress and increased susceptibility to severe disturbance events resulting from a gradual change in structure and composition. Rather, at low elevations the primary risk is conversion to grassland as regeneration becomes more difficult under future climate scenarios. While many effects of climate change are anticipated to be gradual, there is also the potential for interacting disturbances such as insects, drought and fire to drive systems towards sudden large-scale transformations (Millar and Stephenson 2015). Dry forests that already occur at the edge of their climatic tolerance will be increasingly prone to conversion to non-forests after wildfires due to regeneration failure (Stevens-Rumann et al. 2018, Davis et al. 2019, Davis et al. 2020). Increases in non-native grasses, such as cheatgrass, may facilitate this conversion due to the grass-fire cycle – a feedback process that can shift current ecosystems to different vegetation types (Peeler and Smithwick 2018). This trend is likely to continue in the future as large wildfires remove local seed source and suitable climate space for tree regeneration becomes increasingly rare (Bell et al. 2014, Harvey et al. 2016).

The potential for large, stand replacing fire events can result in long-term change in warm dry forests due to limited seed dispersal capacity and altered site conditions which contribute to loss of resilience to fire by impeding forest regeneration (Stevens-Rumann et al. 2018, Davis et al. 2019), particularly in the case of short interval reburns that are characteristically different than low-severity frequent fire (Coop et al. 2020). Conversions from forest to nonforest will likely continue as the climate warms and disturbance frequency, severity, and interaction increase (Halofsky et al. 2020).

In addition to higher densities, Warm Dry forests of today contain fewer large and old trees compared to the pre-settlement era (Hagmann et al. 2021). Large trees are of particular importance in warm dry forests due to their disproportionate contributions to system-wide resilience, carbon storage, maintenance of seed sources, and unique wildlife habitat (Lutz et al. 2012, Lutz et al. 2018). The loss of large trees is related to selective harvesting and loss due to drought, bark beetle outbreaks, and wildfire (Stephens et al. 2018). Remaining large and old trees are at higher risk of loss due to increased probability of high-severity wildfire, insect outbreaks and competition from increased density of young trees. Increased competitive stresses reduces the ability of old trees to resist bark beetle attacks and accelerates mortality, resulting in losses of old trees faster than they can be replaced (van Mantgem et al. 2009, Lutz et al. 2018).

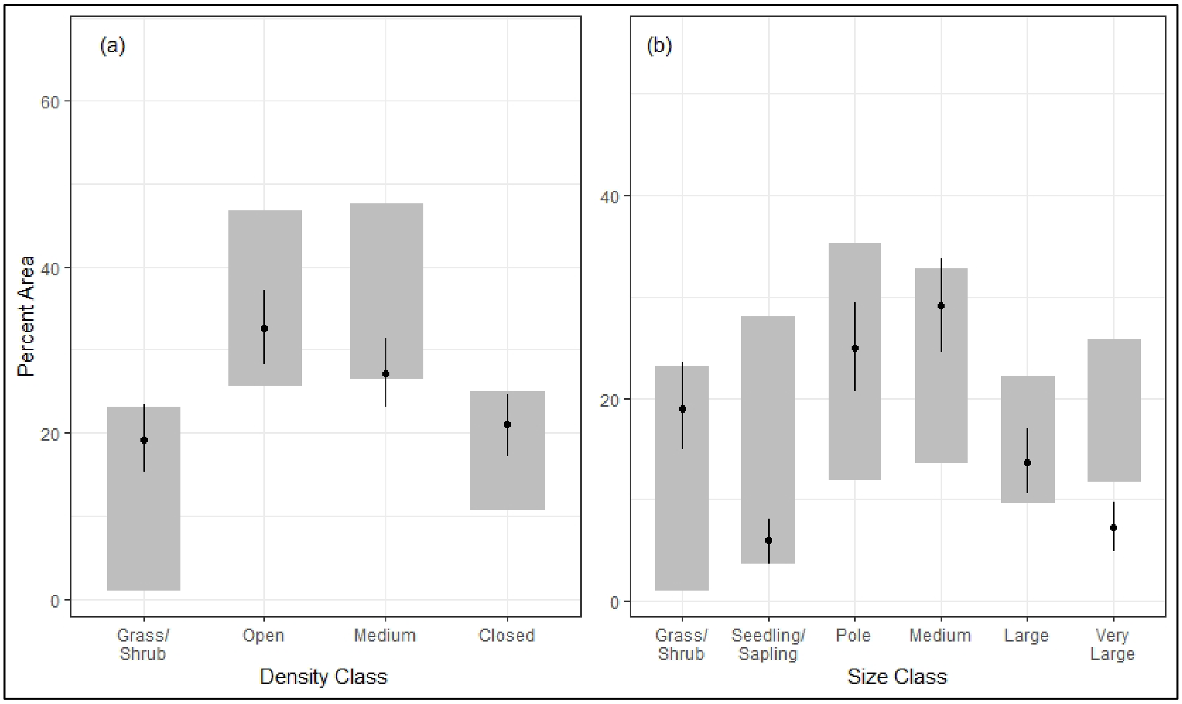


**Figure 10—Natural range of variation of density class and size class compared to the existing condition for Warm Dry Forests. Natural range of variability (grey bars) and current condition estimate (black points; error bars represent 90% CI) for the distribution of (a) density classes and (b) size classes on the warm dry broad potential vegetation type. Density is divided in to four classes based on tree canopy cover: Grass/shrub (<10%), Open (10-40%), Medium (40-60%) and closed (>60%). Size classes are defined based on basal area weighted mean diameter: Grass/Shrub (<10% tree cover), Seedling/Sapling (.1-5" DBH), Pole (5-10" DBH), Medium (10-15" DBH), Large (15-20" DBH), Very Large (>20" DBH). Current condition estimates are based on Forest Inventory and Analysis data.**

## Warm Moist Forest

The **key takeaways** of warm moist forests are:

- The ecological integrity of the Warm Moist Forest ecosystem is **low**.
- Over a century of fire suppression has increased shade tolerant species and the potential for stand-replacing disturbance events and simultaneously reduced the recruitment of large trees and early seral species. Moreover, climatic trends are projected to lead to more drought stressed trees and more frequent high severity fire, thereby further reducing the resiliency and ecological integrity of the warm moist forest. The increased potential for large-scale, high severity fire threatens important ecosystem services associated with productive environments with low fire return intervals including long-term carbon storage and the maintenance of unique wildlife habitat such as large snags with big cavities.
- The potential for management to help restore this ecosystem is **high.** Restoration of western larch and complex in-stand and landscape forest structure can improve ecological integrity. Although limited in extent, restoration of white pine can also occur using blister rust-resistant planting stock.

**Summary.** The Warm Moist Forest ecosystem occupies approximately 237,000 acres or 10% of the Lolo National Forest based on Forest Inventory and Analysis data. This ecosystem mostly occurs on the west side of the plan area on mountain slopes, structural benches, canyon walls, and flood plains between 2,500’-5,000’ (figure A1-27). The Warm Moist Forest provides critical ecosystem services including wood products and unique wildlife habitat such as large amounts of downed wood and snags. In part due to a relatively low fire return interval and high productivity, this ecosystem also provides an important source of Carbon storage and high recreational value. Table 14 displays the current distribution of dominance types across the Warm Moist Forest ecosystem.

**Table 14—Current distribution of Region 1 cover types (Milburn et al. 2015) across the warm moist forest ecosystem. Based on Vmap data**

| Ecosystem | Grass/Shrub (percent) | Lodgepole Pine (percent) | Mixed Mesic Conifer (percent) | Ponderosa pine (percent) | Western Larch Mixed Conifer (percent) |
|---|---|---|---|---|---|
| Warm Moist Forest | 7 | 11 | 61 | 9 | 4 |

The Warm Moist Forest ecosystem is diverse and productive with respect to tree growth rates and tree size growth potential. This type includes the most productive potential vegetation types found on the Lolo National Forest (e.g. western redcedar/queencup beadlily and grand fir/queencup beadlily). The inland maritime climate in northwestern Montana strongly influences stand development and fire occurrence in these forests. Soils range from sandy, rocky, dry, and well-drained to deep, nutrient-rich, and moist. Soils that maintain these forests include, but are not limited to, Spodosols, Inceptisols, and Alfisols. A defining characteristic of some areas is a layer of fine-textured ash that caps residual soils (Jain and Graham 2005).

Numerous conifer species may be present during various stages of stand development including western white pine, western red cedar, ponderosa pine, Douglas-fir, Engelmann spruce, lodgepole pine, subalpine fir, grand fir, western larch, western hemlock and pacific yew. Presence and establishment of these species depends on site conditions, fire frequency, disturbance history and magnitude, and seed availability (Pfister et al. 1977, Fischer and Bradley 1987). All stages of stand development from early- to late-seral occur within a landscape mosaic possessing all possible combinations of species and seral stages. Late seral species include western red cedar, western hemlock and grand fir with western larch, lodgepole pine, Douglas-fir, ponderosa pine and white pine are always the early- and mid-seral species (Daubenmire and Daubenmire 1968). Ancient old growth western red cedar groves with very infrequent fire occurrence (150+ years) and complex structural development are also present (Pfister et al. 1977). Undergrowth is generally characterized by a rich variety of moist site species including western serviceberry, common snowberry, Rocky Mountain maple, menziesia, queencup beadlily, common beargrass, starry false Solomon's seal, twinflower, Columbia bromegrass, pinegrass, and elk sedge. Prior to 1900 western white pine often dominated Warm Moist Forests, accounting for 15%-80% of the trees within stands (Hines 2013). The range of western white pine only extends into the western side of the Lolo National Forest; therefore, while it was an important component in some places, its historic extent and dominance was not as prevalent on many of the Warm Moist Forests within the plan area. In the early 20th century, an exotic rust, white pine blister rust, decimated the once abundant western white pine (Jain 2017).

All stages of stand development in Warm Moist forests are culturally important to tribes. Native people rely on these lands for seasonal gathering and traditional practices. To native cultures, western red cedar is the "tree of life" it is used for boats, baskets, traditional medicines, tools, clothing, ropes, and nets. Native people used western white pine medically to treat tuberculosis, stomach aches, sore and cuts.

**Status and trends.** A complex historical fire regime coupled with ongoing disturbance from snow, ice, insects, and disease, created heterogeneity in patch sizes, forest structures, and compositions in the warm moist forest Ecosystem. Native insects (e.g., bark beetles.) and diseases (e.g., laminated root rot) infected and killed individuals, which tended to diversify vegetation communities and add coarse woody debris and structure (Hagle 2010). Due to high productivity of vegetation growth, fuel loading is generally higher in all size classes than other forest types. Large, downed wood may account for 75 percent of fuel loading, with rotting western red cedar persisting for many decades.

A mixed-fire regime best defines the role fire played in creating a mosaic of forest compositions and structures (Agee 2005). On average, nonlethal surface-fires occurred at relatively frequent intervals (15-25 years) in about a quarter of the area while high severity crown-fires burned about another quarter of the area at intervals of 20-150 years but occasionally extended to 300 years. The mixed-fire regime occurred across the rest of the moist forests at 20 to150 year intervals. Fires typically started burning in July and were usually out by early September (Fischer and Bradley 1987, Hann et al. 1997, Jain and Graham 2005). Mixed severity fires result in a patchy mosaic of all tree species, size, and age classes. Following severe burns shrub competition may be severe with numerous shrub species or ceanothus (drier area) dominating providing excellent wildlife forage for 20-30 years. Moisture is generally not forest-regeneration limiting, but conifer seed source may be after large severe fires.

Root diseases have always been a major cause of tree mortality in Warm Moist forest ecosystems (Lockman and Kearns 2016). However, the incidence and severity of root disease has increased in recent decades due to changes in forest composition resulting from fire exclusion and altered forest management practices (Bennett et al. 2022). One contributing factor was the selective harvesting used to remove western white pine and other high-value trees following establishment of white pine blister rust (Healey et al. 2016, Lockman and Kearns 2016). Selective harvesting and fire exclusion also affected many forests that were previously dominated by pine and western larch, which are more tolerant of root disease. Many of these forests are now dominated by a mixture of highly susceptible hosts such as Douglas-fir, grand fir, and subalpine fir. Based on Forest Inventory and Analysis data, approximately 9% of the Warm Moist Forest on the Lolo has a moderate to high level of root rot infestation. This level of infestation has been associated with mortality resulting in a 25% or greater loss in basal area every fifteen years (Hagle 2010).

The Warm Moist Forest ecosystem looks and functions dramatically differently today than it did in the late 1800s. One of the most notable changes is the near complete loss of western white pine, or “king pine” as it was known due to its ecological and economic significance. During the early to mid-20th century white pine became a casualty of overharvesting, pine beetle damage, lack of fire-mediated opportunities for regeneration, and, perhaps most significantly, an invasive fungal pathogen that causes white pine blister rust disease (Hines 2013). Its foundational role contributed to a landscape that was resilient, fire-adapted, and provided abundant suitable habitat for terrestrial and aquatic species. Tree species that are generally less fire tolerant, economically valuable, and more vulnerable to insects and disease now dominate a landscape that is regularly subject to fire, impacting the persistence of these forests and threatening their ability to provide cultural, regulating, and provisioning services (ibid).

In addition to major shifts in species composition, stand structure has also changed dramatically in the Warm Moist Forest ecosystem. A disrupted fire regime has contributed to forests with higher tree densities compared to the natural range of variation (Figure 11). In addition, large trees, once abundant in these forests prior to the expansion of the Northern Pacific Railroad in the late 19th century, have been greatly diminished. Large western red cedar, western larch, and western white pine were selectively logged as these typically accessible forests were “high-graded” in the late 19th and early 20th century. Additionally, most western white pine was harvested as it was assumed that it would die from white pine blister rust. Limited mature and old growth stands remain. Based on Forest Inventory and Analysis data, 8% of the Warm Moist Forest is currently old growth (90% confidence interval = 3-13%). The large tree component that provided a foundational role to landscape resilience, and abundant suitable habitat for terrestrial and aquatic species, is greatly reduced or absent. This change in large tree structure and seed source impacts dispersal, regeneration mechanisms, site colonization, and species composition (e.g., western larch upslope seed dispersal) as well as other resource values such as carbon storage, wildlife habitat, and fire resilience.

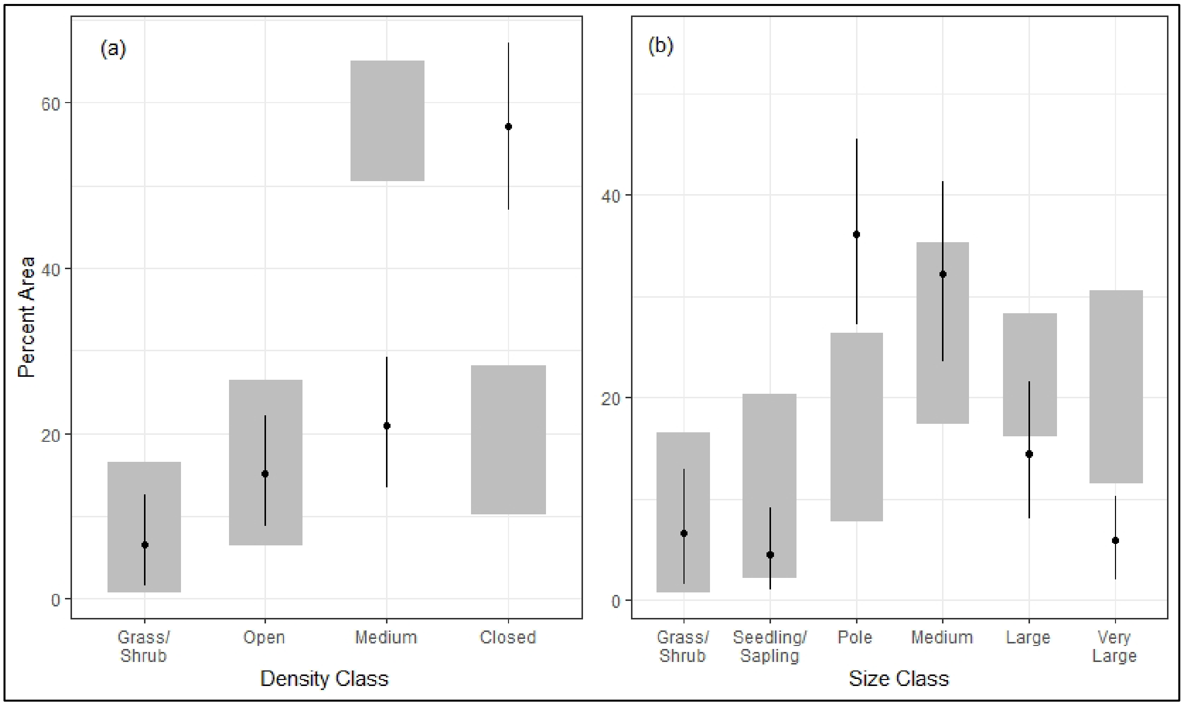


**Figure 11—Natural range of variation of density class and size class compared to the existing condition for Warm Moist Forests. Natural range of variation (grey bars) and current condition estimate (black points; error bars represent 90% CI) for the distribution of (a) density classes and (b) size classes on the warm moist broad potential vegetation type. Density is divided in to four classes based on tree canopy cover: Grass/shrub (<10%), Open (10-40%), Medium (40-60%) and closed (>60%). Size classes are defined based on basal area weighted mean diameter: Grass/Shrub (<10% tree cover), Seedling/Sapling (.1-5" DBH), Pole (5-10" DBH), Medium (10-15" DBH), Large (15-20" DBH), Very Large (>20" DBH). Current condition estimates are based on Forest Inventory and Analysis data.**

## Cool Moist Forest

The key takeaways of cool moist forests are:

- Ecological integrity of the Cool Moist Forest ecosystem is currently **moderate.**
- Cool Moist forests are highly productive and relatively resilient to stressors. Because of greater water availability, there is little risk of type conversion within this ecosystem. However, in the long-term, the interaction of climate change, invasive species, and disease (such as blister rust and root rot) presents a risk to the long-term sustainability of this ecosystem and its associated ecosystem services.
- The potential for management to restore this ecosystem is **moderate** because invasive species management, planting early seral species, and reintroducing heterogeneity though use of fire and timber harvest can help restore this system. Provision of ecological services related to water quantity and quality may be compromised if climate change results in reduced snowpack storage and regulation.

**Summary.** The Cool Moist Forest ecosystem occupies approximately 788,000 acres or 35% of the Lolo National Forest (Forest Inventory and Analysis data). The Cool Moist Forest ecosystem typically experiences relatively infrequent lethal fires and periodic, moderate severity fires. Mean fire return intervals may have much less importance than the range of fire intervals in this forest type (Halofsky et al. 2011). Depending on when and where they occur, these disturbances favor seral stands of western larch, lodgepole pine and Douglas-fir with Engelmann spruce. The composition of western larch is relatively sporadic depending on frequency of fire disturbance, which favors its establishment and development. Mature, all-aged stands of spruce and subalpine fir are of more significance in moist, protected basins. In these conditions spruce is often a long-lived seral species. On drier sites, spruce is usually less prevalent unless lodgepole pine mortality opens growing space. While grand fir is sometimes present, it is at its upper elevational limit. In some areas, stand replacement fires created pure even-aged stands of lodgepole pine. Douglas-fir is sometimes absent because the sites are either too wet or too cool (e.g. frost pockets). Table 15 displays the current distribution of dominance types across the Cool Moist Forest ecosystem.

**Table 15—Current distribution of Region 1 Cover Types (Milburn et al. 2015) across the Cool Moist Forest Ecosystem. Based on Vmap data.**

| Ecosystem | Grass/Shrub (percent) | Lodgepole Pine (percent) | Mixed Mesic Conifer (percent) | Ponderosa pine (percent) | Spruce fir (percent) | Western Larch Mixed Conifer (percent) |
|---|---|---|---|---|---|---|
| Cool Moist Forest | 21 | 25 | 25 | 1 | 18 | 10 |

The most prevalent habitat types in the Cool Moist Forest ecosystem are subalpine fir/beargrass-blue huckleberry and subalpine fir/menziesia. Together these habitat types make up about half of the Cool Moist Forest. Subalpine fir/menziesia an indicator of the maritime influence on cool exposures and upper elevations. Subalpine fir is the most common species in mature stands along with spruce and lodgepole pine. Western larch and Douglas-fir may occur to a lesser extent. Generally, lodgepole pine won't persist beyond 120-160 years (Cooper et al. 1991), particularly where its seed source has not been maintained due to long fire free intervals. The former is abundant on relatively dry slope ridges between 5,000 and 6,300 feet and typically merges with subalpine fir/menziesia on moist exposures. Douglas-fir and lodgepole pine are the most important seral species on these sites.

Fire is a primary driver in Cool Moist Forests and the regime is characterized by primarily moderately long-interval mixed and stand-replacement fires. Lightning strikes are frequent but will often result in small, patchy spot fires. Moisture gradients control the fire regime of these systems relative to the lower-elevation montane mixed conifer types. The relative frequency of which varies across the landscape in response to climate topography and landscape setting. For example, when Cool Moist Forest is in proximity to patches of dry forest, fire frequency may be higher and the effects less severe as the warmer drier system acts as a “conveyor belt” for more frequent surface fires. Arno (1980) reported that almost 60 percent of the mature (greater than 100 years) western Montana subalpine fir/beargrass stands sampled showed obvious evidence of ground fire after establishment. Such fires promote fire tolerant species, such as larch or Douglas-fir, and set back establishment of the more shade-tolerant subalpine fir and spruce, which in the absence of fire form dense understories and eventually take over the site (Fischer and Bradley 1987). However, when Cool Moist Forest is surrounded by cold or wet forest types, the fire regime may be influenced by this context; and fires may tend to be less frequent and more severe (Stine et al. 2014). Fires of moderate severity probably help Douglas-fir maintain a position of dominance or codominance with lodgepole in many stands. The more fire-resistant Douglas-fir or western larch has a better chance of surviving such fires relative to lodgepole pine, and western larch in particular is able to successfully regenerate in fire-created openings where mineral soil has been exposed. Severe, stand-destroying fire will generally favor lodgepole pine on many of these sites. Some large, thick-barked Douglas-fir trees will often survive fires severe enough to kill all the lodgepole pine trees, thereby assuring the presence of Douglas-fir in the new stand (Fischer and Bradley 1987).

**Status and trends.** Today, the Cool Moist Forest ecosystem does not look or function as it did 100 to 200 years ago. With the arrival of Euro Americans in the 1800s several change agents have affected this ecosystem. Some of the most important factors include highly effective fire prevention and suppression (largely since the 1930s), extensive sheep and cattle grazing and livestock fencing, development of extensive road and railroad networks, subdivision of regional landscapes by ownership in to different land uses, and timber harvest entry via selection cutting and clearcut logging (Hann et al. 1997, Arno et al. 2000, Stine et al. 2014). Invasives, such as hawkweed, and St. John's Wort have become established near disturbed areas. These and other factors have limited the function of some present-day Cool Moist Forests and the ecosystem services that can be obtained from them.

Before fire suppression, fire intervals probably fell between 50 and 130 years (Fischer and Bradley 1987). However, as small fires were systematically extinguished, the landscape has become more homogenized and fuels more contiguous shifting the ecosystem from a mixed severity towards a stand-replacing fire regime (Morgan et al. 1994, Quigley and Arbelbide 1997). As a result, current forest structure and species composition differs from historical patterns in predictable ways. Natural range of variability modeling indicates a decline in fire-dependent species such as western larch and the current landscape has greater uniformity of structure, with a surplus of 10-15" size class and high-density forest (Figure 12). The departure in structure and composition is in part due to effects of increasing density of shade tolerant species in the understory, bringing down the stand-level average size. Longer fire intervals have also cause seral herbaceous and shrub species to decline because they will have difficulty surviving under extended periods of dense conifer coverage—the "stem- exclusion stage" (Oliver and Larson 1996). The accompanying pattern of larger and more severe wildfires will pose increasing health risks due to smoke production, as well as risks of fire threatening people and private property (Arno et al. 2000).

Resilience in these forests depends on ecological heterogeneity. Vegetation changes and management activities have shifted fire regimes toward less frequent, but larger and more severe fires, which tend to simplify the landscape into fewer, larger, and less diverse patches resulting in more homogenous conditions (Stine et al. 2014). If the current trend continues, there will be a greater loss of multi-aged stands of seral tree species. The intricate, fine-grained landscape mosaic of diverse stand structures and compositions will be replaced by a coarser pattern of even-aged stands. This landscape pattern, once established, can be reinforced by future large, stand-replacing fires associated with climate change. Climate change will also likely increase moisture deficit during the growing season and increase susceptibility to insect and disease outbreaks. Climate change may also decrease the effects of frost pockets on larch regeneration which might be beneficial to western larch (Keane et al. 2018). Planting of early seral species and promoting heterogeneity at multiple spatial scales can help maintain restore ecological integrity in the Cool Moist Forest.

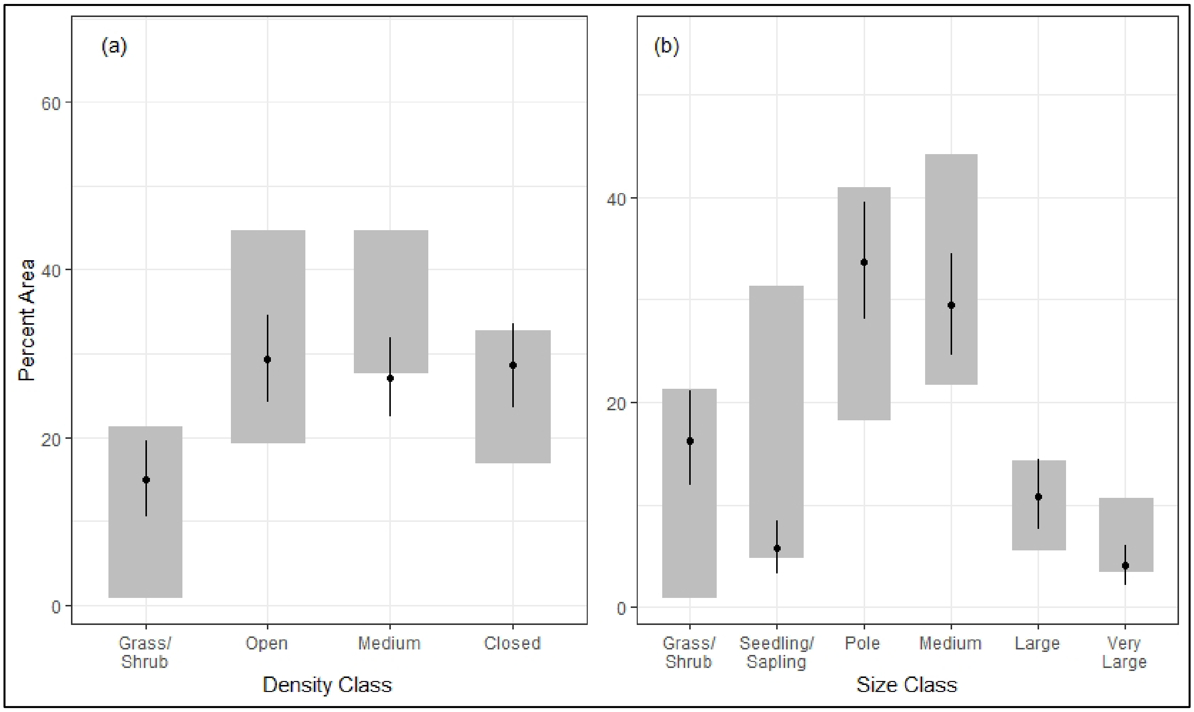


**Figure 12—Natural range of variation of density class and size class compared to the existing condition for Cool Moist Forests. Natural range of variation (grey bars) and current condition estimate (black points; error bars represent 90% CI) for the distribution of (a) density classes and (b) size classes on the cool moist broad potential vegetation type. Density is divided in to four classes based on tree canopy cover: Grass/shrub (<10%), Open (10-40%), Medium (40-60%) and closed (>60%). Size classes are defined based on basal area weighted mean diameter: Grass/Shrub (<10% tree cover), Seedling/Sapling (.1-5" DBH), Pole (5-10" DBH), Medium (10-15" DBH), Large (15-20" DBH), Very Large (>20" DBH). Current condition estimates are based on Forest Inventory and Analysis data.**

## Cold Forest

The **key takeaways** of cold forests are:

- Ecological integrity for Cold Forest ecosystem, in general, is **moderate**. Whitebark pine, a subset of this ecosystem found on cold dry sites, is rated as **low** and is summarized in Section 3.2.4 and 3.5.1. Whitebark pine decline is causing a downward trend in biodiversity and creating a vulnerable state for Cold Forest ecosystems. Ecosystem services such as the availability and quality of clean water is compromised with climate change induced reduction of snowpack and the effects flow downstream to lower elevation ecosystems.
- The potential for management to help restore this ecosystem is **moderate to low**. Management activities related to whitebark pine restoration can include hand thinning, mechanical cutting, prescribed fire, wildfire use, and collecting materials followed by the planting of blister rust resistant whitebark pine; see also Section 3.2.4. Nevertheless, the provision of ecological services related to water quantity and quality may be compromised if climate change continues to result in reduced snowpack.

**Summary.** Cold Forests occupy about 225,000 acres or 10% of the Lolo National Forest (Forest Inventory and Analysis data) and generally occur above 6,000 feet in upper subalpine and timberline settings across the entire plan area (figure A1-27). Species composition is largely governed by harsh growing conditions such as low temperature, high exposure, and a short growing season, all of which typically increase with elevation. Subalpine fir is a common climax species, and whitebark pine and subalpine larch typically aren't found in any other broad potential vegetation types. Table 16 displays the current distribution of dominance types across the Cold Forest ecosystem.

**Table 16—Current distribution of Region 1 Cover Types (Milburn et al. 2015) across the Cold Forest Ecosystem. Based on VMap data.**

| Ecosystem | Grass/Shrub (percent) | Lodgepole Pine (percent) | Mixed Mesic Conifer (percent) | Spruce fir (percent) | Whitebark pine/subalpine larch (percent) |
|---|---|---|---|---|---|
| Cold Forest | 35 | 22 | 4 | 37 | 1 |

The Cold Forest ecosystem may be divided into two categories: upper subalpine and timberline. Upper subalpine is lower in elevation of the two, the majority of which falls between 6,000 and 7,000' and is associated with habitat types such as subalpine fir/beargrass-grouse whortleberry and subalpine fir/smooth woodrush-grouse whortleberry (Pfister et al. 1977). It represents the lower limit of whitebark pine and upper limit of Douglas-fir and western larch. Here, shade-tolerant and short-lived subalpine fir is the potential climax species while shade-intolerant and long-lived whitebark pine would typically serve as a seral species. Engelmann spruce, lodgepole pine, and mountain hemlock are present and occur in varying amounts. Lodgepole pine may form pockets of pure stands as a highly successful seral species. Woodrush is a dominant undergrowth species associated with this habitat type, while beargrass and whortleberry are not uncommon, especially in the upper end of this group.

Timberline begins the break in contiguous forest and ends in virtually inhospitable alpine tundra. It makes up a small portion (~10%) of the cold forest, occurring mostly in the eastern half of the plan area between 7,000 and 8,000'. The only four tree species that can withstand the climatic extremes here are whitebark pine, subalpine fir, Engelmann spruce, and subalpine larch. Whitebark pine is the typical climax species, while more drought and cold intolerant subalpine fir is often present but usually severely stunted, shrub-like, and wind deformed. Subalpine larch is most vigorous and cold hardiest of the timberline species and may occur in pure stands on north facing slopes in this ecosystem (Pfister et al. 1977); this species is rare on the Lolo National Forest, and is only known to occur on Carlton Ridge.

This high-elevation ecosystem has many important ecological functions. For one, it supports a unique spread of biodiversity comprised of species not typically found in lower-elevation ecosystems. Whitebark pine alone is responsible for many ecosystem functions (see also sections 2.4.1 and 2.6.0). It is not only a keystone species, but a pioneer species that lays down the foundation which allows for other species to colonize and thus maintains ecological structure and function. Such ecological structure in this setting (e.g., roots, soil, and vegetation) allows snowpack to accumulate which largely regulates the quantity and quality of water that is widely distributed throughout many various ecosystems.

Fire is a primary driver in Cold Forests and the regime is characterized primarily by moderately long-interval mixed and stand-replacement fires. The high-severity fire regime is characterized by infrequent (fire return intervals of 150-300 years) stand-replacing fires since the last glacial. Large fires, that burn more than 1,000 hectares, account for the vast majority of area burned in the cold forest (Schoennagel et al. 2004). Moisture gradients largely control the fire regime of these systems relative to the lower-elevation montane mixed conifer types. The historical fire regime maintained a natural structural stage distribution and patch size and fire spread was naturally regulated and of less severity overall. On cold dry sites, and in contrast to cold moist sites, fuel availability limited mixed and lower severity fire. This increased successful regeneration, despite the short growing season, and ultimately fed into the diverse species and structural composition.

**Status and trends.** Whitebark pine populations have dramatically decreased due to a change in fire regime and introduction of disease (Tomback and Sprague 2022). Subalpine fir has increased in some Northern Rockies landscapes (Keane et al. 1994) but its future will depend on the degree of warming and the frequency and extent of disturbance. Most models suggest that Engelmann spruce will move up in elevation in the cold forest ecosystem and become established in areas where it was precluded by snow historically (Keane et al. 2018). Invasive species such as St. John's wort have increased in alpine meadows. Finally, a changing climate has altered the dynamics of snowpack, including shorter duration (Gillan et al. 2010) and lengthening of fire season and shorter fire return intervals (Pansing et al. 2020). These factors all interact with one another and ultimately steer the environment further away from its historical conditions. For example, combined effects of loss of whitebark pine and recent fires have resulted in more early seral (grass/shrub) and fewer large trees compared to the natural range of variation (Figure 13).

Altered fire regimes and resulting effects on the landscape in cold moist environments has potentially increased fire frequency and severity. Recovery from fire may be compromised due to delayed regeneration (Hansen et al. 2018, Turner et al. 2019). Given a warmer future with larger and more frequent fires, a greater number of stands that fail to regenerate after fires combined with increasing density in stands where regeneration is successful could produce a less resilient more coarse-grained forest landscape (Hansen et al. 2018). Fire suppression activities and the elimination of cultural burning has played a role in this as well. Without patchy, moderately infrequent fire, subalpine fir and other upper subalpine and timberline competitors replace whitebark pine due to their ability to tolerate shade better and because whitebark pine relies more heavily on the historical fire regime for regeneration (Keane and Parsons 2010). Although Cold Forests generally have long fire return intervals, fire intervals in the northern Rocky Mountains are projected to get shorter as climate warms, and forests that reburn before recovering from previous fire may lose their ability to rebound, potentially eroding ecological integrity (Turner et al. 2019).

The Cold Forest ecosystem provides important ecosystem services. Because whitebark pine seeds are valued as a food source for many types of wildlife, and Cold Forests provide shelter for many other species, the decline of whitebark pine has the potential to greatly decrease the biodiversity of the cold forest (Tomback and Kendall 2001). Moreover, whitebark pine stabilizes ecosystem function (Ellison et al. 2005). Its canopies shade snowpack and protract snowmelt, thus regulating downstream flows; its roots stabilize soil, which reduces erosion, particularly on steep, rocky slopes. Snowpack depth and duration extends soil moisture regime, dampens chances of fire, increases chances of successful whitebark pine regeneration, and may reduce the prevalence of certain insects and disease. It also ensures an even flow regime for mountain streams. Associated non-forest communities, such as avalanche chutes and wet meadows also benefit and are maintained by consistently deep snowpacks. The reduced extent and depth of snowpack has resulted in reduced albedo which affects snow retention at peak discharge and the hydrology in general along with its effect on water quality and quantity. The introduction of blister rust has had devastating effects on the whitebark pine population and the Cold Forest ecosystem. Lodgepole pine, Engelmann spruce, and subalpine fir are projected in have increased climate suitability in this zone and may expand in distribution and density, especially for smaller size classes (Piekielek et al. 2015). More frequent fires may reduce densities of larger size classes of these species.

Climate change has had negative effects on flow regime of cold, clean water as well as negative effects on high elevation meadows that are highly used by pollinators and recreationists. These ecosystems are culturally important areas for native tribes. More severe wildfires and the prevalence of blister rust is resulting in the loss of many of mature whitebark pine stands and, therefore, their genetic diversity and resiliency. If current trends persist, there will likely be a reduction in plant and animal biodiversity, ecosystem service functions, and cultural values.

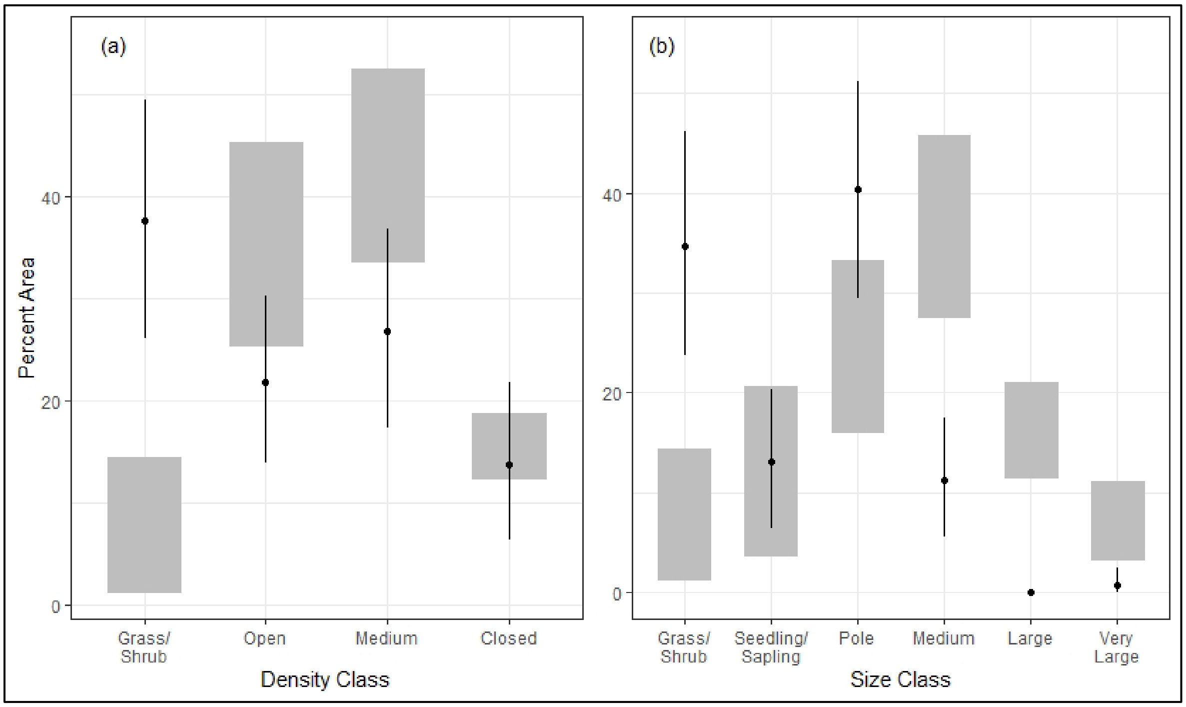


**Figure 13—Natural range of variation of density class and size class compared to the existing condition for Cold Forests. Natural range of variation (grey bars) and current condition estimate (black points; error bars represent 90% CI) for the distribution of (a) density classes and (b) size classes on the cool moist broad potential vegetation type. Density is divided in to four classes based on tree canopy cover: Grass/shrub (<10%), Open (10-40%), Medium (40-60%) and closed (>60%). Size classes are defined based on basal area weighted mean diameter: Grass/Shrub (<10% tree cover), Seedling/Sapling (.1-5" DBH), Pole (5-10" DBH), Medium (10-15" DBH), Large (15-20" DBH), Very Large (>20" DBH). Current condition estimates are based on Forest Inventory and Analysis data.**

## 2.2.4 Non-forest Ecosystems

Non-forest vegetation includes potential grass and shrublands as well as sparsely vegetated or vegetation free areas in alpine environments, on rocky outcrops and scree. Not counting riparian and wetland ecosystems, about 53,000 acres or 2.3 percent of the Lolo National Forest have non-forested potential vegetation types (figure A1-27). The estimate based on Forest Inventory and Analysis data is similar, with about 56,000 acres and a relatively large 90 percent confidence interval of 29,580 – 85,579 acres due to the small number of samples with non-forested potential vegetation types. Potential grass- and shrubland vegetation types are more widespread in the valley bottoms, which are predominantly in private ownership. Many of these low-elevation ecosystems have been converted to livestock range, agricultural lands or used for housing developments. Transitional grass, forb, and shrub communities that are the earliest stages of forest succession are discussed in this section. Wetlands and riparian ecosystem, which include forested and non-forested vegetation types, are discussed in section 2.3.

### Xeric and Mesic Grasslands

The **key takeaways** of xeric and mesic grasslands are:

- The ecological integrity of xeric grasslands is **low**. The ecological integrity of mesic grasslands increases with increasing elevation and is rated as **low to moderate**.
- Composition of xeric and mesic grasslands has been altered by persistent livestock grazing and fire suppression. Invasive species are a major threat in valley bottoms and montane settings.
- Invasive species management on the Lolo National Forest has been focused on existing infestations with no comprehensive inventory and monitoring program to detect new invaders.

**Summary.** Xeric grasslands are the driest potential grassland type in the region. In western Montana, these grasslands are dominated by cold-season perennial bunchgrasses, namely bluebunch wheatgrass with varying amounts of western wheatgrass, prairie junegrass, and sandberg bluegrass. Arrowleaf balsamroot is locally abundant (Mueggler and Stewart 1980). Xeric grasslands are typically found in valley bottoms and lower foothills or on dry south- and west-facing hillsides on a variety of parent materials.

Mesic grasslands are dominated by Idaho fescue or, in northwestern Montana, by rough rescue. In some locations, rough fescue can provide nearly continuous cover with minor components of Idaho fescue and bluebunch wheatgrass. Mesic grasslands are productive ecosystems with higher cover and species richness than other grassland types. These ecosystems occur on deeper soils in valley bottoms and lower foothills, on north- and east-facing slopes, and in opening of conifer forest. Fescue grasslands also occur in small meadows surrounded by high elevation forests all the way up to large grasslands in the subalpine parkland. At elevations greater than 7500 feet, Idaho fescue becomes the dominant species with tufted hairgrass, oatgrass, slender wheatgrass, and single spike sedge as common associates (Mueggler and Stewart 1980, Cooper et al. 1999). Mesic grasslands are utilized by native ungulates and provide important winter habitat.

Cold-season perennial bunchgrasses such as bluebunch wheatgrass, rough fescue and Idaho fescue are well adapted to frequent fire and typically recover within 2-5 years (Zlatnik 1999, Tirmenstein 2000, Zouhar 2000). In comparison to bluebunch wheatgrass and rough rescue, Idaho fescue may be slower to recover to pre-fire conditions depending on fire season and fire severity. Fire disturbance maintains grassland health and discourages establishment of sagebrush or conifers.

**Status and trends.** Xeric and mesic grasslands are both estimated to occur on less than 1% of the Lolo National Forest (Table 10). Major stressors to these ecosystems are persistent livestock grazing and ungulate herbivory, changes to the fire regime, and invasive species (Reeves et al. 2018).

Cold season bunchgrasses provide high quality forage for livestock and wildlife alike. They are, however, sensitive to persistent grazing pressure and will decrease in abundance in favor of less palatable species (Mueggler and Stewart 1980). Rough fescue is perhaps the most sensitive of the principal bunchgrasses. It is highly palatable throughout the grazing season and will be the first to decline after two to three years of moderate or heavy summer grazing. In its place, less palatable forbs and grasses increase in abundance. Starting in the 19th century, heavy cattle and sheep grazing reduced the abundance of native bunchgrasses with long lasting effects on ecosystem integrity. On moister sites, long-term heavy grazing caused persistent shifts in species composition to non-native Kentucky bluegrass, common timothy and smooth brome. These and other non-native species were deliberately introduced for forage and erosion control into many grasslands of the west (Hessburg and Agee 2003).

Decreased vegetation cover and soil disturbance due to improper livestock grazing provided ample opportunities for invasive species to become established. Cheatgrass, Dalmatian and yellow toadflax, knapweeds and leafy spurge may have arrived in the Inland Northwest as early as the late 19th century. Today, these species ae abundant in many grassland communities, and new invaders are still expanding their range. Many of these invasive plants do not provide dependable forage for wildlife or livestock (see section 3.1.6). The Lolo National Forest is actively managing known weed infestations but are falling behind in detection and inventory of new invasive species (U.S. Department of Agriculture 2022f).

Past grazing practices have also been associated with a reduction of fine fuels and associated reduction in fire frequency. A change in fire frequency combined with the effects of climate change are cited as primary reasons for the expansion of conifers into grassland communities (Arno and Gruell 1986, Hessburg and Agee 2003).

Warming temperatures and extended summer droughts will likely result in more frequent fires in the foreseeable future (see section 2.1.1). This may lead to an expansion of grassland ecosystems because conifers and non-sprouting shrubs will be unable to regenerate in now marginal environments. However, many invasive species will respond favorably after fire and increase in cover and density (Reeves et al. 2018). Resistance to invasion may decrease solely because of warmer and drier conditions (Chambers et al. 2014). In addition, dryer conditions combined with ungulate herbivory may result in increased soil erosion. Low elevation grassland communities are therefore highly vulnerable to climate change (Reeves et al. 2018). Their ecological integrity is rated as low.

Mesic grasslands at higher elevations are somewhat buffered from the influx of invasive plants by their relative remoteness and by the high canopy cover of adjacent forests which do not provide suitable habitat. They are also not as vulnerable to increasingly warmer and drier conditions than xeric grasslands. Their ecological integrity is rated as moderate.

### Xeric Shrublands

The **key takeaways** of xeric shrublands are:

- Xeric shrublands on the Lolo National Forest are uncommon and mostly consist of mountain big sagebrush communities at montane and subalpine locations. Their ecological integrity is **moderate**.
- Major stressors are increasing fire frequency and severity and invasive annual grasses.

**Summary.** Xeric shrublands included low elevation, hot, and dry sites where Wyoming or basin big sagebrush are the dominant species of a generally open shrub layer. The understory typically contributes more vegetative cover than sagebrush and consist of rhizomatous and bunch-forming graminoids and perennial forbs. Common species include bluebunch wheatgrass, Indian ricegrass, Sandberg's bluegrass and needle and thread. On some arid south and east facing slopes, antelope bitterbrush may occur in small patches, accompanied by an understory of various cold-season bunchgrasses. Antelope bitterbrush is an important food source for wildlife.

At higher elevation, xeric shrublands are typically characterized by mountain big sagebrush with an abundant understory of graminoids and forbs. This is the most mesic type of sagebrush communities in the region. The understory composition can be diverse and includes rough fescue, Idaho fescue, poverty oatgrass, mountain brome and slender wheatgrass among others (Mueggler and Stewart 1980).

Wyoming, basin and mountain big sagebrush are easily killed by most fires and regrowth tends to be slow. Natural low and mixed severity fire promote a shrub steppe with a patchy distribution of sagebrush. Fire-sprouting species threetip sagebrush, rubber and green rabbitbrush, and white horsebrush may increase after fire. Recovery of big sagebrush to pre-fire condition can take several decades (Lesica et al. 2005).

**Status and trends.** Many xeric shrublands occur on private land, in the valley bottoms or arid lower slopes. Forest Inventory and Analysis has not sampled any xeric shrublands on the Lolo National Forest. However, these communities do exist in small patches and in openings of montane and subalpine forests. The most common types on the Lolo National Forest are mountain big sagebrush communities.

Stressors of this system are similar to those discussed for xeric and mesic grasslands. They include heavy herbivory, departed fire regimes and invasive species. Heavy grazing practices can lead to increases in the shrub cover, decreases in native perennial grasses and invasion of annual grasses and other noxious weeds (see section 2.1.8). If vegetation cover decreases and bare ground increases, loss of topsoil can occur. Lack of fire can facilitate decreases in grass cover and encroachment by conifers (Arno and Gruell 1986, Heyerdahl et al. 2006).

Big sagebrush shrublands are sensitive to predicted increases in fire severity and fire frequency. This is particularly true at lower elevation where fine fuels from cheatgrass and ventenata could facilitate more frequent high-severity burns. Mountain big sagebrush does not form a viable seedbank. Large fires would limit seed dispersal from nearby live sagebrush, and community composition may shift to other more fire resilient species. Type conversion to grassland is possible. Higher elevation shrublands, however, are less likely affected by these processes because invasion by annual grasses is believed to be more restricted (Reeves et al. 2018).

Because mountain big sagebrush is likely the most common xeric shrubland on the Lolo National Forest, and these typically occur on cooler and more productive sites, the ecological integrity of xeric shrublands is moderate.

### Mesic Shrublands

The **key takeaways** of mesic shrublands are:

- Mesic shrublands are uncommon on the Lolo National Forest. Their ecological integrity is rates as **moderate**.

- These systems are well adapted to a variety of disturbances. However, they may be sensitive to persistent and heavy ungulate browsing.

**Summary.** Persistent mesic shrublands are often associated with montane and subalpine forests and occur as patches within mesic grasslands and forests. They are commonly located on steep slopes with shallow soils, in draws and ravines, within cold air drainages or where snowpack lingers into summer. Dominant shrubs include Rocky Mountain maple, serviceberry, chokecherry, oceanspray, common snowberry, thimbleberry and Sitka alder. Snowbrush ceanothus can be common in recently burned areas. Mesic shrublands are well adapted to frequent fire and most species readily resprout from the root system after disturbance. These shrublands can be very productive and are favored by native ungulates.

**Status and trends.** Forest Inventory and Analysis has not sampled any mesic shrublands on the Lolo National Forest. However, these communities do exist in relatively small patches within or adjacent to montane and subalpine forests. Severe browsing by native and domestic ungulates are a major stressor to this system. A shift to hotter and drier climate conditions may result in changes to species composition, from mesic species to more xeric species, such as rubber rabbitbrush and green rabbitbrush. The mesic species Sitka alder and Rocky Mountain maple may move to cooler and moister sites (Reeves et al. 2018). In general, these systems are resistant and resilient to a variety of disturbances. The ecological integrity is rated as moderate.

### Alpine and Sparsely Vegetated Ecosystems

The **key takeaways** of alpine and sparsely vegetated ecosystems are:

- The ecological integrity of alpine ecosystems and other high elevation sparsely vegetated ecosystems is **high**. The ecological integrity of sparsely vegetated ecosystems at lower elevation is **moderate**.
- A major stressor for alpine and high elevation sparsely vegetated ecosystems is climate change with warming temperatures and changes in timing and length of snow cover.
- At lower elevation, sparsely vegetated ecosystems may be at risk for invasion by non-native species with potential changes to fuel accumulation and fire behavior.

**Summary.** Alpine potential vegetation types are estimated to be present on less than 1 percent of the Lolo National Forest (about 3,100 acres, see Table 10). Sparsely vegetated ecosystems are somewhat more common but still amount to less than 1 percent of the Lolo National Forest (about 18,000 acres). True alpine ecosystems occur at and above timberline where climatic conditions are too severe for the establishment and persistence of continuous forest vegetation. Trees may grow as “Krummholz” in isolated pockets or islands. Alpine plant communities are diverse and include shrublands, dense turf communities and sparsely vegetated cushion plant communities and fellfields (Cooper et al. 1997, Johnson 2004). Soils are often poorly developed and rocky. Environmental conditions are characterized by short growing seasons and variable snow cover depending on wind exposure. Short and compact growth forms, dense pubescence and thick and waxy leaves are common adaptations of alpine plants to survive in these environments.

In western Montana, alpine ecosystems typically occur at elevations above 9,000 feet. However, sparsely vegetated ecosystems also occur on rocky ridges, unstable slopes and shallow soils below the climatic timberline, along lower mountain ridges and mountain slopes. While typically different in species composition, these sites share some of the harsh environmental conditions of alpine ecosystems. Many of the forbs and grasses grow in small, protected microsites and are bordered by small patches of shrubs and trees. Rocks provide hibernation sites as well as daily protection and food storage sites for species such as hoary marmots, pika, and others. Rocks also provide habitat for many invertebrate species, such as moths and beetles that provide food for species such as grizzly bears. Other species associated with alpine and sparsely vegetated ecosystems include mountain goat, wolverine, gray-crowned rosy-finch, peregrine falcon, and golden eagle.

**Status and trends.** Most alpine and sparsely vegetated ecosystems that occur at high elevations are not substantially altered from historical conditions, because they are primarily determined by biophysical factors and have relatively low levels of human accessibility. Historically, these ecosystems have been affected by high winds, extreme temperatures, avalanches, unstable rock, poorly developed soils with low organic matter, and/or high UV radiation levels. On the Lolo National Forest, much of the acreage in this ecosystem category is snow-covered for much of the year, with snow retention providing moisture during the growing season, as well as habitat for species such as gray-crowned rosy finches and wolverines.

Climate change is the main factor that could affect these ecosystems, decreasing duration, extend or timing of snow cover. In some portions of Montana, these ecosystem types have been developed for minerals, but the Lolo National Forest does not have active mines and many of these rocky ecosystems are found in federally designated Wilderness or other remote areas where there is no mineral development. The scenic values of many of these areas make them attractive for recreation, and areas along popular hiking trails and lakes may experience some impacts from camping and other recreation related activities. Such impacts are usually very localized.  Within or above the alpine zone, ecosystem processes mostly function within their natural range of variation. The ecological integrity of alpine and other high elevation sparsely vegetated ecosystems is rated as high.

Sparsely vegetated ecosystems that occur at low elevations may have a larger proportion of invasive species, compared to reference conditions, because these sparsely vegetated ecosystems tend to be more accessible than those at high elevations and many invasive plants are well-adapted for growing in sparse soil conditions. The ecological integrity of these ecosystems is rated as moderate.

# 2.3 Aquatic, Wetland, and Riparian Ecosystems

## 2.3.1 Introduction

The biodiversity present in aquatic, wetland, and riparian ecosystems is perhaps greater than any other biome. Water, and water-related habitats, offer much life. Many important human values are also served, such as municipal and residential water supply, agricultural uses (stock water, irrigation), flood water energy reduction and storage, summer baseflows and temperature moderation, sediment detention and water filtration, streambank stability and land loss control, groundwater recharge, wildlife habitat and migration corridors, fishing, many forms of recreation, scenic beauty – even neotropical bird homes and byways.

In this section, status and trends of ecological integrity are described and evaluated for these ecosystems. Ecological integrity is addressed by assessing if key components are functioning properly and are represented according to a defined datum such as undeveloped/reference conditions, natural ranges of variability, and/or to pre-European settlement conditions. Resilience, the ability to favorably adapt and/or recover from environmental or human-caused disturbances, is also a key factor in ecological integrity.

Many definitions exist for the terms "aquatic, wetland, and riparian areas". Herein, the term "aquatic" relates directly to water and water-related habitats and species. Aquatic species generally spend all or significant life stages in water such as fish, mollusks, frogs, salamanders, and macroinvertebrates. Lakes, ponds, streams, and rivers are aquatic systems that are considered surface waters and are the ecosystems with which most people commonly interact. Most surface water directly or indirectly depends upon soil-water storage and groundwater to maintain volume, flow, and other functions (Glasser et al. 2007). Wetlands are areas with distinct vegetation, hydrology, and soils where water saturates the soil consistently or for part of the year. Riparian areas are the vegetated areas bordering water-habitats that transition to upland areas.

From large rivers and upper elevation cirque basins to intermittent streams and various wetlands, the Lolo National Forest's aquatic ecosystems are diverse. Different frameworks, categories, and physical ranges are used to characterize, understand, and best describe each ecosystem and assessment component relative to the assessment question, the human value served, or the distinct feature of an important element. Time scale of analysis varies from current (within 10 years), past (greater than 100 years ago and pre-European settlement), or future (climate change projections of 40-80 years). Linkages or connectivity between habitat elements is also importantly considered, and at times is described in terms of impairment, such as habitat fragmentation or isolation. Table 17 displays important riparian, aquatic, and wetland ecosystem characteristics and indicators.

**Table 17—Key riparian and aquatic ecosystem characteristics and indicators**

| Key Characteristic | Indicator |
|---|---|
| Composition | |
| Life form presence | Presence of diverse riparian and aquatic life forms and communities |
| Native species | Presence of native species in historically occupied habitats |
| Exotic/invasive species | Presence of exotic/invasive species (plant and animal) |
| Aquatic habitat diversity | Presence of habitat and channel types (i.e. streams, lakes, wetlands, groundwater habitats, Rosgen channel types, aquatic ecological systems) |
| Riparian/wetland vegetation | Presence, lifeform, and dominance types of vegetation in riparian and wetlands (i.e. hydric/mesic/xeric, bare ground, etc.) |

| Key Characteristic | Indicator |
|---|---|
| Structure | |
| Channel shape and function | Pool quantity and quality<br>Beaver presence potential<br>Stream width-to-depth ratios<br>Channel and streambank stability<br>Substrate composition |
| Large woody debris | Quantity of large-sized downed wood greater than 3 inches diameter, montane streams; potential recruitment (e.g. insect and disease, tree size) |
| Function | |
| Water quantity | Hydrograph departure from expected natural hydrography (e.g. dams and diversions/water withdrawal; riparian/wetland storage, groundwater extraction and recharge) |
| Water quality | Beneficial use attainment; riparian and wetland areas filtering sediments, stabilizing banks, etc. |
| Habitat fragmentation | Number of barriers impeding movement of biota and habitat elements within aquatic and riparian habitats (e.g. large woody debris, nutrients)<br>Miles of stream artificially constrained or disconnected from floodplain access |

This analysis draws upon the best available scientific information found to be relevant to the ecosystems on the Lolo National Forest. Literature sources that were the most recent, peer-reviewed, and local in scope or at least directly applicable to the local ecosystem were selected, cited throughout, and discussed in sections specific to the data topic. Uncertainty and conflicting literature are acknowledged and interpreted when applicable.

## Inland Native Fish Strategy (INFISH)

The Inland Native Fish Strategy (INFISH) was amended to the 1986 Forest Plan in 1995 to provide comprehensive management direction in riparian areas to include riparian goals, management objectives, standards, and guidelines, and to establish riparian habitat conservation areas. Riparian habitat conservation areas consist of a buffer on either side of a waterbody where riparian-dependent resources receive primary emphasis and are made up of traditional riparian corridors, wetlands, intermittent streams, and other areas that help maintain the integrity of aquatic ecosystems. This is accomplished by (1) influencing the delivery of coarse sediment, organic matter, and woody debris to streams, (2) providing root strength for channel stability, (3) shading the stream, and (4) protecting water quality (U.S. Department of Agriculture 1995b). The Lolo National Forest uses the slope distances provided by INFISH to establish riparian habitat conservation area buffer widths for each of the four categories of streams or waterbodies:

- Category 1: Fish-bearing streams: 300 feet slope distance on either side of the stream.
- Category 2: Permanently flowing non-fish-bearing streams: 150 feet slope distance on either side of the stream.
- Category 3: Ponds, lakes, reservoirs, and wetlands greater than 1 acre: 150 feet slope distance from the edge of the maximum pool elevation of constructed ponds and reservoirs or from the edge of the wetland, pond, or lake.
- Category 4: Seasonally flowing or intermittent streams, wetlands less than 1 acre, landslides, and landslide-prone areas:

- the extent of landslides and landslide-prone areas.
- the intermittent stream channel and the area to the top of the inner gorge.
- the intermittent stream channel or wetland and the area to the outer edges of the riparian vegetation.
- for Priority Watersheds, 100 feet slope distance on either side of the stream.
- for watersheds not identified as Priority Watersheds, 50 feet slope distance on either side of the steam.

These default riparian habitat conservation area buffer widths may be modified if site visits determine if the attainment of riparian management objectives would require less protection (smaller buffer) or more protection (larger buffer). Specific standards and guidelines are also provided for common land management actions such as for timber, roads, grazing, recreation, minerals, fire/fuels, lands, and watershed restoration.

## 2.3.2 Valley Bottoms, Stream Habitat, and Associated Riparian Systems

### Key Takeaways

**Valley bottoms:**

- Evidence that valley bottoms (i.e., river-wetland corridors) were wet, widespread, and ecologically productive in the geologic, prehistoric, and recent past is irrefutable (Wohl et al. 2021). Geology, as well as geomorphic and biotic processes (e.g., beaver, wood jams, and vegetation) are the largest drivers of functional valley bottom integrity, resilience, and ecosystem services.
- Valley bottoms and their ecosystem components provide critical and a disproportionate amount of ecosystem services relative to their size and proportion. Managing valley bottoms to restore riparian species and return them to more wet-riverine corridors will maximize ecosystems services, greatly assist fire management relative to wildfire resilience, and increase wildlife species diversity.
- Beavers are a keystone species and major disturbance agent that are historically were as likely responsible for valley bottom conditions as wildfire and flooding, although existing populations and habitat are well below potential (see section 2.1.4).

**Stream habitat:**

- Stream habitat in general is functioning well on the Lolo. Habitat trends exhibit positive trends in health indicators. However, geomorphologically, most streams are overly simplified because of the loss or degradation of overall natural valley bottom (i.e. wet-river corridor processes).
- Individual streams and distinct stream segments are known to have impacts and management actions are addressing issues through a large watershed and stream restoration program (see section 2.1.7). More attention, monitoring, and remedial actions are needed pertaining to grazing impacts on allotments (see section 2.1.8). Infrastructure continues to threaten specific streams and road-stream crossings, and remedial management actions are necessary.

**Riparian vegetation:**

- Riparian ecosystems are likely departed from their potential condition and area represented relative to riparian vegetation species present and their location and presence in valley bottoms, wetlands and hillside seeps/springs, and along intermittent and perennial stream corridors. The extent of departure is not fully understood.
- A greater understanding is needed with respect to climate change influences and management considerations for valley bottom conditions and stream corridors to reduce departures in riparian vegetation.

### Summary

**Valley bottoms.** Evidence that valley bottoms (i.e., river-wetland corridors) were wet, widespread, and ecologically productive in the geologic, prehistoric, and recent past is irrefutable (Wohl et al. 2021). Functional valley bottoms and river-wetland corridors are entirely possible in arid and semi-arid climates, but because of various changes since the early 1800s, there is lack of understanding of departure and potential. Geologic, geomorphic, and biotic drivers have substantial influence on groundwater, seeps, and springs, which support riparian vegetation. These drivers can cause an otherwise dry floodplain to remain wet, or a hillside to have a ground-surface level water table, through most of the year. In these cases, precipitation and runoff can be secondary drivers to influencing the form and function of valley bottoms and associated river corridors (Wohl et al. 2021).

Geology and groundwater influence surface water and soil-water availability by structural controls, faults and fracturing, weathering, and erosion processes. Geomorphic processes and landforms commonly create local or temporary base levels and/or valley-width constrictions such as alluvial fans, debris flows, landslides, and rock avalanches (Miller et al. 2012). Glacial moraines that act as a local base level and temporarily dam a stream can create a depositional zone upstream from the moraine (Cooper and Merritt 2012).

Aquatic, riparian, and floodplain plants increase drag and surface roughness, resist erosion, and create obstructions to flow both within active channels and across the valley floor – all conditions that assist keeping valley bottoms hydrated (Collins et al. 2012). Other biotic features documented as being capable of driving hyporheic exchange and influencing stream conditions include beaver dams (Polvi and Wohl 2012); large wood, especially in the form of logjams or wood rafts (Miller et al. 2012); and dense stands of aquatic, herbaceous, and/or shrubby vegetation (Larsen 2019). Vegetation type and density, which reflect the regional climate, biome, and depth to alluvial aquifer, also influence the amount and spatial distribution of large wood in the stream corridor (Wohl et al. 2017).

In the northern hemisphere, the presence of beavers (*Castor canadensis* in North America) has a large influence on valley bottom conditions (Pollock et al., 2017). Obstructions within the active channel(s) and floodplain associated with the presence of vegetation, large wood, and beaver dams increase subsurface hydrologic connectivity and hyporheic exchange flows (Doughty et al. 2020). Beaver modifications of the river corridor increase resilience to drought (Hood and Bayley 2008) and wildfire (Fairfax and Whittle 2020). Dense wetland vegetation can also create a condition of dynamic stability in which changes in hydrology drive shifts in the areas of emergent vegetation versus open water (Larsen and Harvey 2010).

Valley bottoms are very vulnerable to the impacts of human and forest management activities. Historic removal of large wood accumulations, cutting of logjams in streams (i.e., recreational fishing and floating), and individual wood (i.e., cumulative effects from access and firewood cutting and hazard tree removal) causes simplification of river-wetland corridors. The exclusion of fire in valley bottoms has caused likely more homogenous timber stand types than historic natural assemblages, which has likely resulted in wildfire propagation, rather than breaks in timber that would thwart or reduce rampant wildfire spread as fires encounter breaks in canopy spread afforded by green, moist deciduous/riparian tree and shrub stands, wetlands, and beaver complexes. Channel incision and/or over-widening has also occurred depending on stream bank and stream bed composition and stability, among other factors where lack wood, beaver, and consequent channel simplification have occurred. Further, roads often artificially reduce valley floor width, which may transform a multi-thread planform to a single-thread, high-conveyance channel (Wohl et al. 2021).

**Stream habitat.** By the beginning of the 1990s, there was great concern about stream habitat degradation in the western United States, as well as the potential loss of salmon, trout, and char populations (Nehlsen et al. 1991); (Rieman and McIntyre 1993). A broad strategy was developed for national forests without ocean going fish called Inland Native Fish Strategy-Interim Strategies for Managing Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and Portions of Nevada (U.S. Department of Agriculture 1995b Idaho, western Montana, and portions of Nevada). INFISH was designed to maintain options for inland native fish by reducing negative impacts to aquatic habitat. To test if INFISH was working, a monitoring effort was developed to determine the strategy's effectiveness. The monitoring effort is called PACFISH/INFISH Biological Opinion Monitoring Program (PIBO-MP). The PIBO monitoring effort is an Interior Columbia Basin-wide monitoring program that began in 1998. PIBO-MP employs a useful approach for assessing the state of stream habitat condition at a given stream reach by comparing habitat characteristics to those of streams likely to be functioning properly (Stoddard et al. 2006). PIBO-MP uses this approach to evaluate and document changes in habitat conditions (e.g. “trend”) over the entirety of PIBO-MP temporal frame (2001 to present).

Determining the condition of an individual, or group of stream reaches is a difficult task because of the natural inherent variability in stream conditions due to geoclimatic and disturbance regimes (Ebersole et al. 1997). PIBO-MP’s approach is to compare stream habitat conditions at sites in ‘managed’ watersheds (watersheds exposed to disturbance from various management actions) to habitat conditions at sites within ‘reference’, or relatively pristine, watersheds, which are used as a benchmark of expected condition. Because all streams are affected by natural disturbance, data analysis focuses on how the range of stream habitat conditions expressed at managed sites compares to what would be expected if the stream had experienced only natural disturbance.

Over 1,300 subwatersheds (6th Hydrologic Unit Code) have been selected for monitoring in the Columbia Basin, of which 207 are reference and the rest are managed. This number equals about a third of all subwatersheds on federally managed lands. Within each reference and managed sub-watershed, a randomly selected ‘integrator’ site located at the lowermost, low-gradient (< 3 percent) reach occurring on federal land is selected. These low-gradient sites are influenced by the remaining watershed area upstream of the site and are considered the most sensitive to changes from variable sediment and flow regimes.

To ascertain the status of a given site, PIBO uses an index of habitat condition to help account for some for some natural variability among sites. A significant difference between the reference prediction and the actual managed site index scores can potentially be attributed to management. If the distribution of managed site conditions mimics the reference condition distribution, it can be assumed that managed sites fall within the range of natural variation. Conversely, if the distributions of reference and managed sites are different, then management may have influenced stream condition.

The **riparian vegetation** along streams and rivers is diverse and multi-dimensional. Vegetation composition changes longitudinally from high elevation headwaters to the mouths of streams and rivers and laterally from the stream to the outer limits of the floodplain. Upland vegetation is commonly described in the framework of potential vegetation which considers the successional trajectories in the absence of disturbance. This concept is less meaningful for riparian vegetation. Many riparian communities are subject to frequent disturbance by flooding, sediment deposition or erosion. Plant communities are interspersed along riparian corridors in a mosaic pattern that corresponds with the width of the valley bottom, fluvial surface, and hydrologic characteristics (Naiman et al. 2005).

Riparian plant communities in western Montana were classified by Hansen et al. (1995). Riparian communities along high gradient streams are often dominated by conifer forests. At higher elevation subalpine fir and spruce are common. With decreasing elevation western red cedar, western larch and Douglas fir become more abundant. The understory is typically sparse and mesic shrub species may only form a narrow band along the stream channel. Lower gradient valley bottoms at mid-elevation may support willow communities along sinuous stream channels. Beaver activity may raise water levels in these systems and flood the entire valley bottom, potentially widening the riparian zone.

Deciduous woodlands dominated by cottonwoods occur in the floodplain of low elevation streams. These systems depend on a natural hydrologic regime with frequent flooding. They are described in section 2.4.4.

Riparian ecosystems are important to wildlife for feeding, dinking, cover, breeding season habitat. They provide corridors for habitat connectivity. Many species are associated with riparian ecosystems, including Canada lynx, grizzly bear, black bear, fisher, and bald eagle.

## Status and Trends

**Valley bottoms.** Although the geology and geologic processes on the Lolo National Forest present a relatively stable environment as compared to some adjacent national forests and other environs, the landscape and valley bottoms are dynamic. Mass wasting is likely the largest influence relative to geology as it relates to avalanche chutes, natural dry-ravel processes, and debris flows. Post-wildfire debris flows have significantly altered the landscape in some areas, negatively affected road infrastructure, damaged private residences (West Mullan Fire near Superior, 2013), and affected valley bottom and stream processes (Monture and Dunham Debris Flows, Walters, 2017). Geomorphologically, valley bottoms vary on the Forest from narrow, steep, colluvial headwaters to wide, alluvial, terraced bottoms with meandering streams. Streams begin from steep mountainous narrow step-pool systems, transition to ripple/rapid dominated streams to lower elevations and broader valleys with alluvial fans and meandering streams. The geology, geomorphic, and biotic processes all integrate differently depending on the valley type, location across the forest and level of human/management development. The primary human-caused effects on geomorphic drivers in valley bottoms include the following:

- Road and trail infrastructure (see sections 3.8 and 2.6.2). Road effects on valley bottom processes include floodplain encroachment, large wood reductions as it relates to eliminating tree presence and recruitment, undersized culverts and failures, fish passage and wood/sediment/nutrient transport blockage, access-related issues such as dispersed camping and erosion/land loss near stream banks, increased sediment deliveries, among others.
- Recreation sites and trails (see section 3.5). Most recreation sites (i.e., campgrounds and other facilities) are located out of floodplains, but some issues still exist. Trail location and crossings are largely in good shape, but issues remain on some trail systems.
- Dams and diversions (see section 3.8). Dams are not a significant issue except in a few locations. Some diversion dams exist across the forest largely for water supply; these structures can cause localized geomorphic effects and stream damage and block fish passage. The 10 dams in the Rattlesnake Wilderness Area are being evaluated by the City of Missoula for decommissioning or rehabilitation. A dam was removed on Elsina lake in the late 2000s to enable fish passage.
- Road-stream crossings and undersized culverts. Discussion below and sections 2.3.2 and 2.6.2.

The failure of undersized culverts during rain-on-snow runoff events have cause relatively large landslides on or near the Lolo National Forest as well (Fisher Creek Slide tributary to Ward Creek, 1995) and Route of the Hiawatha Railroad Grade Culvert Failure (Moss Creek, Idaho Panhandle National Forest, 1995). The Lolo continues to prioritize replacing undersized culverts (see section 2.7.2). Large mass failures are imminent on the Lolo along the Route of the Olympian Railroad Grade as well (Allied Engineering Services 2022) and the Forest is currently developing remedial strategies.

Because beaver is a keystone species and populations are far below historic levels, the Lolo has assessed beaver conditions. Populations are substantively departed from natural conditions (see section 2.1.4).

**Stream habitat condition.** To estimate status and trend of physical stream habitats at each site, data is collected on stream channel attributes that (1) influence the production or survival of native salmonids; (2) are sensitive to land-use changes; and (3) can be measured consistently by observers. For a complete description of these variables and field methods used, see Kershner et al. (2004). The attributes are: D50 (median substrate particle size), percent fine sediment (<6 mm diameter, in pool tails), large wood frequency (pieces /km), residual pool depth (m), percent pool habitat, bank stability (% bank covered with plants or rock), and percent of bank with undercuts (bank angle <90 degrees). The need to summarize overall condition has led PIBO-MP to develop a habitat index that combines several stream habitat attributes (Al-Chokhachy et al. 2010a). To create an overall index of physical habitat condition for a site, individual attribute scores included in the index were summed and then rescaled from 0-100.

For the following analyses, the PIBO MP used data from 60 managed sites and 9 reference sites on the Forest to make statistical comparisons to describe the differences between the two kinds of sites (Figure 14). Reference values from the ecoregion and the entire analysis area are also included.

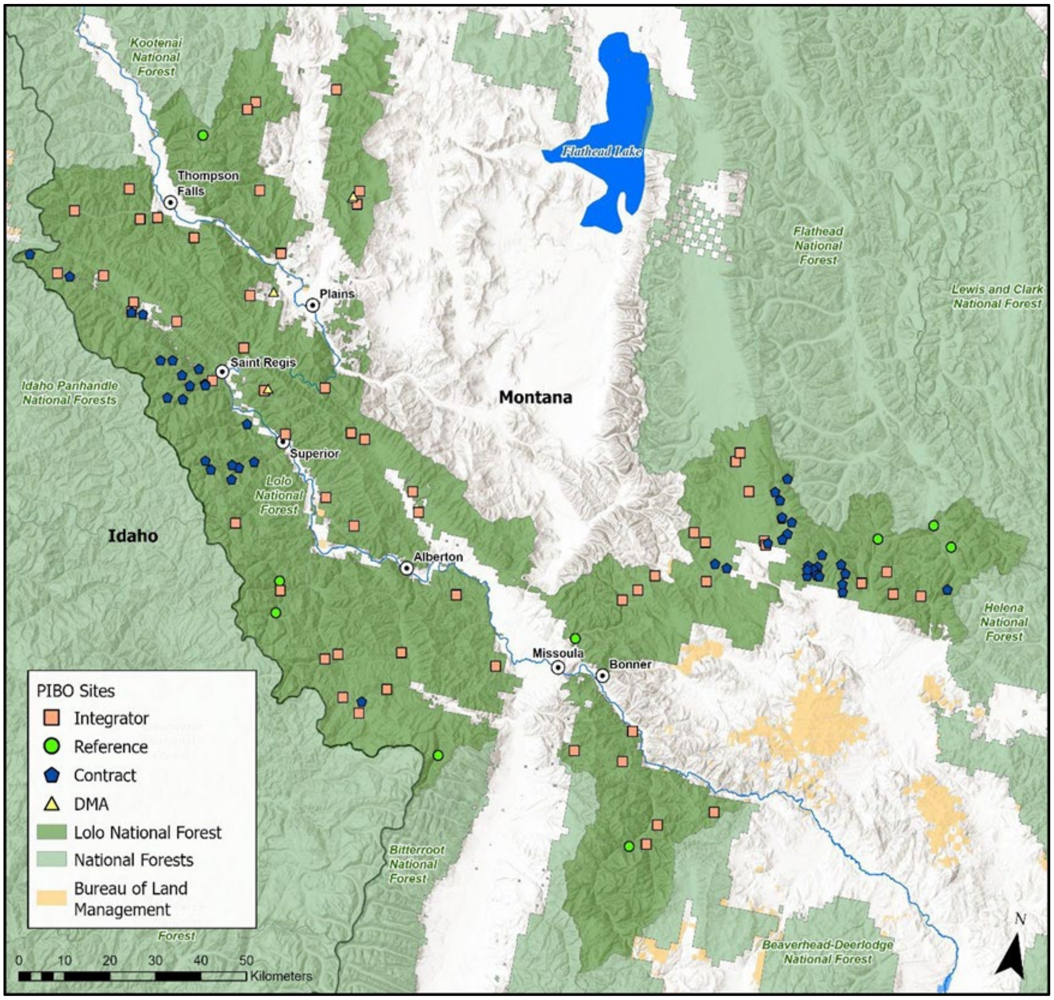


**Figure 14—PIBO monitoring sites on the Lolo National Forest**

Trends for relevant metrics are summarized as follows:

- Total Index Trend: The Total Index attribute combines all the attributes to describe stream trends on managed sites on the forest against reference condition. Overall managed conditions are slightly departed when compared to both ecoregion and all reference conditions. The managed condition appears to move towards reference, but the trend is not significant. Total index is not statistically significantly changing over time even though it appears slight movement towards reference conditions. See also Figure 15.
- Residual Pool Depth Trend: Trends for managed, ecoregion reference and all reference are statistically significant. Managed conditions are departed but positively trending in a desired condition towards reference conditions. See also Figure 16.
- Pool Tail Fines Trend: Trends for managed, ecoregion reference and all reference are not statistically significant. Pool tail fines at managed sites based on linear regressions are lower than pool tail fines in reference sites. The value presented for managed, between 12.7 and 10.7%, appears lower than raw data presented later in the Wilcoxian Rank Test at the end of this section because the regression data used for the image has been transformed and includes covariates. As higher fine sediment levels are often considered a negative because of influence on egg rearing, this

lower amount could be considered a positive metric. Currently, no literature exists that provides guidance on lowermost concentrations of fine sediment. See also Figure 17.

- Pool Percent Trend: Overall managed conditions are slightly departed when compared to both ecoregion and all reference conditions. Trends for managed, ecoregion reference and all reference are not statistically significant. The managed condition appears to move towards reference, but the trend is not significant. See also Figure 18.
- D50 Trend: Overall managed conditions are slightly departed when compared to both ecoregion and all reference conditions. Trends for managed, ecoregion reference and all reference are not statistically significant. The managed condition appears to move towards reference, but the trend is not statistically significant. See also Figure 19.
- Large Woody Frequency Trend: Overall managed conditions are slightly departed when compared to both ecoregion and all reference conditions. Trends for managed, ecoregion reference and all reference are statistically significant. The managed condition is trending towards reference. See also Figure 20.
- Bank Angle Trend: Overall managed conditions are slightly departed when compared to ecoregion and all reference conditions. Managed, all-reference, and ecoregion reference all have statistically significant trends, moving away from desired conditions. Bank angle may be trending negatively in both managed and reference because of several years of low precipitation. See also Figure 21.
- Percent Undercut Banks Trend: Overall managed conditions are slightly departed when compared to both ecoregion and all reference conditions. The managed condition is trending away from reference, but the trend is not statistically significant. See also Figure 22.
- Vegetation Bank Stability Trend: Overall managed conditions are departed when compared to ecoregion and all reference conditions. Managed, all-reference, and ecoregion reference all have statistically significant trends, and the managed conditions are moving away from desired conditions. See also Figure 23.

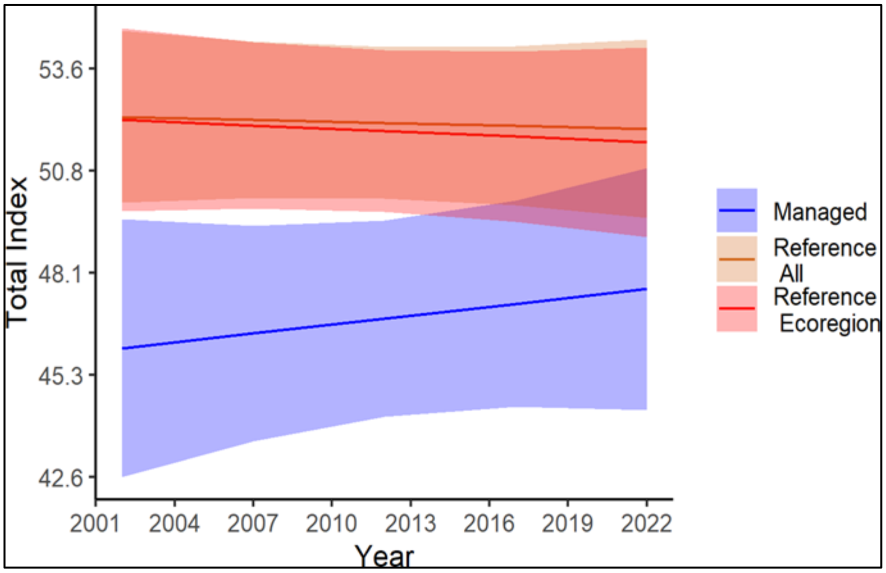


**Figure 15—Modeled trend in total index across the Lolo as a solid blue line. Shaded portion represents the 90% confidence interval. Modeled trend in reference sites are included for comparison with local ecoregion in orange and all reference in red.**

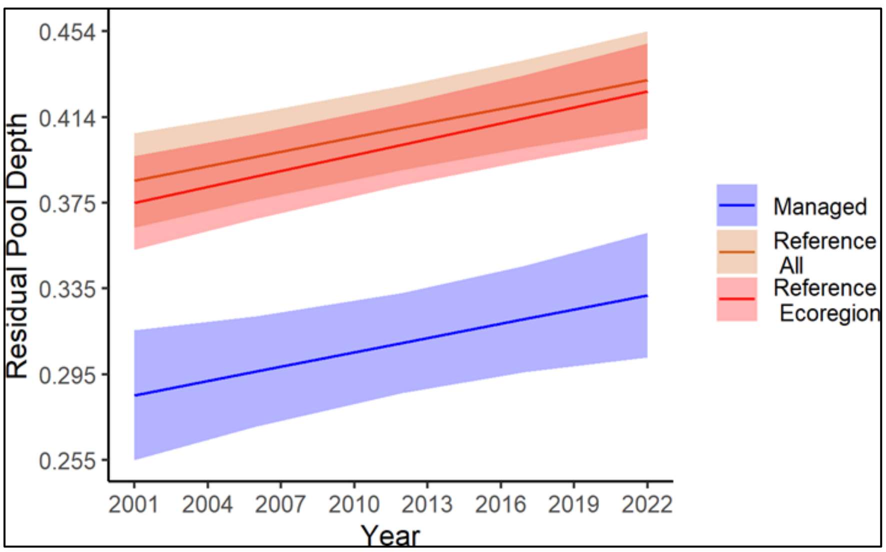


**Figure 16—Modeled trend in residual pool depth across the Lolo as a solid blue line. Shaded portion represents the 90% confidence interval. Modeled trend in reference sites are included for comparison with local ecoregion in orange and all reference in red.**

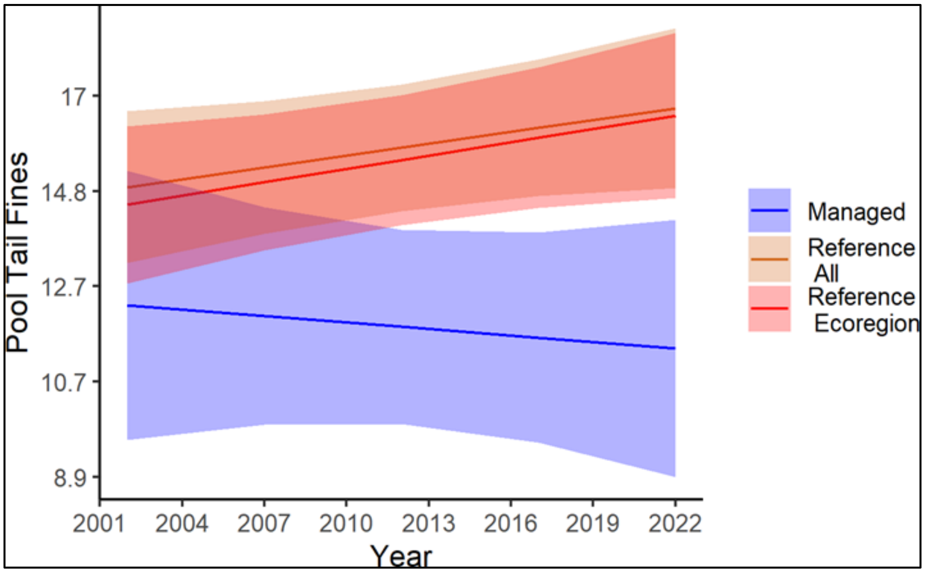


**Figure 17—Modeled trend in pool tail fines across the Lolo as a solid blue line. Shaded portion represents the 90% confidence interval. Modeled trend in reference sites are included for comparison with local ecoregion in orange and all reference in red**

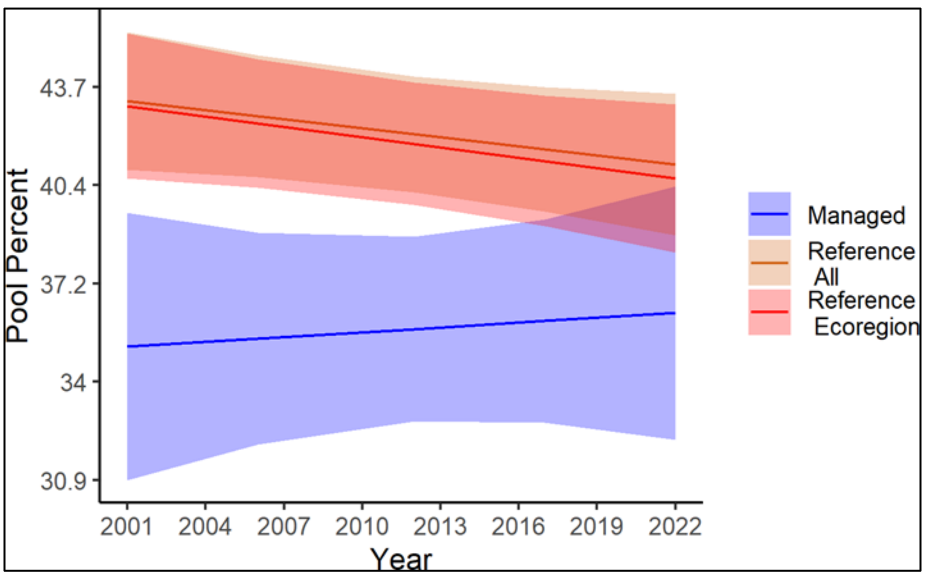


**Figure 18—Modeled trend in pool percent across the Lolo as a solid blue line. Shaded portion represents the 90% confidence interval. Modeled trend in reference sites are included for comparison with local ecoregion in orange and all reference in red**

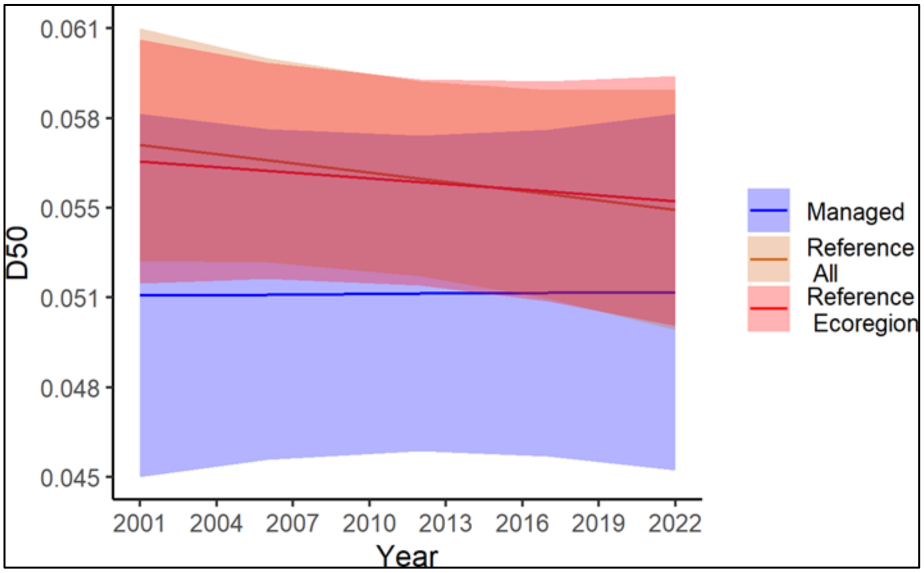


**Figure 19—Modeled trend in D50 across the Lolo as a solid blue line. Shaded portion represents the 90% confidence interval. Modeled trend in reference sites are included for comparison with local ecoregion in orange and all reference in red**

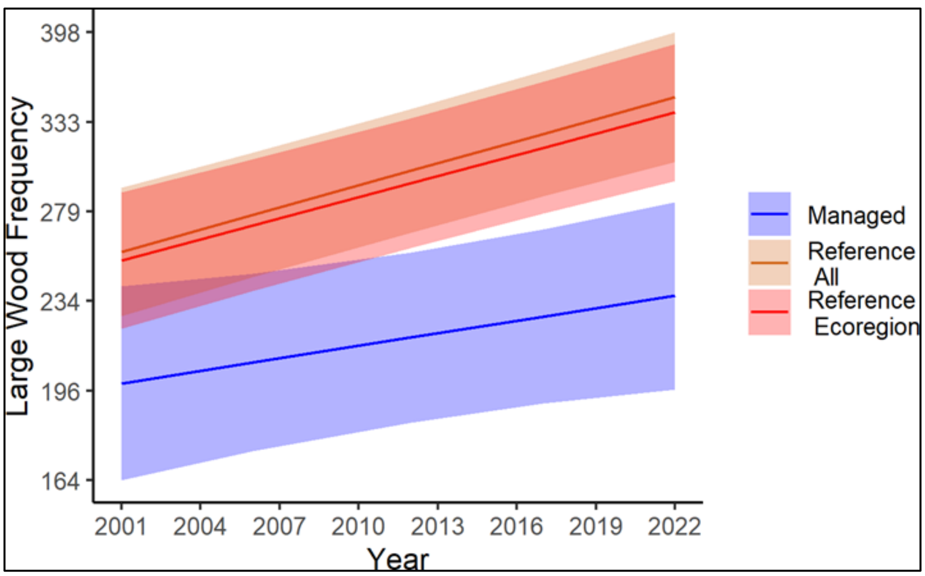


**Figure 20—Modeled trend in large wood frequency across the Lolo as a solid blue line. Shaded portion represents the 90% confidence interval. Modeled trend in reference sites are included for comparison with local ecoregion in orange and all reference in red**

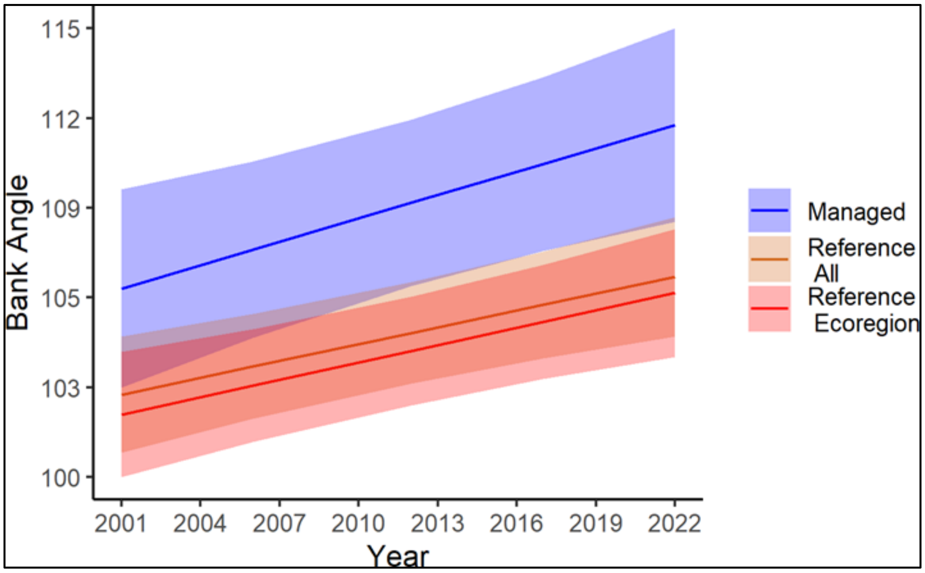


**Figure 21—Modeled trend in Bank Angle across the Lolo as a solid blue line. Shaded portion represents the 90% confidence interval. Modeled trend in reference sites are included for comparison with local ecoregion in orange and all reference in red**

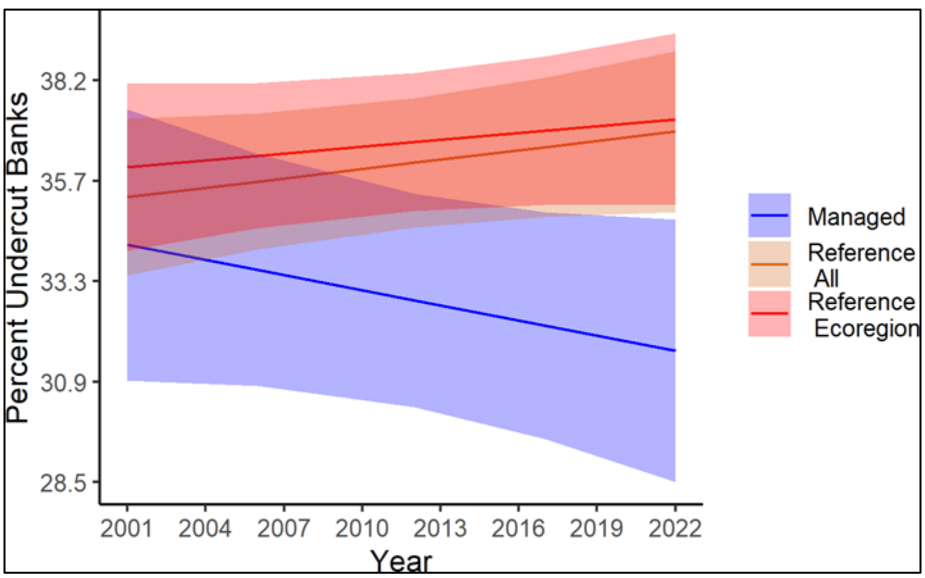


**Figure 22—Modeled trend in Percent Undercut Banks across the Lolo as a solid blue line. Shaded portion represents the 90% confidence interval. Modeled trend in reference sites are included for comparison with local ecoregion in orange and all reference in red**

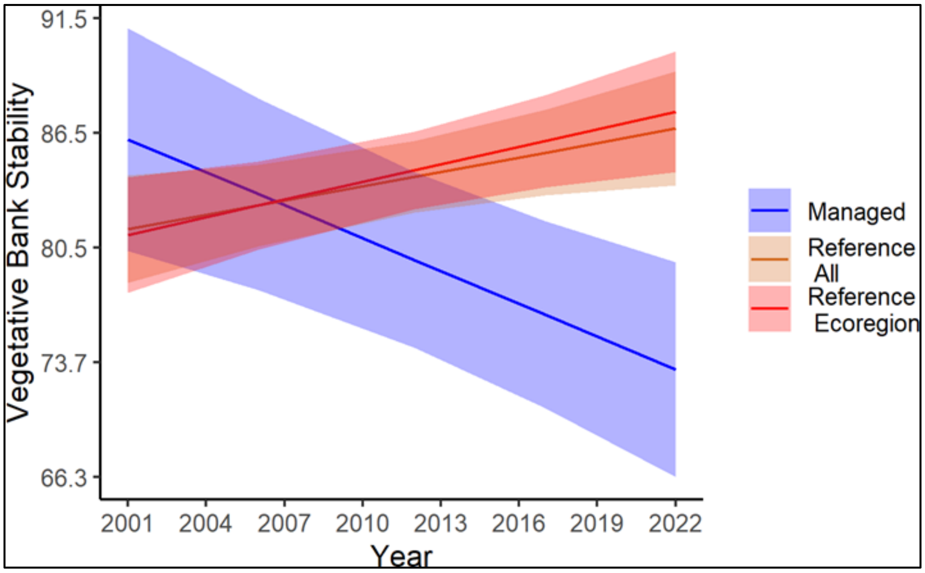


**Figure 23—Modeled trend in Vegetative Bank Stability across the Lolo as a solid blue line. Shaded portion represents the 90% confidence interval. Modeled trend in reference sites are included for comparison with local ecoregion in orange and all reference in red**

The Wilcoxian Signed Rank Test was used to compare raw data between first and last observations (Table 18). There was a positive change for the total index, residual pool depth, and large wood attributes. Two indicators, however, do have negative trends: bank angle and vegetative bank stability. Reasons are uncertain; several drought years are suspected to be affecting these indicators. The range of managed stream habitat conditions are close to the range of reference stream habitat conditions on Forest.

**Table 18—Wilcoxon signed rank test for differences between the first and last observation of metrics across the Lolo National Forest.**

| Metric | Time[1] Mean | Time[2] Mean | Percent Change | Sample Size | Negative Number | Positive Number | None Number | p Value | Desired Direction | Actual Change |
|---|---|---|---|---|---|---|---|---|---|---|
| Index | 44.5 | 46.7 | 4.94 | 60 | 34 | 24 | 2 | 0.08 | + | + |
| RPD | 0.294 | 0.339 | 15.31 | 60 | 43 | 17 | 0 | 0.003 | + | + |
| PoolPct | 36.6 | 39 | 6.56 | 60 | 30 | 30 | 0 | 0.482 | + | NS |
| PTFines6 | 14.6 | 14.2 | -2.74 | 60 | 27 | 32 | 1 | 0.616 | - | NS |
| D50 | 0.052 | 0.051 | -1.92 | 60 | 30 | 27 | 3 | 0.946 | + | NS |
| LWFrq | 259 | 313 | 20.85 | 60 | 38 | 22 | 0 | 0.02 | + | + |
| BankAngle | 107 | 111 | 3.74 | 60 | 33 | 27 | 0 | 0.078 | - | + |
| UnCutPct | 35.2 | 32.8 | -6.82 | 60 | 25 | 34 | 1 | 0.334 | + | NS |
| VegStab | 73.6 | 66.7 | -9.37 | 60 | 23 | 36 | 1 | 0.049 | + | - |

Time1 = mean during first visit; Time2 = mean value for last visit; Percent Change = percent change in the mean values between the first and last visit; Sample size = number of observed sites; Negative Number = number of sites where actual measurement was lower on last visit; Positive Number = number of sites where actual measurement was higher in last visit; None Number = number of sites where last visit and first visit values were equal; p-value = significance test; Desired Direction = direction of change in the mean that would be considered beneficial to fish; Actual Change = actual direction of change in the mean. Change can be either +, -, or not statistically significant (NS).

**Riparian vegetation.** The Montana Natural Heritage Program mapped wetland and riparian vegetation on 32,930 acres (1.5 percent) of the Lolo National Forest (Table 19). Mapping is based on aerial imagery and follows the Cowardin classification system adopted by the National Wetland Inventory (Cowardin et al. 1979, Federal Geographic Data Committee 2009). Wetlands in include three systems, Riverine (streambeds and shores), Palustrine (freshwater wetlands and ponds; discussed in section 2.3.4), and Lacustrine (Lakes; discussed in section 2.3.3). Areas where vegetation composition and growth is influenced by nearby water bodies but does not display true wetland characteristics are mapped as Riparian using National Wetland Inventory conventions (U.S. Department of the Interior 2015). The "riparian" classification utilized by Montana Heritage Program mapping is too narrow to characterize the vegetation encountered along stream sides and floodplains. Vegetation in abandoned channel sections, near backwaters and in wetlands created by beavers will classify as palustrine system and differentiation of what is influenced by perennial streams versus subsurface runoff or upwelling groundwater is not possible.

**Table 19—Wetland and riparian ecosystems mapped on the Lolo National Forest**

| System | Acres | Lolo National Forest (percent) |
|---|---|---|
| Riverine (Stream channel and edge) | 3,092 | 0.1 |
| Riparian | 14,891 | 0.7 |
| *Riparian Emergent* | *368* | *< 0.1* |
| *Riparian Shrub* | *1,700* | *0.1* |
| *Riparian Forested* | *12,823* | *0.6* |
| Palustrine | 14,269 | 0.6 |
| *Freshwater Pond* | *1,488* | *0.1* |
| *Palustrine Emergent* | *4,452* | *0.2* |
| *Palustrine Shrub* | *5,353* | *0.2* |
| *Palustrine Forested* | *2,976* | *0.1* |
| Lacustrine | 677 | < 0.1 |
| **Total** | **32,930** | **1.5** |

Mapping based on aerial imagery likely results in an underestimate of the real riparian extent because mesic understory species may be obscured by conifer forests and wetlands species may be misclassified as upland. Another route to assess riparian ecosystems is to map associated geomorphic features, namely the portions of the valley bottom influenced by surface flow and groundwater. This will overestimate the extent of current riparian ecosystems but give a depiction where these ecosystems could currently exist (Smith et al. 2020). We used the national riparian area base map (see planning record exhibit L-001) to depict 50-year flood heights and combined it with riverine and riparian systems mapped on the Lolo National Forest. This was necessary because modeling of flood heights is based on digital elevation models that do not always accurately depict the location of streams. The resulting composite represents the potential riparian footprint, which we then compared with the amount of wetland and riparian vegetation included in Table 20. The potential riparian footprint is estimated to cover 80,431 acres (3.6 percent) of the plan area. Only about a third of that potential footprint is currently occupied by riparian ecosystems. This is consistent for all subbasins on the Lolo National Forest.

**Table 20—Potential and existing extent of riparian ecosystems for the Lolo National Forest**

| Subbasin (Lolo NFS lands only) | Perennial stream miles | Modeled 50-year floodplain acres | Acres within potential riparian footprint[1] | Acres of mapped riparian ecosystems within footprint |
|---|---|---|---|---|
| Bitterroot | 130 | 5,691 | 5,867 | 703 |
| Middle Clark Fork | 683 | 28,396 | 32,740 | 12,264 |
| Lower Clark Fork | 305 | 12,440 | 14,245 | 5,067 |
| Lower Flathead | 5 | 133 | 146 | 43 |
| Blackfoot | 409 | 18,538 | 19,489 | 5,998 |
| Flint-Rock | 165 | 7,344 | 7,943 | 2,521 |
| **Total** | **1,697** | **72,542** | **80,431** | **26,597** |

[1]combines the modeled floodplain with mapped riparian vegetation to account for modeling and mapping inaccuracies

Comparison of current extent of mapped riparian ecosystems with the potential riparian footprint provides and indicator for the departure from historical pre-European settlement conditions in valley bottoms and along perennial and intermittent stream corridors. Changes in flooding events and stream flow, decline of beaver populations, improper grazing practices, and a lack of floodplain connectivity due to roads, dams, and other embankments have likely limited the development or persistence of riparian ecosystem. Fire suppression in surround upland forests has also affected some riparian ecosystems. High canopy cover of conifers shades out many of the deciduous trees and shrubs characteristic for riparian zones (see sections 2.4.3 and 2.4.4). Remaining deciduous woody plants experience higher browsing pressure from native and domestic ungulates. In addition, composition of riparian communities has been altered by non-native species, many of which are now persistent components of the understory.

## 2.3.3 Intermittent Streams and Associated Riparian Systems

### Key Takeaways

- Intermittent and ephemeral streams comprise over half of our stream channel networks and provide many important ecosystems services. They are important to the diversity of biotic and abiotic systems.
- The duration and abundance of intermittent flow expression is likely to increase under projected climate scenarios.

### Summary

Intermittent and ephemeral streams are watercourses or stream segments that flow periodically. Local estimates and scientific literature suggest that these stream segments comprise over 50% of the stream network and offer many important values such as, but not limited to the following:

- Transporting flow, sediment, wood, and nutrients to the lower stream reaches,
- Water quality (either good or impaired), and
- Corridors for movement of terrestrial, semi-aquatic, and aquatic species; yet, in some situations they provide important barriers to movement.

The Montana Streamside Management Zone law (MCA 77-5-301[1]) includes a suite of protections for stream channels and adjacent wetlands, including those with intermittent and ephemeral flow regimes. The law contains definitions for flow intermittency (termed stream classes) and stipulates specific activities that are permitted based on stream class. These protections are implemented as integral project design features and are evaluated under the Montana Forest Practices Reviews administered by the Montana Department of Natural Resources and Conservation.

### Status and Trends

With perennial streams receiving most focus relative to information gathering, understanding, and management consideration and stewardship, the ecosystem services related to intermittent and ephemeral streams are overlooked, undervalued, under-assessed, and less understood (Datry et al. 2017, Shanafield et al. 2021). In Montana (and with similar numbers nationally), 48% of stream miles within native trout historical range are classified as intermittent or ephemeral and 59% exist in headwater streams. In the Blackfoot River, 51% of streams are intermittent and 60% are headwaters based on USGS, National Hydrography, 1:100,000 maps.

Generally, intermittent and ephemeral streams are watercourses or stream segments that don’t flow at some point in time and location. Flow regimes can vary widely in duration, timing, volume, location, and predictability. During spring snow melt and/or heavy rains, intermittent streams fill with water, draining the surrounding watershed, and transporting flow, sediment, wood, and nutrients to the lower stream reaches. The intermittent segments are typically located in the uppermost reaches of stream systems; however, dry segments also are prevalent at the mouths of certain streams, especially in valley bottoms with deep alluvium.

Ecologists assume that different components of the flow regimes promotes species richness by creating a spatial mosaic of habitats during the wetting-drying cycle (Datry et al. 2018). Although it’s true that studies show that perennial streams, or segments with longer flows, have much higher biodiversity, the dry segments also provide local and regional biodiversity relative to habitat diversity and food for semi-aquatic and terrestrial biota that aren't available in the perennial segments (Steward et al. 2012). Moreover, the intermittency that exists at stream mouths is becoming better understood with regards to the influence of fish movement and the potential great role that intermittency is playing in precluding non-native species from entering certain streams of high value native fisheries.

To semi-aquatic and terrestrial species, these dry channels and their vegetation (both riparian and upland) provide essential corridors for security and movement such cumulatively and perhaps at key locations these streams become critical for maintaining and enhancing biodiversity (Sánchez-Montoya et al. 2016). Further, with climate change influences, these stream segments are likely to increase temporally and spatially. Streamflow projections developed by Wenger and others (2010) and geospatial data recently updated and available at https://storymaps.arcgis.com/stories/6a6be7d624db41638a24b659305af522, suggest that mid- (2040), and late-century (2080) baseflow index values (ratio of average daily flow during seven day low flow/average annual daily flow) and minimum weekly flows, among other low flow metrics, may decline substantially across the Lolo National Forest. Though not a direct projection of flow intermittency, these estimates do suggest that an increasing proportion of the flow network may experience flow intermittency for greater durations of the year.

Given that intermittent and ephemeral streams comprise over half of our channel networks, that they present many important ecosystems services to the diversity of the entire biotic and abiotic systems, and that their frequency, duration, and abundance likely increasing, management considerations for their value and protections are warranted.

## 2.3.4 Lakes and Reservoirs

### Key Takeaways

- There are a variety of natural lakes and man-made reservoirs and ponds on the Lolo National Forest.
- Higher elevation lake ecosystems have higher ecological integrity than lower elevation systems. Although public use of dispersed recreation sites near mountain lakes is increasing, the lack of access and low-impact nature of dispersed use means the overall status and trend of ecological integrity is 'high'. In addition, the very cold, deep water makes these lakes resistant to the effects of climate change.
- Lower elevation lakes have **moderate** ecological integrity because of shoreline development, valley bottom land use practices, and presence of non-native plant and animal species. These same factors will continue to be threats in the future as lower elevation lakes are susceptible to climate change and invasion of other non-native species. Lower elevation lakes and reservoir conditions and trends are dominated by non-Federal land use.

### Summary

Lake ecosystems are broadly classified by nutrient content and productivity as determined by how much nitrogen and phosphorus are available to support aquatic plants and algal growth. Much of the plan area is mountainous such that high- to middle-elevation lakes are generally deep, cold, and low in nutrients (oligotrophic). These lakes are heavily influenced by groundwater and snowmelt. Aquatic animals generally include insects, amphibians, and waterfowl that are most abundant in the narrow ring of relatively shallow water along the shoreline where sunlight supports algal growth and some rooted emergent/submergent plants (littoral zone); high mountain lakes typically do not naturally contain fish. There is little aquatic life in the open water portion of oligotrophic lakes (limnetic zone) because nutrient levels are too low to support much algae or phytoplankton growth which is the reason these lakes have remarkably clear water. However, fish such as rainbow trout, brook trout, and westslope cutthroat trout have been stocked into mountain lakes in the 1900s to provide additional fishing opportunities. Montana Fish, Wildlife, and Parks currently continues to stock and manage about half of mountain lakes as westslope cutthroat trout fisheries and about half as fishless to support a variety of recreational experiences and ecological conditions. Mountain lakes are often located in designated wilderness, roadless areas, or otherwise surrounded by national forest ownership such that there is very little development along shorelines. Exceptions occur on the very few lakes that have road access where the Lolo National Forest maintains recreation sites such as dispersed campgrounds and hiking trails (such as Heart and Moore lakes).

Valley bottom lakes typically have larger drainage areas and receive more water from stream input and overland flow. The topography surrounding these lakes is relatively flat and is much more conducive to agricultural and residential development. 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, although this now includes a large non-native component such as curly leaf pondweed. Fish naturally occur in these systems and include native species like mountain whitefish, westslope cutthroat trout, and bull trout as well as non-native species like brown trout, rainbow trout, kokanee, northern pike, and yellow perch. The high accessibility of valley bottom lakes means much of the shoreline in private ownership has been developed for residences and shoreline in Federal ownership has been developed for campgrounds and boat launches (such as Seeley and Salmon lakes).

The plan area also includes notable man-made bodies of water. The largest is the Thompson Falls Reservoir that is created by the Thompson Falls hydroelectric dam at the western edge of the Lolo National Forest. This reservoir receives substantial nitrogen and phosphorus inputs from agricultural and wastewater treatment systems in the upper Clark Fork watershed. This high-nutrient environment supports extensive algae and emergent/submergent plant growth (eutrophic) that in turn support large numbers of aquatic insects, waterfowl, and non-native fish like smallmouth bass and northern pike. Water levels may fluctuate more so than on a natural lake because of hydropower operations. Much of the shoreline is owned by Northwestern Energies or other private landowners to include the town of Thompson Falls on the north side of the reservoir. The Milltown dam created a similar reservoir east of Missoula until it was removed in 2011 and restored to a riverine condition. Other man-made bodies of water in the plan area include numerous ponds created by irrigation diversions and or low dams for water supply. These ponds are typically small and shallow and support very little in terms of aquatic ecosystems because of their highly managed status generally on private lands and fluctuating water levels.

### Status and Trends

Although public use of dispersed recreation sites near mountain lakes is increasing, the lack of access and low-impact nature of dispersed use means the overall status and trend of ecological integrity is ‘high’. And the very cold, deep water makes these lakes resistant to the effects of climate change. The lower elevation lakes have a ‘moderate’ ecological integrity rating because of the combination of shoreline development, valley bottom land use practices, and presence of non-native plant and animal species. These same factors will continue to be threats in the future as lower elevation lakes are susceptible to climate change and invasion of other non-native species; invasive mussels are of particular concern considering the high volume of recreation boat traffic from all over the country during summer months. The man-made reservoir and pond systems typically have an aquatic ecological integrity rating of ‘low’ because of their highly unnatural and altered condition. They are also highly susceptible to threats like climate change and invasive species. There are few Federal management actions that could substantially reduce these threats because they are located largely outside of lands managed Federally. A notable exception is the process by which aging dams and diversion structures on National Forest System lands are being evaluated for maintenance or removal if they no longer serve their primary purpose.

## 2.3.5 Wetlands, Ponds, and Groundwater Dependent Ecosystems

### Key Takeaways

- There is high uncertainty about the ecological integrity of many wetland, spring, and groundwater dependent ecosystems. The ecological integrity is likely high for remote, high elevation systems but low to poor at lower elevation. Several fens are protected as Research Natural Areas or Botanical Areas and their integrity is moderate to high.

- Surveys are needed to better understand the conditions and trend of these ecosystems. Major stressors are changes to hydrological characteristics including spring developments, water diversions and roads.

- Groundwater dependent ecosystems 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. They 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. Hansen et al. (1995) describe and classify many of the diverse plant communities occurring in wetland areas in northwestern Montana. These include conifer forests with Engelmann spruce and Western redcedar, aspen woodlands, shrublands dominated by willows and wet grasslands and meadows.

Groundwater dependent ecosystems are "communities of plants, animals, and other organisms whose extent and life processes are dependent on access to or discharge of groundwater (U.S. Department of Agriculture 2012a). These wetlands occur at aquifer discharge locations and include special habitats such as springs and fens. Many perennial streams and lakes are also supported by upwelling groundwater.

Fens are wetlands supported by groundwater with an accumulation of peat (30 centimeters or more). These systems are characterized by low oxygen and nutrient availability and are exceptionally stable ecosystems in the absence of disturbance (Chadde et al. 1998). They are relatively uncommon in the northern Rocky Mountains and support a distinctive flora with high concentration of rare species restricted to these extreme environmental conditions. Peatlands in the Northern Rocky Mountains provide habitat for herbaceous or shrub communities characterized by sedges, rushes and a small number of willow species. In western Montana bog birch, hoary willow or Drummond willow are common shrub associates (Chadde et al. 1998). Forested wetland types dominated by Engelmann spruce or lodgepole pine may occur adjacent to open peatland areas.

Springs play a key role in delivering cool water to warming streams and support late-season stream flows (Lawrence et al. 2014). Spring ecosystems support a unique fauna and flora with many species that are physically confined to spring-fed wetland, aquatic or riparian habitats (Cartwright et al. 2020). One example for the Lolo National Forest is giant helleborine (*Epipactis gigantea).* Springs are often called biodiversity hotspots and can function as keystone ecosystems with large ecological influence over surrounding areas (Cartwright et al. 2020). In water limited landscapes, they serve as natural oases providing consistent resources such as water and food to birds and mammals.

## Status and Trends

Montana Natural Heritage Program riparian and wetland mapping shows 14,269 acres of palustrine wetlands and ponds, which amount to less than 1 percent of the Lolo National Forest (Table 21). Most of these are either shrublands or wet meadows typically dominated by grasses and grass-like plants. A small subset of these is classified as continuously saturated or flooded and saturated throughout the growing season, indicating ta possible influence of groundwater. These emergent and shrub wetlands are marked as potential fens in Table 21. However, remotely sensed data are likely insufficient to determine groundwater influence of wetlands and in the resulting classification fens may remain undetected or described as other wetland types. Chadde et al. (1998) describe three extraordinary fen complexes on the Lolo National Forest: Mary's Frog Pond, Sheep Mountain Bog, and Shoofly Meadows. These sites support floating and anchored mats of sphagnum moss, roundleaf sundew (*Drosera rotundifolia*) and number of other uncommon or rare vascular plant species. All three of these are protected as Research Natural Areas or Botanical Areas and display high to moderate ecological integrity. One additional Botanical Area, Elk Meadow, features an alkaline groundwater dependent ecosystem. Whether this area has sufficient accumulation of organic matter to qualify as fen is not known.

**Table 21—Mapped freshwater wetlands and ponds on the Lolo National Forest (Montana Natural Heritage Program Riparian and Wetland Mapping)**

| Wetland Type | Cowardin classification | Acres | Lolo National Forest (percent) |
|---|---|---|---|
| Palustrine Wetlands (Total) | P | 14,269 | 0.63 |
| Forested | PFO | 2,976 | 0.13 |
| Shrub | PSS | 5,353 | 0.23 |
| Emergent (herbaceous) | PEM | 4,452 | 0.2 |
| Pond | PUB, PAB, PUS | 1,488 | 0.07 |
| Potential Fens[1] | Subset of PEM and PSS | 646 | 0.03 |

[1]Includes shrub and emergent wetlands with continuously saturated, seasonally flooded-saturated, or semipermanently flooded water regimes (D, E, F)

The National Hydrography Dataset reports a total of 42 springs on the Forest; only seven are named. This data layer typically underestimates the true number of springs, but no further spring records exist in the Springs Online database. The number of springs is the best indicator available to document the currently known occurrence of groundwater dependent ecosystems around springs. Many more springs likely exist, including those that discharge directly into a perennial stream, but they are not yet mapped. No systematic groundwater dependent ecosystem surveys or assessments are available for the plan area beyond work accomplished in the above-mentioned Research Natural Areas and Botanical Areas.

Stressors to wetlands, ponds and groundwater dependent ecosystems include changes in surface or subsurface water runoff, water diversions and lowering of the groundwater table. Spring boxes that divert water from springs can have detrimental effects on the entire wetland ecosystem; see section 2.1.5 for a summary of water rights on the Forest. Roads can act as barriers to runoff and depending on their location permanently increase or decrease the water table of an adjacent wetland. In addition, they are known transportation corridors for invasives and may deliver sediments and nutrients to wetlands altering wetland chemistry and depth.

About 200,000 acres on the Lolo National Forest are located in active grazing allotments. Livestock and wildlife herbivory can strongly affect wetland composition by decreasing or even eliminating palatable plant species such as aspen or cottonwood regeneration, willows and many native grasses and sedges. Around springs and small wetlands, physical trampling is also a concern.

Climate change will alter snowpack storage in the Northern Rockies, and a shift to a more rain-dominated hydrological regime may negatively affect groundwater recharge (Dettinger and Earman 2011, Luce 2018). The process of groundwater recharge is complex and Luce (2018) calls for monitoring information to improve our understanding of surface water-groundwater interactions. However, reduced water supply because of increasing frequency and severity of droughts, decreasing snowpacks, and increasing water use demands for livestock and irrigation will likely lead to continuing changes in the extent and composition of wetland and groundwater dependent ecosystems. Lower water table levels may cause wetlands to completely dry out in summer and make such areas unsuitable for obligate wetland species.

There is high uncertainty about the ecological integrity of many wetland, spring, and groundwater dependent ecosystems and surveys are needed to better understand the occurrence and distribution of springs and fens. The ecological integrity is likely high for remote, high elevation systems but low to poor at lower elevation. There is insufficient information to evaluate restoration needs. In general, management 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.

# 2.4 Unique or Rare Ecosystems

## 2.4.1 Whitebark Pine Ecosystems

### Key Takeaways

This section addresses the conditions, status, trends, and integrity of high elevation ecosystems defined by the presence of whitebark pine. Whitebark pine is a federally listed species (section 2.6.0). It is also a part of the Cold Forest Ecosystem (section 2.2.3).

- The ecological integrity of whitebark pine communities, which are found on cold dry sites in the broad Cold Forest ecosystem, is **low** based on existing status, trends, and threats (especially white pine blister rust). The primary drivers and stressors include natural fire, fire exclusion and suppression, climate change, drought, bark beetles, white pine blister rust, and wildlife regeneration mechanisms.
- Whitebark pine may become functionally extinct in some areas due to connectivity issues related to fragmented stand size and seed dispersal mechanisms, and the loss of this species fundamentally alters the integrity of these ecosystems. The level of certainty with this finding is high based on a large body of available scientific information.
- The ability of the Forest Service affect change for the status and trends of this ecosystem is moderate to low. Management actions to improve integrity can include the planting or seeding of blister rust-resistant stock to a small degree and thinning to reduce competition. There are greater restoration opportunities associated with prescribed fire and benefits from wildfire to create suitable sites for regeneration. The level of certainty with this finding is medium.

### Summary

The whitebark pine cover type as estimated with VMap represents less than 5% of each geographic area on the Lolo National Forest (Table 12). This ecosystem is found in the Cold Forest ecosystem. Whitebark pine ecosystems are present in high elevation sites across western North America and are found in all geographic zones on the Lolo National Forest above 6,000'.

Whitebark is a keystone species that grows at or near treeline and delivers many ecosystem functions and services. The most relevant ecosystem services supported by this ecosystem include water regulation, climate regulation, aesthetics, erosion regulation, spiritual values, traditional uses by native American tribes, and food and habitat for wildlife. These forests also play an important role in soil stabilization and snowpack retention in upper watersheds (Farnes 1990). Whitebark pine seeds are an essential food source for many animals on sites where other food sources are limited, including at least 13 species of birds and eight species of mammals (Tomback and Kendall 2001), including Clark's nutcracker, squirrels, and grizzly bears. Squirrel seed middens have also been linked to lynx food sources. These nutritious seeds were also a traditional food source for indigenous peoples. Today, many people place high importance on the aesthetic qualities and spiritual values of these high elevation ecosystems.

Characteristics of this ecosystem that are fundamental to its integrity include species compositions, stand structure, and connectivity. Ecosystem connectivity (for example, stand sizes and distance between stands) and the structure of stands including the presence of seed-bearing trees are factors that maintain the genetic diversity of whitebark pine and conditions attractive to Clark's nutcracker. Whitebark pine is dependent on Clark's nutcracker, and other wildlife species to a lesser degree, for seed dispersal and scarification to improve germination success.

Historically, these ecosystems supported mixed severity fire regimes, and experienced such fires at intervals of 35-200 years. These fires created suitable sites for natural regeneration and promoted whitebark pine dominance over shade-tolerant conifer species. The natural role of bark beetles also resulted in individual and patch mortality of the largest trees at periodic intervals; the timing and extent of these events was limited by cold temperatures and the natural patchiness of whitebark pine forests.

Healthy whitebark pine stands often have low to moderate competition from other conifer species such as Engelmann spruce and subalpine fir. The mixed severity disturbance regime resulted in the development of a mix of size classes, which included the presence of cone-bearing trees, and often the maintenance of sparse and discontinuous fuel loadings that served to perpetuate the mixed severity regime. The natural disturbance regime also provided for openings on the landscape suitable for re-establishment from the seed-bearing trees maintained on the landscape.

Climate conditions are also important to these ecosystems. Whitebark pine itself is drought resistant, and capable of thriving on cold, drier sites with discontinuous fuels and where it can outcompete other species in the harshest environments at high elevations with cold temperatures.

## Status and Trends

The combination of several factors has resulted in a widespread decline in whitebark pine, resulting in its listing under the Endangered Species Act. Although whitebark pine remains widely distributed in North America, these ecosystems are threatened by the following synergistic stressors that also affect whitebark pine as an individual species.

1. An important stressor is the introduction of white pine blister rust to North America across the range of whitebark pine, causing direct mortality, a reduction in seed production, and lowered defenses to other mortality factors. Efforts to directly control this disease have failed. The natural selection process for resistance traits is occurring too slowly given the influence of other stressors that cause the loss of viable seed trees.
2. Another key stressor is the shift in wildfire regimes. The whitebark ecosystem is often present at the highest elevations with little fuel and little competition, but also occurs at slightly lower elevation dry subalpine sites where disturbance regimes are crucial to maintaining whitebark dominance. In the latter case, a century of fire suppression has allowed shade-tolerant species to outcompete whitebark pine and change the fuel profile, although there is conflicting science regarding the degree of departure associated with this trend. Broadly, climatic shifts and fuel build-up has resulted in a shift of fire regimes toward large scale stand-replacing events, which can compromise seed availability for regeneration. There is an increased fire frequency and shift to higher severities in forests where Engelmann spruce and subalpine fir have become prevalent.
3. Bark beetle outbreaks have become widespread due in part to warming temperatures which results in lower winter mortality of beetles and increases reproduction rates. The homogeneity of neighboring lodgepole pine forests in some places has led to outbreaks which can “spill” into whitebark pine forests. Bark beetles have resulted in a loss of some large seed-producing trees that had thus far survived other stressors. The trend of this stressor is less certain, due to the potential for climate shifts to disrupt beetle life cycle synchronicity.
4. Climate change is an overarching stressor that exacerbates the other stressors described and directly impacts whitebark pine whose competitive advantage relies on its ability to survive cold temperatures at treeline.

Due to these factors, the extent of whitebark pine is estimated to be well below its natural range of variation across its natural range. The natural range of variation analysis estimated that historically the whitebark pine cover type was present on 23 to 52 percent of Cold Forests (Appendix 3). Remaining whitebark pine stands on the Lolo tend to be small and scattered, usually in a mix of other, shade tolerant conifers. The expected trend of this ecosystem is a continued decline, except for areas where active restoration occurs (e.g., prescribed fire and planting of stock that is genetically resistant to white pine blister rust). The Lolo National Forest has actively participated in whitebark pine restoration programs, including the collection of materials to support the breeding program for rust-resistant planting stock. Several rust-resistant whitebark pine trees used for rust-resistant materials collections were recently lost in the wildfires of 2017.

The reduction in representation and the condition of whitebark pine ecosystems has compromised the delivery of ecosystem functions and ecosystem services. Likely trends include:

- Reduction or loss of whitebark seeds as a food source for wildlife.
- Loss of biodiversity
- Loss of forests that attract grizzly to higher elevations and reduces conflict with humans.
- Compromised role of high elevation forests to provide watershed protection, snowpack retention, and erosion control at the highest elevations where few other species thrive. It is possible that tree species other than whitebark pine can help fill this role in some places, whereas others are likely to become nonforested.
- Compromised delivery of uniquely aesthetic landscapes popular for some recreationists, as well as the spiritual values important to people associated with these unique places.
- Loss of traditional food source for native American cultures.
- Loss of carbon sequestration role.
- Genetic depression which increases the need for active restoration activities to increase the population.

## 2.4.2 Western Redcedar Bottomlands

### Key Takeaways

- The ecological integrity of western red cedar bottomlands is **moderate**.
- Western red cedar bottomlands are compromised by altered hydrological cycles (e.g., water diversion, roads, upland vegetation), altered fire regimes, land use (e.g., acquired industrial timber lands, recreation, road location), timber harvest, and climate change.
- This ecosystem is expected to deliver major functions and services, including supporting biodiversity and productivity but at a reduced level relative to expectations for this ecosystem. The potential for management to restore western red cedar bottomlands is moderate.

### Summary

Western red cedar bottomlands are warm, wet, low-elevation, highly diverse and productive forest ecosystems. This unique forest community is the most productive potential vegetation type on the Lolo National Forest in terms of growth rate and potential (western redcedar/queen cup beadlily). In Montana, the western redcedar habitat type described by Pfister et al. (1977) occurs most extensively in the Swan Valley and Mission Range, extends eastward locally to Missoula, and forms small riparian stringers along major streams in the Bitterroot Range west of Hamilton. On the Lolo National Forest, this community is more common on the west side, due to the maritime influence, but occurs on the east side. This type occupies wet bottomlands, flood plains, riparian areas, ravines, protected sites, and toe slope seepage areas between 2500’ and 5000’ in elevation (Hansen et al. 1995). Soils range from sandy and well-drained to deep, nutrient-rich, and wet (Fischer and Bradley 1987). Western red cedar bottomlands may support numerous other conifer species during various stages of stand development including western white pine, ponderosa pine, Douglas-fir, Engelmann spruce, lodgepole pine, subalpine fir, grand fir, western larch, western hemlock and pacific yew. Species presence and establishment is dependent onsite conditions, fire frequency, disturbance history and magnitude, and seed availability (Pfister et al. 1977, Fischer and Bradley 1987).

All stages of stand development of this type are culturally important to tribes. Native people rely on these lands for seasonal gathering and traditional practices. To native cultures, western red cedar is the “tree of life” it is used for boats, baskets, traditional medicines, tools, clothing, ropes, and nets.

### Status and Trends

Ancient growth western red cedar groves with complex structural development typify this unique community (Pfister et al. 1977). Stands have complex vertical and horizontal structure with numerous snags, downed trees, logs, and cavities that support wildlife diversity. Western red cedar bottomlands may range from young and older open-canopy forests that support extremely lush undergrowth to closed canopy forests that allow little sunlight to reach the cool, moist forest floor and anywhere in between (Fischer and Bradley 1987). Terrestrial and aquatic species depend on this type, but the limited, natural disconnected type distribution impacts connectivity.

Western red cedar bottomlands and ancient old growth groves serve as important gene conserving fire refugia areas. Historic fire occurrence was very infrequent (150+ years) (Habeck 1976). These are mesic sites where fires generally burn to their edge and die out. Western red cedar bottomlands frequently contain large, downed rotting trees that persist for many decades. Fuel loading is higher in all size classes than other types. Heavy fuel loading, fuel arrangement and juxtaposition, combined with drought, and adjacent forest conditions set the stage for severe, widespread fire. Severe burns may lead to shrub fields with numerous species present, providing abundant wildlife forage for years. Mixed severity fires create a mosaic of tree species, size, and age classes (Fischer and Bradley 1987).

Stands often occur as isolated, vulnerable island populations with reduced and limited spatial extent. This ecosystem is expected to deliver major functions and services, including supporting biodiversity and productivity but at a reduced level relative to expectations for this ecosystem. Western red cedar bottomlands are compromised by altered hydrological cycles (e.g., water diversion, roads, upland vegetation), altered fire regimes, land use (e.g., acquired industrial timber lands, recreation, road location), timber harvest, and climate change. Restoration of hydrological conditions, floodplains and wetlands, and large tree structure within western red cedar bottomlands, as well as, increasing type redundancy, extent, and connectivity would enhance their ecological integrity and ability to provide important cultural, regulating, and provisioning services within the plan area.

## 2.4.3 Subalpine Larch

### Key Takeaways

- On the Lolo National Forest, subalpine larch is most abundant at the northern end of the Bitterroot Mountains. Carlton Ridge provides unique habitat because it escaped past glaciation and soils are unusually well developed considering the altitude. A portion of the subalpine larch communities on Carlton Ridge are designated as a Research Natural Area.
- Much of this area burned in 2017 resulting in high severity effects. In addition to losses from disturbance, this species is vulnerable to the effects of climate change. Therefore, although small, the subalpine larch community on Carlton Ridge is important for biodiversity.
- Its ecological integrity is **low**, due to its small size and the impacts of disturbance, although this level of integrity is not applicable to the broader status of this species across its range.

### Summary

Subalpine larch (*Larix lyallii*) is a hardy, high elevation conifer with a very restricted geographic distribution. It occurs at or near timberline in the northern Rockies and the northern Cascades. The current discontinuous distribution is believed to be a remnant of a more continuous range when climate conditions were cooler and timberline habitat was more extensive. On the Lolo National Forest, subalpine larch occurs at the northern end of the Bitterroot Mountains, on Carlton Ridge, Lolo Peak and the mountain ridges along the South Fork of Lolo Creek. It is a dominant species in pure stands or mixed timberline communities on about 1,290 acres.

### Status and Trends

Carlton Ridge contains an extensive and well-developed grove of subalpine larch (*Larix lyallii*) which appears as an open park like community. Carlton Ridge provides unique habitat because it escaped past glaciation and soils are unusually well developed considering the altitude. A portion of the subalpine larch communities on Carlton Ridge are designated as a research natural area (see section 3.9.4). These subalpine larch stands occur on the upper slope positions and are best displayed between 7,600 and 8,000 ft. Although subalpine larch is a common component of the upper timberline forest in the Bitterroot Mountains, its occurrence on well-developed soils on Carlton Ridge is a rare phenomenon - typical habitats for subalpine larch are coarse talus and boulder slide tracks. These high-elevation forests are virtually unique in occurring on a well-developed soil and supporting luxuriant undergrowth communities, thus representing a climatic climax of special importance in ecological studies.

Because of its well-developed soil, the larch forest atop Carlton Ridge is unique in having a luxuriant low, undergrowth layer, dominated by mountain heath, smooth woodrush, and grouse whortleberry. Normally the distributions of subalpine larch and western larch *(L. occidentalis*) are separated by about 500 feet of elevation, but in the Carlton Ridge area subalpine larch descends in a strip of rock-land to unusually low elevations where it hybridizes and back-crosses with western larch (Arno and Habeck 1972). In addition to alpine larch forest and hybridization zone, this unique ecological area also hosts old growth whitebark pine forest covering about 350 acres and an ancient slump supporting an old spruce/ riparian community containing exceptionally large western larch trees.

Much of this area burned in 2017 resulting in high severity effects to portions of this unique forest; it is currently estimated to be less than 250 acres in size. In addition to losses from disturbance, this species is vulnerable to the effects of climate change. Therefore, although small, the subalpine larch community on

Carlton Ridge is important for biodiversity. Its ecological integrity is rated as low for the small community present on the Lolo National Forest, due to its small size and the impacts of disturbance, although this level of integrity is not applicable to the broader status of this species across its range.

## 2.4.4 Aspen Stands

### Key Takeaways

- The ecological integrity of aspen stands on the Lolo National Forest is **moderate**.
- Aspen stands are affected by fire exclusion and ungulate herbivory. Stands at the drier and warmer end of suitable habitat are vulnerable to climate warming. Management actions such as prescribed fire, conifer thinning and fencing can restore seral aspen stands but will do little for drought-stressed stands at the limit of suitable habitat.

### Summary

Aspen (*Populus tremuloides*) is a common but minor seral component of mesic forests in northwestern Montana (DeByle and Winokur 1985, Cooper et al. 1991, Campbell and Bartos 2000). Typical habitat includes valley bottom toe slopes adjacent to streams along with toes of talus slopes where there is additional subsurface moisture. Aspen is a shade intolerant, clonal, deciduous tree with short-lived stems but long-lived root system. The species responds favorably to fire (or any disturbance that results in top kill) and regenerates quickly if there is sufficient soil water. Regeneration is primarily vegetative through root sprouting, resulting in a clone or stand of genetically identical aspen trees.

Montana's aspen dominated riparian and wetland communities have been described by Hansen et al. (1995). On riparian and wetland sites, aspen occurs with willows and other mesic shrubs. Within coniferous forests, aspen tend to occupy sites where periodic disturbance (e.g., wildfire, logging, landslides) has removed conifers. Succession will favor subalpine fir, spruce or Douglas-fir to reclaim these areas (Pfister et al. 1977).

On sites with both high soil moisture and solar radiation, climax aspen communities can occur. On these sometimes sparsely vegetated sites, environmental conditions appear to preclude establishment of conifers in the absence of periodic disturbance. Such communities have been described from the Blue Mountains in eastern Oregon (Swanson et al. 2010) and the foot of the Montana Rockies near or east of the Continental Divide (Pfister et al. 1977). They may also occur in small, isolated patches in the plan area.

Aspen leaves, young trees, and spring shoots provide important year-round food for cattle, sheep, elk, moose, deer, small mammals, and a diversity of birds (DeByle and Winokur 1985, Sallabanks et al. 2001). Protein-rich aspen buds, small twigs, and bark are heavily used by mammals and birds, especially during the critical winter months when other food may be scarce. Aspen ecosystems support a high diversity of insects which attract numerous bird and bat species. Aspen trees and associated understory plants provide shelter, shade, and nesting habitat.

### Status and Trends

Aspen dominated communities occur on only 157 acres of the Lolo National Forest, mostly in the Warm Moist broad potential vegetation type and in mapped riparian or wetland settings. Native ungulate browsing, livestock and hydrological changes to wetlands or stream terraces are major stressors affecting aspen regeneration and distribution. On sites with history of heavy grazing and browsing pressure, the understory of aspen stands may be dominated by non-native grasses such as redtop (*Agrostis stolonifera*), common timothy (*Phleum pratense*), and Kentucky bluegrass (*Poa pratensis*). In addition, fire exclusion has caused many early seral stands to progress to conifer dominated forests which eventually overtop and shade out aspen (Campbell and Bartos 2000, Shepperd et al. 2001).

A warming climate with increased fire frequency and intensity is likely to favor aspen regeneration on moist sites. However, aspen stands on warmer, drier sites may experience high mortality due to increased water deficit. Sudden aspen decline has been associated with severe drought, especially stands at the fringe of suitable habitat (Frey et al. 2004, Ireland et al. 2014). Drought-stressed stands may not be able to regenerate under intense ungulate herbivory which may lead to a loss of entire aspen clones.

Aspen stands on the Lolo National Forest are small, scattered, and likely remnants of formerly large clones which persisted because of sufficient disturbance by fire and flooding. Active restoration of aspen stands with prescribed fire and thinning of conifers is a priority for the Lolo National Forest. Climate warming may remedy a century of fire exclusion but is projected to reduce aspen distribution in the western United States due to increased frequency and severity of droughts (Keane et al. 2018). Considering the future climate trajectory, the ecological integrity of aspen stands is rated as moderate.

## 2.4.5 Cottonwood Forests

### Key Takeaways

- The ecological integrity of cottonwood forests is **low**.
- Establishment of new cottonwood stands along rivers in western Montana require regular (usually every 1 to 2 years) flooding events along floodplains that are hydrologically connected to the river.
- Forest management can maintain existing stands by thinning out conifers and protecting stands from high ungulate herbivory. Restoration of floodplain connectivity will require cooperative work with other agencies and private landowners.

### Summary

Cottonwoods typically dominate riparian communities on fluvial surfaces along floodplains of streams and rivers. In the plan area, black cottonwood (*Populus trichocarpa*) and narrowleaf cottonwood (*Populus angustifolia*) occur. Both are shade intolerant. Black and narrowleaf cottonwood are facultative wetland species which can occur in riparian and less frequently in adjacent upland settings. Black cottonwood has a slightly broader moisture amplitude of the two. Cottonwoods require frequent and regular flooding for germination and establishment. Seeds are airborne and only have 2 weeks of viability. The fluvial surface must be moist but not saturated and germination is timed with receding water from peak flow events. Floodplain roughness features (downed trees, debris/rack lines etc.) create “safe sites” for accumulation of fine textured sediment which is critical for successful germination and establishment. Once established, cottonwoods continue to require access to the water table throughout most of the growing season (Rood et al. 2003). The diversity and pattern of floodplain communities is shaped by erosion and deposition of alluvium from frequent floods. Each new alluvial deposit provides a surface for cottonwood regeneration. Cottonwoods and associated shrub communities help attenuate peak flows, protect floodplains, and assist with sediment deposition.

Hansen et al. (1995) describe multiple cottonwood community types for western Montana. Black cottonwood is the dominant cottonwood species west of the continental divide, where it typically occurs with willows, alder, birch and other mesic shrubs, along with various forbs and graminoids. Ponderosa pine, Douglas-fir, and Rocky Mountain juniper may be present on drier, more elevated sites, where flooding is less frequent. Here the recruitment of young cottonwoods has typically ceased, and the understory is composed of snowberry, rose, chokecherry and other upland species.

Cottonwood forests provide cover, food, and shade for wildlife along important corridors for landscape connectivity. Beavers use cottonwoods for food and building materials and their activities provide important services for the health of riparian ecosystems (see section 2.1.4). Numerous bird species, herptiles, along with large and small mammals, use cottonwood forests for nesting, breeding, rearing young and shade. These linear forests serve as important corridors for wildlife, including bears and other large mammals. While they are a small percentage of the larger landscape, they provide critical habitat for a large diversity of wildlife species.

### Status and Trends

Cottonwood stands along the Clark Fork, Bitterroot and Blackfoot Rivers are commonly in private ownership and these lands are prime real estate for housing developments. On the Lolo National Forest, cottonwood dominated stands occur on 3,146 acres along tributaries to the major river drainages, such as Rock Creek, and Rattlesnake Creek. However, cottonwood often co-dominates with ponderosa pine, Rocky Mountain Juniper and Douglas-fir depending on flooding regime and fire history (Hansen et al. 1995). For example, the Council Grove Research Natural Area northwest of Missoula showcases several black cottonwood and ponderosa pine communities that interlace along old and current channels of the Clark Fork River. At a regional scale, in VMap, these are classified as ponderosa pine. Forested wetland and riparian communities are mapped in 18 percent of the potential riparian footprint of the Lolo National Forest, for a total of 14,630 acres.

The main stressors to the ecological integrity of cottonwood forests are changes in the frequency, magnitude and timing of flood events and decreases in streamflow which affect the regeneration and survival of cottonwood stands (Auble and Scott 1998, Beschta and Ripple 2005). Decreased streamflow and declining water tables may result in a conversion of streamside vegetation from cottonwoods to upland species. Engelmann spruce, grand fir, Douglas-fir and other conifers can shade out remaining cottonwoods. In addition, large portions of the floodplain are already disconnected from any flooding water because of roads, dikes, and other embankments.

Herbivory of cottonwoods and palatable shrubs is an additional threat to the integrity of these stands. Under high browsing pressure, desirable shrub species such as red-osier dogwood (*Cornus stolonifera*) and many willow species are eliminated and the understory may become dominated by non-native grasses, including Kentucky bluegrass (*Poa pratensis*), common timothy (*Phleum pratensis*) and smooth brome (*Bromus inermis*) (Hansen et al. 1995). This disturbance state is very persistent even when herbivory by wildlife and livestock is strongly reduced.

A warming climate combined with increased human demand for water will likely result in further decreased streamflows (Keane et al. 2018). A decline of winter snow accumulation combined with earlier snowmelt may shift the timing of peakflows to earlier in the season, potentially out of sync with cottonwood seed dispersal. Considering current conditions of floodplain connectivity and future climatic trends, the integrity of cottonwood forests is rated as low.

# 2.5 Landscape Pattern and Connectivity

## 2.5.1 Key Takeaways

- The distribution of habitat elements and vegetation on the landscape is as a key ecosystem characteristic. A resilient landscape is made up of a mosaic of age classes, composition, and successional stages.
- Openings in the forest, such as early seral forests, are meaningful for habitat for many wildlife species and represent the crucial initiation point in forest successional development. Approximately 13 percent of the Lolo National Forest currently provides early seral habitat, generally distributed in patches ranging widely in size and their abundance is generally within the natural range of variation.
- Large multi-storied patches are a key ecosystem characteristic for many wildlife species. At the landscape scale, the amount and connectivity of multistory forest has increased dramatically and is currently dominated by medium sized or smaller, shade-tolerant trees. Without the backbone of large or very large trees to anchor resilient multistory forest conditions, many of these stands are at high risk of catastrophic loss to wildfire or other disturbances. These forests are at risk of widespread loss.
- Montane grasslands and associated edge habitat represent key habitat for many species. The general trend is a slight, gradual increase in the amount of grassland. However, the threats associated with native grasslands are associated with function over direct loss (e.g., invasive species altering fire behavior and forage quality).
- With respect to habitat diversity, the suppression of disturbances prior to 1985 resulted in a gradual loss of landscape heterogeneity, particularly a loss of early seral habitat patches, though the loss was not uniform across the Forest. After 1985, an increase in wildfire activity and density-related tree mortality has reversed this trend, resulting in a greater distribution of early seral patches. While we see a trend toward increased heterogeneity, the structural diversity on the Lolo National Forest is currently low.
- Ecosystem connectivity, defined as the distribution of vegetation types, cover types, size classes, and densities, helps facilitate ecological connectivity and is meaningful for disturbance processes, genetic flow, and the integrity and functionality of wildlife habitat. Preliminary modeling efforts show that:
    - ♦ The area just west of St. Regis appears to provide some of the highest potential for connectivity across Interstate 90.
    - ♦ The Bitterroot Valley represents a significant barrier to closed-canopy species; however, the area just south of Lolo may provide crossing opportunities for species capable of longer distance dispersal by leveraging the riparian areas and existing conservation easements along the Bitterroot River.
    - ♦ Highway 83 represents a potential barrier in the Upper Blackfoot Clearwater geographic area. However, a section just south of Seeley Lake may provide crossing opportunities for closed canopy species.

## 2.5.2 Summary

The distribution of habitat elements and vegetation on the landscape is as a key ecosystem characteristic because it affects ecological processes, including wildlife and plant dispersal. It affects spread rate and shape, risk and intensity of such disturbance processes as fire, invasive species and insect or disease activity. Connectivity of forests and ecosystems can be affected by natural landscape factors such as topography, soils, variation in precipitation, and wildfire but can also be affected by human developments and activities. It is also one of the most complex attributes of ecosystems to quantify. The goal of understanding connectivity and pattern is to better understand the appropriate mosaic of conditions that make up a resilient, diverse, and functioning landscape that provides for native biodiversity and supports natural disturbance regimes.

Heterogeneity is the quality of consisting of dissimilar elements, as with mixed habitats or cover types occurring on a landscape (Turner et al. 2001). Heterogeneity on landscapes may occur as mosaics of patches generated by many events, but also may be created by single large events that occur infrequently (Kashian et al. 2005). Because landscapes are dynamic and unique there is no optimal landscape mosaic that will increase all ecosystem services; however, land managers can intervene to sustain ecosystems services (Turner et al. 2013). Generally, a resilient landscape is made up of a mosaic of age classes, composition, and succession stages because variability ensures that not all areas are equally susceptible to the same drivers at the same time. Spatial heterogeneity is influenced by feedbacks with interrelated ecosystem drivers and has implications for important ecosystem services such as reforestation, timber productivity, wildlife habitat quality, watershed health, and carbon storage (Turner et al. 2013).

Connectivity and spatial pattern are also meaningful in the context of biodiversity and genetic exchange, which has implications for the adaptability of species to future conditions. Seed dispersal strategies, e.g. the ability of species to establish on sites after disturbance, will depend on spatial heterogeneity and the suitability of future site conditions including climate conditions and the characteristics of microsites. Genetic diversity greatly influences the adaptability of both plants and animals to changing conditions. Maintaining a diverse and robust genetic base, and promoting connectivity both within and between native populations, is therefore a primary foundation of resilience.

Many elements of composition and structure contribute to and could be assessed to understand the overall landscape pattern of a forest or grassland ecosystem. These elements occur across a range of spatial scales, from individual trees to stands to landscapes. They also develop at different temporal scales, ranging from days to centuries or more. Fine-scale structures that support native biodiversity include large trees, snags, and coarse woody debris. Key elements at the stand or landscape scale include:

- Forest openings and early seral post-disturbance forests: Abundance, average and range of the sizes of early successional forest patches created by stand-replacing disturbance (transitional and seedling/sapling size classes).
- Large multi-storied forest patches: Amount and extent of > 3,000-acre patches of two, three, and continuously storied forests in medium and larger size classes.
- Montane grasslands: The amount and patch size of montane grasslands.
- Habitat diversity: The extent and structural condition of conifer forests.
- Ecosystem Connectivity: The average and range of connected patch sizes; patch frequency/density; and perimeter (edge).

Many other elements contribute to landscape pattern and associated ecological processes. However, not all these elements can be addressed with the data and analysis tools currently available.

## Information Sources

- Natural range of variation modeling represents a core component of forest planning under the 2012 Planning Rule. Managing forest and grassland systems within the natural range of variation is presumed to provide a resilient landscape capable of supporting native biodiversity and natural disturbance regimes. The methods used for modeling natural range of variation and detailed results are included in appendix 3. Here, those results are used to provide context for an interpretation of changes in landscape pattern on the Lolo National Forest over both short and long-term horizons.
- As described in Section 2.2 and appendix 5, VMap is a geospatial dataset developed using the Northern Region existing vegetation classification system (Barber et al. 2011).
- The Landscape Change Monitoring System is a remote sensing-based system produced by the Forest Service for mapping and monitoring changes related to vegetation canopy cover, as well as land cover and land use. Data produced extend from 1985 to the most recently completed growing year. This product is intended to provide a consistent monitoring method for applications including, but not limited to, post-disturbance monitoring, broadscale vegetation cover change, land cover and land use conversion trends monitoring, and sensitive habitat monitoring.
- The Montana Natural History Program Land Use/Land Cover dataset records all Montana natural vegetation, land cover and land use, classified from satellite and aerial imagery, mapped at a scale of 1:100,000, and interpreted with supporting ground-level data. The baseline map is adapted from the Northwest ReGAP project land cover classification, which used 30-meter resolution multi-spectral Landsat imagery acquired between 1999 and 2001. Vegetation classes were drawn from the Ecological System Classification developed by NatureServe (Comer et al. 2005). Additionally, the Montana land cover layer incorporates several other land cover and land use products (e.g., Structures and Transportation themes and the Montana Department of Revenue Final Land Unit classification) and reclassifications based on plot-level data and the latest imagery to improve accuracy and enhance the usability of the theme. Updates are done as partner support and funding allow, or when other datasets can be incorporated. Recent updates include fire perimeters and agricultural land use (annually), energy developments such as wind, oil and gas installations (2014), roads, structures and other impervious surfaces (various years): and local updates/improvements to specific ecological systems (e.g., central Montana grassland and sagebrush ecosystems).
- Other regional assessments can also provide context regarding landscape-scale patterns and trends. The Interior Columbia Ecosystem Management Project provides a broad-scale assessment of the socioeconomic and biophysical systems of the lands in the interior Columbia River basin, including quantification of conditions and trends in vegetation patterns and disturbance regimes (Hessburg et al. 1999a, Hessburg et al. 2000). This regional assessment provides a means of comparing our findings regarding vegetation conditions on the Forest with documented conditions at the broader scale. Findings from the regional assessment were reported by ecological reporting units; much of the Forest lies in the Upper and Lower Clark Fork ecological reporting unit.
- Information on anthropogenic modifications to the natural landscape was taken both from specific Forest Service datasets on development (e.g. transportation, infrastructure) as well as from a global human modification dataset developed by (Theobald et al. 2020). This dataset reflects a variety of human impacts on the landscape, such as development, shifts in land use, and water diversion, and has been used to evaluate changes in functional connectivity (Belote et al. 2022)

- Conservation Science Partners (2021) developed and mapped areas of "high ecological value" on the Lolo National Forest. The determination of high ecological value was based on a composite of indicators such as total carbon, climate resilience (estimates the degree to which the climate conditions currently experienced by a species will be accessible in the future), biodiversity, ecological intactness (the degree to which a given location remains in a natural state) and connectivity.

## 2.5.3 Status and Trends

### Key Landscape Elements

**Forest openings and early seral, post-disturbance patches.** Openings in the forest, such as those created after a stand-replacing disturbance, are the most distinct, easily detectable structural conditions in a forested landscape. They are meaningful for habitat for many wildlife species because of their distinctive composition and openness which affects the growth and survival of plants upon which wildlife depend, and strong contrast to adjacent mid or late successional forest (in other words, the forest "edge"). They also represent the crucial initiation point in forest successional development, the foundation upon which rests the character and pattern of the future forest. For management purposes, it is critical to understand the size of openings expected under a natural disturbance regime. This aspect is not well understood or defined in current Forest Plan direction for maximum sizes of openings that can be created by harvest. A robust analysis of the extent, size, and abundance of forest openings is not currently available. It is desirable to estimate these metrics for each ecosystem on the Forest during the revision process. These metrics help us understand the existing condition of forest openings and may help inform plan components.

Preliminarily, VMap indicates that across the Forest as a whole, there are over 2,700 patches mapped as "transitional", where forest cover has not yet reestablished following disturbance, with an average patch size of 80 acres. These patches are distributed at a density of 3.5 patches per 100 hectares and account for approximately 8.4% of the Forest. The largest patch is nearly 24,000 acres, located in a recent fire area on the Seeley Ranger District. Smaller patches are generally attributable to mountain pine beetle, small patches of high severity fire or, to a lesser extent, harvest. Early successional forests which are mapped in VMap as seedling/saplings are present on over 7,000 patches across the Forest, with an average size of 16 acres and distributed at a density of 17 patches per 100 hectares. These stands account for another 4.5%. Cumulatively, VMap data estimates that approximately 13% of the Forest can be considered early seral habitat, generally distributed in patches ranging widely in size. Montana Natural Heritage Program data estimates that nearly a quarter of the forest is in some post-disturbance state, however much of this may have grown beyond the early-seral stage.

Based on natural range of variation modeling, in all forest ecosystems the availability of grassland and non-forest areas is currently higher than the associated natural range of variation, while the abundance of seedling/sapling stands (dominated by trees <5 in diameter at breast height) as well as open forest areas (10-40% canopy cover) is within national range of variation.

The Montana Natural Heritage Program Land Use and Land Cover dataset estimates that approximately 24% of the Lolo National Forest is in some post-disturbance recovery state, including post-fire (18%) and post-harvest (6%). However, this dataset does not differentiate by forest structure, and therefore cannot inform estimates of early-seral conditions.

In a separate analysis of natural range of variation of the Upper and Lower Clark Fork ecological reporting unit, (Hessburg et al. 1999a) found that historically an average of 16% and 33% of the landscape was in stand initiation condition, respectively. In the Upper Clark Fork ecological reporting unit, this was distributed in patches that averaged approximately 70 hectares in size, with a density of 21.2 patches per 10,000 hectares. In the Lower Clark Fork ecological reporting unit, average stand initiation patch size was 208 hectares, distributed at a density of 22.8 patches per 10,000 hectares. Aerial photo interpretation from 1985 show a 5% and 23% reduction in stand initiation habitat. Stand initiation habitat also showed evidence of fragmentation, with reduced average patch size and increased patch density in both ecological reporting units. The authors interpreted the reduction in acreage, patch size and connectivity as evidence of effective fire suppression and a "the substitution of small regeneration cutting units for larger stand-replacing fires". While useful for understanding trends, these results cannot be directly compared to the VMap results due to differences in analysis area and methods.

**Large multi-storied patches** are a key ecosystem characteristic for many wildlife species. Currently, this attribute is not available in a spatially explicit manner due to the difficulty in interpreting multistory conditions via remote sensing. However, some interpretations can be drawn from modelled data.

Hessburg et al. (2000) quantified the natural range of variation of old forest structure in Upper and Lower Clark Fork ecological reporting units, defined as stands that have developed either in the absence of lethal disturbances (old forest multi-story) or stands that have developed in the presence of low-intensity fire that suppressed understory but not dominant tree development (old forest singe story) (Oliver and Larson 1996, Hessburg et al. 1999b). This is not directly comparable to the definition and estimates of old growth found in Section 3.2.3. In the Upper Clark Fork ecological reporting unit, old forest structure was a relatively rare condition, accounting for <1% of the landscape. The average patch size of old forest, multistory stands was 3.1 acres at a density of 0.6 patches per 10,000 hectares. The size of old forest single story patches was smaller, averaging 1.1 ac at 0.5 patches per 10,000 hectares. In the Lower Clark Fork ecological reporting unit, old forest structure was more common, accounting for 2.5% of the landscape and occurring in larger patches (11.8 hectares for old forest multistory and 39.4 hectares for old forest single-story). Over the approximately 40-year sampling period of the Interior Columbia Basin Interior Columbia Ecosystem Management Project, the amount of old forest structure in the Lower Clark Fork ecological reporting unit remained relatively stable, though average patch size dropped. Total old forest also remained stable in the Upper Clark Fork ecological reporting unit, though average patch size increased.

Natural range of variation modeling for the Lolo National Forest summarizes canopy cover and tree size for different ecosystem types (see section 2.2 and appendix 3). Across the Forest, the current amount of multistory and closed-canopy forest exceeds natural range of variation, however this is predominantly driven by the density of pole and medium sized trees. In general, all forest types are at the low end of natural range of variation for the large tree size class (15-20 inches in diameter on average) and below natural range of variation for forests with a very large size class (>20 inches in diameter on average). Across forest types, the availability of closed canopy forests dominated by medium sized trees (10-15 inches in diameter on average) exceeds natural range of variation, with the one exception being the Cold Dry type. Comparatively, the availability of closed canopy stands dominated by trees >15 inches in diameter on average is either at the low end of, or below, natural range of variation.

Current VMap data on the availability and distribution of closed canopy (>60% canopy) stands dominated by trees >15 inches in diameter shows 2,638 such patches with an average patch size of 15.8 acres and a maximum size of 627 acres. VMap data is unable to identify multistory conditions. Further, the aerial photo interpretation data used by Hessburg et al. (2000) cannot be directly compared to remotely sensed VMap data or plot-based Forest Inventory and Analysis data. Therefore, while the different studies provide some context for each other the results cannot be directly compared.

At the landscape scale, the amount and connectivity of multistory forest has increased dramatically. However, this forest type is currently dominated by medium sized or smaller, shade-tolerant trees. Without the backbone of large or very large trees to anchor resilient multistory forest conditions, these stands are at high risk of catastrophic loss to wildfire or other disturbances. Therefore, while multistory forest on the Lolo National Forest may currently support native biodiversity and associated ecosystem processes, the forest type is unstable and at risk of widespread loss.

**Montane grassland.** The Montana Natural Heritage Program identifies two primary types of grassland that occurs on the Lolo National Forest: 1) lower montane, foothill and valley grassland and 2) subalpine-upper montane grassland. Lower montane grasslands are typically found below approximately 5,400 feet in elevation and can range in size from small meadows to extensive valley grassland landscapes. Upper montane grasslands can occur as small meadows to open parks surrounded by higher elevational forest. Both grassland types currently occupy approximately 2% of the Forest and are at high risk due to fire suppression, invasive species, and conversion to agriculture, though the integrity of the upper montane grasslands may be more secure.

Historically, Hessburg et al. (2000) estimated that approximately 5.5% of both the Upper and Lower Fork ecological reporting unit was covered by montane grassland. Over the approximately 40-year sampling period, the study estimated that grassland availability in the Upper Clark Fork ecological reporting unit remained relatively stable while it dropped 2.3% in the Lower Clark Fork ecological reporting unit. However, the authors caveated that result, stating that much of the historical loss of grasslands to agriculture had already occurred prior to the collection of their historical data and that their results may therefore underrepresent the loss of native grasslands. Current modelling suggests that roughly 10-14% of the forest is grassland, with an estimated natural range of variation of 2-25%, though this includes patches of early seral, transitional forest.

VMap data estimates that approximately 2.3%, or just under 60,000 acres, of the Lolo National Forest consists of grasslands. This is distributed in almost 5,500 patches averaging 11 acres in size and occurring at a density of 2,500 patches per 10,000 hectares. This dramatic increase in patch density compared to the Interior Columbia Ecosystem Management Project data reflects improvement in mapping technology rather than true changes in grassland distribution. The largest patch is 910 acres, though this is truncated by the lower elevation boundary of the forest, where grasslands on public land adjoin with private lands.

In a 2022 assessment of more recent rates of change, the Landscape Change Monitoring System analysis indicates an increase in grass and forb area between 1985 and 2021, going from roughly 2.17% to 3.6%. Given the trends in vegetation loss and gain over that period, this is most likely a result of increased wildfire activity coupled with more gradual forest mortality due to insects and disease.

Montane grasslands represent key habitat for species such as elk, grizzly bear and bighorn sheep. The edge habitat between grasslands and conifer forest is often exploited by foraging herbivores, nesting birds, and predators. The general trend evident in the data summarized here is a slight, gradual increase in the amount of grassland on the forest most likely due to increased fire activity, tree mortality and management meant to limit conifer encroachment on meadows. However, the threats associated with native grasslands are associated with function over direct loss (e.g. invasive species altering fire behavior and forage quality).

**Refugia.** The key attribute of refugia within a landscape is their relative persistence, despite changes in the in the surrounding landscape or region. In the context of climate change, two broad categories of refugia are worth considering: climate refugia and fire refugia. Climate refugia are areas that remain relatively buffered from contemporary climate change over time and enable persistence of valued physical, ecological, and socio-cultural resources (Morelli et al. 2016). Climate refugia can result from spatial variability in topography that decouples climatic processes at a smaller scale from broader, regional conditions. One such example is cold-air pooling, were concentrated cold, dense air flows downslope into valleys or basins, creating temperature inversions. Other examples are drought refugia where certain forest stands exhibit low response and high resilience to regional drought due to variables such as topographic position, elevation, and aspect (Post-Leon et al. 2022); or hydrologic refugia such as springs or a subset of vernal pools that provide wetland habitat later into the year even under relatively dry conditions (Cartwright et al. 2020, Cartwright et al. 2021).

Fire refugia are locations on the landscape burned less severely and/or less frequently than surrounding areas (Camp et al. 1997, Meddens et al. 2018). Fire refugia can vary based on spatial scale (e.g., individual trees to stands or watersheds), fire severity (e.g., low severity versus unburned), predictability (e.g., topo-climatic fire refugia versus stochastic fire refugia). As such, the complete set of fire refugia includes locations that remain unburned through their complete successional development as well as areas where chronic, short-interval under burning creates vegetation conditions that are unlikely to support high-severity fire. Understanding and mapping the different types of fire refugia and how they may play into a broader conservation strategy is an area of active interest and development among both managers and scientists (Krawchuk et al. 2023).

## Habitat Diversity

The Lolo National Forest is dominated by conifer forest in a variety of age, composition, and structural combinations. According to the Montana Natural Heritage Program Land Cover dataset, 60% of the Forest is dominated by various conifer ecosystems, including mixed conifer, spruce-fir and lodgepole pine systems. Information on the diversity of forest types and structure, as well as a review of natural range of variation is presented in section 2.2 and appendix 3.

According to the Interior Columbia Basin  dataset, over 85% of the Upper Clark Fork ecological reporting unit and over 90% of the Lower Clark Fork ecological reporting unit was forested during the first half of the 19th century, and little change was recorded during their sampling period (Hessburg et al. 2000). Over the approximately 40-year sampling period of the Interior Columbia Ecosystem Management Project, patch richness, defined as the number of different patch types on the landscape., remained relatively stable in the Lower Clark Fork ecological reporting unit (30.6 to 30.0) but increased in the Upper Clark Fork (22.5 to 26.1). During the same period, the diversity of patch types, remained relatively stable. As diversity typically increases with increased patch richness, this suggests a loss in heterogeneity in the Upper Clark Fork ecological reporting unit during the Interior Columbia Ecosystem Management Project sampling period.

In the Lower Clark Fork ecological reporting unit, the total forested area increased from 91.7 to 94.5%, however the density of forest patches dropped from 3.4 to 2.4 per 10,000 hectares and the average patch size increased by over 1,000 hectares (Hessburg et al. 1999a). This suggests a homogenization of the landscape by expanding forest cover during the Interior Columbia Ecosystem Management Project sampling period. The amount of stand initiation an open canopy, stem exclusion forest decreased significantly (23% and 7% loss, respectively) during that period, while the amount of closed-canopy stem exclusion and understory re-initiation forest increased (7% and 21%, respectively). The average size of stand initiation patches dropped from over 200 to just under 25 hectares, while the average size of understory re-initiation patches rose from 68 to 190 hectares. These trends all indicate an aging forest with limited disturbance activity.

These trends are not evident in the historical data for the Upper Clark Fork ecological reporting unit, where the amount of forested area, patch size and patch density all remained relatively stable over the 40-year Interior Columbia Ecosystem Management Project sampling period (Hessburg et al. 1999a). There was a trend toward reduced stand initiation area and patch size, matched with a similar increase in closed-canopy stem exclusion forest, though to a much lower degree (a 20-hectare reduction in the average stand initiation patch size, for example).

As of 2022, the Landscape Change Monitoring System data suggests a loss in forest cover, from 91.2% to 83.4% between 1985 and 2021, with the rate of forest conversion to grassland and shrubland increasing slightly after 2005. This change is likely due to large fires that occurred in 2003, 2007 and 2017, coupled with a steady increase in more gradual mortality due to insects and disease. This data shows an increase in the total vegetated area, from approximately 8% (± 5%) to 20% (± 5%) suggesting a substantial increase in the area that is experiencing rapid growth or recovery from disturbance. Over this same time the number of acres that appear relatively stable from year to year (no major gain or loss of vegetation) has significantly decreased from around 87% (± 2%) in 1985 to 75% (± 5%) in 2021. This loss in stability reflects a general increase in disturbance and associated recovery from disturbance over this time.

Taken together, the data suggest that prior to 1985 the suppression of disturbances on the Forest resulted in a gradual loss of landscape heterogeneity, particularly a loss of early seral habitat patches, though the loss was not uniform across the Forest. After 1985, an increase in wildfire activity and density-related tree mortality has reversed this trend, resulting in a greater distribution of early seral, post-disturbance patches.

According to recent VMap data, 86% of the Lolo National Forest is covered by conifer forest. Half of that is dominated by a single age-structure combination: medium sized forests (10-15" diameter on average) with canopy cover > 40% (Table 22). Only 8% is characterized as 'transitional forest', reflecting recovery from previous disturbance. This pattern varies by geographic area, with the highest dominance of this forest type occurring in the Saint Regis River geographic area (66%) and the lowest in the Rock Creek geographic area (34%). Therefore, while Landscape Change Monitoring System data may suggest a trend toward increased heterogeneity, VMap demonstrates that structural diversity on the Lolo is currently low.

**Table 22—Distribution of conifer forest structural characteristics on the Lolo National Forest by percent canopy cover and tree size diameter breast height (d.b.h.), summarized by 2022 VMap data**

| Canopy Cover (percent) | d.b.h. 0-4.9" (percent) | d.b.h. 5-9.9" (percent) | d.b.h. 10-14.9" (percent) | d.b.h. 15-19.9" (percent) | d.b.h. >20" (percent) |
|---|---|---|---|---|---|
| 10-24.9 | 3 | 4 | 2 | 0 | 0 |
| 25-39.9 | 1 | 9 | 7 | 1 | 1 |
| 40-59.9 | 0 | 10 | 25 | 2 | 1 |
| >60 | 0 | 7 | 25 | 2 | 0 |

## Ecosystem Connectivity

Ecological connectivity refers to the unimpeded movement of species and natural processes, and disruption of this connectivity alters the utility of habitat for native species, the flow of nutrients and energy between systems and organisms, and the ability of native species to adapt to changing climates (Hilty et al. 2020). 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, and the integrity and functionality of wildlife habitat. The 2012 Planning Rule requires explicit consideration of ecological connectivity during forest plan revisions, and a fundamental precursor to this is understanding the status of ecosystem connectivity in a planning area (Williamson et al. 2020).

To better understand the state of ecosystem connectivity on the Lolo National Forest, we employed a coarse-filter modeling process developed by stakeholders during the Custer-Gallatin Forest Plan revision process. Coarse-filter connectivity modelling are typically species-neutral and focus on structural connectivity (the physical arrangement of habitat patches or land cover types within a landscape, as opposed to individual species habitat requirements). Specific combinations of species characteristics and land cover types modelled included:

- 4 habitat associations: closed canopy forest, open canopy forest, non-forest, habitat generalist,
- 2 types of response to human activity: sensitive and neutral (Belote et al. 2022), and
- 2 maximum dispersal distances: 10 kilometers and 50 kilometers.

By targeting species groups rather than individual species, we can effectively model connectivity for hundreds of species using a limited set of models. While the approach necessarily ignores the details of an individual species' unique habitat requirements, it creates a limited set of connectivity models that can be incorporated into forest planning without overwhelming the process. It also considers the broader landscape context, such as how habitat on National Forest System lands may link to other conservation efforts on private lands, such as conservation easements.

The proposed species associations resulted in 16 unique connectivity analyses, for example a closed-canopy forest specialist capable of long-distance dispersal and sensitive to human modification, such as a fisher or a Canada lynx, or a non-forest specialist unaffected by human modification with limited dispersal capacity such as a badger. The analysis area included a 50-kilometer buffer around the Lolo National Forest to accurately represent connectivity with surrounding areas, and the resistance of riparian areas was reduced to reflect animals' tendency to move along riparian corridors. At the time of writing this Assessment, only initial results for closed-canopy species are available with the full connectivity analysis ongoing. Initial results for closed-canopy species are presented in Figure 24.

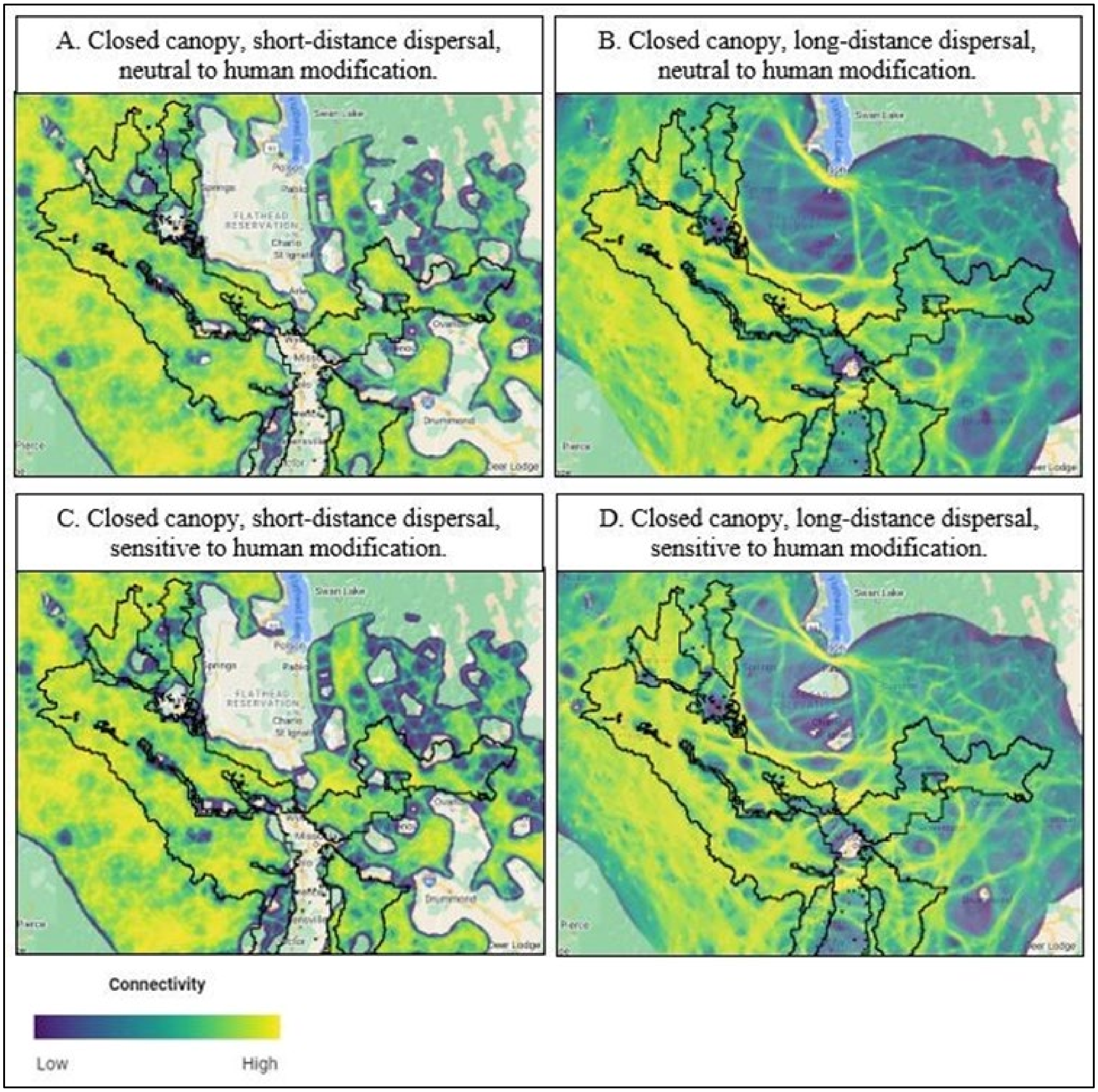


**Figure 24—Preliminary connectivity maps for closed-canopy species on the Lolo National Forest**

Limited information is currently available from the pending connectivity analyses. However, several details are worth noting.

1. The area just west of St. Regis appears to provide some of the highest potential for connectivity across Interstate 90, which represents a potential barrier for sensitive species such as wolverine or grizzly bear.
2. The Bitterroot Valley represents a significant barrier to closed-canopy species, however the area just south of Lolo may provide crossing opportunities for species capable of longer distance dispersal by leveraging the riparian areas and existing conservation easements along the Bitterroot River.
3. Highway 83 represents a potential barrier in the Upper Blackfoot Clearwater geographic area. However, a section just south of Seeley Lake may provide crossing opportunities for closed canopy species.

## 2.6 Native Plant and Wildlife Diversity

The 2012 Planning Rule provides direction to maintain diversity of animal communities and the persistence of native species through emphasis on a coarse filter approach. All wildlife species are contributors to biological diversity and ecosystem integrity as components of "the diversity of plant and animal communities" and the revised plan must address "persistence of most native species in the planning area" (36 CFR 219.9). Plan components in the revised plan that address ecosystem integrity would be expected to provide for ecological conditions necessary to maintain the persistence or contribute to the recovery of native species in the plan area (FSH 1909.12, sec 23.11). Providing for the ecosystem integrity of the ecosystems would in turn provide for the needs of most wildlife species.

Most native wildlife species' needs are evaluated in the context ecosystem integrity, so most wildlife species are not discussed individually. Rather, we focus on the condition, status, and trends for "at-risk species." Under the 2012 Planning Rule, at-risk species are defined as:

- the federally recognized threatened, endangered, proposed, and candidate species; and
- species of conservation concern.

The 2012 Planning Rule requires the identification of species of conservation concern, which are "species, other than federally recognized threatened, endangered, proposed, or candidate species, that are known to occur in the plan area and for which the Regional Forester has determined that the best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area" (36 CFT 219.9 (c)). The directives (FSH 1909.12.52) state that the responsible official will coordinate with the regional forester to identify potential species of conservation concern's "relevant to the plan area and the planning process".

In this assessment, we refer to a list and rationale for *potential* species of conservation concern. The species of conservation concern will be selected by the Regional Forester based in part on public feedback received on the potential list. The species of conservation concern list is developed for forest planning purposes; it does not confer special regulatory status on any species beyond existing state and federal statutes. Species were selected for consideration as potential species of conservation concern if they were reason ably likely to occur in the planning area and were either currently recognized as Regional Forester Sensitive Species on the Lolo National Forest, identified as an species of conservation concern on an adjoining national forest, had received a positive 90-day finding by the U.S. Fish and Wildlife Service, had been recently removed from Endangered Species Act protection, or were ranked as GS1-3 or S1/2 on the NatureServe database.

The purpose of identifying species of conservation concern 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 in the revised plan (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 species of conservation concern and federally recognized species, or where the species requires unique and specific ecological conditions that are best addressed with more focused plan components.

The 1986 Forest Plan operates under a policy for sensitive species, which are "those plant and animal species identified by a Regional Forester for which population viability is of concern" (FSM 2670.22). Both species of conservation concern and Regional Forester sensitive species were established to maintain viable populations of species on National Forest System lands. Regional Forester sensitive species are similar to species of conservation concern but the shift to species of conservation concern is more focused than the emphasis on sensitive species under the viability provisions of the 1982 rule. Sensitive species include all vertebrate species, for which population viability is a concern, regardless of whether there is substantial concern for persistence of the species in the plan area. Species of conservation concern include invertebrate species as well. Species of concern must be native to, and known to occur in the plan area, whereas sensitive species could include non-native species, and/or species for which presence in the plan area is only suspected due to habitat capability.

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 Forest Service 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.

## 2.6.1 At-Risk Plants

### Federally Recognized Threatened, Endangered, Proposed and Candidate Plant Species

**Key takeaways:**

- As of February 2023, two plant species listed as threatened by U. S. Fish and Wildlife Service may be present on the Lolo National Forest: whitebark pine (*Pinus albicaulis*) and Spalding's catchfly (*Silene spaldingii*).
- Whitebark pine occurs on all high elevation mountain ranges in the Lolo National Forest, but populations are declining. Spalding's catchfly has not been recorded on the Lolo and little suitable habitat exists.

**Summary.** As of February 2023, two plant species listed as threatened by U. S. Fish and Wildlife Service may be present on the Lolo National Forest: whitebark pine (*Pinus albicaulis)* and Spalding's catchfly (*Silene spaldingii)*. Whitebark pine is a foundational species of high elevation forests up to timberline. It is known from all high elevation mountain ranges within the plan area. Populations have been declining mostly due to white pine blister rust, an invasive pathogen that affects western white pine, limber pine, whitebark pine and other closely related five-needle pines. The continuing decline of whitebark pine is affecting the integrity of high-elevation ecosystems (see section 2.4.1). Spalding's catchfly occurs in low elevation grasslands, habitat types that are not very common on the Lolo. There are no current or historic records for this species in the plan area. The only suitable habitat is in the Lower Clark Fork area.

**Status and trends: Whitebark pine.** Whitebark pine is a high-elevation conifer with a broad distribution across mountain ranges of the western United States and Canada. Its distribution, ecology and habitat characteristics are well described in Tomback et al. (2001), Keane et al. (2012, 2017), the U.S. Fish and Wildlife Services' species status assessment (U.S. Department of the Interior 2018b) and literature cited therein. Whitebark pine was listed as threatened under the Endangered Species Act on December 15, 2022 (U.S. Department of the Interior 2022a). The primary stressor driving the status of whitebark pine is white pine blister rust caused by the non-native pathogen *Cronatium ribicola*. The U.S. Fish and Wildlife Service determined it is not prudent to designate critical habitat for whitebark pine because neither habitat loss nor range restriction is a threat to this species' continued survival.

*Distribution on the Lolo National Forest.* Based on Forest Inventory and Analysis data, whitebark pine is estimated to be present (one live tree per acre or more) on 99,763 acres across the Lolo National Forest (90% CI = 70,476 to 134,371 acres). According to VMap, whitebark pine is a dominant species on only 864 acres in the plan area.

*Population status and trend.* A high percentage of the whitebark pine decline in the plan area is due to the introduced white pine blister rust. Keane and Arno (1993) found that in western Montana 42% of whitebark pine died between 1971 to 1991, with white pine blister rust responsible for 90% of that mortality. Fiedler and McKinney (2014) sampled whitebark pine ecosystems in north-western Montana and found that 75% of all whitebark pines were dead and 90% of the remaining whitebark pines were infected with blister rust. In the Bob Marshall Wilderness, live whitebark pine decreased by 87% from 1994 to 2014 (Retzlaff et al. 2016). In that study, more than 60% of all tree mortality was attributed to white pine blister rust. In a comparative analysis of five-needle pines in the western United States, Goeking and Windmuller-Campione (2021) found that levels of whitebark pine mortality outpaced the growth of surviving trees.

*Habitat condition.* Whitebark pine can be found in high elevation forests, near and at timberline, throughout western Montana. About 27 percent (611,642 acres) of the plan area are considered to have moderate suitability for the species (Montana Natural Heritage Program 2023b). See also section 2.4.1.

*Population-level drivers and stressors.* The U.S. Fish and Wildlife Service identified four factors in the form of stressors that affect the continued existence of whitebark pine. These stressors are white pine blister rust, mountain pine beetle, altered fire regimes and climate change. Refer to section 2.1 for a detailed discussion on these stressors.

Current vegetation conditions in the plan area are dominated by dense stands of shade-tolerant conifers which support high severity fire even in potential vegetation types that historically burned at low and mixed severity. Many remaining whitebark pine stands are at risk of uncharacteristic fire activity. The Rice Ridge and Lolo Peak fires (both 2017) burned stand replacing through whitebark habitat. The resulting openings provide the early seral habitat needed for successful whitebark pine regeneration but local whitebark pine seed sources may be reduced to such levels that natural regeneration is unlikely in many cases (McKinney and Tomback 2007, Keane and Parsons 2010, Barringer et al. 2012).

Warming temperatures have likely exacerbated recent mountain pine beetle outbreaks by shortening the beetle's life cycle and lowering tree resistance due to droughty conditions. Temperatures have also been more favorable for tree growth in subalpine forests and the timberline ecotone. This increases competition by subalpine fir and Engelmann spruce and increases the likelihood of moderate or high severity fire, which would likely be detrimental to live whitebark pine.

**Status and trends: Spalding's catchfly.** Spalding's catchfly (*Silene spaldingii*) is a long-lived herbaceous plant species regionally endemic to eastern Washington, northeastern Oregon, west-central Idaho, northwestern Montana and adjacent British Columbia, Canada (U.S. Department of the Interior 2020a). The plant was listed as threatened under the Endangered Species Act on October 10, 2001.

*Distribution on the Lolo National Forest.* In Montana, Spalding's catchfly occurs in the Intermontane Valleys of northwestern Montana, one of five physiographic regions described in the species' recovery plan (U.S. Department of the Interior 2007). Populations in Montana are geographically separated from other occurrences of Spalding's catchfly by more than 100 miles. They are all located within the northwest portion of the state. There are no current or historical occurrences of Spalding's catchfly on the Lolo National Forest, but the species occurs just to the East and the North of the Lower Clark Fork area, in Sanders, Flathead and Lake County.

*Population status and trend.* Inventories for Spalding's catchfly continue to be conducted on all lands managed by the Federal government and some state, tribal and private lands. The number of known occurrences has increased between 2009 and 2020. However, new occurrences are likely the result of increased survey efforts and did not significantly expand the known range of the species (U.S. Department of the Interior 2020a). The most recent species review in 2020 determined that multiple delisting criterions have not been met and the species continues to meet the definition of threatened.

*Habitat condition.* Spalding's catchfly is typically found in low to mid-elevation mesic bunchgrass communities and sagebrush steppe but can occasionally be found in open ponderosa pine forests. The habitat of Spalding's catchfly is characterized by deep loamy soils in somewhat mesic sites such as northern slopes, swales, or other small landscape features. These sites are highly productive and dominant bunchgrasses include Idaho fescue (*Festuca idahoensis*) and bluebunch wheatgrass (*Pseudoregnia spicata*). Habitat conditions in Montana differ from other physiographic regions with glacially influenced soils and a codominance of rough fescue (*Festuca scabrella*) on many sites (U.S. Department of the

Interior 2007). The mesic grasslands that could provide suitable habitat for the species are not very common in the plan area (see section 2.2.4).

The Montana Heritage Program has modeled suitable habitat for the species (Montana National Heritage Program 2021). Habitat suitability was most strongly influenced by the presence of grasslands, lower minimum winter temperatures, lower distance to forest and higher soil clay content. Within the Lolo National Forest there are only 29 acres modeled with moderate suitability for the species, and 1,675 acres with low suitability. Combined, this is less than 0.1% of the forest. These areas of low to moderate suitability are all located in the Lower Clark Fork area.

*Population-level drivers and stressors.* Spalding's catchfly was listed because of concerns regarding habitat fragmentation and habitat loss due to human development, habitat degradation due to invasive plant species and use of nonnative grasses for rangeland restoration, and grazing and trampling effects by livestock and wildlife (U.S. Department of the Interior 2007). In the plan area, invasive annual grasses are a major threat to the ecological integrity of grass and shrubland ecosystems. Lower elevation mesic grasslands are considered highly vulnerable to climate change (see section 2.2.4).

### Potential Plant Species of Conservation Concern

**Key takeaways:**

- Eighty-one plant species were considered for designation as potential plant species of conservation concern. Considerations included whether the species was native and documented as occurring in the plan area within the past 40 years, and whether sufficient scientific information existed to document substantial concern for the species' capability to persist over the long-term in the plan area.
- Eight plant species were selected as potential species of conservation concern: Arctic Sweet Coltsfoot, Hiker's Gentian, Hollyleaf Clover, Howell's Gumweed, Idaho Barren Strawberry, Oregon Bluebells, Sandweed, and Scalepod.
- The list of potential species of conservation concern is subject to modification during the planning process, and final authority for designation of species of conservation concern rests with the Regional Forester.

**Summary.** Species of Conservation Concern are native species known to occupy the Lolo National Forest that are not recognized under the Endangered Species Act, but for which the Regional Forester has determined there is substantial concern for the species' long-term persistence within the plan area. Using Forest Service and Montana Natural Heritage Program data, a master list of possible at-risk species known to occupy the Lolo was compiled. To be considered a species of conservation concern each species was evaluated to determine whether the species met the following mandatory requirements (FSH 1909.12 Section 12.52):

> "The best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area. Information may come from a variety of population sources, including Federal and State agencies, literature, local information on occurrence and population status, subbasin analyses, broad-scale assessments, and information available from local species experts and other organizations."

Substantial concern is demonstrated using the best available scientific information to document significant threats to the species or its habitats, declines in species or habitat abundance and distribution, or other unique factors about the species ecology, life history, or distribution that may affect the species resilience to environmental perturbation and thereby persistence within the plan area. An outline of the process to identify potential species of conservation concern is included in Forest Service Handbook directives (FSH 1909.12.5) and the specific approach detailed in the potential species of conservation concern process and determination document (U. S. Department of Agriculture 2023b) concurrently out for public review.

Based on the potential species of conservation concern identification criteria, 81 plant species warranted an in-depth evaluation for identification, including 17 bryophytes, 7 lichens and 56 vascular plants. Based on the best available scientific information eight plant species were identified as potential species of conservation concern with the following rationale.

- Arctic Sweet Coltsfoot (*Petasites frigidus* var. *frigidus*). The species is known from two locations in the northeastern extent of the plan area, which also includes the only alternative suitable habitat area (Montana Natural Heritage Program 2022). Populations with a limited distribution within the plan area may be more likely to experience localized extirpation (Smith and Almeida 2020).
- Hiker's Gentian (*Gentianopsis simplex*). The species is known from a single location in the southwestern extent of the plan area, which also includes the only alternative suitable habitat (Montana Natural Heritage Program 2020b). Species with a limited distribution within the plan area may be more likely to experience localized extirpation (Smith and Almeida 2020).
- Hollyleaf Clover (*Trifolium gymnocarpon*). The species is known from a single location within the plan area and alternative suitable habitat within the plan area is limited, which suggests the population within the plan area is likely small. Small populations are more likely to face localized extirpation, particularly when isolated from other source populations (Dias 1996, Ovaskainen and Hanski 2004, Smith and Almeida 2020).
- Howell's Gumweed (*Grindelia howellii*). The species has an extremely limited range and a highly limited distribution within the Plan Area. Systematic surveys for the species have failed to increase the number of known populations (Ingegno 2017) and recent events have resulted in the loss of known populations. Small populations are more likely to face localized extirpation, particularly when isolated from other source populations (Dias 1996, Ovaskainen and Hanski 2004, Smith and Almeida 2020). Although suitable habitat is available, habitat degradation and competition from invasive species represent a substantial threat in the plan area that may limit the ability of the species to replace lost populations.
- Idaho Barren Strawberry (*Waldsteinia idahoensis*). The species is known from a single location within the plan area and alternative suitable habitat within the plan area is limited, which suggests the population within the plan area is likely small. Small populations are more likely to face localized extirpation, particularly when isolated from other source populations (Dias 1996, Ovaskainen and Hanski 2004, Smith and Almeida 2020).
- Oregon Bluebells (*Mertensia bella*). The species is known from one location in the plan area and alternative locations with suitable habitat that overlap the known range of the species are limited, which suggests that the population within the plan area is likely small. Small populations are more likely to face localized extirpation, particularly when isolated from other source populations (Dias 1996, Ovaskainen and Hanski 2004, Smith and Almeida 2020).
- Sandweed (*Athysanus pusillus*). The species is known from a single location within the plan area and alternative suitable habitat within the plan area is limited, which suggests that the population within the plan area is likely small. Small populations are more likely to face localized extirpation, particularly when isolated from other source populations (Dias 1996, Ovaskainen and Hanski 2004, Smith and Almeida 2020), as indicated by the distribution of modelled habitat suitability across

western Montana (Montana Natural Heritage Program 2020a). Additional stressors from invasive competitors may further limit the resilience of the known populations of the species within the plan area.

- Scalepod (*Idahoa scapigera*). The species is known from a single location within the plan area and alternative suitable habitat within the plan area is limited, which suggests that the population within the plan area is likely small. Small populations are more likely to face localized extirpation, particularly when isolated from other source populations (Dias 1996, Ovaskainen and Hanski 2004, Smith and Almeida 2020), as indicated by the distribution of modelled habitat suitability across western Montana (Montana Natural Heritage Program 2020c).

Additional information on population and habitat conditions for each species considered during the potential species of conservation concern process, including decision rationales, are included in a process and determination document (U. S. Department of Agriculture 2023b). Moving forward, the potential species of conservation concern list may be modified based on the best available scientific information and public input before approval of the final land management plan.

**Status and trends.** Detailed status and trends for each species considered is provided in the potential species of conservation concern process and determination document (U. S. Department of Agriculture 2023b).

## 2.6.2 Terrestrial Wildlife Species

For this assessment, terrestrial wildlife species known to occur on the Lolo National Forest were evaluated in the context of categories directed and defined by the National Forest System Land Management Planning Final Rule and Record of Decision (hereafter 2012 Planning Rule), detailed in the Code of Federal Regulations (36 CFR 219 2012). The Forest Service Handbook provides specific, detailed direction called directives for implementing planning rules.

The 2012 Planning Rule states that assessments must "identify and evaluate existing information relevant to the plan area" for threatened, endangered, proposed, and candidate species, as well as for potential species of conservation concern present in the plan area (36 CFR 219.6(b)(5)). Discussions of existing information for certain species of interest is included. Information about individual species is organized into those groupings: species that are federally recognized and species that are potential species of conservation concern. Individual species evaluations include information regarding occurrence, habitat status, and population status in the plan area and other appropriate scale(s), to the extent that these are known. Each species evaluation also considers drivers, threats, and stressors for that species or its habitat, and where possible, historic condition along with expected trends for that species or habitat. Not all species have the same kind or amount of information available, so not all species evaluations will appear the same in organization and content.

The 2012 Planning Rule also requires the assessment to evaluate key ecosystem services and multiple uses (36 CFR 219.6 (b)(7)). These are identified in the directives as including the contributions of fish, wildlife, and plants to social and economic stability (FSH 1909.12, Chapter 10, part 13.35). The directives call for identifying information regarding fish and wildlife species that may be commonly enjoyed and used by the public for hunting, fishing, trapping, gathering, observing, or sustenance, and assessing the conditions and trends of these species and their habitats. These considerations are discussed in section 3.10.5, focusing on the contributions of those species to social and economic sustainability.

### Federally Recognized Threatened, Endangered, Proposed and Candidate Terrestrial Wildlife Species

**Key takeaways.** Threatened, endangered, candidate and proposed wildlife species that may be present on the Lolo National Forest include grizzly bear, Canada lynx, and wolverine. The Lolo National Forest—

- Provides key connectivity corridors between recovering the Northern Continental Divide Ecosystem and Cabinet-Yaak grizzly bear populations, as well as to the unoccupied Bitterroot Ecosystem;
- Contains the Ninemile Demographic Connectivity Area, designated in the Northern Continental Divide Ecosystem grizzly bear conservation strategy;
- Is situated on the edge of currently occupied Canada lynx habitat, but most of the Forest is not occupied by resident lynx; and
- Provides widespread wolverine habitat.

**Summary.** Federally recognized species that may be present on the Lolo National Forest include Canada lynx (threatened), grizzly bear (threatened), yellow-billed cuckoo (threatened), wolverine (proposed), and monarch butterfly (candidate). Resident populations of Canada lynx and grizzly bear are primarily limited to the Seeley Lake Ranger District, though individuals have been observed in other districts. Wolverine are distributed throughout the plan area, and monarchs have been detected on the Forest in the vicinity of Missoula. Yellow-billed cuckoo are not known to occur on the Forest.

**Table 23—Federally recognized species on the Lolo National Forest**

| Species Name | Federal Status |
|---|---|
| Canada lynx | Threatened |
| Grizzly bear | Threatened |
| Yellow Billed cuckoo | Threatened |
| Wolverine | Proposed |
| Monarch butterfly | Candidate |

The Lolo National Forest represents important habitat connectivity for grizzly bear recovery, as it provides corridors between three of the identified recovery ecosystems; the Northern Continental Divide Ecosystem, the Cabinet Yaak Ecosystem, and the Bitterroot Ecosystem. Recovery of grizzly bears has been inconsistent between the different ecosystems, with the Northern Continental Divide Ecosystem showing the greatest population growth. The Cabinet Yaak Ecosystem is currently undergoing limited growth with relatively high mortality, and the Bitterroot Ecosystem is currently unoccupied by resident grizzlies though dispersers are occasionally observed.

The 1986 Lolo Forest Plan has been amended to incorporate both the Northern Continental Divide Ecosystem Grizzly Bear Conservation Strategy and the Northern Rockies Lynx Management Recommendations. These documents will form a foundation for development of revised plan content for the conservation of these species.

Both Canada lynx and wolverine are considered to be at high risk of negative effects of climate change, particularly with respect to changing precipitation patterns (McKelvey and Buotte 2018). For wolverine, the availability of persistent spring snow is an important component of denning ecology, and projections of spring snowpack suggest large-scale reductions over the next 50-100 years. Lynx are at additional risk due to large-scale habitat loss associated with changing disturbance regimes and increased fire activity.

**Canada lynx.** On March 24, 2000, the U.S. Fish and Wildlife Service designated Canada lynx within the contiguous United States as a threatened species under the Endangered Species Act. While no recovery plan has been developed, a Lynx Conservation Assessment and Strategy was first published in 2000, and the Northern Rockies Lynx Management Direction was released in 2007. These documents were most recently revised in 2017 (U.S. Department of the Interior 2017a).

*Distribution on the Lolo National Forest.* Lynx are known to be consistently present on the Seeley Lake Ranger District and based on approximately 30 years of monitoring data the population appears stable, though recent large fires may be shifting areas of occupancy across the Southwest Crown of the Continent landscape. Aside from a few documented locations of GPS collared lynx on the Missoula Ranger District, there is little recent information indicating that lynx occur consistently on other Ranger Districts. In 2020 a male lynx was detected in the vicinity of Lolo Pass on the Missoula Ranger District; however, long-distance exploratory movement and dispersal, outside occupied habitat, is well documented (Interagency Lynx Biology Team 2013). Based on this information, as well as detailed habitat analyses, there is no evidence that lynx are currently expanding from the Seeley Ranger District to permanently occupy other areas of the Forest. Lynx detections on the Superior and Plains Ranger Districts are very rare and habitat is far more marginal than on the Seeley Lake Ranger District.

*Population status and trend.* For the Seeley Lake Ranger District and small portions of the Missoula Ranger district, the Lolo National Forest has had a long history of conducting carnivore surveys. Detailed monitoring data, associated with research efforts on the Seely Lake District, has been collected since

1998. Systematic forest-wide surveys, part of a regional meso-carnivore monitoring program, began in 2020 and are scheduled to be repeated every three years (Golding et al. 2018). Lynx are known to be present on the Seeley Lake Ranger District and appear to be persisting in similar areas and at similar levels as when research began in the late 1990s (U.S. Department of the Interior 2017b, Olson et al. 2021, Olson et al. 2023).

*Habitat condition and connectivity.* Across their range, lynx typically occur in boreal and subalpine coniferous forests dominated by subalpine fir and spruce in landscapes with gentle topography (Squires et al. 2013). During winter, lynx foraged primarily in mid- to high-elevation forests (4,134–7,726 feet) composed of mature, large-diameter (greater than about 11 inches diameter) trees. However during the summer months, lynx in Montana broaden their preferred habitat use to include more of the early-successional forest (stand initiation structural stage) with dense horizontal cover provided by abundant shrubs, spruce and fir saplings, and small-diameter trees (Squires et al. 2010). In a comparison of use versus variability within a lynx home range, Squires et al. (Squires et al. 2010) found that lynx selected forests with relatively denser horizontal cover, more abundant hares, and deeper snow. The preferred forests had a multistory structure with dense horizontal cover provided by the young trees in the understory and conifer boughs touching the snow surface during winter, which could support snowshoe hare populations at varying snow depths throughout the winter. Engelmann spruce and subalpine fir were the dominant tree species in forests used by lynx, but these forests contained a mix of other conifer species, including lodgepole pine, western larch, and Douglas-fir.

At the landscape scale, a mosaic of forest structure, from young regenerating to mature multistory stands, is recommended to provide for the habitat needs of lynx (Interagency Lynx Biology Team 2013). Kosterman (2014) collected field data on denning and offspring survival in northwest Montana from 1998–2012, studying the relationship between female lynx reproductive success and habitat composition/arrangement at the scale of a lynx home range on both the Lolo and Kootenai National Forests. Connectivity of mature forest, percent composition of young regenerating forest, low perimeter-area ratio of young regenerating forest patches, and adjacency of mature to young regenerating forest types were the most important predictors for overall lynx reproductive success in her study areas (Kosterman et al. 2018).

The Forest currently has 55 lynx analysis units which have been delineated according to Forest Service Region 1 direction (U.S. Department of Agriculture 2022f). See figure A1-12. Lynx analysis units represent a spatial approximation of a female lynx home range and are used for planning purposes only. They are intended to help guide management that will support a viable reproductive population of lynx across a planning area, and are not indicative of actual use or habitat quality (Interagency Lynx Biology Team 2013). In total, the Lolo National Forest lynx analysis units encompass approximately 1,744,800 acres across multiple ownerships. Approximately 61% of this is considered suitable lynx habitat (1,061,715 ac) of which 943,207 acres are under Forest Service jurisdiction, based on mapping conducted in 2020 (Roberts 2022). The remaining acreages are located on other ownerships—private, industrial timber lands, State of Montana (Department of Natural Resources Conservation or Fish, Wildlife and Parks), and Bureau of Land Management.

Lynx habitat managed by the Forest Service includes approximately 257,000 ac multi-story habitat, 28,000 ac stand initiation habitat, and 159,000 ac temporarily unsuitable habitat, as defined by the Northern Rockies Lynx Management Direction (U.S. Department of the Interior 2017a). The remaining habitat acreage includes stem exclusion forest and ‘other’ areas such as barren, rocky slopes or open water. Additional information on the availability of habitat by structural stage and lynx analysis unit can be found in the 2021 Biennial Monitoring and Evaluation Report for the Lolo National Forest (U.S. Department of Agriculture 2022f).

Currently, Endangered Species Act-designated Canada lynx critical habitat on the Lolo is limited to just under 488,000 acres on the Seely and Missoula Ranger Districts. This may change in the future, as the U.S. Fish and Wildlife Service is currently revising the Canada lynx critical habitat map with a proposed rule expected to be published by November 2024.

One intent of the Standards in the Northern Rockies Lynx Management Direction is to limit the amount of temporarily unsuitable (early stand initiation) habitat in any lynx analysis unit at a given time. The associated direction (Standard Veg S1 and Veg S2) limits the number of lynx analysis units with more than 30% early stand initiation habitat. There are currently four clusters of lynx analysis units with >30 percent early stand initiation, primarily due to recent large fires:

- Boles and Placid lynx analysis units on the Seeley Lake Ranger District were impacted by the Jocko Lakes Fire of 2007 and the Liberty Fire of 2017. In addition, these occupied lynx analysis units have some areas of recently acquired lands that were under Plum Creek Timber Company ownership until recently – this translates to some additional areas of early stand initiation from regen harvesting.
- On the east side of Seeley Lake Ranger District there are 5 adjacent lynx analysis units with > 30 percent early stand initiation. This is largely due to the 160,000-acre Rice Ridge Fire of 2017. These are the Morrell, Cottonwood-Dunham, Monture, Lake and Scapegoat lynx analysis units. Between January and March 2021, lynx were detected in three of the five lynx analysis units by the Southwestern Crown of the Continent carnivore monitoring program despite the large areas of recent conversion to early stand initiation.
- The Wyman, Ranch Face, Ranch and Gilbert lynx analysis units in the Rock Creek drainage, Missoula Ranger District are all adjacent and currently > 30 percent early stand initiation due to several large and recent fires.
- Chippy, Little Thompson and Murr lynx analysis units on the Plains-Thompson Falls Ranger District are all above 30 percent early stand initiation due primarily to the 2007 Chippy Fire. These areas are outside the occupied lynx area on the Forest, outside designated critical habitat, and are considered low quality habitat (Olson et al. 2021).

*Population-level drivers and stressors.* The primary stressors to the persistence of Canada lynx in the Northern Rockies are climate change, vegetation management, wildfire and habitat fragmentation (Interagency Lynx Biology Team 2013).

**Grizzly bear.** The grizzly bear was listed as a threatened species in the lower 48 states on July 28, 1975. No critical habitat has been designated. A recovery plan was completed in 1993 (U.S. Department of the Interior 1993) with a chapter for the Bitterroot Ecosystem added in 1996 (Servheen 1996). The most recent five-year review, published in 2022, concluded that "the grizzly bear in the lower-48 States does not meet the definition of an endangered species, but does meet the definition of a threatened species in accordance with Section 3(6) and 3(20) of the Act" (U.S. Department of the Interior 2022b).

*Distribution on the Lolo National Forest.* The Lolo National Forest intersects with three grizzly bear recovery zones identified in the 1993 recovery plan (U.S. Department of the Interior 1993), including the Northern Continental Divide, the Cabinet Yaak Ecosystem and the Bitterroot Ecosystem (figure A1-11). The Northern Continental Divide Ecosystem comprises the largest area on the Forest with 7 grizzly bear analysis subunits (representing putative female home ranges for habitat analysis purposes) located on the

Seeley Lake (6 of 7) and Missoula Ranger Districts (1 of 7). Overlap with the Cabinet Yaak and Bitterroot Ecosystems is limited; however, grizzly bears have been documented on all districts on the Forest. The Forest is currently engaged in consultation with the U.S. Fish and Wildlife Service regarding the identification of 30 other grizzly bear analysis subunits covering the portions of the Forest outside recovery zones. In total, 20% of the Lolo is in designated grizzly bear recovery zones (Table 24). Approximately 20% is in other designated grizzly conservation areas, specifically Management Zone 1 and the Ninemile Demographic Connectivity Area, and the remaining acreage is not identified in the recovery strategy.

**Table 24—Acres of Lolo National Forest within designated grizzly bear management and recovery zones**

| Grizzly bear recovery designation | Acres | Percent of Lolo NF |
|---|---|---|
| Lolo NF land within the Cabinet-Yaak recovery zone | 145,782 | 7 |
| Lolo NF land within the NCDE recovery zone | 269,822 | 12 |
| Lolo NF land within the Bitterroot recovery zone | 9,802 | <1 |
| Lolo NF land in the NCDE Management Zone 1 (adjacent to NCDE recovery zone) | 173,099 | 8 |
| Lolo NF land in the Ninemile DCA (adjacent to NCDE recovery zone) | 256,299 | 11 |
| Remaining Lolo NF land outside the above designated areas | 1,375,433 | 61 |
| **Total** | **2,230,167** | **100** |

*Population status and trend in the Cabinet-Yaak Ecosystem.* As of 1988, research in the Cabinet Mountains indicated that only a small population of perhaps 10 bears remained. Concerns regarding the ability of the grizzly bear population to persist within the Cabinet Mountains led to a successful program to augment that population with bears from the Northern Continental Divide Ecosystem. All methods of detection (capture, collared individuals, DNA sampling, photos, and credible observations) indicated that a minimum of 54 individual grizzly bears were alive in the Cabinet-Yaak grizzly bear population at some point during 2018 (25 in the Cabinet Mountains and 29 in the Yaak) (Kasworm et al. 2020). Based on trends in population growth and mortality, approximately 60-65 grizzly bears are currently estimated to persist in the Cabinet-Yaak Ecosystem (Kasworm et al. 2022). As an indicator of the distribution of grizzly bears across the recovery zone, the authors also reported that 14 of the 22 bear management units had sightings of females with young in 2021 (Kasworm et al. 2022). Numbers of females with cubs in the Cabinet-Yaak recovery zone averaged 3.3 per year, varying from two to five during 2016–2021. The probability that the population is stable or increasing was estimated to be about 70%.

There are few records of grizzly bears occurring in the portion of the Lolo National Forest that intersects the Cabinet Yaak recovery area, known as the Mt. Headley Bear Management Unit, and at present it is not known to be occupied by any female grizzly bears with young (Kasworm et al. 2022). In 2017-2018, one marked subadult male grizzly bear used a portion of this bear management unit as part of its life range (Kasworm et al. 2020). Two known mortalities of male grizzly bears in or near the Mt. Headley bear management unit occurred in Fishtrap Creek Watershed in 2008 and in the Little Thompson River Watershed in 2014 (Kasworm et al. 2022).

*Population status and trend in the Bitterroot Ecosystem*. The Bitterroot recovery zone lies along the boundary between east central Idaho and western Montana. There does not appear to be a resident population of grizzly bears in the Bitterroot recovery zone based on recent monitoring conducted by the Montana Fish, Wildlife, and Parks. Recently, however, there have been a few observations of individual grizzly bears reported in and near the Bitterroot recovery zone. For example, one radio-collared bear is known to have moved from the Cabinet Mountains into the Bitterroot Mountains in 2019. Because there is not a resident population of grizzly bears, no Bear Management Units have been formally delineated for the Bitterroot recovery zone.

On November 17, 2000, the U.S. Fish and Wildlife Service published a final rule designating the Bitterroot a nonessential, experimental population (65 FR 69624-69643), meaning this is an area where a reintroduction program could be undertaken. The Bitterroot Experimental Population Area is much larger than the Bitterroot recovery area and includes the Lolo National Forest west of Missoula and south of the Clark Fork River. On January 21, 2020, the Service confirmed that the 10(j) rule for the Bitterroot grizzly bear experimental population area does not apply to grizzly bears that dispersed into the area on their own, and therefore section 7 consultation requirements pertain to these individuals.

*Population status and trend in the Northern Continental Divide Ecosystem*. The Northern Continental Divide Ecosystem recovery zone is in northwestern and north central Montana, and includes Glacier National Park, portions of the Flathead, Kootenai, Lolo, and Helena-Lewis and Clark National Forests, and part of the Blackfeet Indian Reservation. The portion of the Northern Continental Divide Ecosystem recovery zone located on the Lolo National Forest is divided into three bear management units (Rattlesnake, Upper South Fork Flathead, and Monture/Landers Fork) and 7 bear management subunits.

The Northern Continental Divide Ecosystem recovery zone has been occupied by grizzly bears continuously since before the species was listed under the Endangered Species Act. (Mace and Roberts 2012) estimated grizzly bear population vital rates and trend for the Northern Continental Divide Ecosystem using radiotelemetry data collected between 2004 and 2009. The authors reported an increasing population trend, estimating a mean annual rate of approximately 3% and an overall population size of more than 1,000 grizzly bears residing in and adjacent to this recovery area. Females with young have been documented consistently in all 23 Bear Management Units of the Northern Continental Divide Ecosystem as well as throughout the surrounding Management Zone 1 that is included in population monitoring (Costello and Roberts 2022). The Northern Continental Divide Ecosystem grizzly bear population has continued to expand geographically, with an estimated 35% of the occupied range of grizzly bears being outside of the combined Northern Continental Divide Ecosystem grizzly bear recovery zone, Primary Conservation Area, and Management Zone 1 by 2018 (Costello and Roberts 2019). Genetic evidence collected in 2021 indicated movement by one male grizzly between the Northern Continental Divide Ecosystem and Cabinet-Yaak ecosystems, and well as movement by 3 males from the Northern Continental Divide Ecosystem toward the Bitterroot Ecosystem (Costello and Roberts 2022).

*Population status and trend in the Ninemile Demographic Connectivity Area*. The Ninemile Primary Conservation Area, located west of Missoula and intersecting the Forest, was recognized as providing population connectivity and genetic exchange between recovery areas. Grizzlies were first detected there in 2013, were consistently detected annually between 2018 and 2020, but were not detected in 2021 (Costello and Roberts 2021;2022).

*Habitat condition and connectivity.* In general, a grizzly bear's daily movements are largely driven by the search for food, mates, cover, security, and den sites, and they use a variety of habitats in pursuit of these activities. Grizzly bear habitat is not generally defined by specific habitat types or associations. Rather, habitat availability depends on large tracts of varied habitats protected from human development. This may include forested and open habitats, riparian areas, recently burned or harvested landscapes, and avalanche chutes, meadows, and high-elevation slopes (Servheen 1981, Mattson et al. 1991a, Mattson et al. 1991b, Schwartz et al. 2003, Felicetti et al. 2004). As opportunistic omnivores, grizzly bears exploit a wide range of food resources found across this diversity, including huckleberries and other fruits, a variety of insects such as cutworm moths, plants such as cow parsnip and glacier lily, and a variety of mammalian carrion and prey such as ground squirrels, beaver, and elk (Servheen 1983, Mace and Jonkel 1986). Spring and denning habitats occur throughout the area currently occupied by grizzly bears and are being redefined as bears reoccupy historic ranges. Summer habitat includes an enormous range of types, rendering it not useful to attempt to map at the scale of the plan area.

Habitat security, as opposed to habitat type, has been instrumental in grizzly bear recovery. Generally speaking, “secure habitat” is an area with low levels of human disturbance where grizzly bears can meet their life history needs without heightened risk of human-caused mortality or experiencing the negative consequences of human disturbance, such as habitat avoidance, shifting to nighttime activity patterns, or repeated flight response. Secure habitat is an important metric because it portrays the impact of the spatial arrangement of motorized routes on the landscape more effectively than a simple road density calculation. In the Northern Continental Divide Ecosystem, secure habitat is defined as an area greater than 2500 ac in size and more than 500m from a road or motorized route that is open during the non-denning season (Northern Continental Divide Ecosystem Subcommittee 2018). In the Cabinet Yaak recovery area, there is no acreage limitation as bears have been observed using smaller blocks of unroaded land (Wakkinen and Kasworm 1997). On the Lolo National Forest, almost 908,200 acres meet the criteria for secure habitat, 88% of which occurs in blocks.

*Population-level drivers and stressors: mortality*. Human activities are the primary factor impacting grizzly bear habitat security in the Northern Continental Divide Ecosystem and elsewhere (Northern Continental Divide Ecosystem Subcommittee 2018) and have been considered the primary factor driving grizzly bear mortality. Of 337 known grizzly bear mortalities documented between 1998 and 2011 in the Northern Continental Divide Ecosystem, 86% (290) were human-caused (Northern Continental Divide Ecosystem Subcommittee 2018). Of the 37 known or probable mortalities reported in the Northern Continental Divide Ecosystem in 2020, only 2 were identified as due to natural causes (Costello and Roberts 2021). Management removals, either over livestock or property conflicts, accounted for 15 (41%) of these mortalities. Another 12 mortalities were due to either legal or illegal killing by humans (i.e. defense of life or poaching). Despite these mortalities, the survival rate for adult females, the most important cohort affecting population trend, remains approximately 93-95% (Mace and Roberts 2012, Costello and Roberts 2021).

Management removals are usually associated with availability of attractants, or human or livestock food, with bears becoming food-conditioned and habituated to human presence. There are 11 active cattle grazing allotments on the Forest, with one each in the Cabinet-Yaak recovery zone, the Northern Continental Divide Ecosystem recovery zone, Management Zone 1, and the Ninemile demographic connectivity area. There are 7 active allotments in the remaining portion of the Forest. No known incidents of grizzly bear mortality or grizzly bear-human conflict have occurred on the Forest as the result of livestock grazing-related management control actions after the listing of the grizzly bear as Threatened in 1975. A food storage order has been in place since 1995, supported by 1986 Forest Plan components.

*Population-level drivers and stressors: population connectivity*. The ability of bears to move between blocks of secure habitat on the Lolo National Forest, thereby facilitating connectivity between the recovery populations, is a critical consideration for managers. (Servheen et al. 2003) found that the fragmentation of grizzly bear habitat in Montana is largely associated with human development on private land in valley bottoms. On the Forest, large blocks of habitat are separated by rivers, private land, and highways such as Interstate 90 and State Highway 200. Providing connectivity across the landscape is a significant concern.

*Population-level drivers and stressors: habitat security*. Secure habitat is widely distributed on the Forest. The percentage per subunit or analysis unit ranges from 100% on the North Scapegoat Bear Management Unit subunit to 0% on the Middle Blackfoot and Upper Thompson analysis units. Of the 7 Northern Continental Divide Ecosystem subunits on the Forest, 5 are fully consistent with 1986 Forest Plan criteria for motorized route density and security core. The Mission subunit is not consistent, but less than 75% of the land in this subunit is administered by the Forest Service. As a result, this subunit has been managed under a no net loss strategy. The Swan subunit is also not fully consistent with the road density and security core criteria. In 2011, the Forest reinitiated consultation for the access management strategy for the Swan bear management subunit due to noncompliance with portions of the 1996 incidental take statement. In recognition of its unique characteristics, requirements were modified to no more than 17% Total Motorized Route Density; no more than 31% Open Motorized Route Density, with no more than 22% open motorized route density during the spring; and at least 55% security core (U.S. Department of Agriculture 2011a).

*Population-level drivers and stressors: climate change*. The Northern Continental Divide Ecosystem grizzly bear conservation strategy (Northern Continental Divide Ecosystem Subcommittee 2018) summarizes a variety of ways that climate change may influence grizzly bear behavior and habitat availability. This may include changes in the abundance, distribution, and timing of various food resources, associated changes in denning behavior, and the potential for increased bear/human conflict. While there is significant uncertainty regarding how these changes may affect grizzly bears, the scientific consensus is that they are unlikely to directly threaten grizzly population persistence and may be beneficial (Servheen and Cross 2010). Grizzlies' wide-ranging, opportunistic nature, and their flexibility in resource use, allow them to be resilient in the face of anticipated changes such as shifts in fire and hydrologic regimes or the distribution of key food resources.

**Yellow-billed cuckoo**

*Distribution on the Lolo National Forest.* The species is a rare neotropical migrant songbird found at low densities but occurring throughout much of the United States and some eastern Canadian provinces (Hughes 2020). The western population, generally identified as occurring west of the Rocky Mountains and listed as federally threatened in 2014, includes known breeding populations Idaho, Wyoming, Colorado, Utah, Nevada, California, New Mexico, and Arizona (ibid). There are fewer than ten confirmed observations of the species and no breeding records from western Montana, and no documented observations of the species within the plan area. A recent playback survey designed to increase detection rates of yellow-billed cuckoos was conducted in Missoula County and found no evidence that the species was present (see planning record exhibit R22-002). There are no known population estimates for the species in Montana or on the Lolo National Forest, and as the species is often overlooked in traditional surveys (Hughes 2020) surveys designed to provide reliable abundance estimates for the species (Thompson 2004) are not on-going in the plan area.

*Population status and trend.* There are no known specific population trends for the species in Montana or the Plan Area. Habitat loss and fragmentation and alteration of hydrological patterns have led to extirpation from many formerly occupied breeding locations (Laymon and Halterman 1987;1989) and populations declines have generally exceeded 50% throughout the species range (Hughes 2020). Although populations have declined across the species range, populations in the western extent of the species range have diminished precipitously (Hughes 2020). In 2014, the U.S. Fish and Wildlife Service listed the western population as threatened under the Endangered Species Act.

*Habitat condition and connectivity.* The species occupies deciduous riparian woodlands, with western populations being mostly associated with tall cottonwood riparian stands that include willow understory (Hughes 2020). Suitable breeding locations consist of relatively large (greater than 50 acres) patches of multi-layered riparian vegetation (Halterman et al. 2015). Isolated or narrow, linear patches of riparian habitats while not suitable for nesting, may provide important migratory stopover habitat (Halterman et al. 2015). In western Montana, suitable habitat is most likely to occur along the Bitterroot, Clark Fork, Flathead, and Kootenai Rivers.

*Population-level drivers and stressors.* Locations that traditionally supported breeding populations have experienced long-term habitat degradation and loss throughout the species western range due to infrastructure development, invasive species, dams, irrigation, and land-use practices that have affected the distribution, patch size, successional stage and quality of riparian forests (Stanek et al. 2021, Wohner et al. 2021). A recent survey for the species in Missoula County found that riparian areas near the confluence of the Bitterroot and Clark Fork rivers were represented by small often homogenous riparian-woodlands that lacked the size or complexity to support breeding (see planning record exhibit R22-002), a pattern that is likely consistent with habitat conditions across the Forest. Habitat conditions in the plan area may, however, be suitable for migratory stopover (Stanek et al. 2021, Wohner et al. 2021).

**Wolverine.** The wolverine (*Gulo gulo)* is circumboreal in distribution, occurring in Europe, Asia, and North America (Glass et al. 2022). In North America, the wolverine historically occurred in Alaska, Canada, western and northeastern United States, and the Great Lake states. Currently, wolverines appear to be distributed as functioning populations in Alaska, Canada, and in two regions of the contiguous United States: the north Cascades in Washington, and the northern Rocky Mountains in north and central Idaho, western Montana, and northwestern Wyoming (Aubry et al. 2007, figure 5-5 ). Even in the northern Rockies very little is known about the extent and status of wolverine populations (Aubry et al. 2007).

The North American wolverine was proposed to be listed as a threatened species under the Endangered Species Act by the U.S. Fish and Wildlife Service in February 2013 (U.S. Department of the Interior 2013b). The following year, the U.S. Fish and Wildlife Service withdrew their proposed rule (U.S. Department of the Interior 2014). The District Court for the District of Montana subsequently vacated the 2014 withdrawal of the proposed rule in 2016 after legal challenges were filed against the agency. The U.S. Fish and Wildlife Service responded by reopening the comment period on the 2013 proposed rule and initiated a new status review of the species (U.S. Department of the Interior 2016). This included completion of a Species Status Assessment to help inform their decision-making process (U.S. Department of the Interior 2018a). In October 2020, the agency withdrew their 2013 proposed rule to list wolverine as threatened (U.S. Department of the Interior 2020b). Additional litigation followed, and the U.S. Fish and Wildlife Service requested a voluntary remand of their decision in the spring of 2022. On May 26, 2020, the District Court for the District of Montana vacated the 2020 withdrawal of the proposed rule and wolverine was once more considered "proposed" under the Endangered Species Act.

*Distribution on the Lolo national forest.* Given their dispersal potential, wolverines are assumed to potentially be present across the Lolo National Forest. While this does not suggest that all lands are occupied by wolverine, it suggests that wolverine could potentially move across all parts of the Forest when moving between patches of primary habitat. Numerous detections on the Bitterroot National Forest, directly south and connected via designated alpine wilderness, support this assumption.

*Population status and trend.* While anecdotal observations of wolverine on the Lolo National Forest are relatively common, population-level information across the plan area is unavailable. Between 2012 and 2018, winter mesocarnivore survey were conducted over the eastern part of the forest by Southwest Crown of the Continent partners. Detection rates varied widely, from one in 2012 and 2013 to 71 in 2016. In 2016, 22 of the suspected detections were genetically confirmed to be wolverine and 2 individual males were identified. Detections occurred on the Seely Ranger District in all survey years, and on the Missoula Ranger District in 2016 and 2017. In 2020 regional multicarnivore surveys were initiated on the Lolo and a single wolverine was detected on the Seeley Ranger District. These surveys are intended to be repeated every three years and will provide information on regional occupancy and population trends. Results from 2023 surveys on the Forest are not yet available.

*Habitat condition and connectivity.* Year-round habitat for the wolverine is found at high elevations centered near the tree line, in conifer forests (below tree line), rocky alpine habitat above tree line, cirque basins, and avalanche chutes that have food sources (U.S. Department of the Interior 2013a;2018a). Deep, persistent, and reliable spring (mid-April to mid-May) snow cover is the best overall predictor of wolverine occurrence, possibly due to the species' need for deep snow during the denning period (ibid). Wolverines do not appear to depend on a certain vegetative component or other biological ecosystem attributes. Wolverines appear to select areas that are cold and receive enough winter precipitation to reliably maintain deep persistent snow late into the spring season (ibid). The requirement of cold, snowy conditions means that, in the southern portion of the species' range where ambient temperatures are warmest, wolverine distribution is restricted to high elevation areas.

Wolverines have evolved to exploit a cold, low-productivity niche where growing seasons are brief, and food resources are limited, as shown by adaptations such as extremely large home ranges, territoriality, low densities, and low reproductive rates (Inman et al. 2012a). While wolverines were formerly thought to use a variety of habitats (Hornocker and Hash 1981, Butts 1992), Lofroth (Lofroth 1997) suggested that wolverine habitat was best defined in terms of adequate year-round food supplies in large, sparsely inhabited wilderness areas, rather than in terms of types of topography or plant associations. Recent studies have refined the understanding of wolverine habitat use, as fine-scale wolverine occurrence, documented via radio telemetry and GPS technology, has been strongly associated with high elevation alpine and avalanche environments (Copeland et al. 2007, Inman et al. 2007, Krebs et al. 2007, Lofroth and Krebs 2007, Copeland and Yates 2008). More specifically, Inman et al. (Inman et al. 2012b) found that habitat in the areas wolverines selected in the Greater Yellowstone Ecosystem was characterized by steep terrain with a mix of tree cover, alpine meadow, boulders, and avalanche chutes.

Overall, the best available information indicates that within the contiguous United States the wolverine's physical and ecological needs include large territories in relatively inaccessible landscapes; at high elevation (1,800 to 3,500 meters or 5,906 to 11,483 feet); access to a variety of food resources that varies with seasons; and physical/structural features (e.g., talus slopes, rugged terrain) linked to reproductive behavioral patterns (U.S. Department of the Interior 2018a). Mapping of predicted wolverine habitat in the Northern Region of the Forest Service is based on the work of Inman et al. (2013), which used radio-telemetry data collected in the Yellowstone Region of the United States and Resource Selection Function modelling. This work produced four habitat layers: maternal habitat, primary habitat, female dispersal habitat, and male dispersal habitat.

Except for approximately 1,000 ac in the vicinity of Missoula, the entire Lolo National Forest is male wolverine dispersal habitat. Female dispersal habitat is nearly equally widespread, accounting for almost 1.95 million acres of the forest and bisected primarily by the Interstate 90 and Highway 93 corridors. Primary and maternal habitat are more restricted to the alpine areas of the forest. Approximately 534,000 ac of primary habitat occurs in the Superior, Ninemile, and Seeley Lake Ranger Districts, and to a more limited degree on the Missoula Ranger District. Approximately half of these acres (266,000 acres) qualifies as maternal habitat, occurring in approximately the same distribution. While primary and maternal habitat patches are widely dispersed across the forest, this is primarily based on topography and the available habitat patches are connected via potential dispersal habitat. The primary threat to connectivity occurs along the I-90 and Highway 93 corridors.

*Population-level drivers and stressors.* Climate change, the inadequacy of existing regulatory mechanisms to climate change, harvesting, trapping and small population size were identified as the primary and secondary threats to the continuous wolverine distinct population segment per the U.S. Fish and Wildlife Service five factor analyses[1] (U.S. Department of the Interior 2013a) (Table 25).

**Table 25—Summary of five factor analysis for North American wolverine**

| Factor | Threat | Finding |
|---|---|---|
| A1 | Climate Change | Primary Threat |
| A2 | Habitat Impacts due to Human Use and Disturbance (4 categories) | |
| | 1) Dispersed Recreation (e.g., snowmobiling and heli-skiing) | Not a Threat |
| | 2) Infrastructure Development (e.g., buildings, oil and gas, ski areas) | Not a Threat |
| | 3) Transportation Corridors | Not a Threat |
| | 4) Land Management (e.g., timber harvest, prescribed burning, grazing) | Not a Threat |
| B | Harvest (trapping) [currently prohibited by Montana Fish, Wildlife and Parks] | Secondary threat |
| C | Disease and Predation | Not a Threat |
| D | Inadequate Regulatory Mechanisms (climate change) | Primary Threat |
| E | Small Population Size | Secondary Threat |

The U.S. Fish and Wildlife Service also analyzed four categories of human disturbance as part of their rulemaking process. This included: (1) Dispersed recreational activities with primary impacts to wolverines through direct disturbance (e.g., snowmobiling and heli-skiing); (2) disturbance associated with permanent infrastructure such as residential and commercial developments, mines, and campgrounds; (3) disturbance and mortality associated with transportation corridors; and (4) disturbance associated with land management activities such as forestry, or fire/fuels reduction activities. These were not found to be a threat to the wolverine distinct population segment (Table 25).

The 2018 Species Status Assessment  (U.S. Department of the Interior 2018a) included similar conclusions based on a review of additional science since the 2013 proposed rule. And more recent scientific literature (Heinemeyer et al. 2019, Kortello et al. 2019) support the U.S. Fish and Wildlife Service findings that human disturbance in occupied primary habitat may affect wolverine habitat use but currently is not at the scale that threatens the distinct population segment (DPS). For instance, Heinemeyer et al. (2019) found that wolverine avoided areas of both motorized and non-motorized winter recreation, though the response to non-motorized activities was relatively weak and driven by individual animal behavior as opposed to a consistent population-level response. The authors demonstrated a more consistent avoidance of areas with motorized winter recreation, though the impact varied between males

[1] Five factors are utilized to determine if a species should be listed under the Endangered Species Act. This includes: A. the present or threatened destruction, modification, or curtailment of its habitat or range; B. overutilization for commercial, recreational, scientific, or educational purposes; C. disease or predation; D. the inadequacy of existing regulatory mechanisms; and E. other natural or man-made factors affecting its continued existence.

and females due to males' use of more diverse terrain. Kortello et al. (2019) observed a negative association with forestry road density and wolverine occurrence, particularly females, in the Canadian Rockies. Heinmeyer et al. (2019) speculated that the impact of winter recreation on wolverine may increase over time due to a 'funneling' effect of climate change; as winter snowpack declines both wolverine and recreationists may be concentrated in more limited areas. Future concentration of winter recreation in declining denning habitat could elevate this conflict to the scale of a threat to the DPS.

The **monarch butterfly** was identified as a candidate for federal listing in December 2020.

*Distribution on the Lolo National Forest.* The Montana Natural Heritage Program has collected 29 observation of monarch butterflies, primarily in the southeastern regions of the state. Four observations have occurred in Missoula County in the past 10 years, including observations of eggs in the Maclay Flat region of the Greater Missoula geographic area.

*Population status and trend.* There are no known specific population trends for the species in Montana or the plan area. Across the species range in western North America, populations have been declining over the past 23 years, and the probability of extinction is estimated at 99% in the next 60 years (U.S. Department of the Interior 2020c).

*Habitat condition and connectivity.* Monarch butterflies lay eggs exclusively on milkweed. While adults can feed on nectar from a variety of flowering plants, caterpillars rely solely on milkweed for food. Only one type of milkweed, *Asclepias speciosa,* is found on the Forest. This species is typically found in grasslands, meadows, and roadside areas. The Montana Natural Heritage Program recently developed a monarch suitable habitat map based on the distribution of milkweed. The model predicts the highest quality habitat to be primarily on non-National Forest System lands in the vicinity of Missoula, with additional patches of moderate quality habitat along the I-90 corridor, the Ninemile drainage, and in the vicinity of the towns of Plains and Thompson Falls (figure A1-31).

*Population-level drivers and stressors.* The primary stressors of Monarch butterflies in North America are the loss and degradation of habitat, widespread use of insecticides, and climate change (U.S. Department of the Interior 2020c). Habitat loss results from a variety of anthropogenic activities such as conversion of grasslands for agriculture, logging at wintering sites and development, as well as drought and changes in natural disturbance regimes. Because monarchs conduct multi-generational migrations, habitat loss along the migration pathway, particularly the loss of native milkweed, can have significant population-level impacts. Given the population declines observed over the past 30 years, monarchs are also now more vulnerable to stochastic events such as storm events or wildfire, and changes in breeding season weather has been identified as a significant source of variation in population size (Zylstra et al. 2021).

## Potential Terrestrial Wildlife Species of Conservation Concern

**Key takeaways:**

- Thirty-two terrestrial species were considered for designation as potential species of conservation concern. Considerations included whether the species was native and documented as occurring in the Plan Area within the past 40 years, and whether sufficient scientific information existed to document substantial concern for the species' capability to persist over the long-term in the plan area.
- Three terrestrial species were selected as potential species of conservation concern: bighorn sheep, fisher, and Harlequin duck.

- The list of potential Species of Conservation Concern is subject to modification during the planning process, and final authority for designation of species of conservation concern rests with the Regional Forester.

**Summary.** Species of Conservation Concern are native species known to occupy the Lolo National Forest that are not recognized under the Endangered Species Act, but for which the Regional Forester has determined there is substantial concern for the species' long-term persistence within the plan area. Using Forest Service and Montana Natural Heritage Program data, a master list of possible at-risk species known to occupy the Lolo was compiled. To be considered a species of conservation concern each species was evaluated to determine whether the species met the following mandatory requirements (FSH 1909.12 Section 12.52):

> "The best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area. Information may come from a variety of population sources, including Federal and State agencies, literature, local information on occurrence and population status, subbasin analyses, broad-scale assessments, and information available from local species experts and other organizations."

Substantial concern is demonstrated using the best available scientific information to document significant threats to the species or its habitats, declines in species or habitat abundance and distribution, or other unique factors about the species ecology, life history, or distribution that may affect the species resilience to environmental perturbation and thereby persistence within the plan area. An outline of the process to identify potential species of conservation concern is included in Forest Service Handbook directives (FSH 1909.12.5) and the specific approach detailed in the potential species of conservation concern process and determination document (U. S. Department of Agriculture 2023a) concurrently out for public review.

Based on the potential species of conservation concern identification criteria, 32 terrestrial species warranted an in-depth evaluation, including 9 birds, 8 mammals, 3 terrestrial insects and 12 terrestrial mollusks. Using the best available scientific information, 3 terrestrial species were identified as potential species of conservation concern with the following rationale.

- Bighorn Sheep (*Ovis canadensis*). All herds in the plan area have demonstrated population declines, and currently most are well below population objectives. Disease, the primary cause of the population decline, is persistent in the plan area and extremely difficult to manage (Ramsey et al. 2016). The species has a demonstrated propensity for localized extirpation even when surrounding populations are stable (Donovan et al. 2020), especially when populations fall below critical abundance thresholds (Berger 1990, Smith et al. 1991, Singer et al. 2001, Beecham et al. 2007, Carpenter et al. 2014), as is the case for some populations in the pan area.
- Fisher (*Pekania pennanti*). Structured surveys in the plan area (Golding et al. 2018, Yeats and Haufler 2020, Golding 2022, Krohner et al. 2022) demonstrate that the species is extremely rare and has a distribution that is limited to the western extent of the Forest (Montana Natural Heritage Program 08/2022). In the Northern Rockies the species occupies large home ranges, and does not generally occupy disconnected or small habitat patches (Schwartz et al. 2013, Olson et al. 2014, Sauder and Rachlow 2014, Krohner 2020, Krohner et al. 2022), which may prevent the species from increasing in distribution and abundance in the plan area where habitat is more disjunct. The species has a limited dispersal capacity and a slow life history strategy that may prevent the species from responding to stochastic event that reduce the population or substantially alters habitat conditions.

- Harlequin Duck (*Histrionicus histrionicus*). In the plan area the distribution of the species has contracted as the number of streams with known breeding populations is currently limited to three, including two in the same drainage. Assessing occupancy for the species is challenging (Wiggins 2005), but recent sampling has not identified any new breeding locations in the plan area. The combination of a numerically small populations with a limited distribution in the plan area creates a credible risk to the localized extirpation of the species. Moreover, compared to most duck species, the species exhibits a life history strategy that is particularly slow to recover from habitat degradation or loss, or other stochastic events that may affect local demography (Wiggins 2005).

Additional information on population and habitat conditions for each species considered during the potential species of conservation concern process, including decision rationales, are included in the potential species of conservation concern process and determination document (U. S. Department of Agriculture 2023a). Moving forward, the potential species of conservation concern list may be modified based on the best available scientific information and public input gathered during the planning process before approval of the final land management plan.

**Status and trends.** Detailed status and trends for each species considered is provided in the potential species of conservation concern process and determination document (U. S. Department of Agriculture 2023a).

## 2.6.3 Fish and Other Aquatic Wildlife

### Federally Recognized Threatened, Endangered, Proposed and Candidate Aquatic Wildlife Species and Sensitive Species

**Key takeaways:**

- Plan-area native aquatic communities are highly dependent upon cold, clean water.
- Several species are listed as threatened or sensitive from land/water use that has degraded habitat.
- Recovery efforts are underway but complicated by non-native species and climate change.

**Summary.** Aquatic species that inhabit the plan area are adapted to cold, clean, complex, and connected systems. These habitat requirements make them sensitive to land or water use actions that degrade or reduce the quality and quantity of these elements. For example, historic mining, road building, timber harvest practices, dam construction, and agriculture have degraded stream habitat and connectivity to the extent that several native species are now listed as threatened under the Endangered Species Act (bull trout) or the Regional Forester sensitive species list (westslope cutthroat trout and western pearlshell mussel). While many legacy actions no longer pose significant threats, the persistent nature of mainstem river dams and forest transportation networks and recreation facilities continue to affect species and their habitat. The presence of non-native species and climate change are perhaps now among the most severe threats to the continued existence of native, cold-water-dependent species.

**Status and trends.** Geologic events and glaciation in the upper Columbia River basin have greatly influenced native fish presence and distribution on the Lolo National Forest. This past glacial activity and proximity to the Continental Divide has resulted in fish movement and colonization over the last 10,000-15,000 years (Pierce et al. 1976) to the uppermost part of the watershed and occupation of very cold, clear, flowing habitat. As a result, there are relatively few native fish species in the plan area. Native gamefish include bull trout (*Salvelinus confluentus*), westslope cutthroat trout (*Oncorhynchus clarkii lewisi*), and mountain whitefish *(Prosopium williamsoni*). Non-game native fish species include northern pikeminnow (*Ptychocheilus oregonesnsis*), peamouth (*Mylocheilus caurinus*), sculpin (*Cottus spp*.), redside shiners (*Richardsonius balteatus*), longnose dace (*Rhinichthys cataractae*), largescale sucker (*Catostomus macrocheilus*), and longnose sucker (*Catostomus platyrhynchus*).

These native fish species are adapted to cold, clear stream and river systems that are high in oxygen and low in nutrients. They are therefore highly susceptible to habitat degradation from common land use practices such as mining, forestry, agriculture, infrastructure, and urbanization; introductions of non-native fish species and warming water due to climate change also threaten native species. Perhaps the most affected species are those that must undergo long migrations between overwintering habitat and spawning areas because they are potentially exposed to a greater number of threats. On the Forest this includes bull trout and westslope cutthroat trout whose historic migratory corridors have been severely fragmented by dam construction on major rivers and road construction in tributary watersheds. As a result, bull trout were listed as threatened under the Endangered Species Act in 1998 and westslope cutthroat trout are a Montana species of conservation concern and Regional Forester sensitive species. All other populations of native fish species, while perhaps not as numerous as prior to European settlement, are considered stable. Western pearlshell mussels are also described in detail below because they are native to plan-area rivers and susceptible to the same threats as native fish; western pearlshell mussels are a Montana species of conservation concern and Regional Forester sensitive species.

**Bull trout: Endangered Species Act threatened species.** Bull trout require colder water than any other fish species in the plan area to survive, particularly for spawning and rearing (Rieman and McIntyre 1993). And although some resident bull trout can live entirely in tributary streams, the full expression of their migratory life history requires migration from large lakes and rivers in winter to tributary streams in summer. In fact, migratory bull trout in the plan area historically swam back and forth from Lake Pend Oreille every year (~200 miles). With annual access to Lake Pend Oreille, bull trout were historically so abundant in the plan area that their importance as a food source to native tribes is well documented (http://fwrconline.csktnrd.org/Explore/ExploreTheRiver/CultureHistory/History/). In addition to very cold water that is well-connected along migratory routes, bull trout require complex habitat and clean water. Complex habitat includes streams with high numbers of fallen trees and boulders that create pools of slower water for fish to take shelter from fast current and successfully find prey such as aquatic insects and fish (Al-Chokhachy et al. 2010b). Clean water is also important for bull trout because they spawn in the fall with eggs that hatch in spring. This means eggs must be able to survive within the spaces between large stream gravels for at least six months without getting smothered by fine sediments or organic material.

Threats to bull trout populations potentially include any form of land or water use that compromise or degrade cold, connected, complex, clean habitat (U.S. Department of Agriculture and U.S. Department of the Interior 2013). For example, mining for precious metals in the late 1800s resulted in entire tributary streams being turned inside-out in search for gold. This was followed by early timber practices that not only cut large trees from along streambanks that were necessary for shade and habitat complexity, but shipped the logs downstream using rivers as log transportation corridors. Both mining and forestry practices required road networks that were historically built with undersized culverts or bridges that impeded or blocked fish from moving in and out of spawning tributaries. The demand for hydroelectric power to supply electricity to lumber mills, businesses, and homes required the construction of large dams on mainstem rivers that blocked migratory bull trout from seasonal movements in and out of Lake Pend Oreille as well as access to some Lolo National Forest rivers and streams. Water development, agriculture, livestock grazing, and urbanization have degraded rivers and streams through bank erosion, channel simplification, chemical and nutrient runoff, and higher water temperatures. The remaining strongholds of bull trout in the plan area are those streams and rivers that are within designated wilderness areas or roadless areas because these areas have largely been spared the intensive land and water development over the past 150 years. Recreation angling also impacted bull trout in the 1900s, but not because people wanted to catch bull trout. Rather, it was because people didn't want to catch bull trout and they were considered inferior to other introduced non-native sportfish such as brown trout, rainbow trout, and brook trout. It was the introduction of these non-native species that was the most harmful component of angling to bull trout due to subsequent species competition and hybridization.

Public outcry and overall concern for the country's natural resources prompted an era of legislation in the mid-1900s that would form a foundation upon which bull trout habitat can potentially be restored, particularly on public lands: the National Environmental Policy Act of 1970, the Clean Water Act of 1972, and the Endangered Species Act of 1973. The unrestrained mining of streambeds is no longer permitted, buffers have been identified around streams from which trees are no longer harvested, and new roads that cross streams must have large enough culverts or bridges to allow fish passage. The listing of bull trout as threatened under the Endangered Species Act in 1998, and designation of bull trout critical habitat in 2010, have prompted additional recovery actions targeted at bull trout. For example, NorthWestern Energy installed a fish ladder at their Thompson Falls Dam in 2011 designed to pass migrating bull trout;

Montana Fish Wildlife, and Parks prohibits angling specifically for bull trout through angling regulations; and national forests include bull trout habitat improvement opportunities in watershed restoration plans. On the Lolo National Forest, this includes fixing miles of mining damage, dozens of undersized fish passage barrier culverts, and multiple aquatic habitat enhancement projects. Overall, changes in riparian and aquatic ecosystem management practices on national forests have greatly reduced the occurrence of potential threats (Roper et al. 2018), resulting in aquatic and riparian ecosystem conditions that are generally improving (Roper et al. 2019).

In 2013, the Forest Service and U.S. Department of the Interior, Fish and Wildlife Service prepared a conservation strategy for bull trout on USFS lands in western Montana. This strategy identifies bull trout population characteristics and population trends for each local population, and risks to their recovery, with specific restoration objectives (U.S. Department of Agriculture and U.S. Department of the Interior 2013). This strategy document identified that most local populations of bull trout are trending to smaller populations, with some local extinctions.

Despite recent progress in restoring bull trout habitat degradation, several threats to populations remain. Some threats would be within the scope of the revised forest plan to address, and some would not. For example, privately owned dams on mainstem rivers will continue to adversely affect connectivity due to lack of fish passage facilities and those that have fish passage facilities are not completely effective due to design issues or overall lack of migratory bull trout left in the system [e.g., Thompson Falls fish ladder as only passed 21 bull trout from 2011-2022 (Corporation 2023)]. Non-native species will continue to prey on young bull trout and out-compete adult bull trout for space and resources. However, authority to directly manage native and non-native fishes belongs to State agencies. Neither of these major threats to bull trout would be within the jurisdiction of Lolo National Forest planning efforts. However, continuing to reduce the effects of forest system road networks (i.e., undersized culverts and road encroachment into streams and riparian areas) are threats for forest plans can provide components to address. Additional restoration of past mining damage in streams and overall enhancement of bull trout habitat on National Forest System land are also appropriate issues for forest planning. These are likely to be of importance considering climate change predictions that suggest plan-area streams may experience lower flows and warmer temperatures into the future (Bell et al. 2021, Kaeding and Mogen 2022). Findings suggest bull trout recovery efforts should be prioritized in systems where groundwater or high elevation are expected to buffer warming temperatures in systems that still contain native fish communities (Isaak et al. 2022).

**Westslope cutthroat trout: Regional Forester Sensitive Species.** Westslope cutthroat trout historically occupied most cold, clean, connected waterbodies in the plan area. They are generally present throughout the entire length of occupied river basins (Young 1995) but are more likely to occupy and occur at higher densities in reaches with higher stream gradients (D'Angelo and Muhlfeld 2013), (Heckel IV et al. 2020). Headwater streams provide particularly value habitat for westslope cutthroat trout for reproductive and juvenile life stages (Rieman and Apperson 1989), and in many cases support the most genetically pure populations (Allendorf and Lundquist 2003); see hybridization threats below). Although the abundance of westslope cutthroat trout is lower than historic population estimates across much of its range (Shepard et al. 2003), plan-area occupancy is largely unchanged in the recent past (Bell et al. 2021) and the species, or hybrids of the species, remain common (see planning record exhibit R01-002). Neighboring populations in Idaho have increased from historic lows and are now largely stable due to a combination of restoration efforts and changing management practices (Kennedy and Meyer 2014), (Mallet and Thurow 2021); a pattern likewise documented in some drainages within the plan area (Pierce and Podner 2013).

Threats to westslope cutthroat trout populations include impoundments (Schmetterling 2003), (Ardren and Bernall 2017), timber harvest (Hicks et al. 1991), roads (Heckel IV et al. 2020), grazing (Peterson et al. 2010), mining (Mayfield et al. 2019), climate change (Wenger et al. 2011), (Isaak et al. 2012), (Yau and Taylore 2013), (Isaak et al. 2015), (Kovach et al. 2015), (Dobos 2015), (Young et al. 2018)) as well as competition and hybridization with non-native fish (Bell et al. 2021), which is generally considered a significant threat to westslope cutthroat trout populations (Allendorf et al. 2005). Hybridization with rainbow trout is highly variable throughout the species range (Muhlfeld et al. 2017) and is often the consequence of human modifications to the landscape (Biermann and Havlick 2021). Genetically pure populations are present in only a fraction of the waterbodies in the species' historic range (Hitt et al. 2003, Shepard et al. 2005, McKelvey et al. 2016, Muhlfeld et al. 2017) particularly where fish passage barriers block access of rainbow trout; however, non-hybridized westslope cutthroat continue to coexist in some areas with extensive non-native fisheries (Smith 2021). Rates of hybridization have increased in waterbodies in Western Montana (Muhlfeld et al. 2017, Dangora 2022) and are likely to continue to increase due to changing hydrological conditions associated with climate change and subsequent changes in non-native species distribution (Muhlfeld et al. 2014, Bell et al. 2021). The primary risk of hybridization with rainbow trout is the loss of genetic integrity that can result in physical or behavioral changes in westslope cutthroat trout populations including migratory behavior, growth rate, and reproductive strategies (Corsi et al. 2013, Strait et al. 2021, Dangora 2022) with potentially negative consequences (Kovach et al. 2016a, Kovach et al. 2016b). In the plan area, the degree of hybridization is substantial but numerous drainages retain pure strain populations (Montana Department of Fish Wildlife and Parks and U.S. Department of Agriculture 2007; planning record exhibit R01-002) and non-hybridized individuals (Smith 2021). Unfortunately, many of the genetically pure westslope cutthroat trout populations are isolated in small patches of habitat which can reduce population persistence (Peterson et al. 2009), genetic diversity (Carim et al. 2016, Bell 2022, Kovach et al. 2022), and fitness (Feuerstein 2022).

Issues affecting westslope cutthroat trout on private land or from non-native species are outside the scope of land management plans. Forest planning can help place emphasis on reducing forest infrastructure (e.g. roads and recreation) and increasing restoration actions where past land and water use has degraded stream and riparian habitat. These types of efforts have resulted in changes to riparian and aquatic ecosystem management practices on national forests have greatly reduced the occurrence of potential threats (Roper et al. 2018), resulting in aquatic and riparian ecosystem conditions that are generally improving (Roper et al. 2019).

**Western pearlshell mussel: Regional Forester Sensitive Species.** Western pearlshell mussels occupy clear, cold, perennial rivers and streams (Frest and Johannes 1995) where they tend to prefer cobble or gravel substrates interspersed with boulders in locations that are well-aerated but stable and protected from scouring (Geist and Auerswald 2007, Hastie and Toy 2008). Stream flow dynamics like flooding and scouring likely play a substantial role in the availably and distribution of suitable habitat within a waterbody (May and Pryor 2016). Western pearlshells are believed to have been formerly well-distributed across the Northern Rockies and the Pacific Northwest, but they are no longer present in many watersheds (Jepsen et al. 2010). In Western Montana the species formally occupied many of the major river systems but the distribution within the state and individual river systems has contracted; remaining populations are small and isolated with only 35 population in Montana demonstrating sufficient recruitment to ensure long term population viability (Stagliano 2015). In the Lolo National Forest only a fraction of the historic populations remain, all of which are substantially reduced in abundance (Stagliano 2015). In fact, plan-area distribution has contracted to the extent that few watersheds still sustain viable populations (Stagliano 2023).

Aquatic invertebrates are subject to numerous threats that may be escalating (Costante et al. 2022) as they are sensitive to changes in hydrology, water pollution, sedimentation, overexploitation, habitat fragmentation, invasive species, and climate change (Dudgeon et al. 2006, Strayer 2006, Collen et al. 2012, Johnson et al. 2013). Populations that are geographically isolated from core populations are at greater risk for localized extinction (Dias 1996, Ovaskainen and Hanski 2004) because they exhibit slow life history strategies, exist at low densities, and have limited dispersal capacity (Jepsen et al. 2010, Cook 2022). Furthermore, highly localized populations with low numbers are more susceptible to extirpation from random events because a single event is more likely to affect every individual (Smith and Almeida 2020). Of particular concern in the plan area is the growing risk of high-intensity fire (Reinhardt et al. 2008, Stephens et al. 2012) that could potentially result changes to water temperature, stream channel instability, and/or debris flows (Halofsky and Hibbs 2008, Dwire et al. 2016). Changes in river flow dynamics due to impoundments, dewatering, riparian or upland habitat degradation, and climate change that alter sedimentation rates and scouring also likely will continue to have substantial consequences for the western pearlshell mussels (Jepsen et al. 2010, May and Pryor 2016, Wade et al. 2016). As filter feeders, western pearlshells are susceptible to contaminants, including those that lead to eutrophication of waterbodies (Jepsen et al. 2010); however, accumulations of containments may be less than for other filter feeding species because western pearlshell tend not to occupy areas with high sedimentation (Bettaso and Goodman 2010). Western pearlshell are susceptible to changes in water temperature (Jepsen et al. 2010) and may face increasing challenges due to increasing water temperatures in the Plan Area (Wade et al. 2016)). Although mussel, including western pearlshell, are sensitive to changes in water quantity and quality (Jepsen et al. 2010) changes in riparian and aquatic ecosystem management practices on national forests have greatly reduced the occurrence of potential threats (Roper et al. 2018), resulting in aquatic and riparian ecosystem conditions that are generally improving (Roper et al. 2019).

In addition to direct threats, western pearlshell are susceptible to threats to host fish species (Jepsen et al. 2010, Isaak et al. 2018). Although many of the threats to native fish stocks are the same as those facing western pearlshell, changes in fish population abundance or behavior associated with hybridization and competition with non-native fish further exacerbates the conservation challenges for western pearlshell (Isaak et al. 2018), particularly if pearlshell do not readily parasitize non-native fish species as has been demonstrated in other systems (Tremblay et al. 2016).

Issues affecting western pearlshell mussels on private land or from non-native species are outside the scope of national forest land management plans. Forest planning can help place emphasis on reducing forest infrastructure (e.g., roads and recreation) and increasing restoration actions where past land and water use has degraded stream and riparian habitat. Additionally, management guidance to reduce fuels could be indirectly beneficial by reducing the potential for high severity wildfires that can lead to high flows and channel instability.

## Potential Aquatic Wildlife Species of Conservation Concern

**Key takeaways:**

- Twenty-eight aquatic species were considered for designation as potential species of conservation concern. Considerations included whether the species was native and documented as occurring in the plan area within the past 40 years, and whether sufficient scientific information existed to document substantial concern for the species' capability to persist over the long-term in the plan area.
- Two aquatic species were selected as potential species of conservation concern: Idaho giant salamander and western pearlshell.

- The list of potential species of conservation concern is subject to modification during the planning process, and final authority for designation of species of conservation concern rests with the Regional Forester.

**Summary.** Species of Conservation Concern are native species known to occupy the Lolo National Forest that are not recognized under the Endangered Species Act, but for which the Regional Forester has determined there is substantial concern for the species' long-term persistence within the plan area. Using Forest Service and Montana Natural Heritage Program data, a master list of possible at-risk species known to occupy the Lolo was compiled. To be considered a species of conservation concern each species was evaluated to determine whether the species met the following mandatory requirements (FSH 1909.12 Section 12.52):

> "The best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area. Information may come from a variety of population sources, including Federal and State agencies, literature, local information on occurrence and population status, subbasin analyses, broad-scale assessments, and information available from local species experts and other organizations."

Substantial concern is demonstrated using the best available scientific information to document significant threats to the species or its habitats, declines in species or habitat abundance and distribution, or other unique factors about the species ecology, life history, or distribution that may affect the species resilience to environmental perturbation and thereby persistence within the plan area. An outline of the process to identify potential species of conservation concern is included in Forest Service Handbook directives (FSH 1909.12.5) and the specific approach detailed in the potential species of conservation concern process and determination document (U. S. Department of Agriculture 2023a) concurrently out for public review.

Based on the potential species of conservation concern identification criteria, 28 aquatic species warranted an in-depth evaluation, including 3 amphibians, 21 aquatic insects, 2 aquatic mollusks, and 2 fish. Based on the best available scientific information, 2 aquatic species were identified as potential species of conservation concern with the following rationale.

- Idaho Giant Salamander (*Dicamptodon aterrimus*). Structured surveys suggest the species has a limited distribution within the plan area (Montana Natural Heritage Program 04/2022) composed of only a few small populations (Mullen et al. 2010). Populations in the plan area are geographically isolated from neighboring source populations in the core distribution of the species (Sepulveda and Lowe 2009, Mullen et al. 2010, Honeycutt et al. 2016). Small populations are more likely to face localized extirpation, particularly when isolated from other source populations (Dias 1996, Ovaskainen and Hanski 2004, Smith and Almeida 2020). The species also exhibits a slow life history strategy and has limited mobility, which further limit the ability of the species to respond to perturbation.
- Western Pearlshell (*Margarittifera falcata*). Structured surveys indicate that the distribution and abundance of the species has significantly contracted to the extent that the plan area now supports a single viable population that is substantially separated from other viable populations (Stagliano 2015). Small populations are more likely to face localized extirpation, particularly when isolated from other source populations (Dias 1996, Ovaskainen and Hanski 2004, Smith and Almeida 2020). The species also has limited mobility and exhibits a life history strategy that is dependent upon other species that increasingly face conservation challenges, both of which may further limit the ability of the species to respond to perturbation.

Additional information on population and habitat conditions for each species considered during the potential species of conservation concern process, including decision rationales, are included in the potential species of conservation concern process and determination document (U. S. Department of Agriculture 2023a). Moving forward, the potential species of conservation concern list may be modified based on the best available scientific information and public input gathered during the planning process before approval of the final land management plan.

**Status and trends.** Detailed status and trends for each species considered is provided in the potential species of conservation concern process and determination document (U. S. Department of Agriculture 2023a).

## 2.6.4 Pollinators

### Key Takeaways

- Invertebrate pollinators are crucial components of functioning ecosystems. There is evidence that, broadly, many pollinator species are in decline due to a variety of factors, including habitat loss and fragmentation, nonnative species, pests and pathogens, and climate change.
- There are gaps in available information for pollinators. No pollinator species are currently identified as potential species of conservation concern for the Lolo National Forest. The Monarch butterfly was identified as a candidate for federal listing in December 2020. Refer to section 2.6.2 for more information on this species.

### Summary

Pollinators are vital to the ecosystem function of native plant communities on the Lolo National Forest and support adjacent farmlands. Pollinators encompass all invertebrate pollinators, but native bee species receive focus due to their importance as pollinators and relatively abundant scientific information. Pollinators provide the pollination services for native plant species and agricultural crops. Pollination maintains native ecosystems, both by pollination services and providing food for other native species.

Pollinators are a large group and a number of factors limit available scientific information. There are about 20,000 described species of bees alone, with possibly another 10,000 yet to be recognized. Data gaps for land managers include the specifics of pollinator-plant interactions; the importance of floral and nesting resources and canopy cover in the determination of bee distribution; the impact of pesticide on pollinator faunas; the identification of major "nectar corridors" for migration paths of pollinators which would be a priority to protect; determination of carrying capacity and the impacts of nonnative species competition for resources; determination of how to most efficiently rights-of-way, and other artificial or edge habitats to sustain pollinators with appropriate native wildflowers and long term monitoring to determine population trends (Allen-Wardell et al. 1998, Burkle and Alarcon 2011).

On June 20, 2014, the President issued a memorandum directing the heads of executive departments and agencies to create a Federal strategy to promote the health of pollinators. The memorandum directs Federal departments and agencies to evaluate and use their resources, facilities, and land management responsibilities to expand knowledge of pollinator health and to increase habitat quality and availability. By doing so, Federal departments and agencies can inform and inspire the private sector toward similar action and foster partnerships with states and counties, businesses, citizen groups, and philanthropists to advance mutual goals. These actions will build on existing Federal mandates for multiuse lands through emphasizing pollinator needs in managing for diverse native plant communities.

Most pollinators are documented to be in decline globally, in North America and regionally (Allen-Wardell et al. 1998, Colla and Packer 2008, Cameron et al. 2011); (Kearns et al. 1998); (Kevan 1977); (National Academies Press 2007); (Watanabe 1994)). However, some native species are persisting (Cane et al. 2012) and other studies indicate that despite changes on the landscape, bee species are able to persist in similar levels of diversity in some habitats (Marlin and LaBerge 2001). While pollinator species present in the plan area face threats and are experiencing declines overall, none are currently identified as potential species of conservation concern.

## Status and Trends

Honeybees and native pollinators enhance biodiversity and support stronger and more resilient ecosystems by pollinating more than 80% of wild flowering plants in temperate latitudes. Managed honeybees cannot adequately replace the pollination services provided by a diverse community of pollinators (Garibaldi and et al. 2013). Population declines could affect native plant communities and the pollination of crops (Aizen and Feinsinger 2003); (Kearns et al. 1998); (Westerkamp and Gottsberger 2000); (Winfree et al. 2009).

Most pollinators are insects, including bees, wasps, flies, beetles, butterflies, and moths (Allen-Wardell et al. 1998); (Kevan 1999). Of these, bees provide the most important pollination services in terms of the fertilization of flowers for agricultural crops (Garibaldi and et al. 2013); (Morse and Calderone 2000) and wild plants in Montana ecosystems due to their efficiency in moving pollen from flower to flower (Gilgert and Vaughan 2011). Flies also provide pollination services especially in alpine areas and tundra (Larson et al. 2001). Most butterfly and moth species contribution to native plant fertilization is unknown (Allen-Wardell et al. 1998). Other insects such as beetles and wasps provide pollination services to a lesser extent (Kevan 1999). Bat species eat insects and are not known to provide pollination service aside of incidental pollination (e.g. capturing insects within flowers). Hummingbirds play an important role in ensuring "ecological redundancy" (Aizen and Feinsinger 1994)) and contribute to pollination services in the plan area, but these pollinator services are limited compared to the invertebrate species.

Pollinators need continuously available forage with appropriate plant diversity, shelter and nest sites, habitat heterogeneity, and landscape connectivity on a landscape. Pollinators benefit from an availability of flowers with a succession of bloom throughout the growing season, across different habitat types, in various seral stages (Hoffman Black et al. 2011); (Smallidge and Leopold 1997). Invertebrate pollinators also require shelter sites for nesting or egg-laying, or overwintering habitat and these areas may differ from their foraging sites. Vegetation provides habitat for above-ground nesters, which nest in hollow or pithy stems or other small cavities or in small, insulated cavities underneath grass clumps or under the thatch of bunch grasses (Hatfield and LeBuhn 2007). The breeding and overwintering habitat needs are less understood for other groups of pollinators, but syrphid fly species and soldier beetles have been recorded overwintering in soil or litter (Schaffers et al. 2011). Butterflies and moths may also utilize similar areas as overwintering habitat or shelter. Landscape connectivity is important for the populations of many species because large uninterrupted tracts of native vegetation provide areas of refuge for pollinators in an otherwise checkerboard habitat.

There are multiple stressors on pollinators. Although researchers have not determined the specific cause of decline, they have developed the following list of pressures that are speculated to cause individual illness and population crashes:

- *Habitat fragmentation and habitat quality.* Pollinator habitat has become increasingly fragmented with housing development and agriculture. Urban sprawl into rangelands, land-use conversion into irrigated farmlands, other developments remove and degrade habitat. There is evidence that bee species can be resilient and present in enough numbers to respond to restoration of native habitats (Cane et al. 2006), but bee abundance and richness are significantly reduced by habitat loss (Winfree et al. 2009). A lack of forage is frequently cited as a primary contributing factor to declines in pollinator health (National Academies Press 2007); (Roulston and Goodell 2011). Urbanization, agricultural intensification, and other human activities are fragmenting habitat and impacting pollinator affect pollinator diversity and abundance, communities and plant visitation (Jennersten 1988); (Steffan-Dewenter and Tscharntke 1999); (Wettstein and Schmid 1999). Human disturbance, particularly the loss of natural and semi-natural habitats, causes pollinator decline and reduces abundance and species richness of native bees (Aizen and Feinsinger 2003); (Goulson et al. 2008); (Winfree et al. 2009). The negative effect of habitat loss on biodiversity is well documented (Fahrig 2002). Livestock grazing can also contribute to the spread of nonnative species and in some areas grazing has reduced habitat quality for pollinators.

- *Nonnative Species.* Honeybees are a nonnative species and could potentially compete with native bee species in ecosystems that are limited in pollen production (Minckley et al. 2003). More information is needed regarding the impacts of honeybees and other nonnative species on native bee diversity. Noxious weeds and nonnative grasses, such as timothy or Kentucky bluegrass, have spread throughout many of the grassland habitats and reduced habitat quality for pollinators by reducing native species diversity.
- *Pests and pathogens.* Pollinators have their own suite of pests and disease. There is a well-publicized colony collapse disorder that has affected honeybee hives in recent years. Colonies may go through cycles of collapse, although no causes are known. Current collapses are in the 30 to 40 percent range, which is substantial. Mites have been introduced from Europe, as well as gut fungus and viruses, contributing to further declines.
- *Climate change.* Climate change can affect the range of pollinators, the range of their food (native plants), the timing of their food (phenology of wildflowers shifting to earlier in the season), and the gap that can exist between when food is available and when the pollinator species are present in an area. Climate change is expected to change the composition of pollinator communities, but effects and pollinator ability to adapt to these changes are uncertain.

Forest Service management can support pollinator populations by maintaining habitat for foraging, breeding, and nesting, and maintaining landscape connectivity. Though there are gaps in scientific literature, there is some available guidance for land management agencies on enhancing pollinator populations (Allen-Wardell et al. 1998); (National Academies Press 2007); (Pollinator Health Task Force 2016). Diverse landscapes with variation in successional stages are best to provide for the greatest number of species and restoration that creates a mosaic of interconnected patches of native habitats within a large matrix of later successional plant communities is most effective (Smallidge and Leopold 1997).

# 2.7 Watershed Conditions

## 2.7.1 Watershed Condition Framework

### Key Takeaways

- The Lolo National Forest evaluated the condition of 166 watersheds using the Watershed Condition Framework. This analysis determined that 51 watersheds were rated as functioning properly, 98 were rated as functioning at risk, and 17 were rated as impaired.
- For watersheds that were rated impaired, the most significant drivers of the ratings in the plan area were roads. Across the Plan area, watersheds were most commonly rated as impaired for the indicators: aquatic biota, roads and trails, and aquatic habitat condition.

### Summary

In 2011, sixth-level watersheds (typically 10,000 to 40,000 acres) across all National Forest Systems lands were classified using the national Watershed Condition Framework (U.S. Department of Agriculture 2011b). A watershed condition was assigned following an assessment of existing data, knowledge of the land, and professional judgment. The three watershed condition classes defined in this framework are directly related to the degree or level of watershed functionality or integrity (U.S. Department of Agriculture 2011b):

- Class 1: Functioning Properly,
- Class 2: Functioning at Risk, or
- Class 3: Impaired Function.

A watershed is functioning properly (Class 1) if the physical attributes are suitable to maintain or improve biological integrity. By contrast, a Class 3 watershed has impaired function because some physical, hydrological, or biological threshold has been exceeded. Substantial changes to the factors that caused the degraded state are commonly needed to improve conditions that sustain physical, hydrological, and biological integrity (U.S. Department of Agriculture 2011b).

The Watershed Condition Framework uses 12 indicators, which are refined into 24 attributes in four categories to assess watershed condition (Figure 25). The 24 attributes are surrogate variables representing the underlying ecological functions and processes that affect soil and hydrologic function. Each attribute was given a rating of 1 (good), 2 (fair), or 3 (poor). The 24 ratings were then put through an algorithm to identify a watershed condition class score. Aggregate class scores of 1, 2, and 3 directly correspond to final class rankings of Class 1, Class 2, and Class 3. The attribute ratings and the watershed class scores are stored in the Watershed Condition and Tracking Tool database by sixth level watersheds, using the Watershed Condition Classification Technical Guide (Potyondy and Geier 2011).

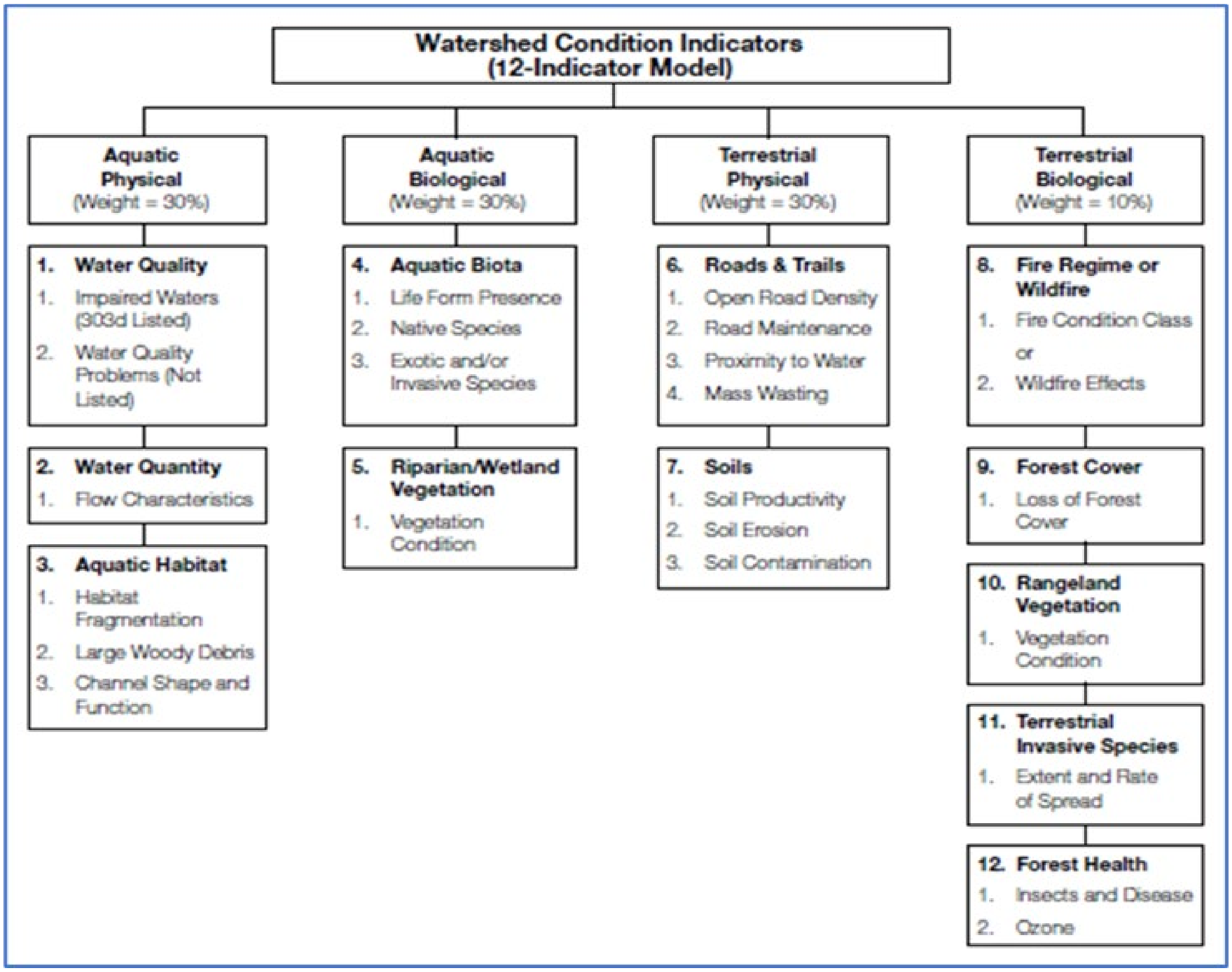


**Figure 25—Core national watershed condition indicators and attributes**

## Status and Trends

Watershed conditions vary across the plan area with conditions ranging from those unaffected by direct human disturbance to those exhibiting various degrees of modification and impairment. According to the model, 31 percent of watersheds in the plan area are in watershed condition Class 1 and “exhibit high geomorphic, hydrologic and biotic integrity relative to their natural potential condition” (Potyondy and Geier 2011). These conditions were re-assessed in 2021 and the results are displayed in figure A1-04. Of the 166 watersheds, 51 were rated as functioning properly, 98 were rated as functioning at risk, and 17 were rated as impaired. For watersheds that were rated impaired, the most significant drivers of the ratings in the plan area were roads. Across the Plan area, watersheds were most commonly rated as impaired for the indicators: aquatic biota, roads and trails, and aquatic habitat condition.

As part of the initial rating process, two watersheds were designated as priority watersheds. Cache Creek and West Fork Fishtrap were identified as priorities, had work plans identified for restoration and have since been completed. Work in Cache Creek focused on reducing the effects of roads by decommissioning 29 miles, storing 13 miles, and removing two culvert barriers. Road density decreased from 1.1 mi./sq mile to 0.5 mi./sq mile. Similarly, Fishtrap restoration activities included road decommissioning and storage, adding large wood, planting vegetation in the riparian and replacing two culverts that were blocking fish passage. Essential work has been completed. Restoration work is currently underway in priority watersheds Upper Lolo, Upper Petty, Lower Petty, and Cottonwood Creeks. Watershed

Restoration Action Plans are attached to the priority watersheds within the interactive map at https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=f4332e5b80c44874952b57e1db0b4407.

Trends in Class 1 watersheds are relatively static. The primary drivers of change in these areas are wildfires, climate, and insect/disease infestations. Changing climate may have contributed to and possibly exacerbated the magnitude and extent of effects from these drivers. Forest management direction over the past 10 years has been to allow natural processes to dictate variations in watershed conditions in these areas. Several Class 1 watersheds have the potential to degrade to Class 2 with only moderate climate changes, due to the influence of multiple stressors.

In Class 2 and Class 3 watersheds, the trends are mixed: while some watersheds are declining, most watersheds are showing slow, continual improvement as restoration activities are implemented or natural recovery occurs. In road-accessible areas, projects have been designed to incorporate a soil and water improvement component to minimize the potential for soil erosion and mass wasting to aid in restoring water flow patterns and re- establishment of native plant species. The main efforts have included the following: restoration of vegetation to natural species, age, and opening patterns; restoration of soil productivity; and reduction of impacts of forest roads by road reconstruction, maintenance, and decommissioning. In these areas, timber harvest, wildfire, mining, livestock grazing, recreation activities, road location, and management have combined with natural disturbances to either accentuate or lessen the intensity or duration of watershed processes. Changing climate may have either exacerbated or contributed to the magnitude and extent of the effects of these drivers.

Every year, the Forests accomplishes watershed improvement work. Much of this is in conjunction with other projects, including timber, road, and fire projects, but also includes stream restoration and riparian projects, and the use of Good Neighbor Authority funding. These projects will contribute to improving conditions and ratings across the watersheds.

## 2.7.2 Water Quality

### Key Takeaways

- The Lolo National Forest continues to provide high quality surface and groundwater to the multiple ecosystems and public needs that vitally depend on clean water.

- Approximately 10% of streams on the Lolo are listed as impaired by Montana Department of Environmental Quality for mining, grazing, silvicultural, and road-related sources, among others. Monitoring data indicates that most streams are within reference conditions, but a few of the metrics show slightly less favorable conditions in developed watersheds.

- Most streams on the Lolo are in good shape; however, some streams, and segments of streams, have issues affecting water quality and stream health. The Lolo has an active watershed restoration program, temperature monitoring program, and implements resource protection measures on projects.

### Summary

The Federal Clean Water Act governs forest management practices that have the potential to affect water quality. The objective of the Clean Water Act is "…to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Section 313 of the Act requires federal agencies engaged in any activity that could result in pollutant conveyance to waterbodies to comply with all applicable federal, state, and local requirements and authorities. Clean Water Act Sections 208 and 319 address control strategies for non-point source pollution, such as forest management activities. The U.S. Environmental Protection Agency is charged with administration of the Clean Water Act with the provision for delegating many permitting, administrative, and enforcement functions to State governments. In Montana, the designated agency is the Montana Department of Environmental Quality and governance is further addressed by the Montana Water Quality Act (Title 75, Chapter 5, Montana Code) as revised October 1999. This Act describes water quality management requirements, water classifications, permitting, water quality standards, and enforcement powers for the State of Montana. Water bodies with impaired water quality are compiled by Montana Department of Environmental Quality in a list under Section 303(d) of the Act. Once listed, development of a Total Maximum Daily Load occurs, which is a designation for the total amount of pollutant that a water body may receive from all sources without exceeding water quality standards.

Forest Service direction addresses the Clean Water Act with National Non-point Source Policy (December 12, 1984), Non-point Source Strategy (January 29, 1985), and the USDA Non-point Source Water Quality Policy (December 5, 1986). Under this direction, soil and water conservation practices were recognized as the primary control mechanisms for non-point sources of pollution on National Forest System lands. The 1986 Forest Plan provides direction to "meet or exceed" state standards, which is achieved through the application of best management practices, water quality data collection, and implementation of total maximum daily load and water quality restoration plans. The Montana Department of Natural Resources and Conservation is responsible for oversight of forestry and road management practices. Best Management Practices for water quality in Montana are voluntary, preferred measures to protect soil and water quality. They are developed for both riparian and for upland management. The Forest Service uses Best Management Practices as mandatory minimum measures for protecting watershed resources, and generally exceeds the minimum efforts required by State law. Stream buffers are to highlight as one of the most important best management practices. The Lolo's Forest Plan through INFISH has more stringent protections than State statutes.

## Status and Trend

There are approximately 2,375 miles of perennial streams on the Lolo and 4,588 intermittent stream miles. Collectively, they are the source waters for all downstream ecosystems and water quality serving ecosystem services and public values. Most drainages within the Forest, except the municipal supply watersheds for Missoula and Thompson Falls, have been classified as B-1 by the Montana State Department of Health and Environmental Sciences (Rattlesnake Creek and Ashley Creek are classified A-closed above the city water system intake). The chemical water quality is generally excellent; however, some water quality issues exist.

**According to the State 303(d) list, 90 stream segments, almost 700 miles, are not meeting water quality standards (Table 26,**

Table 27, and figure A1-06). This equates to approximately 10% of streams on the Lolo and 29% of perennial streams with Montana Department of Environmental Quality designated impairments. Sources of impairments are typically related to mining, grazing, highways, road infrastructure and related habitat fragmentation, and silviculture. Total maximum daily loads have been prepared for many streams and are being implemented for several sub-basins in the plan area. Management on the Lolo emphasizes resource protection measures and restoration activities to address water quality and watershed health.

**Table 26—Number of 303(d) listed streams on the Lolo National Forest**

| Hydrologic unit code (HUC4) total with total maximum daily load planning areas | Number of listed stream segments | Stream length (miles on NFS lands) |
|---|---|---|
| 17010202 Total | 4 | 46.6 |
| *Clark Fork River* | *1* | *0.9* |
| *Rock* | *3* | *45.7* |
| 17010203 Total | 10 | 68.7 |
| *Lower Blackfoot* | *2* | *7.4* |
| *Middle Blackfoot* | *8* | *61.3* |
| 17010204 Total | 46 | 381.0 |
| *Clark Fork River* | *3* | *33.8* |
| *Middle Clark Fork Tributaries* | *25* | *217.4* |
| *Ninemile* | *9* | *41.0* |
| *St. Regis* | *9* | *88.9* |
| 17010205 Total | 11 | 64.4 |
| *Bitterroot* | *5* | *25.2* |
| *Upper Lolo* | *6* | *39.2* |
| 17010213 Total | 19 | 120.2 |
| *Clark Fork River* | *1* | *2.1* |
| *Lower Clark Fork Tributaries* | *1* | *9.0* |
| *Middle Clark Fork Tributaries* | *5* | *11.6* |
| *Prospect Creek* | *5* | *35.6* |
| *Thompson* | *7* | *61.9* |
| **Total** | **90** | **680.9** |

**Table 27—Montana Department of Environmental Quality Impaired Streams Water Quality Category**

| Category | Description |
|---|---|
| 1 | All designated uses are supported, and no use is threatened. |
| 2 | Available data and/or information indicate that some, but not all, of the designated uses are supported. |
| 3 | There is insufficient available data/information to make a use support determination. |
| 4A | Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL has been completed for the water-pollutant combination. |
| 4C | Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed because the impairment or threat is not caused by a pollutant. |
| 5 | One or more applicable beneficial uses are impaired or threatened, and a TMDL is required to address the factors causing the impairment or threat. |
| 5N | Natural conditions may be higher than the water quality standards, but further source assessment is needed to fully determine this condition. The TMDL program completes more thorough source assessments for all pollutants identified as limiting a beneficial use. If natural sources are determined to be a sole cause of water quality standards exceedance during TMDL development, a natural conditions analysis may be pursued. |

When water quality impairment is not related to a pollutant (e.g. habitat alteration), strategies are in the form of a Water Quality Restoration Plan. Frequently, impairments are related to both pollutants and non-pollutants and Total Maximum Daily Loads and Water Quality Restoration Plan are developed in concert. Total Maximum Daily Loads and Water Quality Restoration Plan alone or in combination are plans to improve water quality in a listed water body until water quality standards are met (i.e., until designated uses are fully supported). Currently there are Water Quality Restoration Plans developed for Blackfoot Headwaters, Ninemile Creek watershed, Lolo Creek Watershed, Middle Clark Fork, and Thompson River Tributaries.

In addition, the Lolo implements State of Montana and Federal Best Management Practices and other requirements of the Clean Water Act and the Montana Stream Protection Act (SPA 124), along with other project design features and resource protection measures when implementing silvicultural projects. Use of the water quality Best Management Practices is the primary mechanism utilized to achieve compliance with the Clean Water Act. The State of Montana Forestry Practices Program leads a biennial audit of the application and effectiveness of Best Management Practices on selected sites. Summaries of these audits are available at https://dnrc.mt.gov/Forestry/Assistance/Practices/bmp.asp. Recent audits have indicated greater than 90% implementation and effectiveness.

The Lolo also is also vested in implementation of a Forest Service's National Best Management Practices Program, which integrates water resource protection for many more management activities beyond State forestry practices. The goal of the National Best Management Practices Program is to improve agency performance, accountability, consistency, and efficiency in protecting water quality, and is a significant component of the Agency's water strategy. The National Best Management Practices Program enables forests to readily document Best Management Practices work and compliance (36 CFR 219.8(a)(4)) (see http://www.fs.fed.us/biology/watershed/BMP.html).

The National Core Best Management Practices program provides a standardized set of core best management practices for avoiding or mitigating effects to soil and water resources associated the range of management activities. Best management practices reviews evaluate both the degree to which a given Best management practices is implemented as well as the overall effectiveness of that best management practices. Those implementation and effectiveness ratings are combined into a single composite rating of "excellent", "good", "fair", "poor", or "no best management practices" (U.S. Department of Agriculture 2012b). A rating of "no best management practices" is given when planning or guidance documentation for a project or facility does not include any best management practices that can be rated (or no guidance for an individual facility is available, such as with dispersed recreation sites). A no best management practices rating does not necessarily equate to an adverse water quality concern. Rather, it denotes that there is no way to evaluate the site using a standardized protocol. From 2014-2022, the Forest completed 32 National Core Best Management Practice reviews (approximately 12% of the best management practices reviews conducted across Region 1 during that time frame). Reviews have spanned all categories of management activity. In most instances, three reviews or fewer have been conducted in each resource category across that time frame (Figure 26).

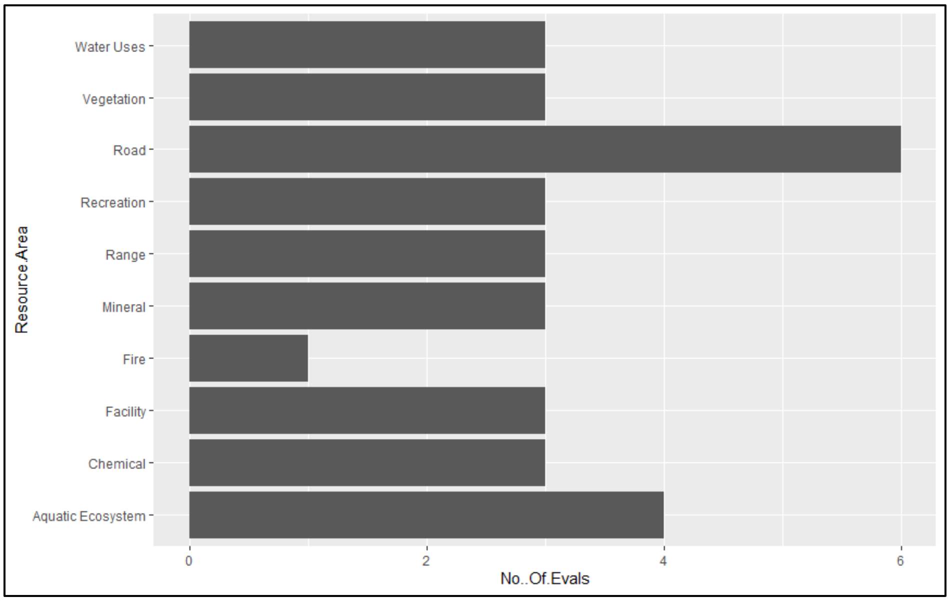


**Figure 26—National Core Best Management Practices evaluations conducted on the Lolo NF, Fiscal Year 2014-2022, by resource area.**

Information was unavailable at the time of writing of the assessment as to what percentage of these reviews were randomly selected. National guidance recommends that reviews are split 50% random/nonrandom to facilitate statistical analysis. Of those reviews, approximately 56% had excellent or good composite ratings. No reviews had fair ratings and 28% had poor ratings (Table 28).

**Table 28—Summary of Composite Ratings for National Core Best Management Practices reviews conducted across the Lolo National Forest from 2014-2022**

| Composite rating | Sum | Percent |
|---|---|---|
| Excellent | 11 | 34.4 |
| Good | 7 | 21.9 |
| Poor | 9 | 28.1 |
| No BMPs | 5 | 15.6 |
| **Total** | **32** | **100** |

Resource categories with the highest percentage of Poor composite ratings (50% or more of reviews) were recreation, range, and aquatic ecosystems (Figure 27). All three recreation reviews conducted to date have resulted in Poor composite ratings. Problems identified during Best Management Practices reviews resulted in identification and implementation of corrective actions. In general, deficient Best Management Practices implementation and effectiveness identified in reviews across the Lolo parallel those deficiencies identified in reviews across the region during that same time frame; recreation and range have a higher number of Poor reviews than other resource categories.

The number of annual reviews conducted by the Lolo National Forest has been and will continue to align with Regional and National direction. As more reviews are conducted, additional data points will allow for better characterization of resource-specific implementation and effectiveness across the forest as well as inference as to trends in Best Management Practices implementation and effectiveness. Despite limited data availability, reviews to date suggest generally successful Best Management Practices implementation and effectiveness across the Forest while also identifying areas where focused interdisciplinary coordination may be needed to address management-related water quality concerns.

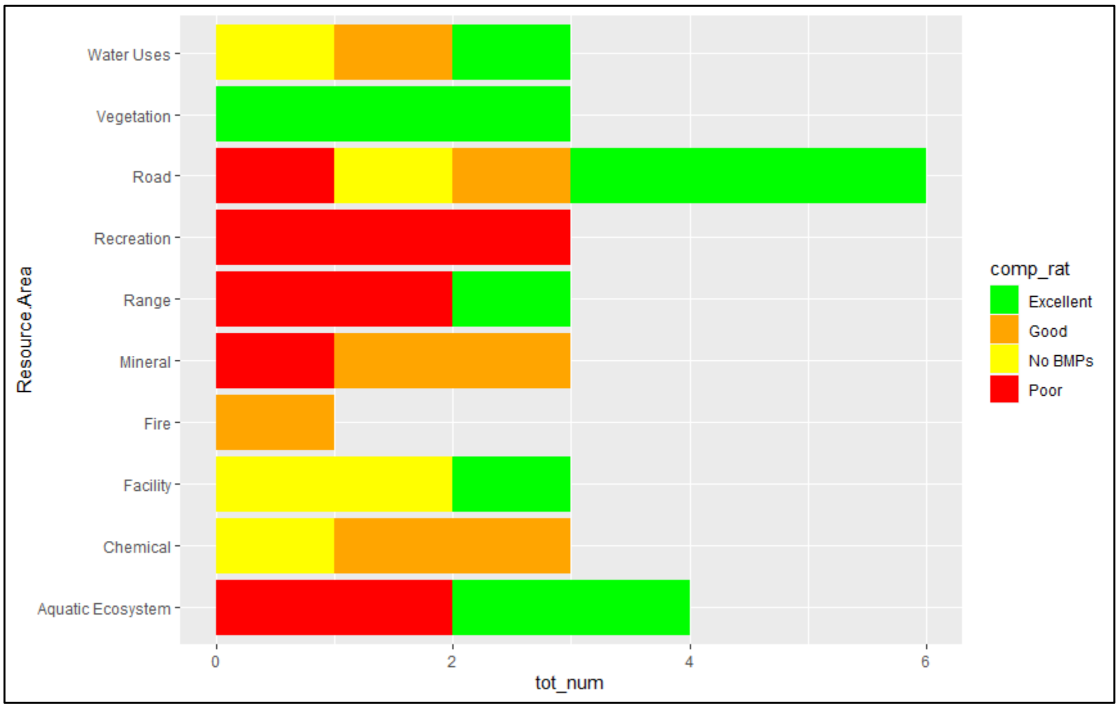


**Figure 27—Lolo National Forest National Core Best Management Practice review composite ratings by resource area, Fiscal Year 2014-2022**

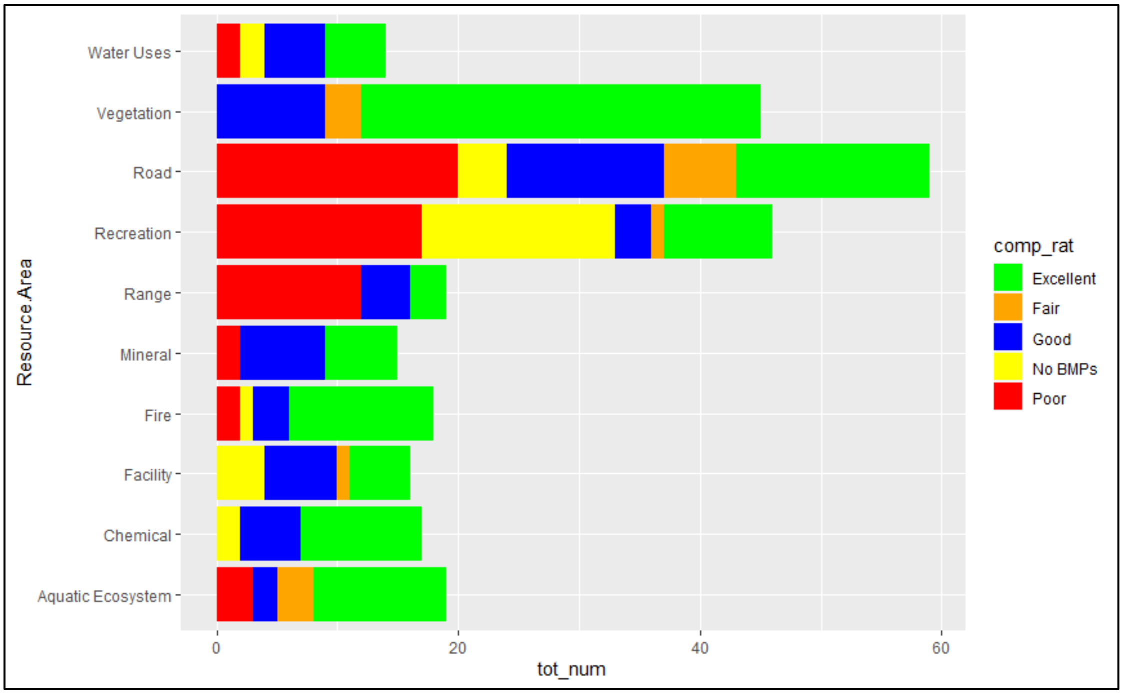


**Figure 28—Region 1 National Core Best Management Practices review composite ratings by resource area, Fiscal Year 2014-2022**

Providing buffers along streams is a fundamental protection strategy mandated by state and federal policy. Streamside management zone (Montana Department of Natural Resources and Conservation 2006) rules are mandatory for timber sales, applying within the streamside management zone, which is "…a strip at least 50 feet wide on each side of a stream, lake, or other body of water, measured from the ordinary high-water mark, and extending beyond the high water mark to include wetlands and areas that provide additional protection in zones with steep slopes or erosive soils" (Logan 2001). In the context of the Streamside Management Zone rules, a stream is a natural watercourse with a defined channel, flowing either continuously or intermittently. Isolated wetlands, lying within a sale boundary but outside Streamside Management Zone boundaries, are not regulated under the Streamside Management Zone law. Under the law, specified activities associated with timber harvest—including broadcast burning, clearcutting, vehicle operation (except on established roads), road construction (except at crossings), and other activities—are prohibited in Streamside Management Zone unless approved by the Montana Department of Natural Resources and Conservation. Streamside Management Zone are not necessarily full-fledged buffers, but special measures are taken in the Streamside Management Zone to protect the special values found there. On National Forest System lands, streamside protection exceeds the Streamside Management Zone law by meeting the Riparian Habitat Conservation Area guidelines described in INFISH (U.S. Department of Agriculture 1995b), which is an amendment to the 1986 Forest Plan. Streamside Management Zone boundary compliance is monitored as a part of the Montana forestry best practices audits discussed previously as well as through timber harvest contract administration.

Although stream temperature changes are largely attributed to climate change, elevated values are a State listed source of water quality impairment. Elevated water temperatures are also a primary factor in fisheries viability. As such, the Lolo maintains an intensive stream temperature monitoring program. This program has maintained over 70 yearlong, continuous monitoring sites for over 10 years. All Montana Fish, Wildlife and Parks, PIBO, US Geological Survey, Montana Department of Environmental Quality, and other data meeting quality control standards are now available. The monitoring system has been moved to a cloud database and represents over 70 million data points. A Storymap is available for the database at [Stream Temperature Monitoring (arcgis.com)]

The Lolo has a large watershed restoration program that addresses many water quality issues and works to restore watersheds and aquatic systems that have been impacted by past land management activities. Restoration activities are designed with the primary purpose of mitigating impacts to or directly improving the condition of aquatic ecosystems including lakes, streams, wetlands, riparian areas, and meadows. There are numerous references in the 1986 Forest Plan that call for watershed restoration activities to be conducted to mitigate adverse effects from other land management activities, like timber harvest. Land management activities that improve watershed and aquatic ecosystem health include, but are not limited to: ecosystem restoration (stream, lake, meadow, floodplain, wetland, etc.), removal of fish barriers or replacement with structures that promote aquatic organism passage, road decommissioning, road storage and/or reconditioning, streamside road relocation, eliminating irrigation diversions or retrofitting to prevent fish entrainment and promote aquatic organism passage, invasive species management (weeds, fish, etc.), and mine reclamation.

Since the early 1990s watershed restoration activities have been documented using the Watershed Improvement Tracking database. This database manages data, observations and planning details about activities that improve watershed and aquatic ecosystem health. Database rulesets establish quantifiable accomplishment metrics associated with different types of restoration activities that have been in place since 2014. Since 1990, the Watershed Improvement Tracking database contains 2,745 entries describing completed watershed restoration activities. Since 2014, more than 521-miles of habitat improvement are associated with watershed restoration activities. Neither of these databases are complete or entirely accurate. Currently the Lolo is working towards continued improvements in accounting for previous restoration, data cleanup, expense accounting, etc., as well as consistency between databases.

# 2.8 Geology and Soils

## 2.8.1 Key Takeaways

- Maintaining soil productivity is as an important part of managing the forest. Over the last decades, the Lolo National Forest established a soil monitoring program. Also, long term research plots across the nation were installed to understand the linkage between disturbance and productivity. Monitoring will continue to inform project designs to maintain soil productivity.
- Best management practices to conserve soils will likely evolve for treating steep slopes mechanically. At least half of the forest treatments on the Lolo National Forest traditionally required skyline logging. A transition to new ground-based systems to treat steep ground is occurring. Soil monitoring of these new systems will usher in new protection measures.
- Increased wildfire will continue to impact soil productivity both positively and negatively depending on burn severity. Soils recover more slowly in dry areas where burned severely and erosion moves soil material. Fire remains the primary vegetation change agent on the Lolo National Forest. Low severity burning can ameliorate soils boosting nutrient cycling and leaving beneficial charcoal.
- The pressure to conduct hazardous fuels reduction treatments while meeting needs to maintain soil productivity and ecological integrity will continue. The need to keep adequate residual organic matter to supplement soil processes remain with site specific ties to habitat type. The needs will adjust based on hazard fuel reduction and ecological integrity factors.
- Conducting soil restoration activities is likely to continue to increase. The level of road decommissioning has increased over the past planning period. As travel management continues, unneeded roads will continue to be decommissioned and shift to productive landbase. Restoration actions in timber harvest areas, particularly on burn piles, will restore soils for productive purpose.

## 2.8.2 Summary

### Geology and Soils Setting

The Lolo National Forest is dominated by steep mountain terrain dissected by large valleys. The Metasedimentary Belt bedrock is pitched and folded such that this bedrock controls the mountainside slope angle. This structural control contributes to steep slopes. To a lesser extent other geological materials occur which affect management. Granitic rocks such as around Lolo Peak form erodible soils when bared. These soil types are termed sensitive. Similarly, the micaceous schist weathers to clay rich soils with some limitations to forest operations depending on sites.

The alpine glaciation left remnant moraines and glacial alluvium in upper basins and pronounced moraine fields in the Seeley valley. Roughly 12,000 years ago, glacial lake filling led to several episodes of the Clark fork drainage backfilling from a dam in Idaho to roughly elevations of 4,200 feet. Glacial lake Missoula affected soils on the lower slopes of the Lolo National Forest. The moraine fields can have poor drainage that form wetlands, though also may lack competence to hold trees against wind shear. The Lake Missoula deposits also have drawbacks where unstable road base as seen on South Side Road (Forest System Road #453) in the Deep Creek area. The 1986 Forest Plan identified the Lake Missoula derived soils, UA16, as sensitive due to potential erosion and displacement. More recently, volcanic ash from the eruptions of Glacier Peak (12,000 years ago), Mt. Mazama (6,700 years ago) and Mount St. Helens (1980) blanketed soils with volcanic influenced loess. This loess ranges from 7 to 20 inches in depth and is more commonly found on lower energy slopes on north and east facing areas. The loess bolsters productivity with added water storage that ameliorates soil processes (McDaniel and Wilson 2007).

This geologic history sets up the primary site controls for forest management. The 1989 Land System Inventory (Sasich and Lamotte-Hagen 1989) was finished shortly after the 1986 Forest Plan and detailed the fertility of the Forest soils keying into geology. The 1986 Forest Plan Final Environmental Impact Statement assessment remains salient outlining the residual soils, fertility of soils, and sensitive soils (VI-16, p. 268). Though water and temperature may control growth, geologic parent materials serve as backdrop of productivity and operability. The Metasedimentary Belt bedrock develops soils with strong cation exchange capacity and overall adequate nutrient base to sustain forest growth. These soils may be resilient to disturbance given high levels of rock content, but also develop thin topsoils where nutrients concentrate in the rhizosphere. Erosion may be checked, but once soils bared recovery slow. Glacial till and relatively recent gravel alluvium in the bottomlands have the least nutrient base. These areas remain sensitive to losses of topsoil and organic matter from fire and timber harvesting. Granitic bedrock derived soils tend to have thin, infertile soils and higher sensitivity to erosion once bared of vegetation. Loess deposits on granitics can bolster nutrient capitol. Sensitive soils comprise less than 10% of the Forest.

Climate remains one of the most limiting factors for productivity on the Lolo National Forest with strong gradients regionally and orographically. The net effect for productivity depends on the available water for vegetation to grow. The combined influence of aspect, elevation and the soil itself – how much the material can store – creates the reservoir to supply vegetation.

The 1986 Forest Plan emphasizes the importance to maintain land productivity while keying into known soil hazards to mitigate projects. Though more general, one primary research need brought forward during the last plan development effort was the impact of timber harvest on soil productivity.

## Soil Productivity Monitoring

The soil serves as a nexus for biophysical processes whereby mineral substrate facilitates functions such as respiration and water transmission, while also storing decomposed residues that sustain soil organisms and vegetation. We can parse soil services into the following functions as soil biology, soil hydrology, nutrient cycling, carbon storage and soil stability and support (Forest Service Manual 2500, chap. 2550, 2500-2010-1). By creating these lists of ecological services, the manual acknowledges the diverse functions associated with soils that support forest management (Craigg et al. 2015).

Since soil function is difficult to measure in the field, we use associated factors that can be readily observed and measured. These factors include the degree of disturbance to surface organic matter and disturbance to topsoil. Most management activities affect surface organic matter, but it can rebound relatively quickly as surface leaf litter and roots in the soil rebuild organic matter stocks. In contrast, the mineral topsoil could be considered a summation of a site’s potential to support growth based on bedrock, terrain, climate, and rate of soil development. When management activities displace or remove portions of the topsoil, this impact involves a longer-term recovery than disturbance to forest floor. These consequences last longer on thin soils with less overall nutrient capitol. Topsoil disturbance on drought-prone sites could proportionally affect the soil’s ability to provide water to trees more than on wet sites where seasonal moisture stress is less.

Most management activities and natural disturbance processes affect soil resources depending on site productivity and recovery potential. To test the relationship between soil disturbance and productivity, the Forest Service established the Long Term Soil Productivity Experiment in 1988 (Powers 1990). Over 100 sites across the Nation provide insight on the variable response to compaction, displacement and forest floor removal treatments depending on soil type and inherent productivity. This continued information from research helps corroborate and interpret local Lolo National Forest soil disturbance monitoring data.

Soil monitoring was formalized in Region 1 in 1999. This monitoring relied on soil disturbance indicators to evaluate the impacts of forest treatments on soil productivity. Disturbance indicators included intensity of compaction, rutting, displacement, erosion, and severe burning. The Region 1 soil quality standards were published in 2014 in the Forest Service manual supplement that identifies indicators and thresholds to monitor impacts, mainly from timber activities. The intensity of disturbance is considered detrimental soil disturbance at 15 percent across a timber harvest unit (Forest Service Manual 2500, chap. 2550, 2500-2014-1), whereby growth could be stymied if above the established thresholds. Since then, monitoring has evolved and formalized to follow published protocol. Monitoring focuses on the productive landbase in line with the National Forest Management Act stipulation that timber harvesting "not result in irreversible damage" (16 USC 472a). Detrimental soil disturbance assessments on the Lolo National Forest have used statistical methods for describing soil damage extent since the early 2000s.

Monitoring on the Lolo National Forest found on average nine percent detrimental soil disturbance, ranging 6-14 percent, on ground-based units up to 10 years post-harvest (Campbell et al. 2019). In general, disturbance may decrease after timber harvest except in main skid trail areas and landings (Gier et al. 2018). Skyline harvests were found at four percent detrimental soil disturbance, although limited sampling was conducted in these types of harvested areas (Campbell et al. 2019). The skyline systems generally have less impact from log suspension and minimal ground-based equipment (Reeves et al. 2011).

Monitoring indicates that, in general, current operations meet forest plan standards. Best management practices restricting ground-based equipment to normal operating periods away from fringe wet seasons when soil compacts easily in addition to slope restrictions are practical methods to limit detrimental soil disturbance (Campbell et al. 2019). Designating skid trails during summer timber harvest and use of coarse wood as amendment in lieu of waterbars are additional effective measures to limit soil damage (Cambi et al. 2015).

## Soil Organic Matter

Along with the evolution in monitoring soils, organic matter rose in significance to assure productivity (Powers 1990, Jurgensen et al. 1997, Page-Dumroese et al. 2010). Woody debris, fungi, mycorrhizae, and associated decomposition functions all play critical roles in soil development and function, in turn contributing to soil productivity. Harvesting timber and addressing fuels reduces the above ground biomass on a site and thus the residual vegetation has high value towards contributing to soil function as both mulch and substrate for soil nutrient cycling. Soil organic matter is also vitally important to sustaining soil productivity (Jurgensen et al. 1997). Soil organic matter has been influenced by fire and silvicultural activities, but fundamentally reflects the result of decomposition versus accumulation rates. This organic component contains a large reserve of nutrients and carbon and sustains microbial activity. The character of forest soil organic matter influences critical ecosystem processes, such as the formation of soil structure, which in turn influences soil gas exchange, soil water infiltration rates and soil water-holding capacity. Soil organic matter also drives decomposition and humus formation, which enhances soil cation exchange capacity and overall fertility.

Soil biological processes and nutrient cycling are two main functions of soil organic matter. Soil provides habitat for a wide variety of organisms including plants, fungi, microorganisms and macro-organisms in the upper sections of the soil in order to promote root growth, control moisture and temperature within the soil profile and provide for nutrients available to plants (Barrios 2007). These organisms, which include mycorrhizae fungi, are important for soil health and overall soil function. There has been some evidence to suggest that maintaining mycorrhizae diversity may be a factor in maintaining forest ecosystem health (Amaranthus et al. 1990, Wiensczyk et al. 2002). The presence of coarse woody debris as at least one form of habitat is an important factor in maintaining mycorrhizae diversity in forest soils (Harvey et al. 1987, Graham et al. 1994).

Nutrient cycling is the movement and exchange of organic and inorganic matter back into the production of living matter. Soil stores, moderates the release of, and cycles nutrients and other elements. In contrast to the annual harvests associated with agriculture, forest harvest— and hence nutrient removal— typically occurs only once per rotation or every 40 to 120 years. This not only reduces the rate of removal, but the long-time interval makes natural additions of nutrients by atmospheric deposition and by weathering of soil minerals very important in maintaining nutrient status. Soil organic matter and carbon storage are extremely important for maintaining nutrient cycling especially on sensitive soils with coarse textures that contain low amounts of inherent nutrients. These sensitive sites on the Lolo National Forest include soils developed on glacial deposits and granitic bedrock.

The forest soils on the Lolo National Forest typically hold most of the soil organic matter towards the surface and form a forest floor. Coarse woody debris lines the surface but decays to soil wood and integrates deeper into the soil via bioturbation. Forest litter and duff on the Lolo National Forest ranges from a few cm to 6 cm or more depending on the time since fire and habitat type.

In the early 1980s, Brown and See (1981) monitored coarse woody debris across seventeen sites in the Bitterroot and Lolo National Forests. The reported loadings were grouped by habitat types that represented the varying forests across moisture and temperature gradients. The term “loadings” borrows from fuel assessment semantics where greater than 3-inch diameter coarse woody debris equates to 1,000-hour fuels. At this time, west of the continental divide forests averaged from 10 to 20 tons per acre depending on habitat type. The cool and moist groups, lodgepole pine and subalpine fir, had the highest loadings. An inventory established baseline natural rates of coarse woody debris to recommend for nutrient cycling and wildlife habitat while optimizing for fire hazard, animal, and human movement (p. 9). Even at this time, the rotten dead and downed was seen as the most desired for this balance.

Another component of the coarse woody debris and organic matter in the forest floor is brown cubicle rot or soil wood. Residue left after advanced brown-rot decay is a brown, crumbly mass composed largely of lignin. In healthy forest ecosystems, especially coniferous forests, the upper-most soil horizon contains a significant portion of brown-rotted wood residues. The sponge-like properties of advanced brown-rotted wood act as a moisture and nutrient sink and also provide habitat. Early logging techniques removed much of the soil wood with follow up burning significantly reducing the occurrence of soil wood in our forests. We see this evidence in our surveys of clearcut units on the Lolo from the 1960s, 1970s, and 1980s when broad cast burning as a method of site preparation was common. The 1986 Plan emphasized coarse wood which has carried forward as standard practice as one element to assure soil productivity (Graham et al. 1994, Brown et al. 2003). The Lolo National Forest created a Coarse Woody Debris Guide in 2016 which established target rates for coarse woody debris retention in forest treatments. The protocol was based on local knowledge and informed by Graham et al. (1994).

### 2.8.3 Status and Trends

Wildfire, timber harvest, and road building are the primary stressors that affect soil productivity on the Lolo National Forest over the past planning period. Recreation, mining, and livestock grazing have lesser impacts. The Forest now considers how these stressors may be affected by the impacts from climate change. The impact of climate change will likely influence the extent of disturbance such as wildfire along with revegetation after disturbance (Whitlock et al. 2017, Davis et al. 2020).

#### Prescribed Fire and Wildfire

Landscape fires were common and stand out from contemporary history of the vast 1910 fire (Heyerdahl et al. 2008). Though fires were suppressed for decades, large wildfires on the Lolo National Forest have increased in the last 20 years following drought and extreme weather. Notable fire years are 1988, 2000, 2003, 2007, 2013 and 2017. The latter year had close to 250,000 burned acres across the Forest. The Forest has also applied prescribed fire throughout the planning period. The effect to soil functions from fire track according to burn severity, but also the climate, topography and vegetation present on the site (Certini 2005). Using a burn severity proxy based on recent Burned Area Emergency Response assessments from 2017, the average wildfire burns at 36% and 8% moderate and high burn severity respectively. Using this metric, low intensity burns have occurred on across over 400,000 acres.

In prescribed burn areas, litter layers and organic matter likely stay intact and nutrient losses minimal where low burn severity (Certini 2005). Wildland fires are unpredictable and burn severities tend to be higher where greater loss of organic matter, soil cover that may shift soil microbial structure (ibid) along with increase susceptibility of erosion (Wondzell and King 2003, Larsen et al. 2009). Surface erosion on granitic soils may take longer to recover since these soils have less fertility with proportionally higher nutrient capitol stored in forest detritus.

Fire also has beneficial effects by increasing the available nutrient base by volatilizing organic matter and stimulating decomposition processes. Almost immediately, burning increases the amount of mineral nitrogen levels for plants and soil organisms (Choromanska and DeLuca 2002, Hart et al. 2005), a limiting nutrient in most forest ecosystems (Binkley 1991). In drier habitats, this increase can be detected as much as 50 years after fire (McKenzie et al. 2004). Nitrogen-fixing plants can colonize sites following fire and help restore nitrogen in the ecosystem (Jurgensen et al. 1997, Newland and DeLuca 2000). Generally, if plants colonize sites following fire, nutrient levels can reach pre-fire levels quickly (Certini 2005). In research on fires on the Lolo National Forest, Lewis and others (Lewis et al. 2017) found that no matter the burn severity, conditions converged to similar groundcover and understory plant cover after 10 years. We can infer from these observations that soil processes follow suit. Also, charcoal deposited following fire adds carbon to the soil that ameliorate soil processes (DeLuca and Aplet 2008) and increases the carbon stores overall.

#### Timber Management

The impact of timber harvest systems on soils depends on type harvest and method. The Final Environmental Impact Statement for the 1986 Forest Plan found that regeneration methods remove more material and thus demand more yarding of logs and debris to accomplish work. Intermediate harvests which largely can include commercial thinning, generally retain more trees and thus less trafficking of material that disturbs soil. Table 29 shows the trend of timber harvest acres decreasing three quarters from 1980s levels. The proportion of intermediate type timber harvest has shifted slightly from 43 percent in the 1980s to 63 percent in the 2010s. Together with less ground disturbed overall and the shift slightly to thinning, less impact is currently occurring to soils from timber harvest.

The current methods of timber harvest have improved dramatically on impacts to soil. During the 1980s, dozer piling of slash caused soil damage where soil and surface debris was piled into wind row and burn piles, as disclosed in the Final Environmental Impact Statement for the 1986 Forest Plan. The broadcast burning was purposeful to bare soil surfaces for planting. Clayton (1990) estimated detrimental soil disturbance at this time for a northern Idaho site upwards of 30% across the site. The nearby Bitterroot National Forest documented summer ground-based systems went from 13-16% detrimental soil disturbance in the 2000s to 7 percent in 2010s (U.S. Department of Agriculture 2021b). The adoption of machine piling by excavators has also limited the severe burning of slash to piles, while retaining the forest floor and leaving coarse wood to ameliorate the soil surface.

**Table 29—Timber harvest acres by decade for the Lolo National Forest, 1970s through 2010s.**

| Decade | All | Regeneration | Intermediate | Intermediate (percent) | Average annual harvest |
|---|---|---|---|---|---|
| 1970s | 132,822 | 76,408 | 56,414 | 43 | 13,346 |
| 1980s | 91,844 | 55,585 | 36,259 | 35 | 9,284 |
| 1990s | 91,822 | 51,285 | 40,536 | 35 | 10,908 |
| 2000s | 48,120 | 15,380 | 32,740 | 58 | 6,393 |
| 2010s | 23,255 | 10,189 | 13,066 | 63 | 3,193 |

Data source: FACTS

The shift away from skyline harvest systems creates pressure to use ground-based systems on steep slopes. This shift impacts soil productivity since skyline systems disturb less soil than ground-based systems (Reeves et al. 2011). In the 1980s, skyline was the dominant removal method, with 40 percent of the timber harvest relying on ground-based systems, as discussed in the Final Environmental Impact Statement for the 1986 Forest Plan. That trend has changed somewhat to 56% percent ground-based systems. The steep slopes on the Lolo National Forest and the moderate growth rates preclude lower slope opportunities for timber harvest. Thus, timber harvest on the Lolo National Forest will continue to address work on steep slopes. Currently, the Forest uses a 35% upper slope limit for ground-based systems.

## Legacy Timber Harvest

The Lolo National Forest continues to harvest timber in areas where past management has impaired soil. The overlap of contemporary harvest occurs in past plantations, currently from the 1960s, and then more recent past thinning and salvage. The legacy effects from timber harvest can leave compacted and displaced soils from cutslope skidtrails and lower rates of coarse wood than desired. The site evaluations by Lolo soil scientists continue to address site specific conditions to limit cumulative effects and meet the Lolo National Forest plan. The Lolo National Forest monitoring notes on average 4 percent detrimental soil disturbance observed from legacy logging impacts within planned timber harvest areas (Campbell et al. 2019). The projects address the cumulative impact to soils with several design criteria that may include re-use of old skidtrails and roads, potential limits on operating conditions to frozen or snow-covered ground, adjustment of logging systems and soil rehabilitation. The Region 1 soil quality standards are used as a means for compliance.

## Road Building

The trend for road building has dropped off precipitously from 1980s levels. Road building was one of the main issues in the original Final Environmental Impact Statement for the plan. Building system roads dedicates soils to administrative purpose and out of productive landbase. Roads typically remove roughly

4 to 8 acres per mile soil depending on the prism width and terrain. The 1987 plan listed 5,440 miles of system road. By 2015, a more refined accounting put the number of system roads at 6,192 miles in Forest Wide Transportation Planning Report (U.S. Department of Agriculture 2015b). The increase likely was from improved mapping in addition to 1990s era road construction. More recently, the road tally is likely higher from recently acquired 200,000 acres of mostly private timber lands that unify ownership.

Over the planning period roads were decommissioned to limit runoff and sediment production. Based on the 2015 report and recent reporting in corporate databases 1,074 miles of roads were decommissioned from years 1995 to 2020. From a restorative standpoint, partial and full contour treatments restore soil function much more effectively (Lloyd et al. 2013). Using more recent data from 2016 to 2021, roughly 49 miles, approximately 233 acres, of these templates were restored such that productivity will improve. Given the new funding available, road decommissioning and obliteration efforts will continue.

### Invasive Species Spread

Invasive plants can alter soil productivity in several ways. First, invaders outcompete native species shifting plant community composition and decreasing plant community diversity. In the northern Rockies ecosystem, cheatgrass (*Bromus tectorum*), spotted knapweed (*Centaurea stoebe*) and leafy spurge (*Euphorbia virgata*) are the top three most impactful invasive plants (Pearson et al. 2016). Invasions of cheatgrass, for example, locally eliminate native perennial forbs and grasses to form monocultures. These overwinter annuals grow under the snowpack and early into the spring changing the timing and quality of plant-derived inputs to the soil.

The pressure from invasive plants is most pervasive near roads or disturbed areas from wildfires and old timber harvest units that have legacy skidtrails. Based on the invasive plant surveys detailed in the Invasive Plants section, the invasive pressure greatest on disturbed forest areas within the warm dry potential vegetation type across 45,985 acres. Droughty soil conditions where a marginal growing environments with sparse forest canopy has higher vulnerability to invasive pressure that may affect soil function. These areas tend to have greater abundance of forb and grass understory that could have experience changes to plant functional groups.

### Geologic Hazards

Slope stability remains a hazard on the Forest where roads cross unstable geology and wildfire bares large sections of watersheds. Strong precipitation following wildfire during spring and summer months can induce debris flow. Typically, intense thunderstorms with rates of 2 inches per hour can trigger these events. Debris flows in Monture Creek and in upper Dunham Creek after the 2017 Rice Ridge Fire are examples of this.

Slope failure or landslide type events do occur and are commonly associated with rock and soil slopes weakened through saturation by snowmelt, heavy rains, groundwater influence or a combination. Natural drivers such as earthquakes, river erosion, wildfire, and human influences such as forest management and road access in unstable geologic types may elevate the risk. The most sensitive soils on the Lolo National Forest include soils derived from Lake Missoula sediments, shales, Micaceous schist, and granites. The level of hazard relies on professional input informed by soil survey and geology layers. Information to assess risk has advanced over the planning period with refined geology mapping completed, Lidar derived products that show terrain, and a preponderance of hazard models. Risk will remain highest where forests burn severely across shrub and forested watersheds (Hyde et al. 2016, Jordan 2016).

## Climate Change

In the geographic region that the Lolo National Forest sits in, average temperatures have been increasing over the last 50 years (Halofsky et al. 2018a) and are projected to continue increase. Precipitation patterns are predicted to favor rain over snow especially at mid-elevations (Luce et al. 2016), decreasing snowpack that can prolong soil moisture deficit during summer. The increase in stochastic rain events during spring and summer can induce flooding, erosion, and debris flow. The potential for peak storms during summer that induce erosion in fresh burn scars could increase. The most susceptible areas are where erodible parent material such as granitic and shist soil types.

The expected rise in soil temperature can push up the growing season in elevation. The Lolo has cold limited conditions whereby temperatures below 10 degrees Celsius (50 Fahrenheit) limit the active period for plants and microbes to grow, expressed as growing degree days. Higher temperatures at the lower elevations may push greater summer soil deficits where water becomes limiting for growth. These shifts affect the timing of nutrient cycling. Since nutrients a biogenic process, minimum temperature and moistures are needed to advance decomposition that includes storing carbon.

Drought increases could occur, which could increase wildfire, but it is complex regionally and locally because of forest management, fuel loading and other factors. Much of the big fires occur during extended summer periods of no rain and not necessarily tie to winter precipitation (Holden et al. 2018). Although drought likely increases wildfire potential, how climate change will affect that at a local and regional level is still uncertain (Littell et al. 2016). Wildfire potential to burn soil severely will have more to do with specifics of locations and summer flash drought situations like in 2017. Increases in wildfire could lead to reductions and/or changes to nutrient cycling and organic matter overall with the potential for increases in soil loss from erosion (Neary et al. 2005).

## Carbon sequestration

The recognition of carbon importance could shape management much like ecosystem management brought out the importance of coarse woody debris and forest structure. This recognition could tailor more site-specific prescriptions of treatments as we gain understanding on gains and losses of carbon. Residual soils on Forest, though shallow, still account for 44 percent of carbon on the site (Heath et al. 2011). Limiting factors of soil carbon storage are soil depth and rockiness of the soil. Much may be tied to soil wood, roots, soil organic matter, forest floor and the wood debris and leaf litter that surface soil. The press for fuels treatment on balance for needs for soil productivity will advance (Brown et al. 2003).

The understanding of carbon from the removal of non-merchantable material will need to consider what is needed for maintaining soil function (Page-Dumroese et al. 2010). Carbon compounds are inherently unstable and owe their abundance in soil to biological and physical environmental influences that protect carbon and limit the rate of decomposition (Schmidt et al. 2011). The amount of carbon stored or converted to carbon dioxide from decomposition of detritus depends on available material and biotic potential within soil (DeLuca et al. 2019). Most carbon in mineral soil comes from root turnover (Schmidt et al. 2011), although slow to decompose wood also contributes (Pierson et al. 2021). Soil carbon also plays a role in developing soil structure and soil stability. The maintenance of active soil carbon is important in maintaining soil stability, which influences water infiltration, reducing surface runoff, lowering sedimentation and improving air infiltration into the soil to support plant root respiration and other soil biota.

The Lolo National Forest has adopted practices to ensure leaving sufficient organic matter. Staff identify sites deficient in coarse woody debris in contract provisions to ensure sale administrators know which sites need most attention. Contract measures now stipulate tons per acre and administrators can leave coarse wood debris in lieu of waterbars. This latter practice increases soil recovery since coarse woody debris quickens soil recovery in skid trails, while limiting erosion.

# 2.9 Air Quality

## 2.9.1 Key Takeaways

- The air quality in and around the Lolo National Forest is generally good.
- The Lolo National Forest has an active prescribed burning program; this program accomplishes all burning in compliance with the Montanan Department of Environmental Quality and Missoula City-County Health Department annual permits and within the approval guidelines set forth in the 2010 Montana-Idaho Airshed Group.
- Air quality can be compromised during winter months in communities where wood smoke causes health standard exceedances, and during fire season months when wildfires cause exceedances across broad portions of the state.

## 2.9.2 Summary

Clean air is an important environmental benefit provided by national forests. Managers become concerned when poor air quality is or may affect forest resources such as forest health, visibility, water quality, aquatic organisms, or heritage resources. By identifying national forest components that are impacted by air pollution, and by measuring the effect of air pollution on these sensitive elements, the degree to which air pollution is affecting the forest can be measured. This information is used by air regulators, land managers and concerned citizens to promote improvements in air quality to benefit national forests and the people who visit them.

Clean air is necessary for all life on Earth, and air pollution has been associated with a range of adverse health and environmental effects. Trees absorb and sequester greenhouse gases through photosynthesis and produce oxygen for people and animals to breathe. Trees also play an important role in capturing air pollutants deemed hazardous to human health: ground-level ozone, particulate matter, nitrogen dioxide, and sulfur dioxide. The pollutants come from dust, pollen, smoke, ash, motor vehicles, and industrial sources such as power plants. There are two primary types of air quality effects concerning the Forest and forest operations: 1) the effects of regional air pollution on forest natural resources and human health, and 2) the effects of forest emissions on forest natural resources, human health, and regional air sheds.

Air pollution affects the natural quality of forest lands, particularly wilderness areas or air quality related values or wilderness air quality values. High ozone concentrations can injure sensitive vegetation. Fossil fuel burning emits sulfur dioxide and nitrogen oxides into the atmosphere. Certain types of agricultural activities, such as livestock grazing and dairy production, emit ammonia to the atmosphere. Such emissions can lead to atmospheric deposition of sulfuric acids, nitric acids, and ammonium to national forest ecosystems above critical load thresholds. Atmospheric deposition can cause lake body acidification, eutrophication, and hypoxia, soil nutrient changes, and vegetation impacts. Deposition of toxic metals such as mercury and lead can be harmful to both aquatic and terrestrial ecosystems. Visibility in most national forests is obscured some portion of the year by anthropogenic haze of fine pollutant particles. In addition, the Clean Air Act requires Forest Service operations and permitted operations such as prescribed burning, fossil fuels development and production, and mining to comply with National Ambient Air Quality Standards and protection of air quality related air quality values.

The Environmental Protection Agency establishes National Ambient Air Quality Standards as directed by the Clean Air Act, and the Montana Department of Environmental Quality manages these standards within the state of Montana. The Montana Department of Environmental Quality, along with select counties, monitor for air pollution, and provide reports summarizing air quality data. The National Ambient Air Quality Standards focus on six criteria pollutants including: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, and particulate matter –including both particulate matter 10 and particulate matter 2.5 as defined by the aerodynamic diameter of the particulate in microns.

Forest Service air quality policy directs coordination of national forest activities with state and federal air quality control efforts. This is done by managing and mitigating the sources of air pollution emitted by Forest Service activities, such as prescribed burning, the construction and use of roads, and the operation of facilities. Mandatory Class I federal areas have special protection afforded by amendments to the Clean Air Act and Wilderness Act. The Selway-Bitterroot, Bob Marshall, Scapegoat, and Rattlesnake Wilderness Areas are Class I federal areas. The Forest Service has the responsibility to protect the air quality related values in Class I areas as directed by the Wilderness Act and Clean Air Act.

### 2.9.3 Status and Trends

The air quality in and around the Lolo National Forest is generally good and the state of Montana forecasts improving air quality conditions across the state and improving visibility in wilderness areas. Air quality is compromised during winter months in communities where wood smoke causes health standard exceedances, and during fire season months when wildfires cause exceedances across broad portions of the state. Prescribed fires, agricultural burning, and agriculture dust can adversely impact air quality, although the pollutants do not generally reach unhealthy levels.

The Montana Department of Environmental Quality regulates open burning throughout the year while working with the Montana and Idaho Airshed Group to coordinate projects and identify potential air quality impacts from each prescribed burn. There are six airsheds on the Lolo National Forest (Table 30).

**Table 30—Acreage and proportions of the six airsheds that occur within the plan area**

| Airshed ID | Description | Acres | Percent Area |
|---|---|---|---|
| 2 | Thompson Fall-Plains | 1,188,376 | 36.8 |
| 3A | Missoula-Superior | 1,288,472 | 39.8 |
| 5 | Upper Rock Creek | 203,895 | 6.3 |
| 3B | Seely Lake | 469,401 | 14.5 |
| 6 | Upper Blackfoot | 74,239 | 2.3 |
| 4 | Lolo Peak | 9,229 | 0.3 |

The Lolo National Forest has an active prescribed burning program. There are two annual prescribed burn permits issued to the Forest: Montana Department of Environmental Quality and Missoula County Major Source Outdoor Burning Permits. The 2021 Biennial Monitoring Report reported that the Montana Department of Environmental Quality did not have any recorded days when smoke monitors exceeded air quality standards based on data collected by the Montana Department of Environmental Quality airshed monitors located in Thompson Falls, Frenchtown, Missoula, and Seeley Lake. From 2018-2020, the Lolo National Forest accomplished all prescribed burning in compliance with the Montanan Department of Environmental Quality and Missoula City-County Health Department annual permits and within the approval guidelines set forth in the 2010 Montana-Idaho Airshed Group. Trends show this being consistent back to the year 2016.

Over the last 10 years, Lolo National Forest proposed almost 134,000 acres of burning, but only about 47,000 acres were burned (about 35 percent) in order to comply with these guidelines. Newer smoke estimating technologies would help enable improvements in the breadth and precision of our understanding of how increasing smoke, and the resulting PM2.5 concentrations, affect a range of societal outcomes (Childs et al. 2022). This is especially true for wildfires where smoke from wildfires is a growing health risk across the country and understanding the spatial and temporal patterns of such exposure and its population health impacts requires separating smoke-driven pollutants from non-smoke pollutants and a long time series to quantify patterns and measure health impacts (Childs et al. 2022).

# 2.10 Carbon Stocks and Carbon Pools

## 2.10.1 Key Takeaways

- According to results of the Baseline Report (U.S. Department of Agriculture 2015a), carbon stocks in the Lolo National Forest increased approximately 9 percent from 1990 to 2013 from (124.8±9.2 teragrams of carbon (Tg C) to 135.6±12.6 Tg C).
- If the Lolo National Forest continues on its current trajectory, more stands will reach a slower growth stage in coming years and decades, potentially causing the rate carbon accumulates to decline and the Forest may eventually transition to a steady state in the future. The interacting and uncertain effects of climate and disturbance will likely be the primary drivers of carbon dynamics in the future.

## 2.10.2 Summary

Carbon assessments can help forest managers understand how much carbon is currently stored in forest ecosystems and harvested wood products and how the potential to reduce atmospheric greenhouse gases may be influenced by management activities and disturbance regimes. The U.S. Forest Service has developed forest carbon assessment whitepapers for each region and national forest. The Lolo National Forest carbon assessment does not include emissions from agency, contractor, or permittee business operations or public recreation uses. Only forest ecosystem carbon stocks and harvested wood product pools are included in this assessment, consistent with Environmental Protection Agency reporting categories and availability of data. Carbon emissions from internal, agency business operations are inventoried annually per Executive Order 13514 and reported to USDA.

Carbon stock is a term used here to describe the total pool of carbon in an area, including live and dead biomass, and above and below ground carbon. A carbon pool is 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. Carbon pools may include live and dead above ground carbon, soil carbon including coarse roots, and harvested wood products.

Forest management activities can be used to increase the amount of carbon that is sequestered in forests, as well as the amount of carbon stored in wood products. The amount of additional carbon that can be sequestered depends greatly upon the condition of the forest (e.g., forest type, age, health) and the forest management practice in question, making it important to take into account change to carbon stocks across the entire system to assess trade-offs between different pools. Forest management practices can reduce carbon losses from forests or increase carbon gains in forests and wood products, although many practices have the potential to do both.

Appendix 2 provides a detailed assessment of the amount of carbon stored on the Lolo National Forest and how disturbances, management, and environmental factors have influenced carbon storage overtime.

## 2.10.3 Status and Trends

Forest carbon stocks increased by about 9 percent between 1990 and 2013, and negative impacts on carbon stocks caused by disturbances and environmental conditions have been modest and exceeded by forest growth. According to satellite imagery, fire has been the most prevalent disturbance detected on the Forest since 1990. Additionally, timber harvests that occurred during this period have been relatively small and low intensity. Forest carbon losses associated with harvests have been small compared to the total amount of carbon stored in the Forest, resulting in a loss of about 0.6 percent of non-soil carbon from 1990 to 2011. These estimates represent an upper bound because they do not account for continued storage of harvested carbon in wood products or the effect of substitution. Carbon storage in harvested wood products sourced from national forests increased since the early 1900s. Unlike wildfires, which releases the carbon vertically to the atmosphere through biomass combustion, timber harvesting moves the carbon laterally from forest sections to wood products and creates a wood products carbon pool which can store the carbon for a long period and contribute to the mitigation of greenhouse effects (Zhao et al. 2022). A substantial amount of carbon is stored in wood products. Notably, differences in the type of wood product, its production, its use, and its disposal have substantial influences on the amount and duration of carbon storage making generalizations difficult. Recent declines in timber harvesting have slowed the rate of carbon accumulation in the product sector.

The biggest influence on current carbon dynamics on the Forest is the legacy of intensive timber harvesting and land clearing for agriculture during the 19th century, followed by a period of forest recovery and more sustainable forest management beginning in the early to mid-20th century, which continues to promote a carbon sink today (Birdsey et al. 2006). However, stands on the Forest are now mostly middle to older aged. The rate of carbon uptake and sequestration generally decline as forests age. Accordingly, projections from the Resources Planning Act assessment indicate a potential age-related decline in forest carbon stocks in the Northern Region (all land ownerships) beginning in the 2020s.

Climate and environmental factors, including elevated atmospheric carbon dioxide and nitrogen deposition, have also influenced carbon accumulation on the Forest. Recent warmer temperatures and precipitation variability may have stressed forests, causing climate to have a negative impact on carbon accumulation in the 2000s. Conversely, increased atmospheric carbon dioxide and nitrogen deposition may have enhanced growth rates and helped to counteract ecosystem carbon losses due to historical disturbances, aging, and climate.

The effects of future climate conditions are complex and remain uncertain. However, under changing climate and environmental conditions, forests of the Forest may be increasingly vulnerable to a variety of stressors. These potentially negative effects might be balanced somewhat by the positive effects of longer growing season, greater precipitation, and elevated atmospheric carbon dioxide concentrations. However, it is difficult to judge how these factors and their interactions will affect future carbon dynamics. Forested area will be maintained as forest in the foreseeable future, which will allow for a continuation of carbon uptake and storage over the long term. Across the broader region, land conversion for development on private ownerships is a concern (Wear et al. 2013) and this activity can cause substantial carbon losses (Tubiello et al. 2013, U.S. Department of Agriculture 2016). The Lolo National Forest will continue to have an important role in maintaining the carbon sink, regionally and nationally, for decades to come.

# Chapter 3: Assessment Findings: Socioeconomic Elements and Multiple Uses

This chapter presents the key assessment findings for social elements, economic considerations, and multiple uses. In each section, we present key takeaways, a summary that provides 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. In some cases, there are appendices that provide more detailed information.

## 3.1 Social and Economic Conditions

*Note: All tables and figures for this section are located in 3.1.7.*

### 3.1.1 Overview

The preamble of the 2012 planning rule for National Forest System land management planning recognizes that ecological, social, and economic systems are interdependent. One system is not a priority over the other. The planning rule requires the consideration of social, economic, and ecological factors in all phases of the planning process. The planning rule also recognizes that, although national forest management can influence social and economic conditions relevant to a plan area, it cannot ensure social and economic sustainability. This is because many factors are outside the control and authority of the responsible official. For that reason, the planning rule requires that plan components contribute to social and economic sustainability within Forest Service authority and the inherent capability of the plan area. The planning rule defines sustainability in the following ways (§ 219.19):

- ‘‘Ecological sustainability’’ refers to the capability of ecosystems to maintain ecological integrity.
- ‘‘Economic sustainability’’ refers to the capability of society to produce and consume or otherwise benefit from goods and services including contributions to jobs and market and nonmarket benefits.
- ‘‘Social sustainability’’ refers to the capability of society to support the network of relationships, traditions, culture, and activities that connect people to the land and to one another and support vibrant communities.

To address the issue of social and economic sustainability, the planning rule requires that an assessment be completed, wherein the responsible official shall identify and evaluate existing information relevant to the plan area for 15 identified items. Three of the items tied most closely to social and economic sustainability are number 6: social, cultural, and economic conditions and trends; number 7: benefits that people obtain from the National Forest System plan area (ecosystem services); and number 8: multiple uses and their contributions to local, regional, and national economies (§ 219.6(b)).

This section of the assessment presents the social, cultural, and economic contexts for the Lolo National Forest. The information provided is intended as a descriptive and comparative baseline about the counties in the area of influence and includes the latest readily available information. To provide the social and cultural contexts, information regarding social characteristics, local government, and county health is presented and several questions often used in social and economic assessment studies are considered:

- What are the structure and dynamics of the population?

- What is the pattern of land ownership?
- What are the characteristics of employment, income, and industry?

In addition to the three questions above, information is also provided on issues especially pertinent to natural resource management on the Forest, including:

- Federal land payments
- Montana's forest products industry
- Data on Forest Service programs, salary and non-salary expenditures, and employment
- The contribution of the Lolo NFs programs and expenditures to jobs and labor income.

A section addressing Environmental Justice (Council on Environmental Quality 1997) (Executive Order 12898 and Executive Order 14008) is also included. Data to develop the assessment is collected concurrently among the planning team of social, economic, and ecological specialists, and as ecological, social, and economic systems are interdependent, one system cannot be given primacy over another. Therefore, this information presented should be used in conjunction with other assessment content.

## Methods

*Scale and spatial extent.* The Lolo National Forest encompasses over 2 million acres now owned by the public and administered by the Forest Service under multiple use management to protect and obtain the greatest benefit among all forest resources; however, the Forest Service is not the first to steward these lands. The U.S. government gained these lands through a variety of treaties that ceded and forcibly turned over significant portions of lands stewarded primarily by Salish, Kalispel, Kalispel, Kootenai, and Nez Perce peoples. These Tribes, today the Confederated Salish and Kootenai Tribes and the Nez Perce Tribe, reserved rights to natural and cultural resources on ceded lands and thus are treaty rightsholders to the Lolo National Forest. The Forest is responsible for ensuring these treaty rights, known as "off reservation treaty rights" or "other reserved rights" (see section 3.4). Thus, throughout this chapter, both the terms rightsholders (Sovereign Tribal Nations with off-reservation treaty rights) and stakeholders (non-tribal members and organizations) are used.

*Existing information.* The 2012 Forest Planning Rule directs Forests to use the best available science and existing information in land management planning efforts. Indigenous Traditional Ecological Knowledge is to be considered as best available science and should also be considered existing information (Prabhakar and Mallory 2022). The Confederated Salish and Kootenai Tribes have the sovereign right to maintain the collection, ownership, and application of their Indigenous Traditional Ecological Knowledge and it will be discussed as a part of the ongoing government-to-government consultation process (Kukutai and Taylor 2016). Thus, this knowledge is not yet included in this section. Content will be updated accordingly as consultation continues.

Much of the information in this assessment was taken from the Economic Profile System maintained by Headwaters Economics (https://headwaterseconomics.org/apps/economic-profile-system/). This toolkit was developed in partnership with the Bureau of Land Management and the U.S. Forest Service. The Economic Profile System is a free software application that produces detailed socioeconomic reports of communities, counties, states, and regions, including custom aggregations and comparisons. The Economic Profile System uses published statistics from federal data sources, including, but not limited to, the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the Census Bureau and American Census. Other significant sources of information used for this report include the following:

- Publications on Montana's forest products industry by the University of Montana Bureau of Business and Economic Research,
- Data on Forest Service programs,
- Salary and non-salary expenditures, and employment from Forest Service corporate databases,
- IMPLAN data for the year 2019.

Many of the above data sources use primary data collected and provided by the US Census Bureau as it is one of the few nationally consistent datasets available. These data are collected in the decennial US Census and the American Community Survey. After each decennial census the US Census analyzes the accuracy of the data collected, and the American Community Survey does so on a rolling basis. Generally, US Census data products are found to be more accurate in more densely populated areas compared to more rural areas, primarily due to larger sample sizes in those more densely populated areas.

The Census report (Khubba et al. 2022) analyzing 2020 US Census data estimated a record high overall error rate with noteworthy undercounts for the following groups: Black or African American, American Indian or Alaska Native, Some Other Race, and Hispanic or Latino as well as renters and children, especially children ages 0 to 4. Overcounts were estimated for White, Non-Hispanic White Alone, and Asian individuals as well as homeowners. The American Community Survey has also historically undercounted young children, ages 0 to 4 and has been shown to be problematically inconsistent and inaccurate in more rural areas (Folch et al. 2016, Jurjevich 2019, Khubba et al. 2022). Most recently, challenges associated with the COVID-19 pandemic have also hampered data collection efforts negatively impacting data quality (Rothbaum et al. 2021). The sum of these challenges underscores multiple layers of uncertainty associated with these data products. Specifically, uncertainty of the American Community Survey data has been shown to lead to "inaccurate analysis and/or biased decision-making" (Wei et al. 2023). Thus, use and interpretation of these data should be cautious and conservative. These data can be used to screen for planning purposes, but it is not a replacement for other systematically collected data especially at the local level. Due to the around the underlying social data, diverse and flexible management guidance that supports opportunities for learning and improvement can help meet the goal of supporting social and economic sustainability.

## Socioeconomic Area of Influence

As indicated in the Land Management Planning Handbook (FSH 1909.12, Ch. 10, 13.2), the Responsible Official should identify and describe a primary area of influence to serve as the spatial scale to evaluate social, cultural, and economic conditions. The area of influence is where the management of the plan area substantially affects social, cultural, and economic conditions.

Biological and administrative designations (for example, watersheds or forest boundaries) do not necessarily correspond with other socially and economically meaningful units. Therefore, the appropriate scale for addressing the social and economic environment will differ from the scales used to address other resources and topics in the technical report. Social and economic data are available at a variety of scales from the national to the neighborhood scale (i.e., US Census tracks); however, data are not consistently available in ways that are compatible with forest planning needs, and some can be inaccurate having large margins of error, particularly in rural areas. Functional economic areas are the primary scale for the social and economic analysis. Typically, these areas are a group of counties.

It is critical to support the tribal treaty rights of sovereign tribal nations with rights to lands managed by the Lolo National Forest. Therefore, the social and economic area of influence includes related Tribal Nation Reservations and associated counties. In addition, the University of Montana's Bureau of Business and Economic Research was commissioned to complete a timber processing capacity and capability report (Pennick McIver et al. 2022) for the Lolo and Bitterroot National Forests, which was completed during fall 2021. The report identified a 15-county timber processing area. That set of counties was expanded on by bringing in the analysis completed by the Social Science and Economics branch of the Forest Service Office of Policy for the forest-level At-A-Glance reports. The social science and economics team followed methods to take other resource areas into account, with recreation playing a major role in selecting counties based on National Visitor Use Monitoring data. The Forest Service National Visitor Use Monitoring questionnaire collects expenditure information from Forest visitors that had overnight stays within 50 miles of the Forest. Table 31 and figure A1-10 show the set of counties included in the area of influence.

## 3.1.2 Population Structure and Dynamics

### Key Takeaways

- Human population structure (e.g., size, composition, density) and population dynamics (e.g., how the structure changes over time such as age distribution, in- and out-migration) are important components to understanding the relationship between forest management and the social environment.
- The 27-county area of influence was first home to a many American Indian Tribes, including the Salish, Kootenai, Coeur d'Alene, and Nez Perce Tribes. These Tribes were forcibly removed from their homelands and segregated to reservations. Today, American Indians live throughout the area of influence. The Flathead Indian Reservation is home to the Confederated Salish and Kootenai Tribes, and the Nez Perce Reservation is the home to the Nez Perce Tribe.
- From 1970 to 2021 the population in the socioeconomic area of influence increased by almost 40 percent. All counties increased in population, although growth rates varied widely. Exceptions, where the population decreased, were in Powell and Mineral counties in Montana and in Clearwater County in Idaho. Most of this area is categorized as either nonmetro or rural rather than urban.
- Federal forest management has shifted into the era of "social forestry" that centers around collaborative decision making and partnerships with non-federal entities.
- Median ages for the Montana portion of the area of influence ranged from 36 to about 56. Median ages for the Idaho portion ranged from approximately 30 to 53. About 20 percent of the population in the area of influence were ages 0-18.
- Most of the land in the 27-county area of influence is publicly managed, with over half of the total acres under forest service management. Since 1970, employment in the area of influence has risen by 162 percent overall, though individual counties have experienced anywhere from a 29 percent decline to a nearly 700 percent increase during that time.
- The overall unemployment rate was 3.9 percent in the area of influence in 2021. The area of influence is experiencing lower unemployment than the nation, but slightly higher than the statewide averages in Montana and Idaho.
- Personal income grew by about 288 percent in the area of influence between 1970 and 2021, compared to 256 percent growth in the United States. Every county in the area of influence had positive real personal income growth during this period.

### Summary

This section focuses on human population structure and dynamics within the 27-county area of influence for the Lolo National Forest. Human population is one of many important considerations in managing natural resources. Human population structure (e.g., size, composition, density) and population dynamics (e.g., how the structure changes over time such as age distribution, in- and out-migration) are important components to understanding the relationship between forest management and the social environment.

All land in the contiguous United States are ancestral lands of Native American Indians. Public lands managed by the Forest Service were forcibly taken from Tribes that had managed the land since time immemorial. This and other systematic actions to eliminate Native American Indians have resulted in tribes being marginalized both historically and currently. While this has resulted in denial and inequity in access to benefits, disproportionate harm, and unfair treatment, it is important to also recognize the strength of Native American Indian peoples and communities.

The 27-county area of influence was first home to a many American Indian Tribes, including the Salish, Kootenai, Coeur d'Alene, and Nez Perce Tribes. These Tribes were forcibly removed from their homelands and segregated to reservations. Today, American Indians live throughout the area of influence. The Flathead Indian Reservation is home to the Confederated Salish and Kootenai Tribes, and the Nez Perce Reservation is the home to the Nez Perce Tribe. Among the counties included in the area of influence, Lake County in Montana and Nez Perce County in Idaho have the highest estimated Native American Populations. Unfortunately, estimates provided for many of the other counties by the US Census, American Community Survey 5-year estimates are largely unreliable, including the specific tribal membership. Despite the challenges in pinpointing these details about the number of tribal members in the area of influence, the Confederated Salish and Kootenai Tribes and the Nez Perce Tribe both have reserved rights to natural and cultural resources on their ceded lands and thus are treaty rightsholders to the Lolo National Forest. The Lolo National Forest is responsible for ensuring these treaty rights, known as "off reservation treaty rights" or "other reserved rights" (for more information, see section 3.3). The Forest Service has a responsibility to maintain these tribal treaty rights.

Today, an estimated 932,644 people reside in the area 27-county area (Wei et al. 2023). Cumulatively, the population of the area of influence has been growing for decades. From 1970 to 2021 the population in these areas of Montana and Idaho cumulatively increased by almost 40 percent. By county, almost all counties increased in population, although growth rates varied widely. Noteworthy exceptions, where the population decreased, were in Powell and Mineral counties in Montana and in Clearwater County in Idaho (Table 32 and Table 33).[2]

We also looked at urbanization, by county, at the three most recent time periods available from U.S. Department of Agriculture's Economic Research Service: 1993, 2003 and 2013. The Economic Research Service classifies all counties along a rural-urban continuum, which describes the degree of urbanization in a county. The 2013 Rural-Urban Continuum Codes form a classification scheme that distinguishes metropolitan counties by the population size of their metro area, and nonmetropolitan counties by degree of urbanization and adjacency to a metro area. Additionally, we computed the median change in urbanization for each county in these time periods, among counties in both Idaho and Montana and across the entire area of influence (Table 31 and figure A1-10). Most of this area is currently categorized as either nonmetro or rural. Across the 27-county area of influence from 1993 to 2013 the area became slightly more urban. Looking just at the counties in Montana there was no change in urbanization. Counties in Idaho, however, became slightly more urban.

It is difficult to generalize what population change of this magnitude means for managing public lands, including Forest Service-managed lands, especially as these public lands and the associated amenities may have been a driving factor for such change (Garber-Yonts 2004). Each landscape has a unique human population and biophysical environment. The large expanse of this area of influence coupled with the low availability of data beyond demographics increases the challenges in generalizing the effects of population increases. Some highlight that population increases tied to increasing use of public lands results in more conflicts among individuals and groups, such as different individuals on public lands (e.g., recreational hunters, tribal subsistence hunters, bikers) and among different forests interest groups (e.g., sovereign tribal nations, timber associations, watershed groups) as well as other challenges such as

[2] ACS 5-year data fails some of the quality standard requirements due challenges administering the survey in 2020 due to COVID-19. For more information, see [Increased Margins of Error in the 5-Year Estimates Containing Data Collected in 2020](#).

increased crowds, litter, and noise (Payne et al. 1992, Bolitzer and Netusil 2000). Many of these conflicts are distributive in nature. That is, they involve questions around who is going to get what, when, and how much. While some conflicts and associated problems can be addressed using biophysical Western science, from ecology to economics to hydrology, many conflicts over public lands and planning their management cannot be "solved" by the best available science. Instead, these conflicts involve individual and group priorities, values, and lived experiences that are not often addressed by biophysical Western science (Rittel and Webber 1973, Head 2008, Nie 2008). More recently scholars have documented the influence of social media on individual's interactions with public lands further complicating the landscape of planning public lands management (Chaudhury et al. 2021).

While challenging, complex conflicts around public lands may be increasing, opportunities for collaboration among these entities also increases. Federal forest management has shifted into the era of "social forestry" that centers around collaborative decision making and completing activities by forging partnerships with non-federal entities (Abrams 2019). The increased population and their shared interest in public lands may serve to benefit the Forest Service in building fruitful partnerships once the ecology of trust is sufficiently cultivated (Stern and Baird 2015, Coleman and Stern 2018). This, however, is primarily in reference to stakeholders as rightsholders, tribal members and associated sovereign governments, are entitled to government-to-government consultation and cooperating agency status during forest and project planning.

## Status and Trends

*Age.* Median ages for the Montana portion of the area of influence ranged from 36 in Missoula County to about 56 years old in Granite County (Table 37 and Table 38). Median ages for the Idaho portion of the area of influence ranged from approximately 30 in Latah County to 53 in Lemhi County (Table 39 and Table 40). The 2012 Planning rule requires outreach and engagement of youth in the forest plan revision process. About 20 percent of the population in the area of influence were ages 0-18. Engagement efforts must be diverse enough to meaningfully engage this youth demographic and be designed with this age cohort in mind.

*Land ownership.* Decisions made by public land managers may influence the local economy, particularly if public lands represent a large portion of the land base. Agency management actions that affect water quality, access to recreation, scenery (as well as other quality-of-life amenities), and the extent and type of resource extraction are particularly important in areas where much of the land is managed by public agencies.

As shown in Table 41 and Table 42, most of the land in the 27-county area of influence is publicly managed, with over half of the total acres under forest service management. The percentages vary widely from one county to another, with over 80 percent of Mineral County, Montana under Forest Service management, and over 90 percent of Lemhi County, Idaho. Other counties in the area of influence such as Lake County, MT and Latah County, ID have less than 20 percent of acres under Forest Service management. Despite these variations between counties, Forest Service management activities clearly play a major role in the communities within the area of influence, with particular importance in the counties with more Forest Service lands. Overall, the area of influence has more than double the proportion of acres under federal management than the nation—59 percent versus 28 percent, respectively.

*Economy.* Employment, unemployment, and income are important considerations for understanding local economic conditions and therefore how Federal land management impacts local economies. The following highlights economic trends in the 27-county area of influence:

- Since 1970, employment in the 27-county area of influence has risen by 162 percent overall (Table 43 and Table 44), though individual counties have experienced anywhere from a 29 percent decline (Deer Lodge County, MT) in employment to a nearly 700 percent increase (Kootenai County, ID) during that time. This compares to a 120 percent increase in employment in the United States over the same period. Employment in the area of influence has increased at a faster rate than employment in the nation.
- Unemployment is a commonly watched measure that helps people understand local and national economic conditions. The unemployment rate is the percentage of the labor force that is unemployed. Though it may seem full employment is often the goal, structural unemployment (mismatch between labor skills and available jobs within a region) and frictional unemployment (people moving or transitioning employment) cause rates to remain above zero even in times of economic prosperity. The existence of structural and frictional unemployment implies that there is an inherent "natural" rate of unemployment. The natural rate of unemployment is believed to fall somewhere between 5 and 6 percent and allows workers to move between jobs and industries without signaling broad economic distress. Since 1976, the overall unemployment rate has fluctuated between a high of nearly 12 percent in the early 1980s and 3.7 percent in 2007 (Figure 30). Unemployment varies between counties. In 2021, Shoshone and Clearwater counties had the highest rates of unemployment of the Idaho counties in the area of influence, and Lincoln and Mineral Counties had the highest rates in Montana. The lowest 2021 unemployment rates in the analysis areas were in Powell and Beaverhead Counties in Montana and Latah and Kootenai Counties in Idaho had the lowest rates (Figure 31). The overall unemployment rate was 3.9 percent in the area of influence in 2021, compared to 5.3 percent in the United States, 3.4 percent in Montana, and 3.6 percent in Idaho. Therefore, the area of influence for the Lolo National Forest is experiencing lower unemployment than the nation, but slightly higher than the statewide averages in Montana and Idaho.
- After adjusting for inflation, (real) personal income in the grew by about 288 percent in the area of influence between 1970 and 2021, compared to 256 percent growth in the United States (Table 43 and Table 44). Every county in the area of influence had positive real personal income growth during this period, though this growth ranged from about 25 percent in Shoshone County, Idaho, to more than ten-fold personal income growth in Kootenai County, Idaho.

## 3.1.3 Contributions to Local Economies

### Key Takeaways

- The Lolo National Forest makes payments to state and local governments through the Secure Rural Schools Act or 25-Percent Payments, the Bankhead-Jones Farm tenant Act, and Federal Payments In-Lieu of Taxes.
- There are approximately 552,000 jobs and $25.1 billion in labor income in the 27-county region. The five largest sectors, in terms of employment, in the regional economy are: (1) government, (2) health and social services, (3) retail trade, (4) accommodation and food services and (5) construction. The Lolo National Forest contributes to the income and employment in the region. The extraction and consumption of forest products (for example, timber and forage), recreation visitors, and forest expenditures (for example, equipment and salaries) all contribute to the economic activity in the region. The number of jobs attributable to Forest Service program areas is approximately 1,889 jobs on an average annual basis. Timber, recreation visitor use, and agency operations contribute the most to employment in the regional economy.
- Jobs associated with timber pay more, on average, than jobs associated with recreation, while payments to states and counties support the highest average annual incomes.
- The Forest supports jobs and labor income in several non-timber sectors, particularly accommodations and food services, multiple levels of government employment, manufacturing, agriculture, and retail trade. This contribution is small relative to the entire local economy in the area of influence—0.3 percent of jobs and labor income. Jobs and income are important to communities, but there is a range of additional benefits from the Forest as well.

### Summary

Contributions to the local economic include several elements, including payments to state and local governments and other economic contributions such as employment. The Lolo National Forest makes payments to state and local governments through three programs:

- The Secure Rural Schools Act (SRS) or 25-Percent Payments.
- The Bankhead-Jones Farm tenant Act.
- Federal Payments In-Lieu of Taxes (PILT).

Economic contribution analysis estimates the role of Forest resources, uses, and management activities on employment and income in the communities that surround the Forest. The Forest Service has historically published Jobs and Income "At A Glance" reports which detail the contributions forest resources make to local economies. These reports reflect existing conditions of benefits provided at the time of the report generation and may not reflect current or average conditions. The results reported below are based an analysis completed specifically for the assessment, using 2019 IMPLAN data, a Forest Service national repository including Lolo National Forest resource data, and local economic conditions.

Lolo National Forest lands are located within seven counties, all within Montana: Flathead, Granite, Lewis and Clark, Mineral, Missoula, Sanders, and Powell. The economic contribution analysis, which estimates employment and labor income attributable to the Lolo National Forest, uses a larger economic region that encompasses 25 counties[3]. This was selected to account for direct Forest Service expenditures across resources and the additional considerations mentioned in the section 3.1.1, above. Other objectives, for example project-level analysis for National Environmental Policy Act (NEPA) documents, may focus on a different geography which will produce different results.

## Status and Trends

*Payments made to states and local governments* are summarized as follows:

- The Secure Rural Schools Act (SRS) or 25-Percent Payments: Since 1908 the Secretary of the Treasury makes an annual payment to the States based on national forest receipts. The States distribute the payment among counties in which national forests are situated for the benefit of public schools and roads. The distribution is in proportion to the acreage of national forest in the county. Beginning in 1908 the payment was 25-percent of the moneys received annually. Since 2008 the payments are based on 25-percent of the 7-year rolling average annual receipts. These payments are commonly called 25-percent payments. However, in 2000, the Secure Rural Schools and Community Self-determination Act was passed which offered a guaranteed source of payments that was not tied to annual commercial revenue on national forests. Under the Secure Rural Schools Act, an eligible county elects to receive a share of the Secure Rural Schools Act State payment or a share of the 25-percent payment to the state.
- The Bankhead-Jones Farm tenant Act: The Forest Service also processes payments to counties from the sale of resources under the provisions of Title III of the Bankhead-Jones Farm Tenant Act. These receipts primarily consist of mineral receipts collected by the Office of Natural Resource Revenue (ONRR), and grazing receipts collected by the Forest Service. After each calendar year, the Forest Service is required to pay to the county in which land is held by the Forest Service, 25 percent of receipts received from the use of grasslands and land utilization projects during the previous calendar year.
- Federal Payments In-Lieu of Taxes (PILT): The PILT program was created in 1976 and provides payments to counties and other local governments to offset losses in tax revenues due to the presence of substantial acreage of federal land in their jurisdictions. PILT payments do not need to be reported. While local governments do receive these payments, they are largely outside the control of national forest management. Generally, under PILT larger payments reflect larger acres under Federal management.

*Forest-specific economic contributions are summarized as follows:*

- *Employment by program area.* There are approximately 552,000 jobs and $25.1 billion in labor income in the 27-county region (Table 46). The five largest sectors, in terms of employment, in the regional economy are: (1) government, (2) health and social services, (3) retail trade, (4) accommodation and food services and (5) construction. The Lolo National Forest contributes to the income and employment in the region. The extraction and consumption of forest products (for example, timber and forage), recreation visitors, and forest expenditures (for example, equipment and salaries) all contribute to the economic activity in the region. Table 45 shows the number of jobs attributable to various Forest Service program areas with a combined approximate 1,889 jobs on an average annual basis. Timber, recreation visitor use, and agency operations (FS expenditures)

[3] This economic contribution analysis was conducted with an initial set of 25 counties. The area of influence was subsequently augmented to include 27 counties shortly before release the Draft Assessment. The economic contribution analysis will be conducted again between the draft and final version of the assessment, and will include all 27 counties.

contribute the most to employment in the regional economy. The agency operations category captures both salary and non-salary expenditures. Therefore, this category includes Lolo National Forest employees, forest contractors and suppliers, as well as employees of businesses where forest employees spend their household income. The jobs estimates, presented in the table, offer an incomplete picture of the Lolo National Forest's contributions to the 25-county economy. Not all jobs are equivalent. Labor income estimates help to clarify the role of forest management in supporting livelihoods in communities near the Lolo National Forest. Looking at average labor income per job reveals that jobs associated with timber pay more, on average, than jobs associated with recreation, while payments to states and counties support the highest average annual incomes. This finding is consistent with recreation related jobs often being part-time (seasonal) or entry-level positions.

- *Economic importance of the Lolo National Forest in the area of influence.* Table 46 displays the contribution of activities in the area of influence to regional employment and labor income by sector. These sectors do not align with the program area categories in Table 45 because the jobs and labor income supported by national forests are spread across many local economic sectors. Sectors that have the highest employment may not generate the highest labor income and vice versa. The Lolo National Forest supports jobs and labor income in several non-timber sectors, particularly accommodations and food services, multiple levels of government employment, manufacturing, agriculture, and retail trade. This contribution is small relative to the entire local economy in the area of influence—0.3 percent of jobs and labor income. Jobs and income are important to communities, but there is a range of additional benefits from the Lolo National Forest as well. Some of those key benefits are discussed in the section 3.1.3, below.

## 3.1.4 Key Ecosystem Services and Benefits to People

### Key Takeaways

- Ecosystem services are benefits (forest goods and services, and benefits to people) that people obtain from ecosystems.
- The Lolo National Forest supports an abundance of such benefits that contribute to human well-being including but not limited to clean water, clean air, jobs and income, traditional foods and medicines, recreation, climate change mitigation, and commercial forest products.

### Summary

Ecosystem services are benefits (forest goods and services, benefits to people) that people obtain from ecosystems. This term stems from economics as a way to bridge economics and ecology and to connect ecosystems to human well-being. This is a human-centered view of forest benefits and the goods and services produced by them. Perhaps much of the desire to interact with forests is underpinned by their ability to more generally contribute to well-being and improve certain health conditions (Beckley 1995, Kusel 2001, Oh et al. 2017). The 2012 planning rule uses the same ecosystem service categories as those in the Millennium Ecosystem Assessment (2005), a scientific appraisal of the condition and trends of the world's ecosystems and the services they provide.

1. Supporting Services, such as pollination, seed dispersal, soil formation, and nutrient cycling.
2. Provisioning Services, such as clean air and fresh water, energy, fuel, forage, fiber and minerals.
3. Regulating Services, such as long-term storage of carbon; climate regulation; water filtration, purification and storage; soil stabilization; flood control; and disease regulation.
4. Cultural Services, such as spiritual and cultural heritage values, educational, aesthetic, recreational experiences, and tourism opportunities.

The Lolo National Forest supports an abundance of such benefits that contribute to human well-being including but not limited to clean water, clean air, jobs and income, traditional foods and medicines, recreation, climate change mitigation, and commercial forest products. The Forest area is a public land setting for a broad suite of uses that initiate and strengthen connections to the land. It is one of the main stages for the Forest Service to carry out its motto of managing the land and serving the people. Importantly, the Forest and its management contribute to the well-being of both rightsholders (Sovereign Tribal Nations with off reservation treaty rights) and stakeholders (non-tribal members and organizations) at a variety of scales—local, regional, national, and global.

### Status and Trends

*Clean water.* Many communities depend on ground and surface water from the Forest for both drinking water and agricultural irrigation. Clean water is a key benefit that supports income and jobs through agriculture and protects community health by providing safe drinking water. Watershed restoration is a top priority for many stakeholders. As populations in the area of influence continue to grow, demand for clean water will also increase.

*Clean air.* One reason people visit public lands, especially national forests and national parks, is for the scenic views and to breathe fresh air. Good air quality promotes tourism and recreation which contributes to the economy of communities around the Lolo National Forest. Additionally, good air quality promotes and nurtures human health. Clean air is also important for maintaining healthy plants, animals, soils, and water bodies, which are sources of drinking water. Trees block the direct heat from the sun and reduce the speed of the winds that would otherwise suck the moisture from our mountain landscapes. Because leaves transpire large amounts of moisture, trees have a cooling effect on the surrounding environment—like air conditioning. By cooling and cleansing the atmosphere, trees help to make air safer for breathing by plants, animals, and humans and has positive benefits on habitat.

*Jobs and income.* As displayed in Table 45 and Table 46, the Lolo National Forest is an important contributor of jobs and income within Forest's area of influence. These jobs and income support social and economic sustainability in the local economy. For more information on the jobs and income supported by the area of influence, see section 3.1.3.

*Traditional foods and medicines.* Foraging for plants, mushrooms, and berries are traditional subsistence and recreational activities on the Forest. These traditional food sources are a key ecosystem service. More information on traditional foods and medicines can be found in section 3.4.

*Recreation.* A wide variety of recreation settings, opportunities, access, and special uses exist on the Forest. Recreation activities enhance the well-being and health of those who engage in them. The Forest provides many different types of recreation experiences which provide opportunities to connect with nature, find spiritual inspiration, engage in physically challenging pursuits, and experience solitude in natural settings. Recreation on the Lolo National Forest, as is the case on many national forests, is an important component of the contribution to social and economic sustainability in the area of influence surrounding the Forest. Lolo National Forest recreation contributes an estimated 599 jobs, and $17.9 million in labor income, annually. Recreation is a key benefit that enhances wellbeing and community health, in addition to providing jobs and income. The breath of recreation opportunities and the status and trends in recreation on the Lolo National Forest is covered in section 3.5.

*Climate change mitigation.* Carbon sequestration is a key benefit that protects public health by mitigating the amount of carbon dioxide released into the atmosphere. Both national and international citizens and businesses have a keen interest in reducing the amount of carbon dioxide released into the atmosphere. The Paris Climate Change Accord compelled nations around the globe to reduce carbon dioxide emissions and increase carbon storage and sequestration, with a particular focus on reducing emissions from deforestation (Krupp 2015). There is strong support, both at home and abroad, for implementing policies that reduce harmful carbon dioxide emissions (World Bank 2009). Communities and residential areas surrounding the Lolo National Forest are growing. Such trends in land use limit the ability of surrounding landscapes to store as much carbon as they have in the past. Thus, the role public lands play in carbon storage and sequestration will be increasingly important as residential land use trends continue. Long-lived durable wood products manufactured from Lolo National Forest timber also play an important role in carbon storage and climate change mitigation (Anderson et al. 2013).

*Timber products.* Timber from the Lolo National Forest supports employment opportunities in harvesting and processing timber. Income earned from timber-related jobs stimulates the area's economy as it circulates through local businesses and households. Commercial and noncommercial timber harvest may enhance the quality of life and safety of the public by improving watershed condition, improving wildlife habitat, and/or reducing wildfire risk through reduced fuel loads. The Lolo National Forest timber program, which administers the sale of timber and other wood material, currently contributes an estimated 806 jobs, and $35.9 million in labor income, annually. Fluctuating market conditions present risks regarding the financial feasibility of managing forests and providing timber for forest products. The Forest relies on sufficient timber processing capacity at mills in reasonable proximity to the Forest to make timber management financially efficient and defray the costs of restoration projects (Pennick

McIver et al. 2022). As the population in the area of influence continues to grow, the demand for wood products is also expected to grow, and maintaining milling infrastructure and capacity will help satisfy that demand.

## 3.1.5 Environmental Justice

### Key Takeaways

- All federal actions consider environmental justice in the local region. Environmental justice has three components: fair treatment and meaningful involvement; avoid disproportionate harm and adverse outcomes to Indian tribes and Alaska natives, low-income and minority populations; and avoid denial and inequity in access to benefits of programs, policies, and activities.
- Internet access is important to communities' ability to understand their exposure to harms related to adverse outcomes, access, and distribution of benefits and their ability to be meaningfully involved in planning processes. About 13 percent of Idaho residents of counties in the area of influence had 80-100 percent access to broadband. In Montana, estimates were slightly better at 25 percent. This provides important context for the design of effective public outreach methods.

### Summary

It is required that all federal actions consider environmental justice in the local region. Looking across Administrative Executive orders 12898, 13985, and 14008, and the Council on Environmental Quality's NEPA guidance for Environmental Justice (1997), environmental justice has three components:

1. Fair treatment and meaningful involvement;
2. Avoid disproportionate harm and adverse outcomes to Indian tribes and Alaska natives, low-income and minority populations; and
3. Avoid denial and inequity in access to benefits of programs, policies, and activities.

The Council on Environmental Quality (CEQ) (1997) provides the following definitions to guide compliance of Environmental Justice requirements:

- "Minority population: Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis..."
- "Low-income population: Low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect."

The 2012 Planning Rule specifies the need to collaborate and conduct outreach to low-income and minority populations, as well as to federally recognized tribal and Alaska Native groups and corporations. Collaboration and outreach begin early in the planning process, including the planning assessment, to help ensure equal opportunities for participation in the planning process. Collaboration and outreach to environmental justice populations are meant to provide such groups an opportunity to provide input and information that may be useful for assessing current ecological, social, cultural, and economic conditions and trends on the forest; and to comment on the finished planning assessments.

## Status and Trends

Given the reliance of the above criteria on U.S. Census data that as previously mentioned can lack accuracy on tribal reservation lands and the rural U.S., consideration of other metrics is advisable. Recent scholarship points to the importance of internet access, specifically high-speed broadband, in communities' ability to understand their exposure to harms related to adverse outcomes, access and distribution of benefits as well as their ability to be meaningfully involved in planning processes (Fusi et al.). While thresholds for broadband access related to environmental justice have not been established, data reflecting internet access in the area of influence is included in this section to inform participation in the planning process and project planning (Table 47, Table 48, Table 49, and Table 50).

Data to identify environmental justice populations according to the Council of Environmental Quality for the area of influence is primarily deemed unreliable or labeled as “low reliability”. Given this data inaccuracy, it is difficult to use those metrics to pinpoint environmental justice populations. Unfortunately, there is little other formal Agency guidance on how to select environmental justice populations. Looking at broadband access data from 2017, the most recent fine-scaled data available, only about 13% of Idaho residents of counties in the area of influence had 80-100% access to broadband. In Montana, estimates were slightly better at 25 percent (Table 51). Thus, there may be many residents in the area of influence that do not have access to highspeed internet and outreach efforts should include some engagement options that do not require a highspeed internet connection.

## 3.1.6 Community Resilience

### Key Takeaways

- In this planning context, community refers to a specific geographic location in the area of influence. Community capacity is one way to better understand a given communities resilience.
- In Idaho, Kootenai, Latah, and Nez Perce Counties were calculated to have the highest rural capacity scores and Lewis County the lowest. In Montana, Missoula, Lewis and Clark, and Flathead counties had the highest capacity scores, and Mineral and Powell Counties had the lowest. The lowest community capacity scores for both Montana and Idaho were all similar.

### Summary

In social science, the term community can refer to many things. A community can be a group of individuals with shared traits with no regard for geographic location (e.g., a community of practice). Community can also be seen as an output or the result of people and organizations interacting over time. In this case, however, community refers to a specific geographic location within the area of influence. Most importantly, it is important to note that communities are not homogenous, but instead can vary much like ecological communities vary. Resilience is the capacity to absorb changes without resulting in substantial changes (Walker et al. 2004). Like ideas about community, how to define and, relatedly, measure community resilience is debated. Regardless, community capacity is one way to better understand a given communities resilience.

### Status and Trends

To better understand the resilience of communities, or counties, in the area of influence, we used the Rural Capacity Mapping Tool from Headwaters Economics. This tool calculates an index score, from low (0) to high (100), based on several metrics including those related to local government, education, engagement, and socioeconomics. Thus, the assumption is that higher capacity scores correspond to higher community resilience. In Idaho, Kootenai, Latah, and Nez Perce Counties were calculated to have the highest rural capacity scores and Lewis County the lowest (see Table 52). In Montana, Missoula, Lewis and Clark, and Flathead counties had the highest capacity scores, and Mineral and Powell Counties had the lowest. The lowest community capacity scores for both Montana and Idaho were all similar—between 65 and 69.

## 3.1.7 Tables and Figures for Social and Economic Conditions

**Table 31—Counties in the socioeconomic area of influence**

| Counties in Montana | Counties in Idaho |
|---|---|
| Beaverhead County | Benewah County |
| Cascade County | Bonner County |
| Deer Lodge County | Boundary County |
| Flathead County | Clearwater County |
| Granite County | Idaho County |
| Jefferson County | Kootenai County |
| Lake County | Latah County |
| Lewis and Clark County | Lemhi County |
| Lincoln County | Lewis County |
| Mineral County | Nez Perce County |
| Missoula County | Shoshone County |
| Powell County | |
| Ravalli County | |
| Sanders County | |
| Silver Bow County | |
| Teton County | |

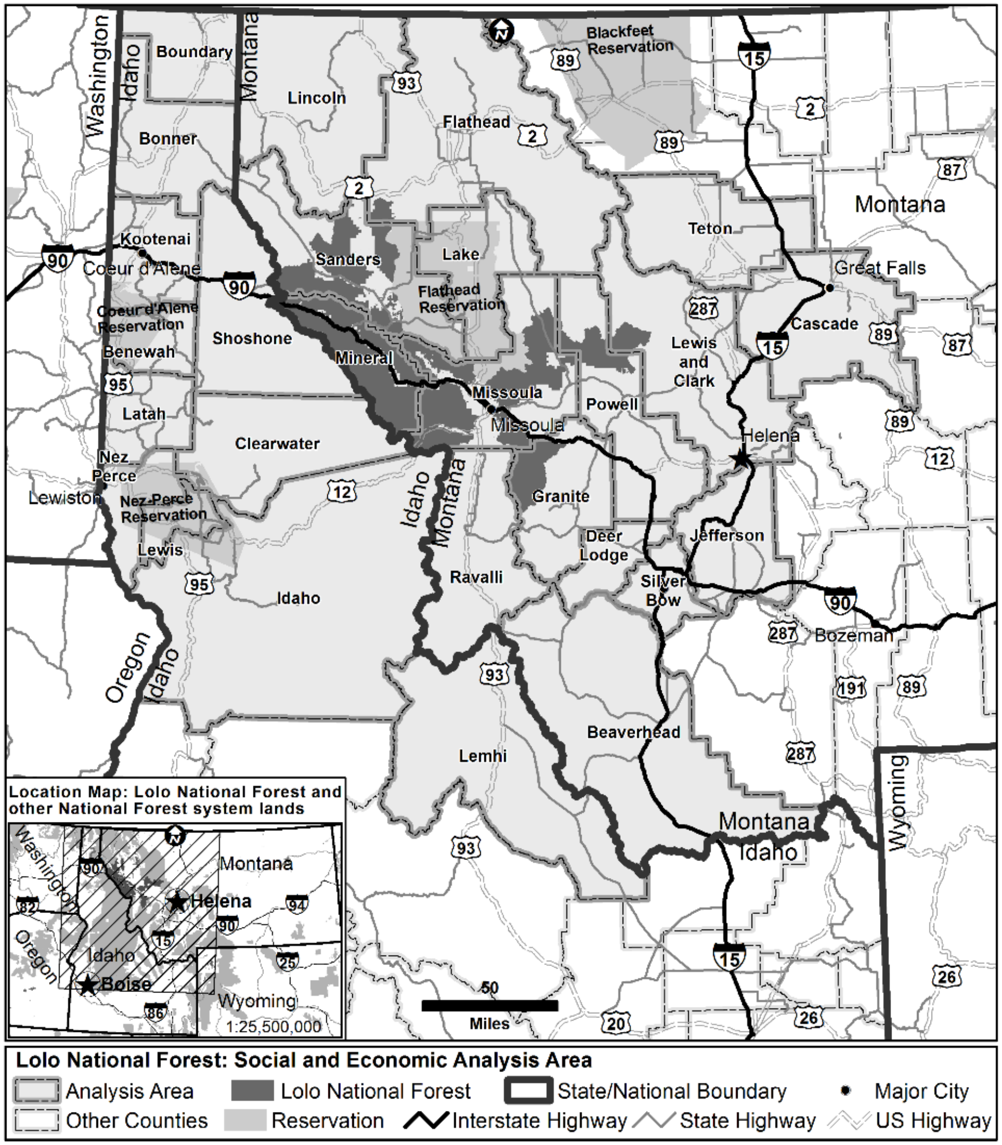


**Figure 29—Socioeconomic area of influence map**

**Table 32—2021 population and population change 2010-2021 of area of influence (Idaho)**

| | Lewis | Idaho | Boundary | Clearwater | Latah | Bonner | Shoshone | Lemhi | Kootenai | Benewah | Nez Perce | Combined Counties | Idaho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population (2021*) | 3,613 | 16,494 | 11,966 | 8,719 | 39,464 | 46,481 | 13,124 | 7,948 | 168,317 | 9,509 | 41,820 | 367,455 | 1,811,617 |
| Population (2010*) | 3,761 | 15,947 | 10,792 | 8,766 | 36,645 | 40,711 | 12,917 | 7,861 | 134,851 | 9,302 | 38,886 | 320,439 | 1,526,797 |
| Population Change (2010*-2021*) | -148 | 547 | 1,174 | -47 | 2,819 | 5,770 | 207 | 87 | 33,466 | 207 | 2,934 | 47,016 | 284,820 |
| Population Pct. Change (2010*-2021*) | -3.9% | 3.4% | 10.9% | -0.5% | 7.7% | 14.2% | 1.6% | 1.1% | 24.8% | 2.2% | 7.5% | 14.7% | 18.7% |

Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 33—2021 population and population change 2010-2021 of area of influence (Montana)**

| | Jefferson | Lincoln | Silver Bow | Teton | Missoula | Granite | Lake | Sanders | Flathead | Mineral | Powell | Ravalli | Lewis and Clark | Beaverhead | Deer Lodge | Combined Counties | Montana |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population (2021*) | 12,057 | 19,674 | 35,017 | 6,173 | 117,379 | 3,333 | 31,030 | 12,298 | 103,400 | 794 | 6,955 | 43,790 | 70,340 | 9,391 | 9,380 | 565,189 | 1,077,978 |
| Population (2010*) | 11,166 | 19,507 | 33,797 | 6,105 | 107,288 | 3,044 | 28,493 | 11,366 | 89,215 | 1,020 | 7,077 | 40,013 | 61,643 | 9,132 | 9,270 | 518,698 | 973,739 |
| Population Change (2010*-2021*) | 891 | 167 | 1,220 | 68 | 10,091 | 289 | 2,537 | 932 | 14,185 | -226 | -122 | 3,777 | 8,697 | 259 | 110 | 46,491 | 104,239 |
| Population Pct. Change (2010*-2021*) | 8.0 | 0.9 | 3.6 | 1.1 | 9.4 | 9.5 | 8.9 | 8.2 | 15.9 | -22.2 | -1.7 | 9.4 | 14.1 | 2.8 | 1.2 | 9.0 | 10.7 |

Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 34—Idaho Native American Indian demographics in the area of influence**

| | Lewis | Idaho | Boundary | Clearwater | Latah | Bonner | Shoshone | Lemhi | Kootenai | Benewah | Nez Perce | Combined Counties | Idaho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Population, 2021* | 3,613 | 16,494 | 11,966 | 8,719 | 39,464 | 46,481 | 13,124 | 7,948 | 168,317 | 9,509 | 41,820 | 367,455 | 1,811,617 |
| Total Native American | 211 | 561 | 171 | 147 | 376 | 352 | 253 | 75 | 2,062 | 820 | 2,267 | 7,295 | 22,799 |
| Percent Native American in ID area of influence | 0.06 | 0.15 | 0.05 | 0.04 | 0.10 | 0.10 | 0.07 | 0.02 | 0.56 | 0.22 | 0.62 | 1.99 | n/a |
| American Indian Tribes; Specified | 146 | 344 | 160 | 90 | 226 | 260 | 217 | 75 | 1,745 | 652 | 1,987 | 5,902 | 17,767 |
| *Apache* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 6 | 0 | 0 | 32 | 303 |
| *Arapaho* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| *Blackfeet* | 0 | 0 | 3 | 1 | 0 | 13 | 0 | 0 | 76 | 4 | 0 | 97 | 246 |
| *Cherokee* | 17 | 2 | 0 | 22 | 28 | 32 | 35 | 0 | 149 | 15 | 71 | 371 | 1,287 |
| *Cheyenne* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 9 | 78 |
| *Chickasaw* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chippewa* | 0 | 6 | 1 | 6 | 1 | 72 | 32 | 0 | 1 | 0 | 33 | 152 | 513 |
| *Choctaw* | 9 | 14 | 0 | 4 | 0 | 20 | 0 | 0 | 49 | 5 | 30 | 131 | 381 |
| *Colville* | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 147 | 57 | 59 | 266 | 340 |
| *Comanche* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 3 | 15 | 21 |
| *Cree* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Creek* | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 83 |
| *Crow* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 27 |
| *Hopi* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 11 | 49 |
| *Iroquois* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 102 | 0 | 41 | 143 | 239 |
| *Kiowa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 7 |
| *Lumbee* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Navajo* | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 46 | 0 | 7 | 55 | 990 |
| *Osage* | 0 | 83 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 83 | 83 |
| *Paiute* | 0 | 6 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 41 | 88 |
| *Pima* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Lewis | Idaho | Boundary | Clearwater | Latah | Bonner | Shoshone | Lemhi | Kootenai | Benewah | Nez Perce | Combined Counties | Idaho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Potawatomi* | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 43 | 1 | 0 | 51 | 144 |
| *Pueblo* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 138 |
| *Puget Sound Salish* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 22 | 52 | 95 |
| *Seminole* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 |
| *Shoshone* | 0 | 0 | 5 | 0 | 28 | 0 | 30 | 0 | 0 | 1 | 0 | 64 | 561 |
| *Sioux* | 0 | 0 | 0 | 0 | 66 | 0 | 0 | 25 | 122 | 5 | 14 | 232 | 779 |
| *Tohono O'Odham* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ute* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 12 |
| *Yakama* | 0 | 0 | 7 | 0 | 44 | 7 | 0 | 0 | 0 | 1 | 84 | 143 | 188 |
| *Yaqui* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 |
| *Yuman* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 7 |
| *All other tribes* | 118 | 173 | 130 | 26 | 52 | 99 | 67 | 12 | 913 | 560 | 1,597 | 3,747 | 9,038 |
| American Indian; Not Specified | 6 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 | 12 | 466 |
| Alaska Native Tribes; Specified | 6 | 86 | 0 | 34 | 100 | 42 | 6 | 0 | 0 | 10 | 22 | 306 | 405 |
| *Alaska Athabaskan* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| *Aleut* | 6 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 33 |
| *Inupiat* | 0 | 0 | 0 | 0 | 93 | 0 | 6 | 0 | 0 | 0 | 0 | 99 | 99 |
| *Tlingit-Haida* | 0 | 86 | 0 | 34 | 0 | 42 | 0 | 0 | 0 | 5 | 22 | 189 | 247 |
| *Tsimshian* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 3 |
| *Yupik* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 2 |
| *Alaska Native; Not Specified* | 48 | 97 | 9 | 16 | 44 | 0 | 29 | 0 | 311 | 129 | 191 | 874 | 3,557 |
| American Indian or Alaska Native; Not Specified | 54 | 97 | 9 | 16 | 44 | 1 | 29 | 0 | 312 | 129 | 195 | 886 | 4,023 |
| International Indian Tribe | 2 | 0 | 2 | 0 | 0 | 14 | 47 | 0 | 41 | 3 | 1 | 110 | 1,929 |

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in gray highlight to indicate that the values should be interpreted with caution.
**Low Reliability**: Data with CVs > 40% are displayed in dark gray with white font to indicate that the estimate is considered very unreliable.
* ACS 5-year estimates used. 2021 represents average characteristics from 2017-2021.

Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 35—Montana Native American Indian demographics in the area of influence**

| | Cascade | Jefferson | Lincoln | Silver Bow | Teton | Missoula | Granite | Lake | Sanders | Flathead | Mineral | Powell | Ravalli | Lewis & Clark | Beaverhead | Deer Lodge | Combined Counties | Montana |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Population, 2021* | 84,178 | 12,057 | 19,674 | 35,017 | 6,173 | 117,379 | 3,333 | 31,030 | 12,298 | 103,400 | 794 | 6,955 | 43,790 | 70,340 | 9,391 | 9,380 | 565,189 | 1,077,978 |
| Total Native American | 3,403 | 141 | 274 | 868 | 103 | 2,595 | 22 | 7,038 | 459 | 1,158 | 1 | 354 | 372 | 807 | 110 | 143 | 17,848 | 65,452 |
| Percent Native American in MT AOI | 0.60 | 0.02 | 0.05 | 0.15 | 0.02 | 0.46 | 0.00 | 1.25 | 0.08 | 0.20 | 0.00 | 0.06 | 0.07 | 0.14 | 0.02 | 0.03 | 3.16 | n/a |
| American Indian Tribes; Specified | 2,857 | 97 | 213 | 615 | 91 | 2,003 | 21 | 6,431 | 388 | 990 | 0 | 285 | 309 | 700 | 77 | 118 | 15,195 | 59,037 |
| *Apache* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35 | 1 | 0 | 0 | 8 | 9 | 0 | 0 | 0 | 53 | 148 |
| *Arapaho* | 44 | 0 | 0 | 0 | 0 | 5 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 55 | 328 |
| *Blackfeet* | 873 | 41 | 35 | 34 | 54 | 352 | 7 | 611 | 13 | 277 | 0 | 60 | 31 | 155 | 12 | 34 | 2,589 | 11,963 |
| *Cherokee* | 0 | 11 | 0 | 6 | 24 | 14 | 0 | 7 | 25 | 14 | 0 | 4 | 0 | 59 | 0 | 0 | 164 | 241 |
| *Cheyenne* | 33 | 10 | 0 | 61 | 0 | 44 | 4 | 58 | 4 | 8 | 0 | 30 | 0 | 51 | 9 | 0 | 312 | 5,698 |
| *Chickasaw* | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 82 | 0 | 0 | 0 | 0 | 0 | 0 | 106 | 106 |
| *Chippewa* | 419 | 5 | 19 | 1 | 2 | 38 | 2 | 51 | 9 | 305 | 0 | 15 | 71 | 199 | 37 | 12 | 1,185 | 2,360 |
| *Choctaw* | 29 | 0 | 0 | 39 | 0 | 0 | 0 | 9 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 92 | 163 |
| *Colville* | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 72 |
| *Comanche* | 0 | 0 | 0 | 0 | 0 | 46 | 0 | 25 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 77 | 85 |
| *Cree* | 123 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 132 | 453 |
| *Creek* | 0 | 0 | 0 | 0 | 8 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 50 | 69 |
| *Crow* | 48 | 11 | 1 | 2 | 0 | 15 | 0 | 159 | 41 | 21 | 0 | 27 | 0 | 3 | 6 | 2 | 336 | 9,448 |
| *Hopi* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 5 |
| *Iroquois* | 0 | 0 | 0 | 1 | 0 | 32 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 13 | 0 | 0 | 47 | 57 |
| *Kiowa* | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 15 |

| | Cascade | Jefferson | Lincoln | Silver Bow | Teton | Missoula | Granite | Lake | Sanders | Flathead | Mineral | Powell | Ravalli | Lewis & Clark | Beaverhead | Deer Lodge | Combined Counties | Montana |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Lumbee* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Navajo* | 0 | 2 | 0 | 3 | 0 | 4 | 0 | 43 | 0 | 4 | 0 | 0 | 0 | 18 | 0 | 0 | 74 | 484 |
| *Osage* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Paiute* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| *Pima* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 5 | 5 |
| *Potawatomi* | 0 | 0 | 0 | 0 | 0 | 17 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 166 |
| *Pueblo* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 17 | 40 |
| *Puget Sound Salish* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 0 | 0 | 0 | 5 | 0 | 0 | 24 | 85 |
| *Seminole* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 16 |
| *Shoshone* | 22 | 0 | 0 | 36 | 0 | 63 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 138 | 318 |
| *Sioux* | 47 | 0 | 0 | 101 | 0 | 133 | 0 | 142 | 0 | 5 | 0 | 6 | 11 | 37 | 0 | 0 | 482 | 2,344 |
| *Tohono O'Odham* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| *Ute* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 0 | 0 | 0 | 56 | 260 |
| *Yakama* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Yaqui* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 |
| *Yuman* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *All other tribes* | 1,195 | 17 | 126 | 331 | 0 | 1,204 | 8 | 5,205 | 290 | 198 | 0 | 127 | 125 | 117 | 8 | 69 | 9,020 | 23,740 |
| American Indian; Not Specified | 96 | 0 | 35 | 36 | 1 | 12 | 0 | 8 | 9 | 15 | 0 | 0 | 0 | 7 | 0 | 0 | 219 | 468 |
| Alaska Native Tribes; Specified | 7 | 0 | 0 | 0 | 0 | 114 | 0 | 9 | 9 | 55 | 0 | 4 | 0 | 50 | 8 | 2 | 258 | 386 |
| *Alaska Athabaskan* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| *Aleut* | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23 | 51 |
| *Inupiat* | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 16 | 104 |
| *Tlingit-Haida* | 0 | 0 | 0 | 0 | 0 | 102 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 8 | 0 | 160 | 160 |
| *Tsimshian* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| *Yupik* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 | 0 | 4 | 0 | 0 | 0 | 0 | 57 | 65 |

| | Cascade | Jefferson | Lincoln | Silver Bow | Teton | Missoula | Granite | Lake | Sanders | Flathead | Mineral | Powell | Ravalli | Lewis & Clark | Beaverhead | Deer Lodge | Combined Counties | Montana |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alaska Native; Not Specified | 314 | 44 | 14 | 202 | 11 | 247 | 1 | 290 | 25 | 27 | 1 | 61 | 56 | 30 | 25 | 23 | 1,371 | 3,720 |
| American Indian or Alaska Native; Not Specified | 410 | 44 | 49 | 238 | 12 | 259 | 1 | 298 | 34 | 42 | 1 | 61 | 56 | 37 | 25 | 23 | 1,590 | 4,188 |
| International Indian Tribe | 0 | 0 | 4 | 0 | 3 | 0 | 0 | 9 | 0 | 39 | 0 | 0 | 0 | 10 | 0 | 0 | 65 | 183 |

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in gray highlight to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in dark gray with white font to indicate that the estimate is considered very unreliable.
* ACS 5-year estimates used. 2021 represents average characteristics from 2017-2021.
Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 36—Rural to urban classification of counties in the area of influence**

| County | State | Rural-Urban Code 1993 | Rural-Urban Code 2003 | Rural-Urban Code 2013 | Median 1999-2013 | Change Since 1993 |
|---|---|---|---|---|---|---|
| Benewah County | ID | 8 | 6 | 6 | 6 | -2 |
| Bonner County | ID | 6 | 6 | 6 | 6 | 0 |
| Boundary County | ID | 9 | 7 | 7 | 7 | -2 |
| Clearwater County^ | ID | 7 | 6 | 6 | 6 | -1 |
| Idaho County | ID | 7 | 6 | 6 | 6 | -1 |
| Kootenai County | ID | 4 | 3 | 3 | 3 | -1 |
| Latah County* | ID | 7 | 4 | 4 | 4 | -3 |
| Lewis County | ID | 9 | 8 | 8 | 8 | -1 |
| Lemhi County | ID | 7 | 7 | 7 | 7 | 0 |
| Nez Perce County | ID | 5 | 3 | 3 | 3 | -2 |
| Shoshone County | ID | 7 | 6 | 6 | 6 | -1 |
| **Median, ID** | **n/a** | **7** | **6** | **6** | **6** | **-1** |
| Beaverhead County | MT | 7 | 7 | 7 | 7 | 0 |
| Cascade County | MT | 3 | 3 | 3 | 3 | 0 |

| County | State | Rural-Urban Code 1993 | Rural-Urban Code 2003 | Rural-Urban Code 2013 | Median 1999-2013 | Change Since 1993 |
|---|---|---|---|---|---|---|
| Deer Lodge County | MT | 7 | 7 | 7 | 7 | 0 |
| Flathead County | MT | 5 | 5 | 5 | 5 | 0 |
| Granite County^ | MT | 9 | 8 | 8 | 8 | -1 |
| Jefferson County | MT | 9 | 9 | 9 | 9 | 0 |
| Lake County | MT | 7 | 6 | 6 | 6 | -1 |
| Lewis and Clark County | MT | 5 | 5 | 5 | 5 | 0 |
| Lincoln County | MT | 7 | 7 | 7 | 7 | 0 |
| Mineral County | MT | 9 | 8 | 8 | 8 | -1 |
| Missoula County* | MT | 5 | 3 | 3 | 3 | -2 |
| Powell County | MT | 7 | 7 | 6 | 7 | -1 |
| Ravalli County | MT | 7 | 6 | 6 | 6 | -1 |
| Sanders County | MT | 9 | 8 | 8 | 8 | -1 |
| Silver Bow County | MT | 5 | 5 | 5 | 5 | 0 |
| Teton County | MT | 8 | 8 | 8 | 8 | 0 |
| **Median, MT** | **n/a** | **7** | **7** | **6.5** | **7** | **0** |
| **Median Change, AOI** | **n/a** | **n/a** | **n/a** | **n/a** | **n/a** | **-1** |

Note: Rural-Urban Codes 1-3 are metropolitan counties. Codes 4-9 are nonmetropolitan counties. 1 = Counties in metro areas of 1 million population or more ; 2 = Counties in metro areas of 250,000 to 1 million population ; 3= Counties in metro areas of fewer than 250,000 population ; 4 = Urban population of 20,000 or more, adjacent to a metro area ;5 = Urban population of 20,000 or more, not adjacent to a metro area ; 6 = Urban population of 2,500 to 19,999, adjacent to a metro area; 7 = Urban population of 2,500 to 19,999, not adjacent to a metro area ; 8= Completely rural or less than 2,500 urban population, adjacent to a metro area; 9 = Completely rural or less than 2,500 urban population, not adjacent to a metro area (ERS 2020).

*County in that state with the lowest median age according to 2021 US Census American Community Survey 5-year estimates

^County in that state with the highest median age according to 2021 US Census American Community Survey 5-year estimates

**Table 37—Montana county age and gender for area of influence***

| | **Jefferson** | **Lincoln** | **Silver Bow** | **Teton** | **Missoula** | **Granite** | **Lake** | **Sanders** | **Flathead** | **Mineral** | **Powell** | **Ravalli** | **Lewis & Clark** | **Beaverhe ad** | **Deer Lodge** | **Combined Counties** | **Montana** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Population, 2021* | 12,057 | 19,674 | 35,017 | 6,173 | 117,379 | 3,333 | 31,030 | 12,298 | 103,400 | 794 | 6,955 | 43,790 | 70,340 | 9,391 | 9,380 | 565,189 | 1,077,978 |
| *Under 5* | *508* | *897* | *2,045* | *430* | *5,712* | *185* | *1,757* | *482* | *5,684* | *24* | *251* | *1,935* | *3,967* | *394* | *299* | *30,080* | *60,366* |
| *5 to 9* | *687* | *1,005* | *2,083* | *450* | *5,268* | *93* | *1,985* | *578* | *6,041* | *41* | *292* | *2,350* | *4,166* | *447* | *379* | *31,507* | *64,963* |
| *10 to 14* | *755* | *951* | *1,937* | *398* | *7,151* | *221* | *2,239* | *709* | *6,999* | *32* | *314* | *2,365* | *4,474* | *425* | *276* | *34,327* | *67,508* |
| *15 to 19* | *718* | *1,063* | *1,988* | *406* | *7,838* | *217* | *1,948* | *650* | *5,952* | *14* | *407* | *2,513* | *4,247* | *746* | *567* | *33,871* | *66,874* |
| *20 to 24* | *621* | *586* | *2,874* | *315* | *11,587* | *130* | *1,670* | *414* | *4,961* | *13* | *272* | *1,843* | *3,936* | *1,011* | *479* | *36,446* | *71,805* |
| *25 to 29* | *494* | *811* | *2,204* | *287* | *10,139* | *39* | *1,678* | *416* | *6,077* | *54* | *516* | *1,835* | *3,997* | *540* | *535* | *35,917* | *70,213* |
| *30 to 34* | *518* | *841* | *2,004* | *310* | *8,523* | *81* | *1,613* | *487* | *6,300* | *69* | *423* | *2,115* | *4,543* | *445* | *581* | *34,531* | *67,878* |
| *35 to 39* | *582* | *969* | *2,101* | *377* | *8,523* | *220* | *1,739* | *558* | *6,558* | *35* | *557* | *2,594* | *5,115* | *454* | *417* | *36,149* | *69,474* |
| *40 to 44* | *755* | *979* | *2,038* | *260* | *7,327* | *192* | *1,519* | *620* | *6,552* | *84* | *354* | *2,308* | *3,799* | *525* | *779* | *32,474* | *63,367* |
| *45 to 49* | *819* | *1,034* | *1,979* | *313* | *6,211* | *137* | *1,628* | *642* | *6,281* | *22* | *548* | *2,430* | *4,003* | *452* | *586* | *31,325* | *59,619* |
| *50 to 54* | *822* | *1,293* | *2,089* | *359* | *6,536* | *181* | *1,750* | *668* | *6,200* | *73* | *502* | *2,825* | *4,340* | *474* | *630* | *33,537* | *61,903* |
| *55 to 59* | *1,015* | *1,462* | *2,002* | *517* | *7,332* | *317* | *2,146* | *1,029* | *6,585* | *68* | *577* | *3,811* | *5,611* | *662* | *825* | *39,418* | *72,740* |
| *60 to 64* | *1,127* | *2,083* | *2,985* | *386* | *6,700* | *323* | *2,486* | *1,192* | *8,936* | *85* | *544* | *3,605* | *4,873* | *714* | *785* | *42,644* | *78,814* |
| *65 to 69* | *1,179* | *1,875* | *2,562* | *361* | *6,998* | *381* | *2,314* | *1,321* | *7,375* | *70* | *370* | *3,925* | *4,655* | *774* | *848* | *39,974* | *71,261* |
| *70 to 74* | *665* | *1,743* | *1,458* | *362* | *4,837* | *225* | *1,901* | *1,100* | *5,771* | *49* | *457* | *3,180* | *3,804* | *490* | *577* | *30,576* | *54,207* |
| *75 to 79* | *353* | *900* | *1,427* | *248* | *3,342* | *158* | *1,425* | *677* | *3,578* | *36* | *315* | *1,853* | *2,258* | *425* | *396* | *20,197* | *35,565* |
| *80 to 84* | *224* | *611* | *683* | *207* | *1,514* | *183* | *717* | *377* | *1,768* | *16* | *161* | *1,367* | *1,438* | *212* | *240* | *11,452* | *21,039* |
| *85 & over* | *215* | *571* | *558* | *187* | *1,841* | *50* | *515* | *378* | *1,782* | *9* | *95* | *936* | *1,114* | *201* | *181* | *10,764* | *20,382* |
| Total Female | 5,902 | 9,824 | 16,999 | 3,130 | 58,431 | 1,637 | 15,602 | 5,914 | 51,604 | 416 | 2,583 | 21,841 | 35,291 | 4,726 | 4,412 | 279,698 | 532,307 |
| Total Male | 6,155 | 9,850 | 18,018 | 3,043 | 58,948 | 1,696 | 15,428 | 6,384 | 51,796 | 378 | 4,372 | 21,949 | 35,049 | 4,665 | 4,968 | 285,491 | 545,671 |
| **Change in median age, 2010-2021*** | | | | | | | | | | | | | | | | | |

| | Jefferson | Lincoln | Silver Bow | Teton | Missoula | Granite | Lake | Sanders | Flathead | Mineral | Powell | Ravalli | Lewis & Clark | Beaverhead | Deer Lodge | Combined Counties | Montana |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Median Age^ (2021*) | 47.5 | 52.9 | 40.5 | 42.5 | 36.3 | 54.6 | 42.7 | 54.4 | 42.3 | 50.8 | 45.7 | 49.1 | 40.9 | 42.4 | 48.4 | n/a | 40 |
| Median Age^ (2010*) | 45.6 | 48.4 | 41.8 | 45.3 | 33.9 | 50.7 | 40.9 | 48.8 | 40.5 | 58.4 | 44.5 | 45.1 | 40.7 | 42.5 | 46.2 | n/a | 39.7 |
| Median Age % Change | 4.2 | 9.3 | -3.1 | -6.2 | 7.1 | 7.7 | 4.4 | 11.5 | 4.4 | -13.0 | 2.7 | 8.9 | 0.5 | -0.2 | 4.8 | n/a | 0.8 |

^ Median age is not available for metro/non-metro or regional aggregations.

*Beginning in July 2021, the U.S. Census Bureau included questions regarding sexual orientation and gender identity. The data presented in the table were collected prior to that change.

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.

Medium Reliability: Data with CVs between 12 & 40% are in gray highlight to indicate that the values should be interpreted with caution.

Low Reliability: Data with CVs > 40% are displayed in dark gray with white font to indicate that the estimate is considered very unreliable

Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 38—Montana: ages for area of influence**

| Age range | 2010* Population (% of total) | 2021* Population (% of total) |
|---|---|---|
| Total Population, 2010*-2021* | 518,698 | 565,189 |
| *Under 18* | *115,442* (22.3) | *116,249* (20.6) |
| *18-34* | *111,697* (21.5) | *120,430* (21.3) |
| *35-44* | *61,820* (11.9) | *68,623* (12.1) |
| *45-64* | *154,003* (29.7) | *146,924* (26.0) |
| *65 and over* | *75,736* (14.6) | *112,963* (20.0) |

**Table 39—Idaho Counties Age and Gender for Area of Influence***

| | Lewis | Idaho | Boundary | Clearwater | Latah | Bonner | Shoshone | Lemhi | Kootenai | Benewah | Nez Perce | Combined Counties | Idaho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Population, 2021* | 3,613 | 16,494 | 11,966 | 8,719 | 39,464 | 46,481 | 13,124 | 7,948 | 168,317 | 9,509 | 41,820 | 367,455 | 1,811,617 |
| *Under 5* | *214* | *773* | *750* | *348* | *2,044* | *2,255* | *871* | *354* | *9,726* | *532* | *2,348* | *20,215* | *114,969* |
| *5 to 9* | *245* | *990* | *813* | *267* | *2,206* | *2,889* | *656* | *386* | *11,267* | *564* | *2,490* | *22,773* | *126,381* |
| *10 to 14* | *256* | *849* | *716* | *486* | *1,966* | *2,405* | *734* | *402* | *10,807* | *660* | *2,567* | *21,848* | *136,714* |
| *15 to 19* | *195* | *918* | *736* | *439* | *3,663* | *2,433* | *751* | *527* | *10,309* | *547* | *2,787* | *23,305* | *130,056* |
| *20 to 24* | *121* | *755* | *731* | *310* | *6,537* | *1,789* | *566* | *231* | *8,862* | *462* | *2,454* | *22,818* | *118,300* |
| *25 to 29* | *150* | *789* | *518* | *475* | *3,238* | *2,011* | *687* | *302* | *10,410* | *431* | *2,669* | *21,680* | *118,378* |
| *30 to 34* | *162* | *725* | *539* | *435* | *2,439* | *2,435* | *734* | *320* | *10,810* | *463* | *2,712* | *21,774* | *116,925* |
| *35 to 39* | *149* | *832* | *520* | *528* | *2,395* | *2,640* | *644* | *582* | *10,719* | *542* | *2,609* | *22,160* | *121,253* |
| *40 to 44* | *201* | *776* | *744* | *463* | *1,701* | *2,534* | *758* | *441* | *10,555* | *441* | *2,282* | *20,896* | *111,935* |
| *45 to 49* | *139* | *833* | *730* | *501* | *1,830* | *2,627* | *746* | *287* | *9,484* | *524* | *2,425* | *20,126* | *104,898* |
| *50 to 54* | *202* | *942* | *680* | *574* | *1,840* | *2,973* | *843* | *428* | *10,429* | *610* | *2,471* | *21,992* | *102,927* |
| *55 to 59* | *251* | *1,432* | *947* | *668* | *2,160* | *3,290* | *976* | *527* | *11,073* | *726* | *2,985* | *25,035* | *111,218* |

| | Lewis | Idaho | Boundary | Clearwater | Latah | Bonner | Shoshone | Lemhi | Kootenai | Benewah | Nez Perce | Combined Counties | Idaho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *60 to 64* | *373* | *1,300* | *834* | *828* | *1,965* | *4,609* | *1,179* | *771* | *12,025* | *859* | *2,789* | *27,532* | *110,565* |
| *65 to 69* | *343* | *1,459* | *1,031* | *813* | *1,943* | *4,342* | *902* | *974* | *10,566* | *682* | *2,693* | *25,748* | *99,777* |
| *70 to 74* | *234* | *1,347* | *707* | *647* | *1,473* | *3,257* | *945* | *441* | *9,211* | *710* | *1,958* | *20,930* | *78,242* |
| *75 to 79* | *205* | *886* | *371* | *432* | *1,050* | *1,842* | *463* | *411* | *5,305* | *421* | *1,543* | *12,929* | *49,977* |
| *80 to 84* | *104* | *512* | *334* | *288* | *434* | *994* | *314* | *194* | *3,530* | *183* | *797* | *7,684* | *30,308* |
| *85 & over* | *69* | *376* | *265* | *217* | *580* | *1,156* | *355* | *370* | *3,229* | *152* | *1,241* | *8,010* | *28,794* |
| Total Female | 1,874 | 7,765 | 5,947 | 3,868 | 19,279 | 23,181 | 6,555 | 3,795 | 84,643 | 4,658 | 21,080 | 182,645 | 899,088 |
| Total Male | 1,739 | 8,729 | 6,019 | 4,851 | 20,185 | 23,300 | 6,569 | 4,153 | 83,674 | 4,851 | 20,740 | 184,810 | 912,529 |
| **Change in Median Age, 2010*-2021*** | | | | | | | | | | | | | |
| Median Age^ (2021*) | 49 | 50.1 | 43.8 | 51 | 30.1 | 48.2 | 46.3 | 52.8 | 40.4 | 45.9 | 40.6 | n/a | 36.8 |
| Median Age^ (2010*) | 47.6 | 47.2 | 42.3 | 48.1 | 27.9 | 44.8 | 45.6 | 47.8 | 38.5 | 43.8 | 40.6 | n/a | 34.4 |
| Median Age % Change | 2.90 | 6.10 | 3.50 | 6.00 | 7.90 | 7.60 | 1.50 | 10.50 | 4.90 | 4.80 | 0.00 | n/a | 7.00 |

^ Median age is not available for metro/non-metro or regional aggregations.

*Beginning in July 2021, the U.S. Census Bureau included questions regarding sexual orientation and gender identity. The data presented in the table were collected prior to that change.

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.

Medium Reliability: Data with CVs between 12 & 40% are in gray highlight to indicate that the values should be interpreted with caution.

**Low Reliability**: Data with CVs > 40% are displayed in dark gray with white font to indicate that the estimate is considered very unreliable

Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 40—Idaho: ages for area of influence**

| Age range | 2010* Population (% of total) | 2021* Population (% of total) |
|---|---|---|
| Total Population, 2010*-2021* | 320,439 | 367,455 |
| Under 18 | 73,336 (22.9) | 78,786 (21.4) |
| 18-34 | 67,986 (21.2) | 75,627 (20.6) |
| 35-44 | 38,508 (12.0) | 43,056 (11.7) |
| 45-64 | 91,363 (28.5) | 94,685 (25.8) |
| 65 and over | 49,246 (15.4) | 75,301 (20.5) |

**Table 41—Land ownership in the area of influence: Montana (underlined numbers are in thousands of acres)**

| | Teton | Granite | Lewis and Clark | Ravalli | Mineral | Silver Bow | Flathead | Cascade | Missoula | Powell | Lincoln | Deer Lodge | Jefferson | Beaverhead | Lake | Sanders | United States |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Acres** | 1,466 | 1,108 | 2,238 | 1,536 | 783 | 459 | 3,363 | 1,735 | 1,675 | 1,492 | 2,351 | 474 | 1,062 | 3,566 | 1,058 | 1,785 | 2,303,091 |
| Private Lands | 1,081 | 386 | 973 | 366 | 83 | 195 | 773 | 1,425 | 525 | 611 | 528 | 188 | 470 | 1,110 | 130 | 360 | 1,406,717 |
| Conservation Easement | 117 | 21 | 134 | 26 | 145 | 2,813 | 32 | 78 | 57 | 153 | 92 | 6,636 | 17 | 122 | 36 | 88 | 21,237 |
| Federal Lands | 256 | 702 | 1,087 | 1,130 | 639 | 235 | 2,431 | 219 | 877 | 752 | 1,752 | 215 | 555 | 2,100 | 188 | 933 | 632,461 |
| Forest Service | 234 | 664 | 996 | 1,127 | 639 | 189 | 1,782 | 178 | 854 | 650 | 1,752 | 210 | 462 | 1,376 | 175 | 923 | 192,648 |
| BLM | 19 | 38 | 79 | 0 | 0 | 45 | 0 | 24 | 22 | 94 | 21 | 5,286 | 92 | 667 | 0 | 0 | 242,857 |
| National Park Service | 0 | 0 | 0 | 0 | 0 | 0 | 635 | 0 | 0 | 1,279 | 0 | 0 | 0 | 658 | 0 | 0 | 78,366 |
| Military | 0 | 0 | 4,274 | 0 | 0 | 0 | 0 | 3,408 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24,412 |
| Other Federal | 1,996 | 0 | 6,063 | 2,986 | 0 | 0 | 13 | 12 | 0 | 4,951 | 0 | 0 | 0 | 55 | 13 | 10 | 94,176 |
| State Lands | 129 | 19 | 176 | 39 | 59 | 28 | 131 | 90 | 171 | 128 | 71 | 70 | 36 | 355 | 64 | 64 | 184,973 |
| State Trust Lands* | 103 | 19 | 133 | 29 | 17 | 12 | 127 | 77 | 92 | 56 | 65 | 7,171 | 31 | 334 | 54 | 60 | 51,983 |
| Other State | 26 | 34 | 42 | 9,929 | 41 | 16 | 4,291 | 12 | 79 | 71 | 5,555 | 63 | 4,977 | 20 | 9,340 | 3,056 | 132,990 |
| Tribal Lands | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 0 | 99 | 0 | 0 | 0 | 0 | 0 | 675 | 427 | 67,946 |
| City, County, Other | 10 | 70 | 1,634 | 0 | 0 | 328 | 0 | 28 | 2,148 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 10,989 |

| | Teton | Granite | Lewis and Clark | Ravalli | Mineral | Silver Bow | Flathead | Cascade | Missoula | Powell | Lincoln | Deer Lodge | Jefferson | Beaverhead | Lake | Sanders | United States |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Percent of Total** | | | | | | | | | | | | | | | | | |
| Private Lands | 73.7 | 34.8 | 43.5 | 23.9 | 10.7 | 42.5 | 23.0 | 82.1 | 31.4 | 41.0 | 22.5 | 39.7 | 44.3 | 31.1 | 12.3 | 20.2 | 61.1 |
| Conservation Easement | 8.0 | 1.9 | 6.0 | 1.7 | 0.0 | 0.6 | 1.0 | 4.5 | 3.4 | 10.3 | 3.9 | 1.4 | 1.7 | 3.4 | 3.4 | 4.9 | 0.9 |
| Federal Lands | 17.5 | 63.4 | 48.6 | 73.6 | 81.7 | 51.1 | 72.3 | 12.6 | 52.4 | 50.4 | 74.5 | 45.4 | 52.3 | 58.9 | 17.8 | 52.3 | 27.5 |
| Forest Service | 16.0 | 59.9 | 44.5 | 73.4 | 81.7 | 41.2 | 53.0 | 10.3 | 51.0 | 43.6 | 74.5 | 44.3 | 43.6 | 38.6 | 16.6 | 51.7 | 8.4 |
| BLM | 1.3 | 3.5 | 3.6 | 0.0 | 0.0 | 9.9 | 0.0 | 1.4 | 1.4 | 6.4 | 0.0 | 1.1 | 8.7 | 18.7 | 0.0 | 0.0 | 10.5 |
| National Park Service | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.9 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 |
| Military | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 |
| Other Federal | 0.1 | 0.0 | 0.3 | 0.2 | 0.0 | 0.0 | 0.4 | 0.7 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 1.6 | 1.3 | 0.6 | 4.1 |
| State Lands | 8.8 | 1.8 | 7.9 | 2.6 | 7.6 | 6.3 | 3.9 | 5.2 | 10.2 | 8.6 | 3.0 | 14.8 | 3.4 | 10.0 | 6.1 | 3.6 | 8.0 |
| State Trust Lands* | 7.0 | 1.8 | 6.0 | 1.9 | 2.3 | 2.8 | 3.8 | 4.5 | 5.5 | 3.8 | 2.8 | 1.5 | 3.0 | 9.4 | 5.2 | 3.4 | 2.3 |
| Other State | 1.8 | 0.0 | 1.9 | 0.6 | 5.3 | 3.5 | 0.1 | 0.7 | 4.7 | 4.8 | 0.2 | 13.3 | 0.5 | 0.6 | 0.9 | 0.2 | 5.8 |
| Tribal Lands | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.0 | 5.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 63.8 | 23.9 | 3.0 |
| City, County, Other | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |

Data Sources: U.S. Geological Survey, Gap Analysis Program. 2018. Protected Areas Database of the United States (PADUS) version 2.0
Accessed via Headwaters EPS, Land Use report. https://headwaterseconomics.org/apps/economic-profile-system

**Table 42—Land ownership in the area of influence: Idaho**

| | Clearwater | Lemhi | Kootenai | Lewis | Nez Perce | Boundary | Idaho | Bonner | Latah | Shoshone | Benewah | United States |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Acres** | 1,592,349 | 2,924,286 | 837,757 | 307,024 | 548,178 | 817,956 | 5,442,286 | 1,227,605 | 689,141 | 1,691,402 | 501,882 | 2,303,091,014 |
| Private Lands | 485,428 | 245,440 | 435,686 | 49,749 | 166,980 | 209,909 | 650,667 | 572,073 | 545,235 | 357,603 | 170,802 | 1,406,717,148 |
| Conservation Easement | 402 | 7,336 | 25 | 1 | 1,347 | 13,997 | 7,522 | 5,796 | 21 | 54,218 | 1,204 | 21,237,199 |
| Federal Lands | 804,351 | 2,640,968 | 253,892 | 3,119 | 31,688 | 496,648 | 4,536,522 | 485,182 | 109,025 | 1,266,288 | 45,462 | 632,461,561 |
| Forest Service | 801,013 | 2,065,788 | 242,006 | 9 | 3,181 | 489,501 | 4,440,130 | 468,770 | 108,826 | 1,210,323 | 31,317 | 192,648,950 |
| BLM | 2,920 | 575,180 | 11,864 | 3,110 | 27,290 | 4,376 | 93,487 | 12,000 | 199 | 55,965 | 14,145 | 242,857,628 |

| | Clearwater | Lemhi | Kootenai | Lewis | Nez Perce | Boundary | Idaho | Bonner | Latah | Shoshone | Benewah | United States |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| National Park Service | 2 | 0 | 0 | 0 | 258 | 0 | 2,778 | 0 | 0 | 0 | 0 | 78,366,536 |
| Military | 398 | 0 | 22 | 0 | 959 | 0 | 0 | 4,412 | 0 | 0 | 0 | 24,412,029 |
| Other Federal | 18 | 0 | 0 | 0 | 0 | 2,771 | 127 | 0 | 0 | 0 | 0 | 94,176,418 |
| State Lands | 234,480 | 37,878 | 44,976 | 5,878 | 86,301 | 107,087 | 75,549 | 170,347 | 34,656 | 67,511 | 62,934 | 184,973,953 |
| State Trust Lands* | 233,845 | 37,281 | 32,882 | 2,096 | 7,647 | 103,893 | 74,177 | 166,200 | 31,124 | 55,145 | 52,561 | 51,983,763 |
| Other State | 635 | 597 | 12,094 | 3,782 | 78,654 | 3,194 | 1,372 | 4,147 | 3,532 | 12,366 | 10,373 | 132,990,190 |
| Tribal Lands | 68,049 | 0 | 103,180 | 248,279 | 262,479 | 4,313 | 179,547 | 0 | 22 | 0 | 222,684 | 67,946,824 |
| City, County, Other | 40 | 0 | 21 | 0 | 730 | 0 | 0 | 0 | 202 | 0 | 0 | 10,989,958 |
| **Percent of Total** | | | | | | | | | | | | |
| Private Lands | 30.5 | 8.4 | 52.0 | 16.2 | 30.5 | 25.7 | 12.0 | 46.6 | 79.1 | 21.1 | 34.0 | 61.1 |
| Conservation Easement | 0.0 | 0.3 | 0.0 | 0.0 | 0.2 | 1.7 | 0.1 | 0.5 | 0.0 | 3.2 | 0.2 | 0.9 |
| Federal Lands | 50.5 | 90.3 | 30.3 | 1.0 | 5.8 | 60.7 | 83.4 | 39.5 | 15.8 | 74.9 | 9.1 | 27.5 |
| Forest Service | 50.3 | 70.6 | 28.9 | 0.0 | 0.6 | 59.8 | 81.6 | 38.2 | 15.8 | 71.6 | 6.2 | 8.4 |
| BLM | 0.2 | 19.7 | 1.4 | 1.0 | 5.0 | 0.5 | 1.7 | 1.0 | 0.0 | 3.3 | 2.8 | 10.5 |
| National Park Service | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 3.4 |
| Military | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 1.1 |
| Other Federal | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.1 |
| State Lands | 14.7 | 1.3 | 5.4 | 1.9 | 15.7 | 13.1 | 1.4 | 13.9 | 5.0 | 4.0 | 12.5 | 8.0 |
| State Trust Lands* | 14.7 | 1.3 | 3.9 | 0.7 | 1.4 | 12.7 | 1.4 | 13.5 | 4.5 | 3.3 | 10.5 | 2.3 |
| Other State | 0.0 | 0.0 | 1.4 | 1.2 | 14.3 | 0.4 | 0.0 | 0.3 | 0.5 | 0.7 | 2.1 | 5.8 |
| Tribal Lands | 4.3 | 0.0 | 12.3 | 80.9 | 47.9 | 0.5 | 3.3 | 0.0 | 0.0 | 0.0 | 44.4 | 3.0 |
| City, County, Other | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 |

Data Sources: U.S. Geological Survey, Gap Analysis Program. 2018. Protected Areas Database of the United States (PADUS) version 2.0
Accessed via Headwaters EPS, Land Use report. https://headwaterseconomics.org/apps/economic-profile-system

**Table 43—Population, Employment, and Income Trends; Idaho area of influence; 1970-2021**

| | Clearwater | Lemhi | Kootenai | Lewis | Nez Perce | Boundary | Idaho | Bonner | Latah | Shoshone | Benewah | United States |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population % change | -18.5 | 45.5 | 405.3 | -5.0 | 39.8 | 127.4 | 31.4 | 216.5 | 60.6 | -30.8 | 58.7 | 62.9 |
| Employment % change | -25.1 | 93.4 | 690.4 | 40.3 | 81.8 | 204.4 | 61.4 | 370.6 | 135.6 | -24.0 | 118.7 | 120.4 |
| Personal Income % change | 28.7 | 234.5 | 993.0 | 87.4 | 165.4 | 309.3 | 126.2 | 640.0 | 265.7 | 25.0 | 192.8 | 256.8 |

Data Sources: U.S. Department of Commerce. 2022. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. (accessed via Headwaters Economics Key Indicators Economic Profile System Report).

**Table 44—Population, Employment, and Income Trends; Montana area of influence; 1970-2021**

| | Teton | Granite | Lewis and Clark | Ravalli | Mineral | Silver Bow | Flathead | Cascade | Missoula | Powell | Lincoln | Deer Lodge | Jefferson | Beaverhead | Lake | Sanders | United States |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population % change | 2.3 | 22.5 | 115.9 | 216.0 | 63.9 | -16.0 | 173.1 | 2.7 | 104.4 | 5.0 | 13.6 | -39.5 | 135.8 | 16.0 | 119.5 | 82.2 | 62.9 |
| Employment % change | 40.9 | 57.5 | 194.3 | 377.9 | 79.6 | 30.9 | 359.4 | 36.0 | 254.1 | 46.4 | 32.0 | -29.2 | 172.1 | 94.6 | 232.2 | 115.2 | 120.4 |
| Personal Income % change | 72.4 | 209.5 | 295.3 | 704.9 | 233.0 | 87.4 | 550.6 | 82.1 | 407.5 | 149.3 | 107.5 | 30.5 | 517.3 | 160.2 | 447.0 | 280.5 | 256.8 |

Data Sources: U.S. Department of Commerce. 2022. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. (accessed via Headwaters Economics Key Indicators Economic Profile System Report).

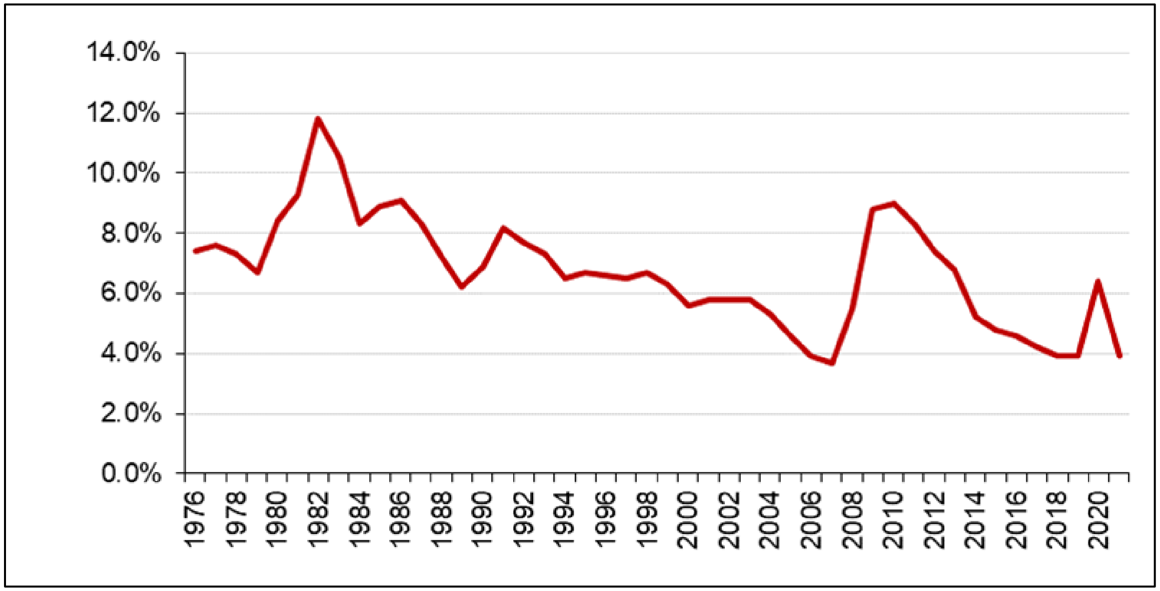


**Figure 30—Unemployment Rate (Average Annual), 27-County Area of Influence**

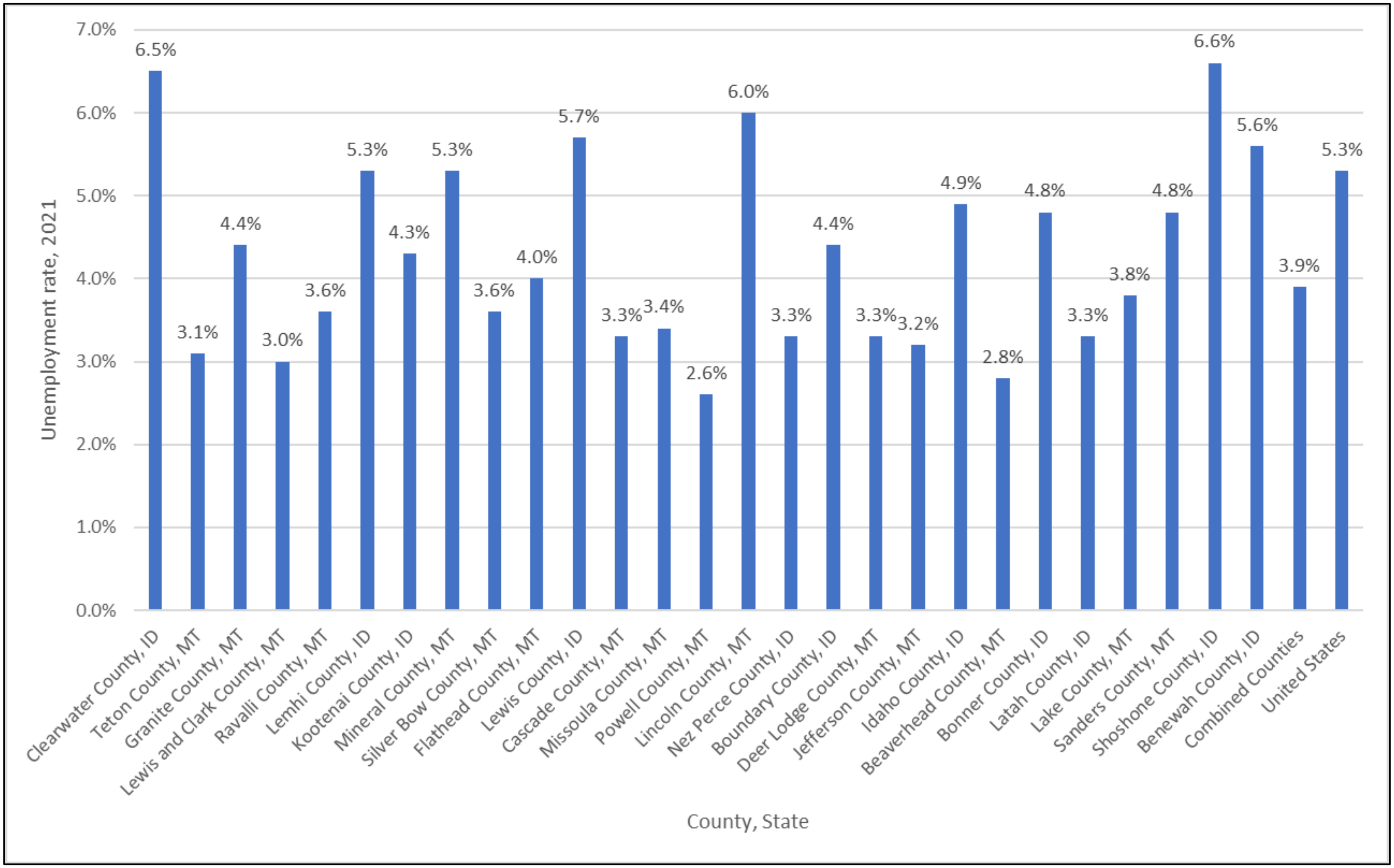


**Figure 31—2021 Unemployment rates in the area of influence**

Accessed via Headwaters EPS, Key Indicators report. https://headwaterseconomics.org/apps/economic-profile-system

Data Sources: U.S. Department of Commerce. 2022. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C.; U.S. Department of Labor. 2022. Bureau of Labor Statistics, Local Area Unemployment Statistics, Washington, D.C.

**Table 45—Total number of jobs contributed by program area**

| Program area | Jobs | Income (1000s of 2019 dollars) |
|---|---|---|
| Recreation | 599 | 17,895 |
| Grazing | 2 | 50 |
| Timber | 806 | 35,856 |
| Payments to States/Counties | 66 | 3,174 |
| Forest Service Expenditures | 417 | 16,443 |
| **Total** | **1,857** | **73,419** |

Source: IMPLAN analysis by author.

**Table 46—Total jobs and labor income supported by the Lolo National Forest in 2019**

| Major Economic Sector | FS Supported Jobs (Avg. annual) | FS Supported Labor Income (thousands of 2019 dollars) | Area of Influence Jobs (Avg. annual) | Area of Influence Labor Income (thousands of 2019 dollars) |
|---|---|---|---|---|
| **Total** | **1,889** | **73,419** | **552,082** | **25,061,322** |
| *FS Percent of AOI* | *0.3%* | *0.3%* | *n/a* | *n/a* |
| *Accom, Food Svcs* | *364* | *8,484* | *48,514* | *1,089,363* |
| *Admin, Waste Mgmt* | *52* | *1,626* | *23,898* | *875,601* |
| *Agriculture* | *194* | *8,338* | *22,335* | *419,641* |
| *Arts, Ent, Rec* | *60* | *963* | *16,613* | *306,078* |
| *Construction* | *17* | *766* | *41,784* | *2,013,402* |
| *Edu Svcs* | *14* | *325* | *6,327* | *161,883* |
| *Finance & Ins* | *35* | *1,806* | *22,036* | *1,275,724* |
| *Govt & Non NAICs* | *314* | *13,108* | *76,899* | *5,112,612* |
| *Health & SocSvcs* | *91* | *4,933* | *64,473* | *3,829,707* |
| *Information* | *13* | *647* | *6,392* | *370,602* |
| *Management* | *7* | *448* | *2,136* | *144,726* |
| *Manufacturing* | *259* | *14,991* | *28,155* | *1,589,727* |
| *Mining* | *2* | *174* | *4,274* | *381,188* |
| *Other Svcs* | *62* | *2,220* | *34,492* | *1,317,020* |
| *Prof, Scient, Tech* | *46* | *2,143* | *33,174* | *1,797,391* |
| *Real Estate* | *55* | *944* | *31,578* | *567,952* |
| *Retail Trade* | *172* | *5,171* | *55,988* | *1,780,655* |
| *Transportation* | *71* | *2,842* | *18,738* | *956,932* |
| *Utilities* | *5* | *544* | *2,122* | *248,799* |
| *Wholesale Trade* | *55* | *2,946* | *12,155* | *822,320* |

**Table 47—Idaho 2021 estimated race and ethnicity by county in the Lolo National Forest area of influence**

| | Lewis | Idaho | Boundary | Clearwater | Latah | Bonner | Shoshone | Lemhi | Kootenai | Benewah | Nez Perce | Combined Counties | Idaho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Population, 2021*** | 3,613 | 16,494 | 11,966 | 8,719 | 39,464 | 46,481 | 13,124 | 7,948 | 168,317 | 9,509 | 41,820 | 367,455 | 1,811,617 |
| White alone | 2,975 | 15,305 | 10,953 | 7,982 | 35,466 | 43,036 | 12,087 | 7,429 | 153,044 | 8,127 | 37,164 | 333,568 | 1,567,799 |
| Black or African American alone | 39 | 22 | 27 | 28 | 479 | 136 | 99 | 2 | 460 | 77 | 48 | 1,417 | 12,242 |
| American Indian alone | 211 | 561 | 171 | 147 | 376 | 352 | 253 | 75 | 2,062 | 820 | 2,267 | 7,295 | 22,799 |
| Asian alone | 45 | 79 | 168 | 54 | 850 | 309 | 6 | 12 | 1,347 | 11 | 393 | 3,274 | 24,616 |
| Native Hawaii & Other Pacific Is. alone | 0 | 4 | 115 | 27 | 39 | 72 | 37 | 9 | 168 | 33 | 31 | 535 | 3,016 |
| Some other race alone | 136 | 117 | 199 | 91 | 277 | 419 | 23 | 83 | 2,068 | 32 | 292 | 3,737 | 77,835 |
| Two or more races | 207 | 406 | 333 | 390 | 1,977 | 2,157 | 619 | 338 | 9,168 | 409 | 1,625 | 17,629 | 103,310 |
| **Race - Percent of Total** | | | | | | | | | | | | | |
| White alone | 82.3 | 92.8 | 91.5 | 91.5 | 89.9 | 92.6 | 92.1 | 93.5 | 90.9 | 85.5 | 88.9 | 90.8 | 86.5 |
| Black or African American alone | 1.1 | 0.1 | 0.2 | 0.3 | 1.2 | 0.3 | 0.8 | 0.0 | 0.3 | 0.8 | 0.1 | 0.4 | 0.7 |
| American Indian alone | 5.8 | 3.4 | 1.4 | 1.7 | 1.0 | 0.8 | 1.9 | 0.9 | 1.2 | 8.6 | 5.4 | 2.0 | 1.3 |
| Asian alone | 1.2 | 0.5 | 1.4 | 0.6 | 2.2 | 0.7 | 0.0 | 0.2 | 0.8 | 0.1 | 0.9 | 0.9 | 1.4 |
| Native Hawaii & Other Pacific Is. alone | 0.0 | 0.0 | 1.0 | 0.3 | 0.1 | 0.2 | 0.3 | 0.1 | 0.1 | 0.3 | 0.1 | 0.1 | 0.2 |
| Some other race alone | 3.8 | 0.7 | 1.7 | 1.0 | 0.7 | 0.9 | 0.2 | 1.0 | 1.2 | 0.3 | 0.7 | 1.0 | 4.3 |
| Two or more races | 5.7 | 2.5 | 2.8 | 4.5 | 5.0 | 4.6 | 4.7 | 4.3 | 5.4 | 4.3 | 3.9 | 4.8 | 5.7 |
| **Ethnicity - Percent of Total** | | | | | | | | | | | | | |
| Hispanic or Latino (of any race) | 4.9 | 3.6 | 5.3 | 4.3 | 4.6 | 3.6 | 3.8 | 3.5 | 5.0 | 4.3 | 4.4 | 4.6 | 12.9 |
| Not Hispanic or Latino | 95.1 | 96.4 | 94.7 | 95.7 | 95.4 | 96.4 | 96.2 | 96.5 | 95.0 | 95.7 | 95.6 | 95.4 | 87.1 |

| | Lewis | Idaho | Boundary | Clearwater | Latah | Bonner | Shoshone | Lemhi | Kootenai | Benewah | Nez Perce | Combined Counties | Idaho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| White alone | 81.1 | 90.5 | 88.8 | 89.4 | 86.6 | 91.3 | 90.3 | 93.2 | 88.3 | 84.0 | 86.3 | 88.4 | 80.6 |
| Black or African American alone | 1.1 | 0.1 | 0.2 | 0.3 | 1.2 | 0.2 | 0.8 | 0.0 | 0.3 | 0.8 | 0.1 | 0.4 | 0.6 |
| American Indian alone | 5.7 | 3.4 | 1.4 | 1.7 | 0.9 | 0.7 | 1.5 | 0.6 | 1.0 | 7.0 | 5.2 | 1.8 | 0.9 |
| Asian alone | 1.2 | 0.5 | 1.3 | 0.6 | 2.1 | 0.7 | 0.0 | 0.1 | 0.8 | 0.1 | 0.9 | 0.9 | 1.3 |
| Native Hawaii & Oth.Pacific Is. alone | 0.0 | 0.0 | 1.0 | 0.3 | 0.1 | 0.2 | 0.3 | 0.1 | 0.1 | 0.3 | 0.1 | 0.1 | 0.1 |
| Some other race | 1.8 | 0.0 | 0.2 | 0.0 | 0.2 | 0.3 | 0.0 | 0.3 | 0.5 | 0.2 | 0.2 | 0.4 | 0.4 |
| Two or more races | 4.2 | 1.9 | 1.9 | 3.4 | 4.3 | 3.1 | 3.2 | 2.2 | 4.0 | 3.1 | 2.8 | 3.5 | 3.1 |

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in gray highlight to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in dark gray with white font to indicate that the estimate is considered very unreliable.
Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 48—Montana 2021 Estimated race and ethnicity by county in the Lolo National Forest AOI (underlined numbers in thousands)**

| Race | Cascade | Jefferson | Lincoln | Silver Bow | Teton | Missoula | Granite | Lake | Sanders | Flathead | Mineral | Powell | Ravalli | Lewis and Clark | Beaverhead | Deer Lodge | Combined Counties | Montana |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Population, 2021*** | 84 | 12 | 19 | 35 | 6 | 117 | 3 | 31 | 12 | 103 | 794 | 6 | 43 | 70 | 9 | 9 | 565 | 1,077 |
| White alone | 72 | 11 | 18 | 32 | 5 | 105 | 3 | 20 | 11 | 95 | 728 | 6 | 40 | 65 | 8 | 8 | 506 | 938 |
| Black or African American alone | 1,228 | 54 | 20 | 54 | 40 | 630 | 5 | 112 | 37 | 417 | 12 | 96 | 151 | 334 | 88 | 85 | 3,363 | 6,236 |
| American Indian alone | 3,403 | 141 | 274 | 868 | 103 | 2,595 | 22 | 7,038 | 459 | 1,158 | 1 | 354 | 372 | 807 | 110 | 143 | 17,848 | 65,452 |
| Asian alone | 755 | 17 | 67 | 183 | 0 | 2,186 | 14 | 197 | 23 | 840 | 18 | 118 | 231 | 423 | 14 | 69 | 5,155 | 8,972 |
| Native Hawaii & Other Pacific Is. alone | 23 | 0 | 53 | 11 | 0 | 134 | 0 | 48 | 10 | 0 | 0 | 0 | 0 | 0 | 11 | 8 | 298 | 581 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Some other race alone | 1,480 | 50 | 147 | 199 | 36 | 936 | 0 | 279 | 27 | 561 | 4 | 33 | 211 | 509 | 80 | 38 | 4,590 | 10,155 |
| Two or more races | 4,911 | 536 | 767 | 1,285 | 238 | 5,433 | 114 | 3,048 | 490 | 4,584 | 31 | 135 | 2,322 | 3,128 | 309 | 419 | 27,750 | 48,359 |
| **Race - Percent of Total** | | | | | | | | | | | | | | | | | | |
| White alone | 86.0 | 93.4 | 93.2 | 92.6 | 93.2 | 89.8 | 95.3 | 65.4 | 91.5 | 92.7 | 91.7 | 89.4 | 92.5 | 92.6 | 93.5 | 91.9 | 89.6 | 87.0 |
| Black or African American alone | 1.5 | 0.4 | 0.1 | 0.2 | 0.6 | 0.5 | 0.2 | 0.4 | 0.3 | 0.4 | 1.5 | 1.4 | 0.3 | 0.5 | 0.9 | 0.9 | 0.6 | 0.6 |
| American Indian alone | 4.0 | 1.2 | 1.4 | 2.5 | 1.7 | 2.2 | 0.7 | 22.7 | 3.7 | 1.1 | 0.1 | 5.1 | 0.8 | 1.1 | 1.2 | 1.5 | 3.2 | 6.1 |
| Asian alone | 0.9 | 0.1 | 0.3 | 0.5 | 0.0 | 1.9 | 0.4 | 0.6 | 0.2 | 0.8 | 2.3 | 1.7 | 0.5 | 0.6 | 0.1 | 0.7 | 0.9 | 0.8 |
| Native Hawaii & Other Pacific Is. alone | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.1 | 0.0 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| Some other race alone | 1.8 | 0.4 | 0.7 | 0.6 | 0.6 | 0.8 | 0.0 | 0.9 | 0.2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.7 | 0.9 | 0.4 | 0.8 | 0.9 |
| Two or more races | 5.8 | 4.4 | 3.9 | 3.7 | 3.9 | 4.6 | 3.4 | 9.8 | 4.0 | 4.4 | 3.9 | 1.9 | 5.3 | 4.4 | 3.3 | 4.5 | 4.9 | 4.5 |
| **Ethnicity - Percent of Total** | | | | | | | | | | | | | | | | | | |
| Hispanic or Latino (of any race) | 4.9 | 2.8 | 3.4 | 4.7 | 0.7 | 3.5 | 4.1 | 4.5 | 3.3 | 3.1 | 1.4 | 1.8 | 3.7 | 3.6 | 5.4 | 3.8 | 3.8 | 4.1 |
| Not Hispanic or Latino | 95.1 | 97.2 | 96.6 | 95.3 | 99.3 | 96.5 | 95.9 | 95.5 | 96.7 | 96.9 | 98.6 | 98.2 | 96.3 | 96.4 | 94.6 | 96.2 | 96.2 | 95.9 |
| White alone | 83.9 | 91.5 | 91.3 | 89.9 | 93.1 | 87.8 | 93.8 | 64.5 | 89.5 | 91.6 | 91.6 | 88.6 | 90.8 | 90.1 | 89.4 | 88.7 | 87.7 | 85.1 |
| Black or African American alone | 1.5 | 0.4 | 0.1 | 0.2 | 0.6 | 0.5 | 0.2 | 0.4 | 0.3 | 0.3 | 1.3 | 1.4 | 0.3 | 0.5 | 0.9 | 0.9 | 0.6 | 0.5 |
| American Indian alone | 3.8 | 0.9 | 1.3 | 2.2 | 1.7 | 2.1 | 0.7 | 21.6 | 3.5 | 1.0 | 0.1 | 4.7 | 0.8 | 1.1 | 1.2 | 1.5 | 3.0 | 5.8 |
| Asian alone | 0.8 | 0.1 | 0.3 | 0.5 | 0.0 | 1.8 | 0.4 | 0.6 | 0.2 | 0.8 | 2.3 | 1.7 | 0.5 | 0.6 | 0.1 | 0.7 | 0.9 | 0.8 |
| Native Hawaii & Other Pacific Is. alone | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| Some other race | 0.2 | 0.0 | 0.1 | 0.1 | 0.1 | 0.3 | 0.0 | 0.1 | 0.0 | 0.2 | 0.0 | 0.1 | 0.3 | 0.3 | 0.0 | 0.2 | 0.2 | 0.2 |
| Two or more races | 4.8 | 4.1 | 3.2 | 2.5 | 3.8 | 3.7 | 0.9 | 8.2 | 3.1 | 2.9 | 3.4 | 1.8 | 3.6 | 3.8 | 2.8 | 4.0 | 3.8 | 3.4 |

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in gray highlight to indicate that the values should be interpreted with caution.
**Low Reliability**: Data with CVs > 40% are displayed in dark gray with white font to indicate that the estimate is considered very unreliable.
* ACS 5-year estimates used. 2021 represents average characteristics from 2017-2021.
Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 49—Montana Poverty by Race and Ethnicity by county in the Lolo National Forest AOI (underlined numbers in thousands)**

| | Cascade | Jefferson | Lincoln | Silver Bow | Teton | Missoula | Granite | Lake | Sanders | Flathead | Mineral | Powell | Ravalli | Lewis and Clark | Beaverhead | Deer Lodge | Combined Counties | Montana |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Population in Poverty, 2021*** | 10 | 663 | 3 | 5 | 849 | 14 | 392 | 5 | 2 | 9 | 95 | 634 | 4 | 5 | 1 | 2 | 67 | 131 |
| White alone | 7 | 630 | 2 | 4 | 796 | 12 | 380 | 2 | 1 | 8 | 83 | 611 | 4 | 5 | 1 | 1 | 55 | 98 |
| Black or African American alone | 123 | 3 | 6 | 25 | 20 | 36 | 0 | 48 | 8 | 65 | 12 | 21 | 12 | 86 | 85 | 8 | 558 | 887 |
| American Indian alone | 1 | 0 | 192 | 487 | 0 | 795 | 0 | 2 | 141 | 272 | 0 | 1 | 89 | 152 | 2 | 100 | 6 | 21 |
| Asian alone | 216 | 0 | 2 | 82 | 0 | 196 | 0 | 0 | 3 | 26 | 0 | 0 | 25 | 1 | 0 | 20 | 571 | 1,278 |
| Native Hawaii & Other Pac Is. alone | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 39 |
| Some other race | 412 | 0 | 80 | 38 | 0 | 160 | 0 | 62 | 21 | 72 | 0 | 0 | 0 | 13 | 28 | 0 | 886 | 1,514 |
| Two or more races | 799 | 30 | 123 | 317 | 33 | 1,246 | 12 | 739 | 53 | 466 | 0 | 1 | 165 | 313 | 32 | 183 | 4,512 | 7,358 |
| **All Ethnicities in Poverty, 2021*** | | | | | | | | | | | | | | | | | | |
| Hispanic or Latino (of any race) | 1 | 7 | 125 | 178 | 0 | 433 | 2 | 312 | 104 | 226 | 2 | 0 | 260 | 387 | 33 | 259 | 3 | 6 |
| Not Hispanic or Latino (of any race) | 7,334 | 623 | 2,787 | 4,427 | 796 | 11,871 | 378 | 2,532 | 1,740 | 8,488 | 83 | 611 | 4,167 | 5,021 | 1,314 | 1,456 | 53 | 95 |
| **Percent Population in Poverty** | | | | | | | | | | | | | | | | | | |
| White alone | 72.0 | 95.0 | 87.5 | 82.5 | 93.8 | 83.2 | 96.9 | 44.3 | 88.7 | 90.4 | 87.4 | 96.4 | 93.8 | 90.3 | 90.0 | 84.6 | 81.4 | 75.1 |
| Black or African American alone | 1.2 | 0.5 | 0.2 | 0.5 | 2.4 | 0.2 | 0.0 | 0.8 | 0.4 | 0.7 | 12.6 | 3.3 | 0.3 | 1.5 | 5.8 | 0.4 | 0.8 | 0.7 |
| American Indian alone | 13.4 | 0.0 | 6.0 | 9.0 | 0.0 | 5.5 | 0.0 | 41.1 | 6.9 | 2.9 | 0.0 | 0.2 | 1.9 | 2.6 | 0.1 | 5.0 | 9.0 | 16.5 |
| Asian alone | 2.0 | 0.0 | 0.1 | 1.5 | 0.0 | 1.4 | 0.0 | 0.0 | 0.1 | 0.3 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 1.0 | 0.8 | 1.0 |
| Native Hawaii & Other Pac Is. alone | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Some other race | 3.9 | 0.0 | 2.5 | 0.7 | 0.0 | 1.1 | 0.0 | 1.1 | 1.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.2 | 1.9 | 0.0 | 1.3 | 1.2 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Two or more races | 7.5 | 4.5 | 3.8 | 5.8 | 3.9 | 8.6 | 3.1 | 12.6 | 2.6 | 4.9 | 0.0 | 0.2 | 3.5 | 5.4 | 2.2 | 9.1 | 6.7 | 5.6 |
| Hispanic or Latino (of any race) | 9.9 | 1.1 | 3.9 | 3.3 | 0.0 | 3.0 | 0.5 | 5.3 | 5.1 | 2.4 | 2.1 | 0.0 | 5.6 | 6.6 | 2.3 | 12.8 | 5.0 | 5.2 |
| Not Hispanic or Latino (of any race) | 69.0 | 94.0 | 86.4 | 81.6 | 93.8 | 81.8 | 96.4 | 43.3 | 85.6 | 90.1 | 87.4 | 96.4 | 89.0 | 85.9 | 89.6 | 72.1 | 79.2 | 72.7 |
| **Percent of People by Race and Ethnicity Who Are Below Poverty** | | | | | | | | | | | | | | | | | | |
| White alone | 10.8 | 5.7 | 15.5 | 14.2 | 14.0 | 11.7 | 12.2 | 12.9 | 16.2 | 9.0 | 11.4 | 12.1 | 10.9 | 8.3 | 15.8 | 20.8 | 11.1 | 10.7 |
| Black or African American alone | 11.9 | 5.6 | 30.0 | 49.0 | 62.5 | 6.1 | 0.0 | 42.9 | 21.6 | 15.8 | 100 | 26.9 | 7.9 | 26.9 | 100 | 9.4 | 18.2 | 15.5 |
| American Indian alone | 45.0 | 0.0 | 75.0 | 58.9 | 0.0 | 32.9 | 0.0 | 34.8 | 32.3 | 24.7 | 0.0 | 12.5 | 24.5 | 20.5 | 3.2 | 87.0 | 36.5 | 34.9 |
| Asian alone | 28.7 | 0.0 | 3.0 | 44.8 | Na | 9.2 | 0.0 | 0.0 | 13.0 | 3.1 | 0.0 | 0.0 | 10.8 | 0.3 | 0.0 | 33.3 | 11.3 | 14.5 |
| Native Hawaiian & Oceanic alone | 0.0 | Na | 0.0 | 0.0 | Na | 4.7 | Na | 6.3 | 40.0 | Na | Na | Na | Na | Na | 0.0 | Na | 4.7 | 7.2 |
| Some other race alone | 28.1 | 0.0 | 54.4 | 19.1 | 0.0 | 17.1 | Na | 22.6 | 77.8 | 13.1 | 0.0 | 0.0 | 0.0 | 2.7 | 38.9 | 0.0 | 19.6 | 15.4 |
| Two or more races alone | 16.6 | 5.6 | 16.7 | 25.9 | 13.9 | 23.4 | 11.0 | 24.4 | 11.1 | 10.2 | 0.0 | 1.2 | 7.1 | 10.2 | 11.3 | 50.3 | 16.6 | 15.5 |
| Hispanic or Latino alone | 26.9 | 2.3 | 19.1 | 11.0 | 0.0 | 10.8 | 1.5 | 22.8 | 27.2 | 7.1 | 18.2 | 0.0 | 16.3 | 16.0 | 7.1 | 85.5 | 16.5 | 16.2 |
| Non-Hispanic/Latino alone | 10.6 | 5.7 | 15.6 | 14.5 | 14.0 | 11.8 | 12.3 | 12.8 | 16.0 | 9.0 | 11.4 | 12.2 | 10.6 | 8.1 | 16.4 | 18.3 | 11.0 | 10.6 |
| Two or more races | 4.8 | 4.1 | 3.2 | 2.5 | 3.8 | 3.7 | 0.9 | 8.2 | 3.1 | 2.9 | 3.4 | 1.8 | 3.6 | 3.8 | 2.8 | 4.0 | 3.8 | 3.4 |

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.

Medium Reliability: Data with CVs between 12 & 40% are in gray highlight to indicate that the values should be interpreted with caution.

Low Reliability: Data with CVs > 40% are displayed in dark gray with white font to indicate that the estimate is considered very unreliable.

~Poverty prevalence by race and ethnicity is calculated by dividing the number of people by race in poverty by the total population of that race.

* ACS 5-year estimates used. 2021 represents average characteristics from 2017-2021.

Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 50—Idaho Poverty by Race and Ethnicity by county in the Lolo National Forest Area of Influence**

| | Lewis | Idaho | Boundary | Clearwater | Latah | Bonner | Shoshone | Lemhi | Kootenai | Benewah | Nez Perce | Combined Counties | Idaho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Population in Poverty, 2021*** | 583 | 1,878 | 2,067 | 1,076 | 5,900 | 5,386 | 1,953 | 973 | 15,506 | 1,378 | 5,986 | 42,686 | 202,560 |
| White alone | 393 | 1,698 | 1,852 | 970 | 4,959 | 5,077 | 1,724 | 859 | 12,921 | 1,071 | 5,038 | 36,562 | 163,301 |
| Black or African American alone | 33 | 9 | 15 | 0 | 65 | 24 | 40 | 0 | 49 | 19 | 0 | 254 | 2,769 |
| American Indian alone | 66 | 23 | 93 | 23 | 63 | 73 | 11 | 0 | 597 | 226 | 388 | 1,563 | 5,623 |
| Asian alone | 0 | 1 | 46 | 0 | 232 | 9 | 0 | 5 | 205 | 0 | 200 | 698 | 3,575 |
| Native Hawaii & Other Pac Is. alone | 0 | 4 | 5 | 0 | 4 | 0 | 37 | 0 | 18 | 4 | 23 | 95 | 934 |
| Some other race | 64 | 110 | 41 | 19 | 89 | 46 | 0 | 28 | 43 | 7 | 54 | 501 | 13,042 |
| Two or more races | 27 | 33 | 15 | 64 | 488 | 157 | 141 | 81 | 1,673 | 51 | 283 | 3,013 | 13,316 |
| **All Ethnicities in Poverty, 2021*** | | | | | | | | | | | | | |
| Hispanic or Latino (of any race) | 67 | 152 | 121 | 45 | 402 | 202 | 187 | 59 | 980 | 62 | 362 | 2,639 | 38,337 |
| Not Hispanic or Latino (of any race) | 393 | 1,652 | 1,772 | 959 | 4,691 | 4,952 | 1,636 | 859 | 12,375 | 1,051 | 4,791 | 35,131 | 145,088 |
| **Percent of Population in Poverty** | | | | | | | | | | | | | |
| White alone | 67.4 | 90.4 | 89.6 | 90.1 | 84.1 | 94.3 | 88.3 | 88.3 | 83.3 | 77.7 | 84.2 | 85.7 | 80.6 |
| Black or African American alone | 5.7 | 0.5 | 0.7 | 0.0 | 1.1 | 0.4 | 2.0 | 0.0 | 0.3 | 1.4 | 0.0 | 0.6 | 1.4 |
| American Indian alone | 11.3 | 1.2 | 4.5 | 2.1 | 1.1 | 1.4 | 0.6 | 0.0 | 3.9 | 16.4 | 6.5 | 3.7 | 2.8 |
| Asian alone | 0.0 | 0.1 | 2.2 | 0.0 | 3.9 | 0.2 | 0.0 | 0.5 | 1.3 | 0.0 | 3.3 | 1.6 | 1.8 |
| Native Hawaii & Other Pac Is. alone | 0.0 | 0.2 | 0.2 | 0.0 | 0.1 | 0.0 | 1.9 | 0.0 | 0.1 | 0.3 | 0.4 | 0.2 | 0.5 |
| Some other race | 11.0 | 5.9 | 2.0 | 1.8 | 1.5 | 0.9 | 0.0 | 2.9 | 0.3 | 0.5 | 0.9 | 1.2 | 6.4 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Two or more races | 4.6 | 1.8 | 0.7 | 5.9 | 8.3 | 2.9 | 7.2 | 8.3 | 10.8 | 3.7 | 4.7 | 7.1 | 6.6 |
| Hispanic or Latino (of any race) | 11.5 | 8.1 | 5.9 | 4.2 | 6.8 | 3.8 | 9.6 | 6.1 | 6.3 | 4.5 | 6.0 | 6.2 | 18.9 |
| Not Hispanic or Latino (of any race) | 67.4 | 88.0 | 85.7 | 89.1 | 79.5 | 91.9 | 83.8 | 88.3 | 79.8 | 76.3 | 80.0 | 82.3 | 71.6 |
| **Percent of People by Race and Ethnicity Who Are Below Poverty** | | | | | | | | | | | | | |
| White alone | 13.2 | 11.5 | 17.0 | 13.3 | 15.1 | 11.9 | 14.5 | 11.7 | 8.5 | 13.3 | 13.9 | 11.2 | 10.6 |
| Black or African American alone | 84.6 | 100.0 | 57.7 | 0.0 | 15.0 | 18.0 | 40.4 | na | 13.0 | 31.1 | 0.0 | 20.3 | 24.6 |
| American Indian alone | 33.5 | 4.2 | 56.0 | 25.0 | 17.3 | 21.3 | 4.3 | 0.0 | 29.5 | 27.8 | 17.4 | 22.0 | 25.8 |
| Asian alone | 0.0 | 1.3 | 27.4 | 0.0 | 32.5 | 2.9 | 0.0 | 100.0 | 15.6 | 0.0 | 53.1 | 22.7 | 14.7 |
| Native Hawaiian & Oceanic alone | na | 100.0 | 4.3 | 0.0 | 10.3 | 0.0 | 100.0 | 0.0 | 10.8 | 12.1 | 74.2 | 18.1 | 32.1 |
| Some other race alone | 47.1 | 98.2 | 20.6 | 20.9 | 32.1 | 11.1 | 0.0 | 33.7 | 2.1 | 22.6 | 19.3 | 13.6 | 16.9 |
| Two or more races alone | 13.1 | 8.9 | 4.5 | 19.3 | 26.7 | 7.4 | 22.8 | 24.1 | 18.3 | 12.9 | 18.5 | 17.5 | 13.1 |
| Hispanic or Latino alone | 38.1 | 28.6 | 19.2 | 14.1 | 24.6 | 12.4 | 37.2 | 24.9 | 11.7 | 15.6 | 20.7 | 16.3 | 16.6 |
| Non-Hispanic/Latino alone | 13.4 | 11.4 | 16.8 | 13.4 | 14.8 | 11.8 | 14.0 | 11.7 | 8.4 | 13.3 | 13.6 | 11.0 | 10.1 |

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in gray highlight to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in dark gray with white font to indicate that the estimate is considered very unreliable.
~Poverty prevalence by race and ethnicity is calculated by dividing the number of people by race in poverty by the total population of that race.
* ACS 5-year estimates used. 2021 represents average characteristics from 2017-2021.
Data Sources: U.S. Department of Commerce. 2022. Census Bureau, American Community Survey Office, Washington, D.C.

**Table 51—Broadband access in area of influence***

| County | State | Broadband access score^ |
|---|---|---|
| Benewah County | ID | 1 |

| County | State | Broadband access score^ |
|---|---|---|
| Bonner County | ID | 1 |
| Boundary County | ID | 4 |
| Clearwater County | ID | 2 |
| Idaho County | ID | 0 |
| Kootenai County | ID | 5 |
| Latah County | ID | 4 |
| Lemhi County | ID | 3 |
| Lewis County | ID | 0 |
| Nez Perece County | ID | 5 |
| Shoshone County | ID | 2 |
| Beaverhead County | MT | 4 |
| Cascade County | MT | 5 |
| Deer Lodge County | MT | 4 |
| Flathead County | MT | 4 |
| Granite County | MT | 0 |
| Jefferson County | MT | 3 |
| Lake County | MT | 3 |
| Lewis and Clark County | MT | 5 |
| Lincoln County | MT | 2 |
| Mineral County | MT | 0 |
| Missoula County | MT | 5 |
| Powell County | MT | 3 |
| Ravalli County | MT | 2 |
| Sanders County | MT | 0 |
| Silver Bow County | MT | 5 |
| Teton County | MT | 2 |

*Data from Federal Communications Commission, Connect2Health Mapping Broadband Health in America 2017

^Broadband access score is based on access to calculated upload and download speeds and broadband adoption: 0 - 0% broadband availability; 1 - 20-40%; 3 - 40-60%; 4 - 60-80%; 5 - 80-100%

**Table 52—Rural Capacity Index**

| County | State | Rural Capacity Index |
|---|---|---|
| Benewah County | ID | 68 |
| Bonner County | ID | 81 |
| Boundary County | ID | 69 |
| Clearwater County | ID | 70 |
| Idaho County | ID | 70 |
| Kootenai County | ID | 93 |
| Latah County | ID | 95 |
| Lemhi County | ID | 68 |
| Lewis County | ID | 65 |
| Nez Perce County | ID | 91 |
| Shoshone County | ID | 66 |
| Beaverhead County | MT | 80 |
| Cascade County | MT | 89 |
| Deer Lodge County | MT | 68 |
| Flathead County | MT | 93 |
| Granite County | MT | 71 |
| Jefferson County | MT | 83 |
| Lake County | MT | 80 |
| Lewis and Clark County | MT | 94 |
| Lincoln County | MT | 69 |
| Mineral County | MT | 67 |
| Missoula County | MT | 96 |
| Powell County | MT | 67 |
| Ravalli County | MT | 81 |
| Sanders County | MT | 89 |
| Silver Bow County | MT | 88 |
| Teton County | MT | 68 |

Headwaters Economics. 2022. A Rural Capacity Map. Retrieved from: https://headwaterseconomics.org/equity/rural-capacity-map/

# 3.2 Public Information, Interpretation, & Education

## 3.2.1 Key Takeaways

- Connecting people to their environment and the natural and cultural history of the area is an important role of the Lolo National Forest. Relevant and timely public information, creative interpretation, and stimulating education help the Forest Service communicate with the public and enable visitors to be involved in the activities, actions, and expectations for activities on National Forest System lands. These connections provide opportunities for the development of stewardship ethics and appreciation for the natural and cultural history of these landscapes.
- The Lolo provides a variety of ways to learn about the Forest and participate in environmental education through information available on the website, in-person and on-line opportunities provided by staff and partners, and on-site interpretative materials and displays.
- Visiting interpretive areas has consistently been one of the top 5 uses by visitors. Continuing to operate and maintain interpretive areas recommended in the 2021 Biennial Monitoring Report.

## 3.2.2 Summary

The Forest operates two visitor centers. Savenac Historic Tree Nursery Visitor Center is open to the public seasonally from Memorial Day to Labor Day and provides self-guided tours year-round. The Visitor Center operates out of the previous administrative building used when the site was an active tree nursery. Additionally, the Forest has improved four of the historic Civilian Conservation Corps-era buildings on-site which may be rented for events or over-night accommodations. The Ninemile Remount Depot location also provides visitor services from Memorial to Labor Day and offers a self-guided tour. The Historic Ranger Station continues to operate as the office for the Ninemile Ranger District. At all District Offices, environmental education and interpretive materials can be obtained year-round. The Lolo Pass Visitor Center on the border of Idaho and Montana is also a popular stop year-round that provides visitor information about the Forest as well, but it managed by the Nez Perce-Clearwater National Forest.

Visitors can learn about the forest and its history at most recreation sites through the public website or site-specific brochures available at visitor centers and Ranger District offices. Additionally, several recreation sites provide on-site interpretive signage about the natural history and cultural context of the landscape. Not only can visitors learn about the variety of recreation opportunities available across the Forest from these resources, but also about the plant and wildlife communities, risks to forest health and the role of wildfire, past uses or events that have influenced the forest, and significant historical and pre-contact events that have taken place.

Some of the specific recreation sites that provide interpretive nature trails and environmental education opportunities include: Big Larch Campground, Blue Mountain Recreation Area and Maclay Flat Nature Trails, Cabin City Campground, Hiawatha Trail, Ferry Landing Picnic Area, Clearwater River Canoe Trail and associated hiking trail, Seth Diamond Trail, Fort Fizzle Historic Site and Picnic Area, Grand Menard Discover Trail and Picnic Area, Historic Lolo Trail at Howard Creek, Lee Creek Campground and Picnic Area, Lolo Creek Campground and Picnic Area, Quartz Flat Campground, and Rock Creek Microburst Viewing site. Unique opportunities, such as ‘Campfire Chats’ at Big Larch Campground, offer another way to connect visitors to the forest. Recreation sites specifically developed for wildlife viewing include Petty Creek, Koo-Koo-Sint, and Spring Creek Bighorn Sheep Viewing Areas, as well as the Clearwater River Canoe Trail and associated Seeley Lake Wildlife Viewing Blind site.

An updated interpretive plan for the Nez Perce (Nee-Me-Poo) National Historic Trail was established in 2016 through the coordination of the Forest Service (Regions 1, 2, and 4), the Bureau of Land Management, and the National Park Service. This plan describes the interagency and tribal coordination approach to develop updated ways to share the trail's story with visitors in a variety of media. Fort Fizzle Historic Site and Picnic area is the only Nez Perce National Historic Trail interpretive site managed by the Lolo National Forest. Information on this Historic Trail is also provided at the Lolo Trail at Howard Creek trailhead, but the focus is largely about the Lewis & Clark Expedition history of the area.

Wilderness education plans are an element of the National Wilderness Stewardship Performance framework. In January 2023, the Forest Service prepared an Education Plan for the Bob Marshall Wilderness Complex that outlines goals and objectives to carry forward environmental education supporting the Wilderness Stewardship Performance framework from 2023 through 2028. The Welcome Creek Wilderness and Rattlesnake Wilderness both have education plan as well.

Forest staff also engage in interpretation and environmental education during in-person events held on-Forest and in communities. Many non-profit organizations, state and local government agencies, and educational institutions enhance these programs and hold partner-led events. Types of events include youth and school-aged groups covering a multitude of forest and resource related topics and activities – fire safety, fishing, bear awareness, historic field trips, orienteering and using a compass and GPS, pollinators, birds and other wildlife. Youth Conservation Corps and summer camps are also supported through the Forest and partners. In addition to presence at community events, the Lolo supports programs about avalanche Safety and Education, Fire-wise and Fire Safety, Be Bear Aware, trail ethics, and educational programs about resource management, public land stewardship, wildlife, and forest communities.

### 3.2.3 Status and Trends

Environmental education is critical to connect people to their public lands. Over the years, the ability for the Forest Service to solely provide these services outside of visitor center facilities and develop interpretive programs has declined. The agency has shifted to partnerships, special hiring authorities, and interagency coordination to support environmental education and interpretation opportunities. Many of the on-site interpretive information could be updated or improved if capacity and funding in the Forest or through partnerships was available.

The most recent National Visitor Use Monitoring survey results indicated that interpretive areas were among the top five targeted special facilities or areas they used during their visit (U.S. Department of Agriculture 2023c). This was also reflected in the 2006 and 2011 National Visitor Use Monitoring results (U.S. Department of Agriculture 2023a;b). Recommendations included in the 2021 Biennial Monitoring and Evaluation Report (U.S. Department of Agriculture 2022f) highlighted maintaining interpretive sites, congressionally designated areas, and scenic byways, along with addressing deferred maintenance, resource damage or health and safety conditions, and improve accessibility (ibid)(U.S. Department of Agriculture 2022f).

The Forest Service began using the Nature Watch, Interpretation, and Conservation Education database in 2001 to capture outreach events held for the purposes of environmental education and interpretation. This information provides insight to the types of outreach the Forest and partners have provided, the number of participants that engaged during those events, and the types of audiences reached. While reporting in the system was inconsistent when first established, the past 13 years of data presents a more reliable portrait of the types of events supported by Forest Service staff and state, local, educational, and non-profit partners. Between 2010 and 2022, the Forest and partners engaged in 286 interpretive and environmental education events averaging about 22 events per fiscal year reaching nearly 5,000 participants. Youth populations represented a large portion of participants for several years but fell off during 2019-2021 likely due to the Covid-19 Pandemic. Excluding those years, over half of all event participants were within the youth age group.

**Table 53—Summary of environmental education and interpretation events held and participants, as reported in the Nature Watch, Interpretation, and Conservation Education database from 2010 to September 2022**

| Fiscal year | Number of events held | Total audience | Number of non-youth | Number of youth | Percentage of youth participants |
|---|---|---|---|---|---|
| 2010 | 5 | 1,729 | 420 | 1,309 | 76 |
| 2011 | 8 | 7,110 | 2,673 | 4,437 | 62 |
| 2012 | 15 | 2,723 | 1,217 | 1,506 | 55 |
| 2013 | 9 | 2,280 | 244 | 2,036 | 89 |
| 2014 | 11 | 4,810 | 3,810 | 1,000 | 21 |
| 2015 | 16 | 6,922 | 4,938 | 1,984 | 29 |
| 2016 | 54 | 7,881 | 3,662 | 4,219 | 54 |
| 2017 | 51 | 6,082 | 3,498 | 2,584 | 42 |
| 2018 | 26 | 4,753 | 556 | 4,197 | 88 |
| 2019 | 37 | 5,245 | 3,502 | 1,743 | 33 |
| 2020 | 11 | 516 | 516 | 0 | 0 |
| 2021 | 23 | 6,458 | 4,301 | 2,157 | 33 |
| 2022 | 20 | 5,210 | 425 | 4,785 | 92 |
| **Total** | **286** | **150,293** | **118,336** | **31,957** | **21** |

# 3.3 Fire Management and the Wildland Urban Interface

## 3.3.1 Key Takeaways

- Fire plays an important ecological role on the Lolo National Forest with on average over 200 fires of various causes started every year since 1992. In addition, from 1985 to 2020, approximately 640,923 acres have burned on the Lolo National Forest.
- New methods to assess fire hazard and risk have emerged and been brought to bear on fire management on the Lolo National Forest, resulting in the development of Strategic Fire Management Zones.
- Over 300,000 acres of hazardous fuel treatments have been accomplished in the Plan area over the last two decades, much of it using prescribed fire and much of it focused on wildland urban interface areas of the Forest.

## 3.3.2 Summary

Fire is a natural and essential ecological disturbance process that occurs along a spectrum of differing intensity, severity, and frequency that allows ecosystems to function in a healthy and sustainable manner. Fire is a necessary disturbance process within the Lolo National Forest. It has shaped the structure and composition of forested and non-forested ecosystems. Fire influences the pattern of vegetation across the landscape and is a critical part of the life cycle for many plant and wildlife species.

Fire is not a simple process, and many factors influence its character, including topography (slope, aspect. elevation), fuel loadings, vegetation structure and composition, and climate and weather. Fuel loadings and the associated live and dead fuel moistures influence fire behavior. Other disturbance processes, such as insect infestations, also affects fire behavior with changes to canopy fuel moistures, standing dead trees, and ultimately the down woody fuel conditions. Fires on the forest generally move from west to east with prevailing winds. Dry cold fronts also produce northwest wind flows that move fires from northwest to southeast. Without wind as the driving mechanism, terrain and diurnal heating are large influences on fire movement. Fire generally moves uphill faster than downhill. The term wildland fire, as used in this assessment, refers to any vegetation fire occurring in on the landscape and is specific to either planned (prescribed) and/or unplanned (wildfire) ignitions. Wildfire should be evaluated based on the temporal and spatial role it plays on the ecosystem and/or how it contributes to hazardous fuel reduction.

While wildfire plays an essential role in maintaining the health and function of the Forest's plant and animal communities, it can also threaten human safety, health, livelihoods, homes, and property. Over the past 150 years, facilities, and infrastructure to support activities such as recreation, outfitting, mining, timber extraction, farming and ranching have been established on lands surrounding and in the Forest.

In addition, the development of residences has occurred on private lands on the borders of Forest, as well as on private inholdings within the Forest. The wildland-urban interface is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. This describes an area within or adjacent to private and public property where mitigation actions can prevent damage or loss from wildfire. The extent of the wildland urban interface was estimated using a collection of "County Wildfire Protection Plan" data (Table 54). Approximately 1,314,494 acres of wildland urban interface occur in the plan area. The wildland urban interface continues to expand as people move into and build homes in wildland areas and County Wildfire Protection Plans are periodically updated. The wildland urban interface is likely to increase. In addition, definitions of wildland urban interface and mapping techniques may also evolve over time.

**Table 54—Acres of wildland-urban interface estimated using individual county wildfire protection plans**

| County Name | Acres |
|---|---|
| Flathead County | 30,521 |
| Granite County | 109,507 |
| Mineral County | 360,173 |
| Missoula County CWPP | 313,002 |
| Powell County | 39,337 |
| Sanders County | 326,618 |
| Seeley-Swan Fire Plan | 135,335 |
| **Total** | **1,314,494** |

## 3.3.3 Status and Trends

### National Trends in Fire and Fuel Management

In January 2022, the Chief of the Forest Service launched an aggressive 10-year strategy to address the wildfire crisis in the places where it poses the most significant threats to communities. This strategy, called “Confronting the Wildfire Crisis: A Strategy for Protecting Communities and Improving Resilience in America’s Forests” (U.S. Department of Agriculture 2022b). This effort builds on thirty years of historic investment of congressional funding combined with scientific research and planning at the national scale in order to dramatically increase the scale and pace of forest health treatments. The chronology of this effort is documented in “Confronting the Wildfire Crisis: A Chronicle From the National Fire Plan to the Wildfire Crisis Strategy,“ (U.S. Department of Agriculture 2022e) and is summarized below.

In 1988, fire burned much of Yellowstone National Park despite the best efforts of the Nation’s wildland firefighters. Subsequent wildfires and fire seasons worsened and fire suppression costs soared in the 1990s, especially in 1994 and 1996, and the Forest Service was becoming increasingly aware of rising wildfire risk from forests overgrown with fuels after decades of fire exclusion. In 1995, the five Federal land management agencies1 responsible for wildland fire management adopted an innovative fire management policy, a radical departure from the past. The policy called on Federal land managers to integrate wildland fire “as a critical natural process” into their land and resource management plans, allowing wildland fire “as nearly as possible … to function in its natural ecological role” (U.S. Department of the Interior and U.S. Department of Agriculture 1995). Accordingly, with congressional support, the Forest Service stepped up the pace of fuels and forest health treatments, including the use of wildland fire. In fiscal years 1997–2000, congressional allocations for hazardous fuels treatments more than doubled, rising from $29.1 million to $71.2 million.

In 2001, under former President George W. Bush (2001–09), the administration coordinated with the Western Governors’ Association to formulate a national strategy for reducing wildfire risk, followed by an implementation plan in 2002. Drawing on national data about fuels and fire return intervals, Forest Service scientists have long published wildfire risk assessments. A 2002 study estimated that 73 million acres on the National Forest System were at moderate to high risk of catastrophic wildfire (Schmidt et al. 2002). In 2003, the focus shifted to the Healthy Forests Initiative, leading to passage of the Healthy Forests Restoration Act of 2003. Nevertheless, record fires continued to mount during worsening fire years in the West. The area burned nationwide exceeded 8 million acres in 2004 and 2005 and 9 million acres in 2006 and 2007. In response, Congress passed the FLAME Act of 2009, which set up contingency funds that the Federal fire organizations could draw on.

The Collaborative Forest Landscape Restoration Program was established by Congress in 2010. Work begun in 2008 by Federal, State, and other fire organizations led to adoption of the National Cohesive Wildland Fire Management Strategy in 2014; a strategy for restoring forest health, reducing wildfire risk, and increasing safe and effective wildfire response nationwide. In 2018, the Forest Service launched Shared Stewardship agreements with States and other partners to reduce wildfire risk across shared landscapes.

Due to the rising risk, Congress asked the administration under former President Donald Trump (2017–21) to “review and update the National Fire Plan, as needed.” In response, the Forest Service launched “The Case for Change,” which focused on the creation of a year-round workforce for wildfire response. First presented to the Forest Service’s Senior Fire Leaders in April 2019, the initiative also called for more integration of the agency’s fire and fuels staff and resources and for getting more low-intensity fire on the landscape. In fall 2020, at the request of Congress, the Forest Service delivered a “thought piece” paper on how to greatly scale up fuels treatments and the projected costs of doing so.

From fall 2020 to spring 2021, Deputy Chief Phipps and other members of the Forest Service’s Executive Leadership Team met with counterparts from the National Association of State Foresters, American Forest Foundation, The Nature Conservancy, American Forests, and other organizations to agree on a common vision for the future of America’s forests. After another historical fire year in 2021, Congress passed the Infrastructure Investment and Jobs Act. The new legislation invests about $5.5 billion in lands and resources entrusted to the Forest Service, as well many of the landscapes and watersheds managed together with Federal, Tribal, State, private and other partners.

As of 2023, the Forest Service has established a strategy for confronting the wildfire crisis by dramatically increasing fuels and forest health treatments by up to four times the current treatment levels in the West. Under this new fuel management paradigm, the Forest Service will work with partners in the West to focus fuels and forest health treatments more strategically and at the scale of the problem, using the best available science as the guide (Ager et al. 2019). The work will focus on key “firesheds”, large forested landscapes with a high likelihood that an ignition could expose homes, communities, and infrastructure to wildfire. Firesheds, typically about 250,000 acres in size, are mapped to match the scale of community exposure to wildfire. In order to reduce wildfire risk to communities, forest health, and other values, science suggests that fire-adapted conditions should be restored on 35 to 45 percent of a fireshed through a range of fuels and forest management activities, including mechanical thinning and prescribed fire, followed by maintenance treatments at intervals of 10 to 15 years. The Forest Service has begun work with partners to identify and prioritize such projects and have launched a number of them in the first two years of the effort (U.S. Department of Agriculture 2022c). Even though much of the Lolo National Forest is in high risk firesheds, no fireshed within the boundaries of the forest have been selected as of yet for this initial work.

## Fire Hazard and Risk

The Lolo National Forest recently developed a comprehensive wildfire hazard and risk assessment. The risk assessment process provides a template that allows risk maps to link the probability of fire and fire intensity with potential resource benefit and loss of resources and assets. The assessment process is temporally scalable by including short-term versus long-term trade off analysis. Analysis results can be used by planners and managers to prioritize projects and investments to reduce wildfire risk. The process can be used to weigh management options in the context of land and resource management plans, collaborative frameworks, community protection plans and other landscape planning efforts. This process initially derives, through modeling, the likelihood and intensity of potential fire on the landscape using the Large Fire Simulator developed by the Rocky Mountain Research Station (Finney et al. 2011). Using wildfire modeling techniques under a full range of burning conditions, the modeling effort produced probability surfaces of fire hazard and risk for the plan area. Figure 32 shows two examples of these surfaces, the burn probability layer and the probability of flame lengths over four feet layer.

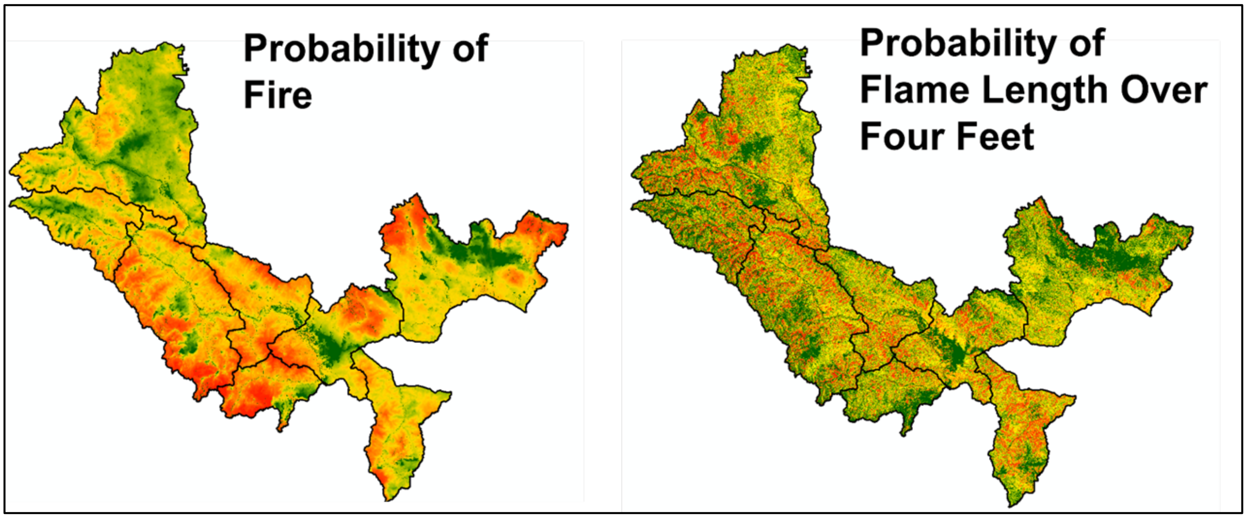


**Figure 32—Two examples of probability surfaces generated by the Large Fire Simulator (FSIM) model: the burn probability layer and the probability of flame lengths over four feet layer. The red represents high values, the yellow colors represent moderate values, and the green represents low values**

The next phase of the process integrated Highly Valued Resources and Assets, which are natural resources and physical assets whose susceptibility to fire must be considered when making fire management decisions (Calkin et al. 2010). Resource specialist quantified the response function for each Highly Valued Resource and Asset in terms of positive or negative change because of experiencing fire based on the conditional probabilities of the various flame length classes. Additionally, these Highly Valued Resources and Asset values were assigned relative importance values to allow for an integrated measure of landscape risk for the forest. Finally, these values were integrated into areas of the forest with similar protection, restoration, or maintenance objectives and assigned classes accordingly called Strategic Fire Management Zones shown in figure A1-08.

This approach was very similar to the state of Montana's efforts to quantify wildfire risk and establish priority treatment areas (Montana Department of Natural Resources and Conservation 2020). Using wildfire hazard potential, in conjunction with mapped areas of wildland urban interface and forest health data, the Montana Forest Action Advisory Council (MFAAC) identified approximately 9.1 million acres of forested land across the state that were termed "areas with elevated fire risk and degraded forest health." A large proportion of acres on the Lolo National Forest were also identified as high risk for many of the same reason but using different methodologies and coincide with acres identified by the MFAAC.

## Fire Management

Fire management strives to balance the natural role of fire while minimizing the impacts from fire on values to be protected, especially in the wildland urban interface. This can be accomplished by implementing a coordinated risk management approach to promote landscapes that are resilient to fire-related disturbances and preparing for and executing a safe, effective, and efficient response to fire. Fire management is achieved through prescribed fire, which includes management-ignited fire and naturally ignited wildfire (ignited by lightning as opposed to humans), and mechanical methods. In many cases, natural ignitions - primarily resulting from lightning - can be managed without a full suppression response. Management can range from limiting human activity within the vicinity of the fire, monitoring fire behavior, to aggressive suppression of those areas of the fire at times and places where the fire may affect human values or ecosystem components.

Full suppression of a fire is a management choice utilized when fire poses an unacceptable risk to human values, ecosystem components, or when a fire is caused by human agency and is unplanned (e.g. abandoned campfire, arson, or equipment operation). Forest Service policy dictates that every management response to wildfire must include some aspect of a protection objective (National Interagency Fire Center 2019). This response can vary from monitoring the fire under conditions that are conducive to obtaining resource benefits to an aggressive suppression effort to protect communities and natural resources from potential damages. Factors in all wildfire management decisions include firefighter safety; public safety; risk to property; fire resource availability; national, regional, and forest priorities; costs; and potential resource benefits. All human-caused wildfires require a suppression strategy.

Despite a legacy of fire suppression over the last century, fire still plays a major role on the Lolo National Forest. Between 1992 and 2011, an average of 246 fires of various causes occurred within the plan area according to the most recent fire occurrence data (https://www.fs.usda.gov/rds/archive/Catalog/RDS-2013-0009.5). Approximately 46% of these are human caused while about 50% are natural. The remainder were undetermined cause. During a longer time span, from 1985 to 2020, approximately 640,923 acres burned on the Forest, according to Monitoring Trends and Burn Severity data (https//:www.mtbs.gov). 175,928 acres of that was high severity fire with 75% or greater mortality of trees. The percent high severity within these burn perimeters varied by fire year and ranged from 3% to 50% and averaged about 25%.

Current direction fire management in the 1986 Forest Plan varies mainly by designated management area (Table 55). Full suppression responses will vary depending on the individual fire and can include strategies to confine the fire. It is possible for a fire to be managed using multiple strategies including resource-benefit. All wildfire management decisions will be made with primary consideration given to both the health and safety of the public and of fire personnel. All decisions to manage wildfire will be made and documented through a decision support process and will emphasize public and fire personnel safety. With all wildland fire management actions, it is critical to only implement actions that can be successful while considering actual values at risk with the least exposure necessary.

**Table 55—Summary of the fire management direction in the 1986 Forest Plan**

| Management Area | Fire Management Direction in the 1986 Forest Plan |
|---|---|
| MR-1 | Wildfires will be confined, contained, or controlled as provided for by criteria and guidelines for each fire management unit. Lolo NF LMRP. 1986. |
| MR-2 | Approved wilderness fire management direction will be implemented that permit prescription fires to perpetuate the natural diversity of plant and animal communities. Wildfires will be confined, contained, or controlled as provided for by criteria and guidelines for each fire management unit. (MA 12 Pg III-37) |
| MR-3 | Wildfires will be controlled to protect old-growth qualities and resource objectives associated with this type. Lolo NF LMRP. 1986. MA 21 Pg III-105 |
| MR-4 | Wildfires will be controlled to protect structures and improvements. Lolo NF LMRP. 1986. MA 2 Pg III-8, MA 4 Pg III-13, MA 5 Pg III-15, MA 8 Pg III-24, MA 9 Pg III-27. |

| Management Area | Fire Management Direction in the 1986 Forest Plan |
|---|---|
| MR-5 | Wildfires will be controlled to safeguard life and property. (MA 7 Pg III-21) |
| MR-6 | All Land recently acquired that have not been allocated a Management designation. |

## Fuel Treatment

The goal of fuel treatments is to manipulate or remove of fuel to reduce the likelihood of ignition and/or to lessen potential damage and resistance to control (https://www.nwcg.gov/sites/default/files/data-standards/glossary/pms205.pdf). Treatments focus on restoring and maintaining essential ecological disturbance processes that occur along a spectrum of differing intensity, severity, and frequency that allows ecosystems to function in a healthy and sustainable manner. Additionally, the emphasis of fuel treatments is to restore and/or maintain fire regimes, reduce negative impacts of wildfires to watershed health, wildlife habitat, and to protect communities' values at risk. There was general agreement that thinning and burning treatments have positive effects in terms of reducing fire severity, tree mortality, and crown scorch across a wide array of western forest types (Kalies and Yocom Kent 2016).

Over the last two decades, the Lolo National Forest has planned and/or implemented over 344,000 acres of hazardous fuel treatments through a variety of treatments across the landscape, including over 166,000 acres of broadcast burning (Table 56). From 2018-2020, the Forest accomplished both wildland urban interface and non-wildland urban interface treatment acres towards vegetative treatments consistent with the 1986 Forest Plan. The wildland urban interface acres reported accounted for 65 percent of the Forest target, while the non-wild urban interface acres accounted for 35 percent. A slight decrease from the projected 70 percent/30 percent split for wildland urban interface and non-wildland urban interface can be attributed to managing ecosystems at a larger scale where some landscape scale vegetative treatments occurred. Both types of treated acres have seen a downward trend in treated acres since 2018; however, the forest target percentage achieved of treated acres remains above 100 percent. Wildland-urban interface areas continue to be a focus of fuels treatments as the Forest emphasizes the need to protect life, property, and highly valued resources and assets.

**Table 56—Acres of hazardous fuel treatments by treatment type across the Lolo National Forest over the last two decades**

| Treatment type | Acres |
|---|---|
| Biomass Removal | 43,535 |
| Broadcast Burn | 166,174 |
| Machine Pile | 21,818 |
| Machine Pile Burn | 26,211 |
| Rearrangement of Fuels | 34,574 |
| Thinning | 52,041 |
| **Total** | **344,353** |

The slight decrease in percentages of target met is due to policy no longer including wildfire acres as forest target acres to report. 1986 Forest Plan direction does not allow for managing fire as resource benefit. As a result, there will not be any decisions for wildfire management on the Forest using this language. Wildfire acres that achieved desired vegetation management conditions were reported for annual primary forest target acres in 2016 and 2017. Beginning in 2018, National direction no longer allowed counting wildfire acres towards a primary target. Contributing to implementation of the Wildfire Crisis Strategy is a management emphasis for the Lolo National Forest.

# 3.4 Cultural Resources and Areas of Tribal Importance

## 3.4.1 Key Takeaways

- The history and culture of the plan area is demonstrated by the rich indigenous history since time immemorial, as well as the history of rural communities and land uses that arose following the arrival of Lewis and Clark.
- Sacred sites, sacred places, tribal cultural landscapes, and traditional cultural properties have religious, cultural, and traditional importance to indigenous individuals and Indian Tribes. Traditional cultural knowledge, Traditional Cultural Properties, Sacred Sites and other places of tribal importance are now part of agency Government-to-Government and National Historic Preservation Act dialogue and interaction with tribes.
- Approximately 1,008 archaeological, traditional cultural properties, and historic sites are recorded on the Lolo National Forest, including sites on the National Register of Historic Places. The condition of these features varies; taken as a whole, historic properties across the planning area exist in fair condition. The chance of discovering additional cultural resources is high.
- The Lolo National Forest remains committed to working closely with tribes during the revision process to continue furthering our understanding of areas of tribal importance, and how the revised plan can honor and support tribal interests including their ability to exercise their treaty rights on lands managed by the agency.

## 3.4.2 Summary

Western Montana was once a kaleidoscope of indigenous (American Indian) cultures. The area now referred to as the Lolo National Forest is the ancestral homeland and travel way of native groups. Today, these groups retain an active culture with an unbroken tie to the area. Aboriginal use of the plan area over the centuries is manifested by hundreds of archaeological sites, sacred sites, and other areas of traditional cultural importance. The arrival of Lewis and Clark and the Corps of Discovery in 1805 marks the beginning of the historic period for central Montana. Following the Corps of Discovery's eastward departure, a slow trickle and then a tide of trappers and explorers entered western Montana. The entry of the railroads boosted the agricultural industry considerably. Not only did railroad access provide transport for produce, but also the transportation access sought out and attracted farmers to Montana. The cattle industry began with the use of the Oregon Trail in the 1840s. Continued mining and small-scale lumbering, ranching, and homesteading typified the use of the planning area during the 1870s and 1880s. The late 1910s and early 1920s brought severe drought and depression. Mapping of the Forest occurred with the establishment of initial communication lines, fire lookout locations and administrative sites.

Numerous laws, regulations, and policies govern the use and administration of cultural resources on National Forest System lands. The most prominently used law is the National Historic Preservation Act, which requires review of agency projects by State Historic Preservation Officers for protecting (Section 106) and enhancing (Section 110) cultural resources. Other commonly used regulations include the Archaeological Resource Protection Act, the Native American Graves Protection and Repatriation Act, and the American Religious Freedom Act. National laws and regulations are also interpreted in Forest Service manuals, handbooks, and regional guides.

## Tribal Perspectives and Areas of Tribal Importance

Tribes are sovereign nations with whom the Forest Service maintains government-to-government relationships. Each Tribe has unique rights, interests, and governing processes, necessitating unique coordination and consultation to ensure the Forest Service meets its trust responsibilities to the Tribes. Trust responsibility is the U.S. Government's permanent legal obligation to exercise statutory and other legal authorities to protect tribal lands, assets, resources, and treaty rights. Figure 33 provides a map of treaty rights and land cessions within and surrounding the Lolo National Forest.


**Figure 33—Map of treaty rights and land cessions in and surrounding the Lolo National Forest**

Some Tribes have reserved treaty-protected rights while others have rights established by Executive Order or statue. Among the items reserved by Tribes in exchange for land, are the rights to hunt, gather, and fish in a manner that would allow them to maintain their traditional way of life on open and unclaimed lands. "Open and unclaimed lands" may include public lands outside of the Tribe's ceded territory and forest lands are generally held to be "open and unclaimed." It is the Forest Service' responsibility to accommodate reserved treaty rights including maintaining and improving the wildlife, fish and plant habitats upon which the Tribes rely.

The Forest Service has obligations under the American Indian Religious Freedom Act of 1978 to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indian (Public Law 95-341). Executive Order 13007 of 1996 further directs federal agencies to accommodate access to, and ceremonial use of, Indian sacred sites by Indian religious practitioners and to avoid adversely affecting such sites. Consultation with recognized tribal governments is further defined and required by the Native American Graves Protection and Repatriation Act of 1990 (Public Law 101-601), the 1992 amendments to the National Historic Preservation Act, and the 1999 revisions to the implementing regulations in 36 CFR Part 800; Protection of Historic Properties. These obligations are applicable to all management actions no matter where they occur on the Forest.

Sacred sites, sacred places, tribal cultural landscapes, and traditional cultural properties have religious, cultural, and traditional importance to indigenous individuals and Indian Tribes. Traditional cultural properties are managed under the authority of the National Historic Preservation Act. They are, by definition, eligible for listing on the National Register and must be a tangible property, that is, a district, site, building, structure, or object as defined in 36 Code of Federal Regulations 64.4.

Sacred sites and sacred places important to Native Americans are managed under the authority of Executive Order 13007: Indian Sacred Sites. Executive Order 13007 defines a Native American or Indian sacred site as "any specific, discrete, narrowly delineated location on federal land that is…determined by an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the Indian tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site." Indian Sacred Sites are identified by an Indian Tribe or indigenous individual determined to be an authoritative representative of an Indian religion. It is the Forest Service' responsibility to protect sacred sites, manage for sacred sites, and provide for tribal traditional and cultural practices. This includes protecting the physical integrity of these sites and access to them.

The information on these resources is provided by cultural resource data for the Forest. In addition, tribal knowledge and perspectives on cultural resources complement formal resource surveys and research. Their systems of knowledge and belief are increasingly accommodated in agency cultural resource management practices. Traditional ecological knowledge, sacred sites, and other places of tribal importance are now part of agency government-to-government and National Historic Preservation Act dialogue and interaction with tribes. The Lolo National Forest's heritage program considers traditional ecological knowledge as an important source of information.

## Cultural and Historical Resources

The history of the planning area left behind hundreds of cultural and historic resources, and their condition varies by resource class, location, and age. Approximately 1,008 archaeological, traditional cultural properties, and historic sites are recorded on the Forest, including sites on the National Register of Historic Places. "Priority assets" is a special Forest Service category that demonstrates a distinct value to the Lolo National Forest and are, or should be, actively maintained.

Historic resources related to early logging and mining practices in the area provide a tie to the early development of many rural communities and remain important to those communities today.

The Nez Perce National Historic Trail, commemorating the flight of members of the Nez Perce Tribe in 1877, also crosses the Lolo National Forest on the southwest border of the Missoula Ranger District.

Sacred sites and traditional cultural properties have religious and/or traditional importance to individuals or cultural groups. Both may be difficult to identify using standard field survey methods and both require consultation with Tribal Historic Preservation Offices and the Montana State Historic Preservation Office. The difference is not in their importance, but rather under which authority they are managed and how they are identified. Traditional cultural properties are managed under the authority of the National Historic Preservation Act. They are, by definition, eligible for listing on the National Register and must be a tangible property, that is, a district site, building, structure, or object as defined in 36 CFR 64.4.

## 3.4.3 Status and Trends

### Tribal Perspectives and Areas of Tribal Importance

Cultural resource law and practice is primarily based in the perspective and tradition of western science. Cultural sites and their material cultural can be studied and classified to gain knowledge about human activities that occurred at those places in the near or distant past (Deaver and Kooistra-Manning 1995). In contrast, tribal people do not readily distinguish between the past and present or the living and the dead (ibid). Cultural sites embody the physical and spiritual world and knowledge about them is derived from traditional practices, place names, and oral tradition. Tribal people have always been connected to these places and treat them with great respect and some feel there is little need to investigate them in the tradition of western science and archaeology because their importance is self-evident.

In agency land management and cultural resource management practice is it important to understand where these perspectives overlap and diverge. Systems of knowledge and belief are increasingly accommodated in agency cultural resource management practices in accordance with federal treaties, laws, executive order, policies, and procedures. Traditional cultural knowledge, Traditional Cultural Properties, Sacred Sites and other places of tribal importance are now part of agency Government-to-Government and National Historic Preservation Act dialogue and interaction with tribes. In these endeavors, confidentiality of information is paramount. This is a work in progress and the Lolo National Forest's heritage program will continue to play an important role in shaping outcomes and opportunities.

Native Americans used many plants in different ways, including for food, medicine, and clothing. Pioneers and settlers also learned how to use native plants. These plant species are still used today by Native Americans and others for the same purpose. The Natural Resources Conservation Service has listed several plant species that are considered culturally significant (Casey and Wynia 2010). Several culturally important plant and fungi species, including those that have been used historically or presently for ceremonies, rituals, nutrition, or medicinal purposes, are present in the plan area. Small camas (*Camassia quamash*), thinleaf huckleberry (*Vaccinium membranaceum*), chokecherry (*Prunus virginiana*), common beargrass (*Xerophyllum tenax*), and bitterroot (*Lewisia rediviva*). While small camas, thinleaf huckleberry, chokecherry, and bitterroot are prized for their edibility, common beargrass is important to western North American indigenous peoples for basketry, regalia, and medicinal purposes. Morel (*Morchella spp.*) mushrooms are a culturally important edible fungi species.

Tribal perspectives include ongoing discussions around emerging issues and potential impacts to areas of tribal importance. For example, a recent indigenous panel on the "Impacts of Recreation to Cultural Resources" at the 2022 Crown Managers Partnership Annual Forum identified potential negative impacts from new and emerging recreation technologies that present important considerations for planning.

Traditional Cultural Knowledge is important and may be considered regarding traditional forest-related knowledge using five criteria for distinguishing the unique character of traditional knowledge: (1) its attention to sustainability; (2) relationships to land; (3) identity; (4) reciprocity; and (5) limitations on market involvement (Trosper et al. 2012). Traditional knowledge should continue as a high priority throughout the planning process. Work is currently ongoing with tribes to provide additional description and understanding of the areas of tribal importance for each geographic area.

### Cultural and Historical Resources

The term "cultural resource" refers to an object or definite location of human activity, occupation, or use identifiable through field survey, historical documentation, or oral evidence (Forest Service Manual 2360). Cultural resources are prehistoric, historic, archaeological, or architectural sites, structures, places, or objects and traditional cultural properties (ibid). Cultural resources include the entire spectrum of resources for which the Heritage Program is responsible for from artifacts to cultural landscapes without regard to eligibility for listing in the National Register of Historic Places (ibid).

Not every cultural resource in the plan area lends itself to study or public use, but for those that do, the Lolo National Forest should offer opportunities to realize the property's benefits, which may be scientific data, education through interpretation, use, or volunteerism. The following examples are opportunities for the study and/or public use of cultural resources (Heritage Program Managed to Standard 2009):

- Adaptive Reuse - administrative or public use of historic properties that furthers the conservation and maintenance of the property and serves the administrative, recreational, education, economic, social, or other purposes essential to the mission of the Forest Service.
- Interpretation - includes media such as (but not limited to) interpretive signing, a website or brochure, and guides for a driving/walking tour.
- Public Dissemination - the presentation of papers using data derived from cultural resources studies in the plan area at local, regional, and national professional and avocational conferences and/or their publication in professional literature.
- Scientific Investigation - professional research and investigation that derives a tangible agency or public benefit, receives appropriate Tribal, State Heritage Protection Office, or other interested party review and consultation, is legally permitted and authorized, and is completed and documented in a professional and timely manner.
- Windows on the Past - the umbrella program for Forest Service heritage public education and outreach activities and projects. Examples of Windows on the Past projects include, but are not limited to Passport in Time, Heritage Expeditions and Excursions, historic recreation rentals (adaptive reuse), volunteer site stewards, interpretation, and conservation education.

The Forest has not been fully inventoried for cultural resources. Most inventories occurred under the authority of National Historic Preservation Act. They are largely project-driven and have focused on areas of Forest Service management for vegetation treatment, recreation, special uses, and engineering projects. Many areas have low cultural resource potential. However, the chance of discovering additional cultural resources is high in areas that have not been inventoried, especially outside of project areas, and in some areas that have received previous inventories due to new information or changed field conditions.

- Approximately 1,008 cultural resource sites reflecting the broad spectrum of prehistory and history are currently identified in the planning area.
- According to criteria outlined in 36 Code of Federal Regulations 60.4, 244 sites have been determined to be historically insignificant. A total of 508 sites are not yet evaluated and therefore are treated as significant and eligible to be listed on the National Register and require management consideration by the Forest.
- 13 historic properties are listed on the National Register of Historic Places, including one historic district with eight contributing properties and features, one historic landscape, and one historic landmark with two contributing properties.
- In addition to the National Register of Historic Places sites, the planning area has 1 traditional cultural property.
- An additional 231 historic properties have been determined eligible for listing in the National Register of Historic Places but have not been fully researched and submitted for listing.

The condition cultural resources across the plan area varies by resource class, location, and age. Site monitoring and condition assessments of these properties show a range of conditions from "excellent" to "destroyed". Taken as a whole, historic properties across the plan area are in fair condition. There are various condition drivers and associated trends occurring with cultural resources in the plan area.

- The destruction of cultural resources and/or the removal of artifacts from their site locations by the public results in the partial or total loss of valuable scientific information and negatively impacts tribal cultural values. The trend of this driver is ongoing.
- The passage of time degrades the physical integrity of the built environment (structures, buildings) and degrades and destroys archaeological sites through alteration of landforms and soils. The trend of this driver is ongoing.
- Budget and workforce limitations constrain the ability to reduce deferred maintenance or investigate, monitor, enhance, interpret or use cultural resources for agency and public benefit. The trend of this driver is increasing.
- Historic management activities have adversely affected cultural resources prior to the establishment of laws and regulations meant to protect those resources, thus contributing to a backlog of deferred maintenance and protection needs. The trend of this driver is stabilizing.
- Authorized recreational activities unintentionally impact sensitive cultural properties, such as in dispersed camping areas or along historic trail routes. Visitors also cause direct and cumulative "wear and tear' impacts to popular forest interpretive sites and buildings used as rental facilities. The trend of this driver is ongoing.
- Warming temperatures are currently influencing the scale and severity of wildfires across the American West. Wildfire suppression and recovery effects cultural resources in some way. The trend of this driver is variable.
- Lack of complete cultural resource inventories and tribal-public engagement across the plan area leave hundreds of cultural resources, including Traditional Cultural Properties, unknown and thus outside the sphere of effective management. The trend of this driver is ongoing.
- Climate Change has the potential to accelerate on-going effects to cultural resources, including prolonged aridity, drought, spring floods and debris flows. Shifting or changing vegetation regimes are likely to affect the visual integrity of some historic landscapes. Certain natural resources associated with traditional cultural landscapes, which continue to be used by tribal people today, may be diminished or entirely disappear. The trend of this driver is increasing.

# 3.5 Sustainable Recreation

## 3.5.1 Recreation Opportunities and Recreation Opportunity Spectrum

### Key Takeaways

- The Lolo National Forest offers world-class recreation opportunities. The combination of big backcountry, wilderness, and roaded access are key opportunities. Recreation use is growing, and the way people want to recreate is diversifying. Population growth, wealth, and demographic changes continue to outpace state averages on portions of the Forest. Front country near rapidly growing or changing communities is under tremendous pressure from both residents and visitors.
- Use on the Forest is year-round, but not uniform across regions and seasons. Summer is the largest visitor season on the Forest. Participation in winter recreation is increasing.
- Residents of rural communities see the Forest as an extension of their community, their livelihoods may be dependent on forest products, and traditional forest uses ingrained in their families.
- Maintenance and capital improvements needed for existing public use of infrastructure, trails, roads, education, and public service routinely exceeds the fiscal capability of the Lolo, and the demand for opportunities is increasing. Funds provided through the Great American Outdoor Act is helping to improve roads and recreation facilities across the Forest.
- Recreation resources are not infinite. As visitor's expectations, needs, and perceptions change, desires must be balanced with resource capabilities. Not all desired uses or future recreation trends may be accommodated on the Forest. Limits based on terrain, safety, resource availability, wildlife and other resource needs may not meet the demands of the public.
- A range of recreation opportunities and settings are key when managing a national forest with a variety of stakeholders in the context of different setting, needs, challenges, and desires. Focusing on the Forest's roles and niches, and opportunities provided by partners, volunteers, and cooperators, is important as financial, ecological, and social resources become limited.
- Travel planning will continue to be a contentious issue nationally, regionally, and locally. The revised plan must provide broad context for sustainable recreation. It will not make site-specific travel planning designations, maintenance level determinations, or operational choices.
- Existing recreation facilities and opportunities demonstrate that recreationists are drawn to water: lakes, streams, waterfalls, reservoirs, seeps, and rivers. Managing dispersed and developed recreation in these areas is important to the recreation opportunity, scenery, wildlife, and water resources. Many highly popular, concentrated use areas were developed more than 40 years ago. These areas can sustainably accommodate visitation growth after investment, redesign, or re-visioning and cause less resource impact than pioneering into less developed, less hardened areas.
- Recreation management issues have grown in complexity and scale since the completion of the 1986 Forest Plan. Current plan direction does not fully address the current scope and complexity of sustainable recreation, demand, recreation participation forecasts, or social, resource, and capacity issues associated with outfitting and guiding activities.

### Summary

Recreation contributes to social and economic sustainability and provides opportunities to connect people with nature. This assessment focuses on recreation settings and the uses, trends and sustainability of recreation opportunities, recreational preferences of the public, recreation access, and scenic character of the Forest (FSH 1909.15 13.4). With four wildernesses, many lakes and rivers, National Historic Trails, and unique visitor centers, the Lolo National Forest provides a variety of recreational experiences. The Forest has a deep connection with communities that creates a sense of ownership and commitment to this natural place. Landscapes rich in history with abundant wildlife and accessible wildlands provide a backdrop for diverse trail-based, day-use recreation that is an everyday way of life for many people. The Seeley Lake complex also provides important destination-camping and snowmobiling opportunities.

Deeply rooted in the culture and traditions of both Native American and early Euro-Americans settlers, the Forest's recreation settings and opportunities are enhanced by the many visible and accessible remnants of the past. A network of historic trails and roads gives visitors a chance to follow in the footsteps of the Native Americans and the Lewis & Clark expedition. Historic cabins and lookouts continue to serve as high value overnight destinations.

Annual forest visitation to the Forest is about 1,450,000 visitors (U.S. Department of Agriculture 2021a). Visitation is primarily local and regional, with 80.4% coming from within 75 miles of the Forest boundary; 62.1% of visitors came from within 25 miles. 71.5% of forest visitors are very satisfied with their recreation experience (U.S. Department of Agriculture 2023c). Visitor safety, minimizing conflicts between uses, responding to existing and future visitor needs, creating connections between people and nature, promoting long- term physical and mental health, and instilling a culture of stewardship and appreciation are all components of a satisfying recreation experience. The top ten reasons people recreate in the plan area are hiking/walking, viewing wildlife, viewing natural features, relaxing, driving for pleasure, fishing, hunting, nature study, downhill skiing, and biking (U.S. Department of Agriculture 2023c). Obvious linkages exist between the types of activities being pursued and the presence and condition of the natural resources.

Spending by recreationists supported an estimated 601 annual jobs and $17.9 million in labor income is attributable to Lolo National Forest, primarily in the accommodation and food services, retail trade, and arts and entertainment sectors (Table 45). The economic value of any given recreation activity is a monetary measure of the economic benefits received by an individual or group doing that activity. The economic value of recreation differs from the economic impact of recreation. Economic impact (or economic contribution) measures how spending by recreationists affects economies in a given geography (e.g., community, region, state, or nation) by virtue of the influence that spending has on employment and income.

Nonmarket values are those that are not addressed or represented in typical market transactions and can include things such as the value someone has for the opportunity to view nature or the loss of well-being from residents who must endure more traffic from people engaging in recreation (Rosenberger et al. 2017). Visitors also benefit intrinsically from those experiences; visitors to the Forest were estimated to derive an estimated $136 million in non-market value from outdoor activities. External factors affecting the economic activity resulting from recreation could be fluctuations in disposable income, user and entrance fee changes, transportation costs, changing climate, and crowding due to high demand for limited recreation opportunities.

## Status and Trends

The 2012 planning rule directs that land management plans provide for sustainable recreation (219.10(b))1)(i). The rule defines this as "The set of recreation settings and opportunities on the National Forest System that is ecologically, economically, and socially sustainable for present and future generations". (219.19) Recreation contributes to ecological, social, and economic sustainability and provides opportunities to connect people with nature in different settings. This assessment identifies recreation settings and opportunities in the plan area; existing uses and emerging trends; recreation use preferences; recreational access; and, ultimately, evaluate the current level of recreation sustainability.

The Lolo National Forest is characterized by rivers, lakes, and valleys with diverse forested landscapes. Distinct geographic areas are defined by local communities, both urban and rural, that are deeply connected to the land. Bisected by Interstate 90, access to the Forest is easy for local and non-local visitors alike. From large, meandering rivers like the Clark Fork and Bitterroot, to smaller, tucked away mountain streams and multiple high mountain and low elevation lakes, the Lolo supports the diversity of habitats and settings needed for high quality fishing and water-based recreation. Along roads and trails, recreationists can find a variety of songbirds, hawks, eagles, and owls, as well as big-game species including bear, elk, moose, big horn sheep, mule and whitetail deer and Rocky Mountain goat.

The history of exploration, settlement, and development of the area for mining, grazing, and timber harvesting activities created a network of roads and trails which made recreational access to remote and rugged country possible. This historic pattern of access has had a notable effect on when and how people use the Forest. Although areas of concentrated use are found along main stream and river drainages and mountain ridge tops, much of the plan area's settings are relatively intact. Abundant and clean water, lush riparian areas, clean air, healthy forests, and diverse wildlife populations all contribute to sustaining the Forest's recreation settings and opportunities.

**Status and trends: recreation niche.** Recreation niches are useful in conveying how Forests fit into the larger context and for determining unique recreation opportunities across a landscape. The Forests' settings, special places, and recreation opportunities were described in niche statements developed through the Forest Service recreation facilities analysis process. The Region 1 niche product is useful in conveying how the Lolo National Forest fits in the bigger context of the State of Montana. Not all recreation opportunities and settings are described; those that give the unit its identity, value, and uniqueness are captured. These niches describe some of the distinctive roles and contributions the Lolo National Forest has within a larger context.

*Forest service region 1 recreation program niche: where rural meets wild.* Wildlands connect with, and complement, vast expanses of rural settings and growing communities. Majestic scenery, clean water, and unique, charismatic wildlife that attracted the Northern Region's first inhabitants continue to draw people seeking a high quality of life. The rich, colorful, and well preserved American Indian and Euro American heritage, as reflected in living cultural traditions, historic buildings, and thousands of archeological sites; is accessible and protected for the benefit of future generations.

Hunting, fishing, and gathering products that were once life sustaining are now life enhancing. The Northern Region is a leader in facilitating collaboration between user groups, other public and private recreation providers, and communities. This protects open space and key access to the Northern Region that is vital to the delivery of quality, sustainable, recreation services. We remain relevant and responsive to communities, visitors, and changing climate. Outfitters and guides are an important connection to new and changing visitors. High value, low impact visitation through geo-tourism, and trail-based recreation, serve to link communities with wildlands and are regional in focus.

*Lolo recreation program niche: we live here.* The Lolo is "just out the back door" from many of the local communities and is used heavily by residents. By analyzing the visitor information, the recreation niche was defined as trail based, day use recreation, which is characterized as "We Live Here."

> "We Live Here – accessible and abundant wildlands provide a backdrop for diverse day use, trail-based recreation that is an everyday way of life for many people." (U. S. Department of Agriculture 2007)

The Lolo National Forest has a depth and connection with communities that creates a sense of ownership and commitment to this natural place. Landscapes rich in history with abundant wildlife and accessible wildlands provide a backdrop for diverse trail-based, day-use recreation that is an everyday way of life for many people. Leadership in conservation education and interpretation provides the foundation for understanding the environment while fostering a deep respect of the land.

Interpretation and education programs and law enforcement are employed to protect the natural and cultural resources of the Forest. Although both management techniques influence visitor behavior, law enforcement is typically a reactive approach, while interpretation and education programs are designed to create an appreciation and understanding to encourage voluntary compliance and deter behavior that would result in negative resource impacts. The Forest is making progress in reaching a broader audience and delivering information before, during, and after visitation through web site updates and linkages to state and other tourism sites.

**Status and trends: recreation opportunity spectrum settings.** The Forest Service uses the recreation opportunity spectrum process to define recreation settings and categorize them into six distinct classes: primitive, semi-primitive nonmotorized, semi-primitive motorized, roaded natural, rural, and urban (36 CFR 219.19). These classes serve as a zoning framework for planning and managing recreation settings and opportunities, both existing and desired, across National Forest System lands. Specific classes convey the physical setting, mode(s) of transportation, anticipated concentration of people, and levels of management and infrastructure. By identifying recreation settings, the Forests can ensure a sustainable set of recreation opportunities for future generations and visitors can select where they recreate based on what they want to do, what equipment they want to bring, and the type of experience they want.

**Table 57—Recreation Opportunity Spectrum Class Definitions**

| Recreation Opportunity Spectrum Class | Definition |
|---|---|
| Primitive (P) | Describes large, remote, wild, and predominately unmodified landscapes. Areas with no motorized activity and little probability of seeing other people. Includes most wilderness areas. |
| Semi-Primitive Nonmotorized (SPNM) | Areas of the Lolo National Forest managed for nonmotorized use. Uses include hiking and equestrian trails, mountain bikes and other non-motor mechanized equipment. Rustic facilities and opportunity for exploration, challenge, and self-reliance. |
| Semi-Primitive Motorized (SPM) | Backcountry areas used primarily by motorized users on designated routes. Roads and trails designed for off-highway vehicles and high-clearance vehicles. Offers motorized opportunities for exploration, challenge, and self-reliance. Rustic facilities. Often provide portals into adjacent primitive or semiprimitive nonmotorized areas. |
| Roaded Natural (RN) | Often referred to as front country recreation areas. Accessed by open system roads that can accommodate sedan travel. Facilities are less rustic and more developed (campgrounds, trailheads, etc.). Often provide access points for adjacent semi-primitive motorized, semi-primitive nonmotorized, and primitive settings. |

| Recreation Opportunity Spectrum Class | Definition |
|---|---|
| Rural (R) | Highly developed recreation sites and modified natural settings. Easily accessed by major highway. Located within populated areas where private land and other land holdings are nearby and obvious. Facilities are designed for user comfort and convenience. |
| Urban (U) | Areas with highly developed recreation sites and extensively modified natural settings. Often located adjacent to or within cities or high population areas. Opportunities for solitude or silence are few. |

*Summer recreation opportunity spectrum.* Table 58 and figure A1-19 display the variety in existing mapped summer recreation opportunity spectrum settings by acreage across the Lolo. The current settings on the Forest are well-distributed across primitive (designated wilderness), semi primitive nonmotorized, semi-primitive motorized, and roaded natural classes. Nonmotorized activities such as hiking/walking, fishing, and hunting are popular on the Forest and have maintained some of the highest participation rates (USDA Forest Service 2016). Nonmotorized recreation opportunities exist within all the settings.

In the summer, most of the plan area (58%) provides settings focused on nonmotorized activities (Table 58). Approximately 17% of the plan area is classified as primitive and 41% is semiprimitive nonmotorized. The remaining 42% of the planning is in motorized settings. These activities are generally associated with use or riding of a motorized vehicle such as a motorcycle, off-highway vehicle, or automobile. Motorized recreation opportunities are most available in the semiprimitive motorized class which accounts for approximately 20% of the plan area, roaded natural setting (13%), and rural settings (8%). Only very small amounts of the urban setting are present near major developments.

**Table 58—Summer recreation opportunity spectrum classes on National Forest System lands on the Lolo National Forest, by Ranger District**

| Ranger district | Primitive (acres) | Semi-primitive non-motorized (acres) | Semi-primitive motorized (acres) | Roaded natural (acres) | Rural (acres) | Urban (acres) | Total acres by ranger district (acres) |
|---|---|---|---|---|---|---|---|
| Missoula | 115,838 | 240,241 | 104,519 | 64,153 | 32,848 | 147 | 557,746 |
| Ninemile | 76,452 | 168,115 | 58,950 | 57,990 | 28,215 | 152 | 389,874 |
| Plains Thompson Falls | 36,215 | 228,868 | 152,169 | 41,861 | 30,950 | 0 | 490,063 |
| Seeley Lake | 153,649 | 82,109 | 14,976 | 58,009 | 38,924 | 0 | 347,667 |
| Superior | 8,919 | 200,126 | 131,394 | 70,949 | 59,152 | 379 | 470,919 |
| **Total by Class** | **391,073** | **919,459** | **462,008** | **292,962** | **190,089** | **678** | **2,256,269** |
| Percentage of Forest | 17% | 41% | 20% | 13% | 8% | 0.03% | n/a |

Total acres by Ranger District may differ from official acres due to GIS processing to map existing ROS Classes by Ranger District.

*Winter recreation opportunity spectrum.* Table 59 and figure A1-32 display the variety in existing mapped winter recreation opportunity spectrum settings by acreage across the Lolo. The current settings on the Forest are well-distributed across primitive (designated wilderness), semi primitive nonmotorized, semi-primitive motorized, and roaded natural classes. Nonmotorized recreation opportunities exist within all the settings.

In the winter, most of the plan area (79%) provides settings focused on nonmotorized activities, moreso than in the summer. Approximately 33% of the plan area is classified as primitive and 46% is semiprimitive nonmotorized. The remaining 21% of the planning is in motorized settings. Winter motorized activities are generally associated with snowmobiles. Motorized recreation opportunities are most available in the semiprimitive motorized class which accounts for approximately 15% of the plan area, with some in roaded natural settings (6%). Rural and urban settings are not represented in the winter.

**Table 59—Winter recreation opportunity spectrum classes on National Forest System lands on the Lolo National Forest, by ranger district**

| Ranger district | Primitive (acres) | Semi-primitive non-motorized (acres) | Semi-primitive motorized (acres) | Roaded natural (acres) | Rural (acres) | Urban (acres) | Total acres by ranger district (acres) |
|---|---|---|---|---|---|---|---|
| Missoula | 226,016 | 223,633 | 79,742 | 26,470 | 3,158 | 0 | 559,019 |
| Ninemile | 141,494 | 189,887 | 30,302 | 28,180 | 186 | 0 | 390,049 |
| Plains Thompson Falls | 148,476 | 242,306 | 57,674 | 41,661 | 0 | 0 | 490,117 |
| Seeley Lake | 150,360 | 84,484 | 104,126 | 5,617 | 3,111 | 0 | 347,698 |
| Superior | 80,283 | 298,306 | 57,815 | 33,280 | 1,252 | 0 | 470,936 |
| **Total by Class** | **746,629** | **1,038,616** | **329,659** | **135,208** | **7,706** | **0** | **2,257,818** |
| **Percentage of Forest** | **33%** | **46%** | **15%** | **6%** | **0%** | **0%** | **n/a** |

Total acres by ranger district may differ from official acres due to GIS processing to map existing ROS Classes by ranger district.

**Status and trends: recreation opportunities.** For this assessment, opportunities are characterized as developed, dispersed, and recreation access. A recreation opportunity is an opportunity to participate in a specific recreation activity in a particular recreation setting to enjoy desired recreation experiences and other benefits that accrue. Recreation opportunities include nonmotorized, motorized, developed, and dispersed recreation on land, water, and in the air (36 CFR 219.19). The Lolo National Forest manages for a set of outdoor recreation opportunities that are consistent with the Forest's recreation niche and recreation opportunity spectrum classifications. Opportunities may be provided by the Forest Service directly or under a special use permit.

*Developed recreation.* The Lolo National Forest has a robust developed recreation program that provides a wide range of opportunities appropriate to their recreation settings. Many Forest visitors rely on recreation infrastructure to support quality recreation endeavors and national forest visits. Developed recreation opportunities are located throughout the plan area but are primarily concentrated in the roaded natural and rural recreation opportunity spectrum settings. Developed recreation opportunities are located at specific locations or "sites" and have infrastructure or features designed for health and safety and to facilitate visitor comfort. The types of features and infrastructure often offered at developed sites are roads and parking areas, toilets, tables, fire rings, water systems, interpretive signs, fee stations, etc. Depending upon the location and the type of opportunity offered, these developed sites may or may not have fees associated with them.

The tables and discussion do not detail the entire list of recreation facilities or infrastructure on the Forest but represent key opportunities provided for the recreating public. Other non-recreation-based infrastructure features, including administrative cabins, water systems, forest offices, staff quarters, and some historic sites, are discussed in sections 3.3 and 3.7. See figure A1-13 for a map of these sites.

The most common developed site types in the plan area are campgrounds, trailheads, cabin and lookout rentals, picnic areas, interpretative sites, fishing sites, and boating sites. Table 60 displays the existing developed recreation site types currently managed by the Lolo. These recreation opportunities are arranged by ranger district to show their distribution and location. Most of the developed recreation sites are located along main roads and travel ways. Many picnic areas and campgrounds are located along or near lakes or rivers and are usually in forested settings. All develop recreation sites are operated by the Forest Service; there are no facilities operated by concessionaire.

**Table 60—Lolo National Forest existing developed recreation site by ranger district**

| Site Type | Missoula | Ninemile | Plains/ Thompson Falls | Seeley Lake | Superior | Grand total |
|---|---|---|---|---|---|---|
| Boating site | 0 | 0 | 1 | 2 | 0 | 3 |
| Campground | 9 | 2 | 7 | 8 | 7 | 33 |
| Day use area | 9 | 0 | 0 | 0 | 0 | 9 |
| Fishing site | 6 | 0 | 0 | 0 | 0 | 6 |
| Group campground | 0 | 0 | 0 | 3 | 0 | 3 |
| Group picnic site | 1 | 1 | 0 | 0 | 0 | 2 |
| Hotel, lodge, resort | 0 | 0 | 0 | 2 | 0 | 2 |
| Interpretive site | 1 | 1 | 0 | 0 | 0 | 2 |
| Lookout/cabin | 3 | 0 | 2 | 1 | 5 | 11 |
| Organization site | 0 | 0 | 0 | 1 | 0 | 1 |
| Picnic site | 1 | 0 | 0 | 0 | 0 | 1 |
| Ski area, alpine | 1 | 0 | 0 | 0 | 0 | 1 |
| Snowplay area | 0 | 0 | 0 | 1 | 1 | 2 |
| Observation site | 0 | 0 | 0 | 0 | 3 | 3 |
| Trailhead | 14 | 2 | 5 | 7 | 5 | 33 |
| **Total** | **45** | **6** | **15** | **25** | **21** | **112** |

There are 43 developed campgrounds and picnic areas, 25 of which require a fee. These sites provide a wide range of settings and levels of development. Group campgrounds and group picnic areas and select sites or campgrounds are available for reservation. Fees for sites range from 10 dollars to 20 dollars per night for a single site and 50 to 100 dollars for a group site or picnic pavilion. In 2022, approximately $302,089 dollars in Forest Service campground and picnic site fees were collected, which is a slight decrease from the prior year but an increase of 48% from 2018 (planning record exhibits R13-001, R13-002, and R13-003). While the increase in fees over 2018 can be attributed to a fee increase that was implemented in 2021, the slight decrease from 2021 is a result of developed closures for site improvements. Temporary closure of fee sites for implementation of improvement projects affects fee revenue. As more projects are approved, loss of fee revenue will continue to occur.

While there is a wide variety of developed recreation opportunities offered, aging of these sites is a pressing concern. This issue is influenced by the decline in appropriated dollars and the ability of collected fees to take care of annual and deferred maintenance needs. Tools such as the recreation facilities analysis have helped with the prioritization of sites and maintenance needs and funds. Additionally, the Great American Outdoors Act, enacted into law on August 4, 2020, provided new opportunities for the Forest Service to deliver benefits to the American public through major investments in infrastructure, recreation facilities, public lands access. On the Forest there are a total of 24 Great American Outdoors Act project that have been funded, for a total budget of $12.9 million dollars. Seven projects are currently in progress, with a combined budget of $2.53 million dollars. Of the seven projects, four are focused on improving recreation facilities including improvements to the Double Arrow Lookout, replacement of picnic benches at select developed sites across the forest, and recreation facility improvements at Blue Mountain and Pattee Canyon recreation areas and in the Rock Creek drainage.

There are two developed ski areas on the Forest: Montana Snowbowl, located approximately 12 miles from Missoula; and Lookout Pass Ski Area, approximately 34 miles from St. Regis. Montana Snowbowl is a year-round resort, offering skiing and snowboarding in the winter, and disc golfing, lift assisted hiking and mountain biking in the summer. Montana Snowbowl operates on National Forest System lands under a special use authorization. A non-exclusive use policy provides public use in the permitted area during non-operational periods. More on Snowbowl is included in the recreation special uses section.

Lookout Pass Ski Area is located on the Idaho Panhandle and Lolo National Forest at the Idaho/Montana state line, roughly half-way between Spokane, WA and Missoula, MT. Lookout Pass features 1,023 acres of terrain, including 53 named runs and prime powder glades, and averages over 400 inches of annual snowfall. Lookout is the oldest ski area in Idaho or Montana having opened in 1935. The historic, rustic wooden lodge is the second oldest in the Pacific Northwest. Lookout operates on National Forest System lands under a special use authorization administered by the Idaho Panhandle National Forest. A non-exclusive use policy provides public use within the permitted area during non-operational periods.

The Lolo Pass Visitor Center is also a developed recreation opportunity in the plan area but is located just outside of the national forest boundary on the Nez Perce-Clearwater National Forest. It offers displays on the Lewis and Clark journey across the Bitterroot Mountains and the 1877 flight of the Nez Perce Indians, and provides historical, natural, and general information about the area. The visitor center is also a recreational destination for winter sports enthusiasts, and doubles as a rest area at the Montana/Idaho border along Highway 12.

A concern, moving into the future, is the need for facilities to be designed and maintained to be fully accessible. As the population ages, there continues to be a need to design facilities that accommodate wheelchairs, walkers, and help those with site and hearing impairments. Typically, though, sites that are designed to be fully accessible help everyone by accommodating a wide variety of abilities. Facilities win the plan area are in marginal compliance with accessibility standards. Overall, visitor satisfaction rates for developed sites within the plan area are relatively high (U.S. Department of Agriculture 2023c).

*Recreation rental cabins.* One of the most unique developed recreation opportunities offered in the plan area is the rental of a cabin or lookout. Currently, there are fourteen cabins/lookouts available to rent. These cabins range from rustic to those that have modern conveniences. A number of these properties are also listed on the National Register for Historic Places.

There are multiple cabins, guard stations, and lookouts available to the public for rent. Built primarily in the early 1900s for use by early forest rangers or as original homesteads, the cabins offer visitors a chance to camp in the forest in a rustic, old-time setting. Some of the cabins have electricity. All have either wood or electric stoves for cooking and heating. Very few have indoor plumbing. Some of the cabins are located right on a road; others require users to hike, ski, or snowmobile to them. Rental opportunities are well-dispersed across the Forest.

Rental fees on the Lolo for cabins range from 45 to 90 dollars per night with the bulk of the sites costing 75 or 80 dollars per night. The Forest Service retains and uses a portion of these collected uses fees to reinvest in the maintenance and operation of these sites under the Federal Lands Recreation Enhancement Act authority. In 2022, the Forest Service collected approximately $128,219 in rental fees at the cabin/lookout facilities. That amount is a decrease from 2021, partially due to facilities being closed administratively. Overall, revenue has increased. Forest wide rental cabin occupancy increased from about 40 percent occupancy in 2018 up to 60 percent occupancy in 2022. Occupancy ranges from a low of 15 percent to a high of 109 percent (the high end is a result of an expanded season). The condition of the facilities at each of the rental cabins varies widely. Although key investments have been made to resolve critical health and safety issues there is a back log of operational and deferred maintenance work that is not being achieved under current budget scenarios.

*Dispersed recreation* includes the full suite of recreation opportunities that take place outside of developed recreation sites. Dispersed recreation activities generally do not have fees associated with them and little or no facilities such as toilets, tables, or garbage collection are associated with dispersed recreation sites.

Over three-quarters of Lolo National Forest visitors come to engage in dispersed recreation activities. Once on the Forest, over 77 percent of visitors participate in dispersed recreation (U.S. Department of Agriculture 2023c), accounting for nearly 1.1 million dispersed area visitors. Increasing population growth and demand for recreation opportunities may lead to more crowding and conflict among users. Despite the many options available for recreation access, there is a desire for more. Local groups have expressed interest in expanding nonmotorized recreation opportunities. There is an equal interest in providing additional opportunities for motorized access. These competing interests can create conflict in resource planning and during the busier seasons such as summer and rifle season for big game hunters.

Even though dispersed recreation activities happen across all Recreation Opportunity Spectrum classes, most of the dispersed recreation sites (such as campsites) are concentrated in the Forests' roaded natural and semi-primitive settings. Most of these sites have been established over time by reoccurring use and tend to be in areas with desirable characteristics, particularly those with easy access from roads, relatively flat topography, and in proximity to water. District personnel have observed that most dispersed campers are seeking a more secluded camping experience without the fees, rules, and regulations associated with developed sites, and many of these dispersed sites hold an important value for families and friends that return year after year for activities such as hunting, camping, hiking and off highway vehicle riding.

Dispersed camping is heaviest during summer holidays (Memorial Day, Fourth of July, and Labor Day weekends) and during bow and general rifle hunting seasons. During these busy times, seclusion is not the objective of the users and dispersed campers often set up camps very close together. Health, safety, sanitation, and crowding issues are much more prevalent during these time periods. This intense dispersed camping has resulted in large site footprints and impacts to natural resources. For both types of dispersed camping users (general and intense) there are places in the plan area where minor site improvements have been made to protect riparian areas and to reduce the useable area in dispersed sites – such as hardening sites with gravel to clearly identify parking locations for vehicles and installing fencing or barrier rocks to define the site area. Some of the most heavily used dispersed camping areas have also installed toilets, tables, and fire rings to protect natural resources. An array of other management approaches can also be used to address the impacts of dispersed camping, including, but not limited to, timing of use and increasing visitor education.

Hunter camps are linked closely to the hunting regulations posted by Montana Fish, Wildlife, and Parks. For detailed information, see the Hunting, Fishing, and Wildlife Viewing section 3.10.5. Areas with special tags receive far fewer hunter camps than those areas that have open seasons. Open season areas are a large draw for the hunting community.

Another issue associated with dispersed recreation is the unauthorized creation of new campsites, trails, or facilities in the general forest area. Although hunting season does see an increased amount of use of dispersed areas, many areas see a concentration of use in the summer season as well. Generally, dispersed areas that are near drivable lakes tend to see a high concentration of use. This is due to a desire for camping close to waterbodies in a manner that is less developed and offers more freedom than developed campgrounds. Additionally, due to what can be a potentially very short access season of June to September in higher elevation areas, as well as terrain constraints, use concentrates in flat areas around waterbodies. Other areas that see a high concentration of use are dispersed areas adjacent to major highways, and interstates for travelers passing through the Lolo as part of a larger road trip or vacation.

In 2009, USFS Region 1 began developing a standardized protocol for inventorying and monitoring resource conditions of dispersed recreation, especially concentration on dispersed camping sites. The focus has been primarily adjacent to main forest access routes, with a priority on concentrated use areas, with limited or no infrastructure and/or facilities outside of the access route and directional signage. Inventorying these sites is the first step toward identifying resource concerns and prioritizing management actions to ensure sustainable opportunities. The Lolo National Forest's long-term goal is to have comprehensive information about dispersed recreation use across the forest. Location, condition, use type, concentration, and other collected information would provide managers with a more comprehensive understanding about dispersed use particularly in concentrated use areas such as peaks, lake basins, hunting areas, shooting areas, river corridors, or other destinations.

There is a wide range of management of dispersed recreation. Dispersed campsites have been designated in some popular, heavily used drainages, or in sensitive areas with resource concerns, including the Muchwater and Peninsula dispersed camping areas, where site delineation and development was needed to manage the level of use while protecting social and ecological resources. On other parts of the Forest, delineation is not necessary because of the level and seasonality of use. The range of management controls, designated areas, and prohibitions vary and are imbedded in travel planning and Forest Plan decisions.

*Forest recreation areas: Blue Mountain and Pattee Canyon.* There are two recreation areas that have been administratively designated by the Forest: Blue Mountain and Pattee Canyon. These areas receive concentrated public use and are in proximity to the Missoula urban area where a wide variety of developed and dispersed recreation opportunities are available, including both trail- and road-related recreation activities.

Pattee Canyon Recreation Area is a 3,200-acre area on the east side of Missoula and is a popular getaway for locals and visitors. The area includes an extensive 27 miles of system trails, is open year-round to non-motorized use and is available to hikers, disc golfers, mountain bikers, joggers, cross-country skiers and dog walkers. The recreation area trails and roads connect the University of Montana and the Clark Fork River areas. Area facilities include both single and group use picnic areas, main trailhead, and disc golf course. Additionally, accessed by the area are the Crazy Canyon Trailhead and the Larch Camp Road.

Blue Mountain Recreation Area is a 4,900-acre area approximately six miles from downtown Missoula. Blue Mountain Recreation Area includes 41 miles of system trails and is a popular spot for locals and visitors because of its proximity to the city of Missoula and the views of the Missoula valley, and the Sapphire and Rattlesnake mountains. Blue Mountain is one of the few peaks around Missoula that can be reached by road, with a forest-fire lookout at road's end offering exceptional views. The area also features trails for hikers, equestrians, bicyclists, people in wheelchairs and all-terrain vehicle enthusiasts.

**Status and trends: recreation access.** Lolo National Forest access, through roads and trails, links local communities with forest settings and facilitates backyard recreation opportunities for residents. Access to and through the Forest is facilitated year-round and in several ways. Visitors select their access based on their preferred setting, experience, and mode of transportation. Roads, motorized trails, nonmotorized trails, and rivers enable forest visitors to walk, bike, boat, ride, or drive to their destination. The Lolo National Forest currently manages approximately 1,875 miles of summer trails, and about 661 miles of winter trails. Driving for pleasure has long been a favored activity on national forests in Montana. Approximately 3,178 miles of the Forest Road System is open to public travel by passenger cars and trucks today (not including other public roads – State, County, Federal Highways). Both roads and trails open to motorized vehicles have a variety of seasonal closures to protect wildlife, minimize erosion and prevent damage to the facility. Trail access is serviced by nearly 34 trailheads, from primitive to highly developed areas for parking, information, and safety. With few plowed Forest Service roads or areas, many areas of the Forest become less accessible in winter. Those with good access and parking become popular destinations.

In some cases, travel routes themselves are the destination and some are recognized by unique designations, such as Highway 12 in the Lolo Creek drainage and the St. Regis-Paradise Scenic Byway. These routes enable visitors to experience unique vistas, wildlife, and scenery (see the Designated Areas section). Special designations for travel corridors also include the Nez Perce Auto Tour, national recreation trails, national historic trails including the Nez Perce (Nee-Me-Poo) and Lewis and Clark National Historic Trails, and several eligible wild and scenic rivers. Regardless of designation, most of the transportation network affords visitors the opportunity to view diverse wildlife and spectacular scenery. Adjacent areas also provide road and trailhead access to the plan area. For example, the Pattee Canyon and Blue Mountain Recreation Area trail systems and the Rattlesnake National Recreation Area are immediately adjacent to the community of Missoula, and link to community trails and hiking paths.

*Summer trails.* There are approximate 1,875 miles of existing summer forest system trails in the plan area. Roughly 359 miles allow motorized use. The largest percentage of the trail system within the plan area is nonmotorized trails outside of wilderness, with approximately 1,608 miles. Additionally, there are 189 miles of trail located within designated wilderness. Table 61 and Figure 34 show the miles of trails broken out by geographic area within the plan area. Trails are further identified by use types and trail types.

**Table 61—Miles of summer trails by ranger district and trail type**

| Ranger district | Miles of Motorized Trail | Miles of Wilderness Trail | Miles of non-motorized non-wilderness trail | Miles of non-mechanized trails (closed to bikes) | Mile of water trail | Total miles trail |
|---|---|---|---|---|---|---|
| Missoula | 51 | 64 | 360 | 100 | 0 | 475 |
| Nine Mile | 16 | 0 | 240 | 0 | 0 | 256 |
| Plains/Thompson Falls | 161 | 0 | 193 | 0 | 0 | 354 |
| Seeley Lake | 5 | 125 | 276 | 134 | 3 | 406 |
| Superior | 126 | 0 | 258 | 7 | 0 | 384 |
| **Total** | **359** | **189** | **1,327** | **241** | **3** | **1,875** |

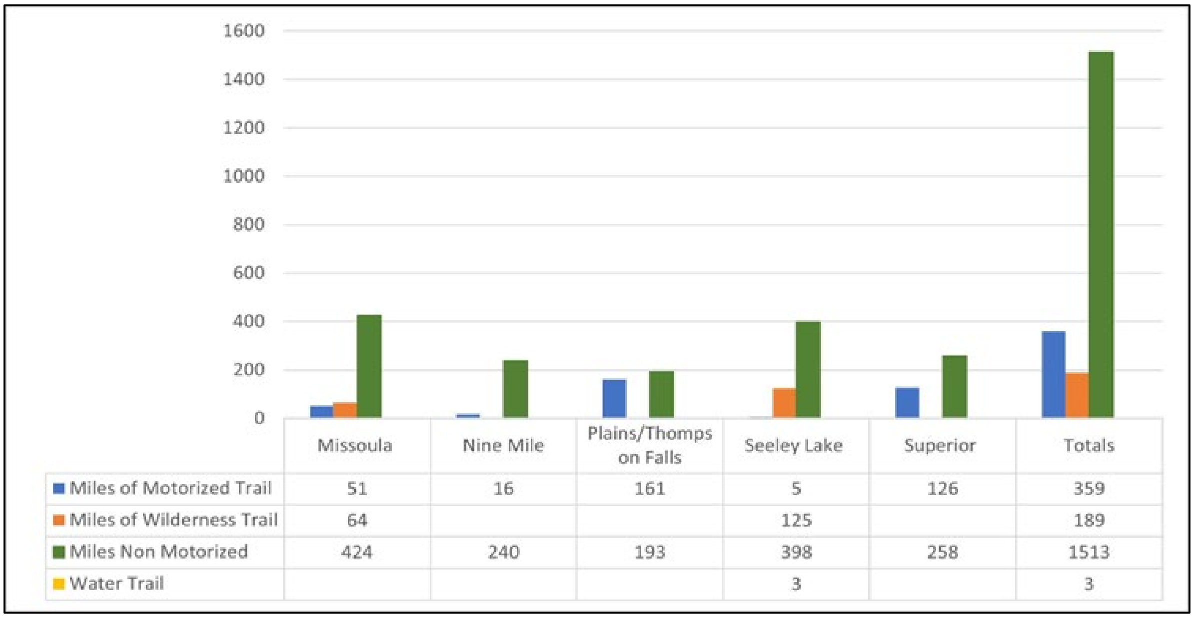


**Figure 34—Miles of trail by ranger district and trail type**

Approximately 19 percent of trail on the Lolo are open to motorized use with about 80% percent of those miles located on the Plains/Thompson Falls and Superior Ranger Districts. Approximately 82% percent of summer non-motorized, non-wilderness trails are open to mountain bikes. However, many trails were not designed for biking, resulting in some challenges in navigation and user conflicts. Another recreational desire that is starting to emerge is the desire for "quiet" recreation areas. These are areas where users can be away from the sights, and more importantly, sounds of motorized and mechanized recreational uses. Mountain biking is a use that has started to grow in popularity, with users requesting dedicated trails to reduce conflicts. Although it is commonly recommended to develop closed or decommissioned roads for off highway vehicle or mountain bike trails, typically these roads were not designed nor placed in such a manner to provide satisfying recreational experiences, and do not offer the challenge, view, or recreation setting motorized users and mountain bikers are seeking out.

*Winter groomed trails and over-snow motorized areas***.** The Lolo has a reputation for being a winter recreationist's paradise. With over 500 miles of snowmobile trails, 18 miles of cross-country ski trails, and endless backcountry opportunities, winter enthusiasts have a wide range of choices for adventure.

Multiple Nordic ski clubs in the area partner with the Lolo National Forest to groom Nordic trails in the Pattee Canyon, Rattlesnake, and Seeley Lake areas.

Missoula Nordic Ski Club grooms, and compacts, approximately 11 miles of cross-country ski trails in Pattee Canyon and Rattlesnake National Recreation Area. Additionally, the Seely Lake Nordic Ski Club grooms approximately 11 miles of Nordic trails in the Seely Lake area. Montana Snowbowl ski area in Missoula is a long-time, local downhill ski area and is under permit with the Forest. Lookout Ski Area on the Idaho/Montana boarder is under permit by the Idaho Panhandle National Forest; however, the permit area is on both the Idaho Panhandle and Lolo National Forest.

Other dispersed winter activities including backcountry skiing, snowshoeing, and fat tire biking have been growing in popularity. Areas with good winter access, trailhead parking, or other developed recreation infrastructure are popular for these activities and see more winter pressure. With improvements in technology and safety equipment, winter sports are becoming more accessible to the general recreationist in and around the mountain-based communities. Although backcountry skiing and snowboarding is not an activity dependent on groomed trails, there is overlap in use of areas for backcountry skiing and snowboarding with snowmobiling, where trails may be used for access, as well as backcountry areas accessed from some of the few plowed trailheads. There are 5 primary areas on the Forest where most of the backcountry use occurs: St. Regis Basin, Hoodoo Pass, Lolo Pass, Morrell Mountain, and the Marshall Mountain area.

Over-snow motorized use is very popular in the plan area. Once the ground is covered, groomed snowmobile trails take motorized users through the plan area and into areas where over-snow use is permitted. Due to resource concerns, these over-snow areas are generally limited to specific areas. Most of these are shown on winter motor vehicle use maps. The plan area has approximately 1.42 million acres open for over-snow motorized use during the winter season. Figure 35 shows the approximate acreages that are open for over-snow motorized uses.

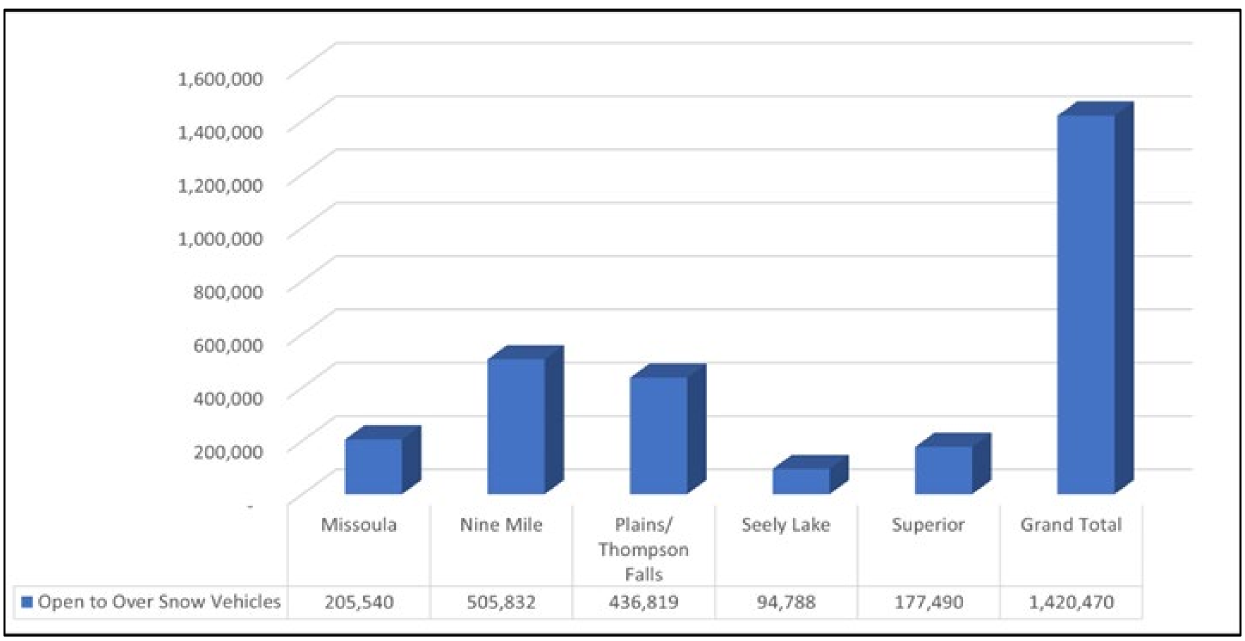


**Figure 35- Acres open to over-snow motorized use by Ranger District**

Snowmobile trails are jointly managed with local snowmobile clubs and the Montana Department of Fish, Wildlife, and Parks being principal partners in grooming and maintenance. Popular areas include Lolo Pass, which is groomed by the Missoula Snowgoers and Seeley Lake groomed by the Seeley Lake Driftriders. On the Superior District, the most popular snowmobile area is the west end and trails are groomed by the Montana Night Riders Snowmobile Club. Hoodoo Pass is also a popular snowmobile area on the Superior that does not have any groomed trails. Allowing use does not necessarily mean the area provides a quality snowmobiling opportunity. For example, just because an area is not restricted does not represent a dependable snowmobile riding opportunity. Areas closed to this use include congressionally designated areas such as wilderness, but also other management area focused on nonmotorized recreation, wildlife, recommended wilderness or resource protection.

*Roads* are the primary conduits that recreationists use to access the Lolo National Forest. Roads provide direct access to recreational facilities, such as campground, trailheads, picnic areas, and interpretive sites. Sometimes the road itself becomes the recreational experience, such as when people drive roads for pleasure, viewing scenery, or both. Travel plans dictate which roads are open and for how long. The Lolo operates over 3,000 miles of road for the purpose of public access and administration of the Forest. Many open roads have some type of seasonal restriction to protect wildlife, watersheds, or infrastructure, to provide winter recreational opportunity, or address social concerns. Some roads are kept as Forest Service system roads for the purpose of future resource management but remain closed to the public; there are over 1,000 miles of road closed to recreation access year-round. Table 70 in the transportation section displays the number of miles of open roads within the plan area by ranger district and maintenance level.

**Trends in recreation use, user preference, and satisfaction.** Recreation opportunities are affected by recreational trends and the mix of outdoor activities chosen by the public, which continuously evolve. National Visitor Use Monitoring provides data on visitor use and visitor satisfaction to improve our understanding about the types of activities people are interested in and the quality of their experiences. This monitoring is the most relevant, reliable, and accurate data available on national forest visitation, and are collected using a random sampling method that yields statistically valid results for each Forest. National Visitor Use Monitoring results are unbiased. The sampling plan accounts for both spatial and seasonal spread of visitation patterns. However, results for any single year or season may under or over-represent some groups of visitors; and unfortunately, due to the COVID 19 pandemic, the 2021 National Visitor Use Monitoring inventory cycle for the Lolo National Forest was missed. Some limited proxy data was processed to estimate general visitation; however, participation and other statistics were not gathered.

According to 2021 National Visitor Use Monitoring data, annually roughly 1,450,000 visitors come to the Forest. Visitation is primarily local and regional, with 80.4% coming from within 75 miles of the Forest boundary; and 62.1% of visitors came from within 25 miles (U.S. Department of Agriculture 2023c). 71.5% of Forest visitors are very satisfied with their recreation experience (U.S. Department of Agriculture 2023c). Visitor safety, minimizing conflicts between uses, responding to the needs of existing and future visitors, creating connections between people and nature, promoting long- term physical and mental health, and instilling a culture of stewardship and appreciation are all important components of a satisfying recreation experience.

The top ten reasons people recreate in the plan area are hiking/walking, viewing wildlife, viewing natural features, relaxing, driving for pleasure, fishing, hunting, nature study, downhill skiing, and biking (U.S. Department of Agriculture 2023c). Linkages exist between the types of activities being pursued and the presence and condition of the natural resources. Figure 36 shows the 20 main recreation activities that visitors participated in in the plan area. Hunting, viewing natural features, hiking/walking, and nature center activities have consistently remained within the top five most popular activities.

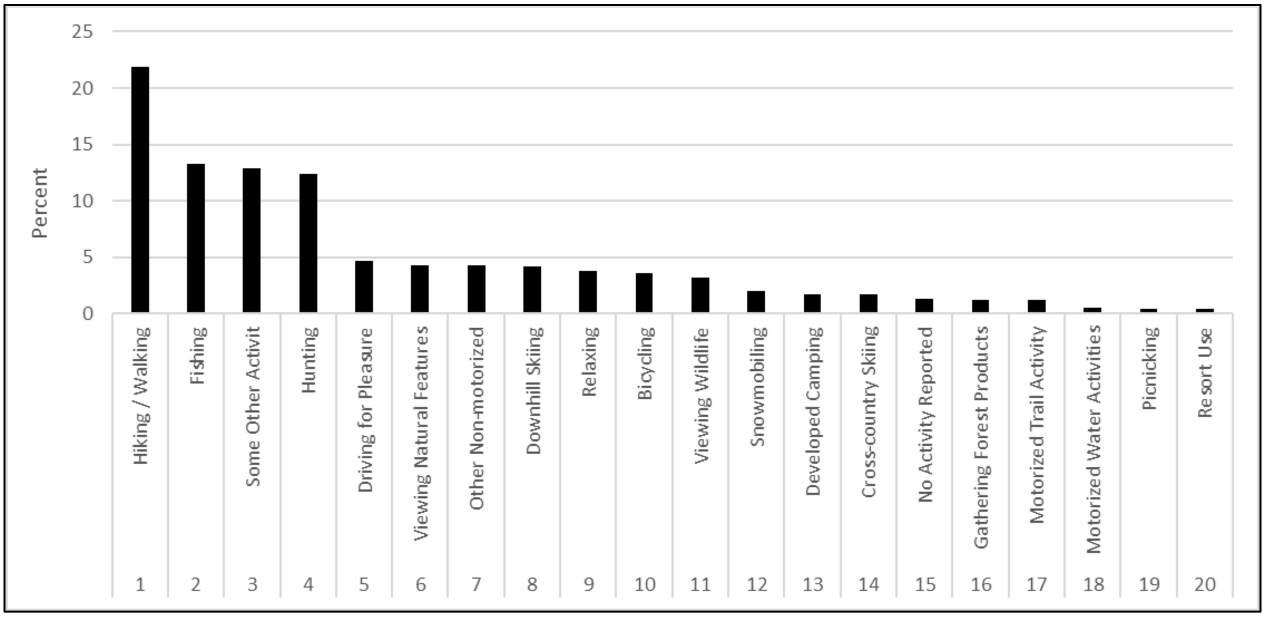


**Figure 36—Top 20 main recreation activities visitors participate in on the Lolo National Forest**

Overall satisfaction with visitors has remained very high. Over 75% of visitors indicated that they were very satisfied (U.S. Department of Agriculture 2023c). Visitors were generally satisfied with the services, access, facilities, and sense of safety at developed sites, undeveloped areas, and in wilderness areas. Visitors did not feel that overcrowding was an issue, though moderate crowding was reported at developed recreation sites.

**Trends in recreation activities.** National research on outdoor recreation trends by Ken Cordell concluded that there has been considerable "growth in the first decade of the 21st century in nature-based recreation. Between 2000 and 2009, the number of people who participated in nature-based recreation grew by 7.1% and the number of activity days grew by about 40% (Cordell 2012). The nature-based activity that has grown the most in the past ten years has been viewing and photographing nature. National projections show that there will continue to be growth in nature-based recreation out to the year 2060.

Since adoption of the 1986 plan, recreation activities in the plan area have changed, especially related to motorized recreation activities. The use and availability of off-highway vehicles, coupled with the power and advanced technology of over-snow vehicles has provided visitors with greater ability to go places within the plan area than had previously been available to them. The Forest Service has been challenged with the development of travel plans that provide direction for motorized activities, while balancing the needs of nonmotorized users.

There has also been growth in the amount of dispersed camping across the plan area. Not only is there an increase in dispersed campers but the size and scale of the recreation vehicles used by campers has grown exponentially. This increase in size of recreation vehicles affects not only resource impacts to the dispersed camping sites, but also has had effects on the developed campgrounds. Campgrounds that were constructed in the 1970s and 1980s strain to accommodate recreation vehicles that are now much longer and, with slide outs, much wider than were originally conceived of and planned for.

As the American public ages, but remains active, there is an increased interest and need to provide adequate accommodations for many forms of recreation activities and infrastructure. Developed campgrounds that have been designed for universal accessibility, as well as improved and new innovations for assistive technology will become increasingly important as the population ages and will influence the recreation activities that visitor choose to participate in (Sperazza and Banerjee 2010).

There has been an increase in the amount and interest in mountain bike use, particularly on the Missoula and Seeley Lake Ranger Districts. Bike users are concerned with keeping available trails open to them and adding additional trails. There is interest to not only protect and enhance existing trails but to expand the influence of the trail, connecting to recreation on a much larger scale. There is concern from users that conversion of roads to mountain bike trails will be their only opportunity to add new routes to the system. Use of decommissioned roads for off-highway vehicles or mountain bike trails can result in unused system trails because these roads were not designed nor placed in such a manner as to provide for satisfying recreational experiences. Decommissioned roads typically do not offer the challenge, view, destination, or overall recreation setting motorized users and mountain bikers are seeking. Simultaneously, another emerging recreational trend is the desire for “quiet” recreation areas. These are areas where users can be away from the sights and sounds of motorized and mechanized recreation.

Lastly, there has been an increase in backcountry ski and snowboard activities, and a desire for areas to participate in this activity without competition from snowmobiles and other over-snow vehicles. As a result of limited road and parking area plowing, backcountry snow activities tend to congregate to 5 primary areas on the Forest including St. Regis Basin, Hoodoo Pass, Lolo Pass, Morrell Mountain, and Marshall Mountain.

**Conflict, crowding, and competing uses.** Increasing population growth and demand for recreation opportunities may lead to more crowding and conflict among Forest users, particularly around Missoula and other population centers to a lesser extent. Sense of crowding is largely perception based on an individual’s experiences, references, and expectations. As population and demographics across portions of the Forest change, those perceptions are likely to vary widely. Despite the many options available for recreation access, there is a desire from segments of the public for more close-to-town, easily accessed opportunities. Trends show many users are looking for opportunities with 25 to 50 miles of their residences. Some local groups and interested public have expressed interest in expanding quiet nonmotorized and nonmechanized recreation opportunities. At the same time, there is an equal interest in providing additional opportunities for mountain biking and summer and winter motorized access to the Forest. Other stakeholders propose limiting all recreation and human entry for the purposes of providing wildlife refugia. These competing interests can create conflict between users, the recreating public, and the local community. Collaborative efforts have attempted to foster communication among a variety of stakeholders to varying degrees of success.

**Climate change** has the potential to affect many biophysical landscape attributes such as vegetative composition, water quantity, fish and wildlife habitats, snow quantity and length of stay, and seasons of use and patterns of recreation activities present and available across the landscapes. Recreation opportunities potentially most vulnerable to climate change include water- and snow-based activities and those activities where wildlife is an important part of the experience, such as hunting and bird watching.

**Emerging or unique recreation.** Advances in technology have had the greatest impact on the recreation resource in the past 20 years. New industries have been created around emerging technologies. Visitors can now GPS locations from their smart phones, reach home computers through the cloud network, find an off-highway vehicle that is as comfortable to ride in as a car, and set up camp in recreational vehicles that are self-contained and include microwaves and big screen TV’s. Paying attention to emerging trends in technology is challenging but will help resource managers ensure that recreation users continue to enjoy their national forests.

**Trends in infrastructure condition.** The condition of infrastructure in the plan area is largely based on two factors: the current age of the infrastructure and the ability of the Forest Service to maintain infrastructure effectively. Most of the developed recreation infrastructure in the plan area was designed and constructed in the 1970s and 1980s. A few sites did receive capital improvements in the late 1990s and early 2000s but have received little improvements since that time. Budget limitations and decline have impacted the Forest's ability to provide minimal upkeep on facilities, leading to a gradual decline in facility maintenance and condition. Use of volunteers and partners has helped with these endeavors and will continue to be influential in the future. With the introduction of the Great American Outdoors Act, additional funds are available for tackling deferred maintenance needs as well as improve access across the Forest.

Conditions of trails have also been affected by budget challenges. There is an ever-increasing struggle to maintain main-line trails into wilderness areas and other landscapes dominated by trail infrastructure. Developments of strong partner relationships have aided other areas in the maintenance of trails. Area horseman groups, motorized groups, snowmobile associations, and others have assisted the Forest Service in maintaining trail infrastructure. Maintaining these partnerships and creating new ones will continue to be an important component in the management of the recreation and trail programs of the future.

**Recreation opportunities and trends in the broader landscape.** The Lolo National Forest is located centrally in Montana, and recreation on this landscape is influenced by many partners and neighboring land management agencies. National and statewide recreation trends influence trends on the Forest.

*Neighboring land-management agencies:*

- The Montana Department of Fish, Wildlife, and Parks provides the largest percentage of recreation opportunities outside of National Forest System lands in the broader landscape. Montana State Parks reports more than 3.4 million visits in 2021 and visitation has increased 71% since 2010. Eighty-eight percent of Montana residents over the age of 18 are active in outdoor recreation with 74 percent visiting public lands (i.e., national forests, national parks, and other federal/state agency-managed lands). For Montana, the statewide recreation priority needs are bike lanes, rifle and handgun ranges, off-road all-terrain vehicles trails, and sledding and tubing areas. Most of the plan area falls in Montana State Parks' Region 1 and Region 2. Region 1 receives the highest visitation of all the regions in the Montana State Parks system, with 844,620 total visits, and Region 2 being the fourth highest, with 493,474 visits in 2021. Within region 1 and 2 there are 18 state parks and eight of these are directly influenced by lands or recreation activities within the plan area. Included in those parks is Milltown State Park, which had the highest visitation in region 2 at 110,734 visits (Montana Fish Wildlife and Parks 2022a).
- The Bureau of Land Management also provides recreation opportunities in the broader landscape. The mission of this agency is to manage and conserve public lands for the use and enjoyment of present and future generations under the mandate of multiple use and sustained yield. The Missoula Field Office manages nearly 150,000 acres of public lands and more than 200,000 acres of mineral estate within Granite, Missoula, Lincoln, Flathead, Sanders, Mineral, Lake, Ravalli and Powell counties in western Montana. The area is rich in history, timber, and mineral resources. Garnet Ghost Town east of Missoula is popular with tourists in the summer and with winter recreation enthusiasts in the winter months. It is the highlight of the Garnet Range Back Country Byway. The Blackfoot River corridor provides world-class opportunities for anglers, floaters, camping, and wildlife viewing. Big game hunting, hiking, fishing, camping, and wildlife viewing are popular activities within the Missoula Field Office.

- The Confederated Salish and Kootenai Tribes' Bison Range, previously managed by the U.S. Fish and Wildlife Service as the National Bison Range, was restored to federal trust ownership to the Confederated Salish and Kootenai Tribes through Public Law 116-260, in 2020. The Tribal Council adopted, as its interim Bison Range management plan, the existing Comprehensive Conservation Plan that was adopted by the U.S. Fish & Wildlife Service in 2019 (for which the Confederated Salish and Kootenai Tribes were a cooperating agency). About 21% of visitors the Confederated Salish and Kootenai Tribes' Bison Range were from the local area (within 50 miles of the refuge), whereas 79% were nonlocal visitors. For most local visitors, the Confederated Salish and Kootenai Tribes' Bison Range was the primary purpose or sole destination of their trips (83%). For almost half of nonlocal visitors, the refuge was one of many equally important reasons or destinations for their trips (46%). Local visitors reported that they traveled an average of 34 miles to get to the refuge, while nonlocal visitors traveled an average of 820 miles. The average distance traveled for all visitors to this refuge was 647 miles, while the median was 200 miles. The top three activities in which people reported participating were wildlife observation (88%), auto tour route/driving (80%), and photography (66%). The primary reasons for visitors' most recent visits included wildlife observation (66%), auto tour route/driving (19%), and photography (10%).
- To the north of the Forest lies Glacier National Park. Known to Native Americans as the "Shining Mountains" and the "Backbone of the World", Glacier National Park preserves more than a million acres of forests, alpine meadows, lakes, rugged peaks and glacial-carved valleys in the Northern Rocky Mountains. This large park, managed by the National Park Service, is consistently one of the top 10 most visited National Parks, and received approximately 2.9 million visitors in 2022. While there are no statistics to show the direct effect that these visitors had on National Forest System lands within the plan area, the main transportation route to Glacier runs through the Lolo National Forest, and the Paradise-St. Regis Scenic Byway is considered a scenic alternative to access the park.
- The U.S. Fish and Wildlife Service is also an important partner. There are two national wildlife refuges that are part of the National Wildlife Refuge System, within or adjacent to the project area: the Lee Metcalf National Wildlife Refuge and the National Bison Range. The Lee Metcalf National Wildlife Refuge close to Missoula and is considered an urban refuge. Most visitors (85%) lived in the local area (within 50 miles of the refuge), and for most local visitors, the refuge was the primary purpose or sole destination of their trips (77%). For almost half of nonlocal visitors, the refuge was one of many equally important reasons or destinations for their trips (48%). The top three activities in which people reported participating in were wildlife observation (71%), bird watching (69%), and hiking (69%). The primary reasons for visitors' most recent visits included hiking (27%), bird watching (23%), and wildlife observation (12%).

*National recreation trends.* The Outdoor Foundation published their 2022 outdoor participation trend report, summarizing some recent trends in outdoor recreation. Some important trends relevant to recreation on public lands include:

- There is overall growth in outdoor recreation participation. The outdoor recreation participant base grew 2.2% in 2021 to 164.2 million participants. 54% of Americans ages 6 and over participated in outdoor recreation at least once, the highest number of participants on record.
- New outdoor participants are more diverse than the overall outdoor participant base and are driving increasing diversity not only by ethnicity but also across age groups.

A publication by Cordell (2012), in support of the 2010 Resource Planning Act Assessment, described the trends and outlooks for outdoor recreation in the United States. Some important trends especially relevant to recreation on public lands include:

- There is substantial growth in both participants and annual days for five nature-based viewing and photography activities: viewing birds, other wildlife (besides birds), fish, wildflowers/trees and other vegetation, and natural scenery.
- Public lands continue to be highly important for the recreation opportunities they offer. In the West, recreation on public lands account for 69 percent of annual recreation days, slightly more than 60 percent of viewing and photographing nature activity, around three-fourths of backcountry activity, 57 percent of hunting, and 67 percent of cross-country skiing.
- Recreation resources will likely become less available as more people compete to use them.
- Trends towards more flexible work scheduling and telecommuting may well allow recreationists to allocate their leisure time more evenly across the seasons and through the week, thus facilitating less concentrated peak demands.
- Technological innovations will allow more people to find and get to places more easily and quickly, perhaps leading to over-use pressure not previously considered a threat.

Projected trends in outdoor recreation up to the year 2060 were also highlighted in the report. The five activities projected to grow fastest in number of participants are:

- developed skiing (68 to 147 percent increase)
- undeveloped skiing (55 to 106 percent increase)
- challenge activities (50 to 86 percent increase)
- equestrian activities (44 to 87 percent increase)
- motorized water activities (41 to 81 percent increase)

The activities with the lowest projected growth in participant numbers are:

- visiting primitive areas (33 to 65 percent increase)
- motorized off-road activities (29 to 56 percent increase)
- motorized snow activities (25 to 61 percent increase)
- hunting (8 to 23 percent), fishing (27 to 56 percent increase), and
- floating activities (30 to 62 percent increase)

*Statewide recreation trends and The Montana Statewide Comprehensive Outdoor Recreation Plan.* The Montana 2020–2024 Statewide Comprehensive Outdoor Recreation Plan serves as the guiding document to promote integrated outdoor recreation management and service provision in Montana in a more holistic and effective manner. The Statewide Comprehensive Outdoor Recreation Plan provides discussion on recreation supply, demand, and usage patterns, for each of the regions as summarized from a variety of sources. The 2020 plan was largely an update of the 2014–2018 planning goals and did not update trend and usage data. During the previous effort, Montana State Parks engaged in a robust data collection effort that included a resident survey, needs assessment of outdoor recreation providers. Moving forward, every ten years the Statewide Comprehensive Outdoor Recreation Plan will include a comprehensive data collection effort to inform the planning process. Information provided below is from trends reported in the

2014 and the 2020 Statewide Comprehensive Outdoor Recreation Plans, as well as the Montana Travel Industry 2021 report completed by the University of Montana. The planning area is primarily in Glacier Country but also overlaps into the Southwest Country areas identified in the 2014 Statewide Comprehensive Outdoor Recreation Plan.

There have been large variations in visitation and expenditures by the Statewide Comprehensive Outdoor Recreation Plan regions. In 2012, Yellowstone Country had the highest visitation at over 3.8 million nonresident visitors, 35 percent of the total statewide visitation, and the highest nonresident expenditures at nearly $920 million. Glacier Country had 33 percent of nonresident visitors and $714 in expenditures. Missouri River Country has about 3 percent of the nonresident visitation and generated just under $400,000 in visitor expenditures. Southwest and southeast Montana have similar visitation levels – around 19 percent – but visitors in southeast Montana spent almost $200 million more than visitors in southwest Montana.

In the Glacier region, 76% of non-resident visitors participated in scenic driving. The rest of the top five activities include: day hiking (50%), nature photography (48%), wildlife watching (45%), and car and RV camping (37%). For Montana resident travel, Glacier Country was also one of the most popular destinations for outdoor recreation in 2012. Non-motorized boating is most popular in Glacier Country, followed by beach activities, golfing, motorized boating, and birding. Other popular activities include wildlife watching, scenic driving, and camping. Glacier Country was also tied with Yellowstone for most popular region for cross country skiing at 32 percent. Other popular activities include nature photography and snowmobiling.

Recreation needs for the region were also identified in the 2012 Public Recreational Use Survey by the University of Montana Institute for Tourism & Recreation Research. The results are presented by top uses, top needs, and those activities that had more people saying there was a need to increase than those who felt the facility/area was adequate. About 77% of respondents used walking/jogging/biking paths and hiking trails in Glacier Country. When asked to rate their use of public lands and areas in Glacier Country on a scale from 1 to 5 (with 5 being the most often), recreationists in Glacier Country most often use rivers and streams (mean 3.53), national forests (3.46), natural lakes (3.39), National Park land (3.12), and State Parks (3.12). The top facility/area need and the highest responses for increase among respondents is both bicycle lanes and walking/jogging/bicycling paths.

A few key statewide trends identified in the 2014-2018 Statewide Comprehensive Outdoor Recreation Plan (Montana Fish Wildlife and Parks 2019) include:

- Trails provide important connections within communities and between communities and public lands. Planning for youth as well as the aging population will help Montanans at all stages of life and will continue to further Montana’s recreation heritage among the young and seniors. Facilities like trails can meet the needs of all ages and abilities, and this theme was strong throughout reference documents and public involvement. Walking remains the primary activity for Montanans, followed by backpacking, hiking, fishing, and hunting.
- In Montana, 62 percent of residents participated in wildlife-associated recreation, with 33 percent participating in wildlife watching and 29 percent participating in fishing or hunting activities. Both these are above the national participation rate, with hunting and fishing considerably higher than the national rate of 16 percent. Montana had the fifth highest participation rate among states in hunting and fishing. Although Montanans participate in fishing and hunting activities more than the national level, data on fishing and hunting licenses indicate participation in fishing and hunting is generally declining.

- Motorized recreation has increased significantly from 2000, with a 300 percent increase in off-highway vehicle registration and a close to 200 percent increase in snowmobile registration. Nearly 30 percent of Montanans aged 16 and over participate in off-highway vehicle recreation, putting Montana in the top 10 states for off-highway vehicle recreation.
- Recreation safety is a growing concern in Montana. Data shows that Montana is in the top states for fatalities related to avalanches and boating.
- The top barrier for participation in recreation included lack of time (30 percent), physical disability (14 percent), cost (11 percent), and poor health (8 percent). The other 23 percent chose unknown. Montanans are trending towards higher rates of obesity. By 2021, nearly one in three Montanans could be obese.

## 3.5.2 Recreation Special Uses

### Key Takeaways

- Recreation special uses such as ski areas, outfitting and guiding services, and organizational camps connect people to the Forest. Annually, tens of thousands of people ski down winter slopes, get packed into remote camps to hunt big game, or attend summer camps on National Forest System lands; many of these activities are possible through the issuance of special use permits.
- Outfitter and guiding services, recreation residences, and recreation events represent the majority (90 percent) of recreation special uses across the Forest. Over half of recreation special use permits are for outfitter and guiding service. Fishing, river recreation, hunting, and equestrian and stock use are the most frequently authorized uses across all Ranger Districts.

### Summary

Recreation special use permits provide for occupancy and use of national forests through issuance of permits. Permitted recreation uses provide specific recreational opportunities to the public and deliver economic benefits to rural economics. There are both commercial and noncommercial recreation special use permits (Table 69). Recreation uses have the potential to impact other resources, as do recreation special use permits to the degree that they facilitate these uses. Agency handbooks guide the process for reviewing and issuing special use permits, and all applications for permits are analyzed with respect to consistency with the land management plan and potential resource impacts.

Commercial special use permits include opportunities such as winter recreation resorts, outfitting and guiding services, lodging resorts, recreation events, and organizational camps. Outfitter and guiding services represent over half of all recreation special use permits with application approved, permits pending signature, or currently issued permits on the Forest. These 68 outfitter and guiding service permits provide a variety of services for forest visitors across all Ranger Districts. Fishing and river-related recreation services are the most frequently permitted recreation opportunities. This includes bank/wade fishing, float fishing, shuttle services, and swimming. Hunting represents the second most common authorized outfitter and guiding permits. In some cases, these businesses provide horse and stock support for their guided hunting trips. Including hunting trip support, equestrian and stock use along National Forest System roads and trails is the third most authorized outfitter and guiding use. Other outfitter and guide services provided to forest visitors include hiking, backpacking, camping, bicycling, trail running, rock climbing, and general summer recreation opportunities. Winter recreation opportunities include cross-country skiing, backcountry skiing/touring, snowshoeing, and dog sledding. Snowmobile and all-terrain vehicle touring are also services provided through these entities. Some outfitter and guides provide environmental education and training services in conjunction with their other services, while some have permits specifically to provide these services to the public and user groups.

Camp Paxson, a historic Civilian Conservation Corps facility located on the Seeley Lake Ranger District, is the only active organizational camp on the Forest. This organizational camp special use permit authorizes the use and occupancy of 15 acres of land for the Camp Paxson Organizational Camp that includes 15 sleeping cabins, one caretaker cabin, two bathhouses, one dining hall, and three storage sheds. Three resorts operate on the Lolo National Forest under a special use authorization and provide year-round recreation services and opportunities. The Montana Snowbowl on the Missoula Ranger District operates the ski area under a permit, while the lodge and main parking area is located on private land. The other two include the Tamaracks and Lodges on Seeley Lake, both of which are located on the Seeley Lake Ranger District. Permits for recreation events are held across the forest and support disc golf tournaments, cross-country skiing, trail running, cycling, motorized charity rides, bi-/dual-/triathlons events, snowmobiling, dog sledding, and other recreation activities.

Non-commercial special use permits are used by individuals, groups, and single families, for purposes other than income or profit. These include permits issued for recreation residences, private recreation features or facilities for private use, and recreation events. All 33 recreation residences are within the Seeley Lake area on the Seeley Lake Ranger District. Other non-commercial recreation special use permits include shelters, a private dock, rental services without facilities, a snow play area, a local park, and non-commercial group use.

**Table 62—Recreation special use permits issued or pending signature on the Lolo National Forest, April 2023**

| Special Use Type | Number of Permits | Percentage of Permits |
|---|---|---|
| Outfitting and Guide Service | 68 | 52 |
| Recreation Residence | 33 | 25 |
| Recreation Event | 18 | 14 |
| Shelter | 3 | 2 |
| Resort | 3 | 2 |
| Boat dock and wharf | 1 | 1 |
| Organizational Camp | 1 | 1 |
| Rental Service (without Facilities) | 1 | 1 |
| Winter Recreation Resort | 1 | 1 |
| Snow Play | 1 | 1 |
| Park or playground | 1 | 1 |
| Non-commercial group use | 1 | 1 |
| **Total (Issued/Pending)** | **132** | **n/a** |

## Status and Trends

The Forest has experienced an increase in interest for recreation special uses in recent years and anticipates that this trend will continue. Permit administration, monitoring, and processing takes additional capacity that the Forest has not had historically. Many special use permit requests are for recreation areas already receiving high public use, such as within the Blue Mountain and Pattee Canyon Recreation Areas. Finding balance between resource management and meeting requests is challenging.

Outfitter and Guiding services have shown an upward trend since 2014 in terms of the number of trips supported and the variety in types of activities provided. Hunting and fishing have consistently been the most supported recreation opportunities. These types of activities increased in the number of trips provided consistently except for 2020 when hunting showed a slight decline while fishing has a small increase. Horse trail riding and packing was the third most often activity provided through 2019 when the frequency of these services provided was maintained before showing a decrease since then. Other activities that have been on the rise include backpacking and hiking, as well as miscellaneous day use.

Recreation uses change as people find new and creative ways to enjoy public lands. Although the Forest's management of outfitter and guiding services and reporting has increased over the years, and the variety of activities that have grown substantially since 2014 (Figure 37). In 2014, hunting and fishing were the only outfitter and guiding services activities provided. By 2021, seventeen different activities were reported. This reflects the Northern Region Outfitter and Guide Needs Assessment where researchers indicated that as new uses that require specialized equipment, skills, and knowledge may result in an increase in outfitter and guide permit needs to support these uses (Oschell and Nickerson 2008).

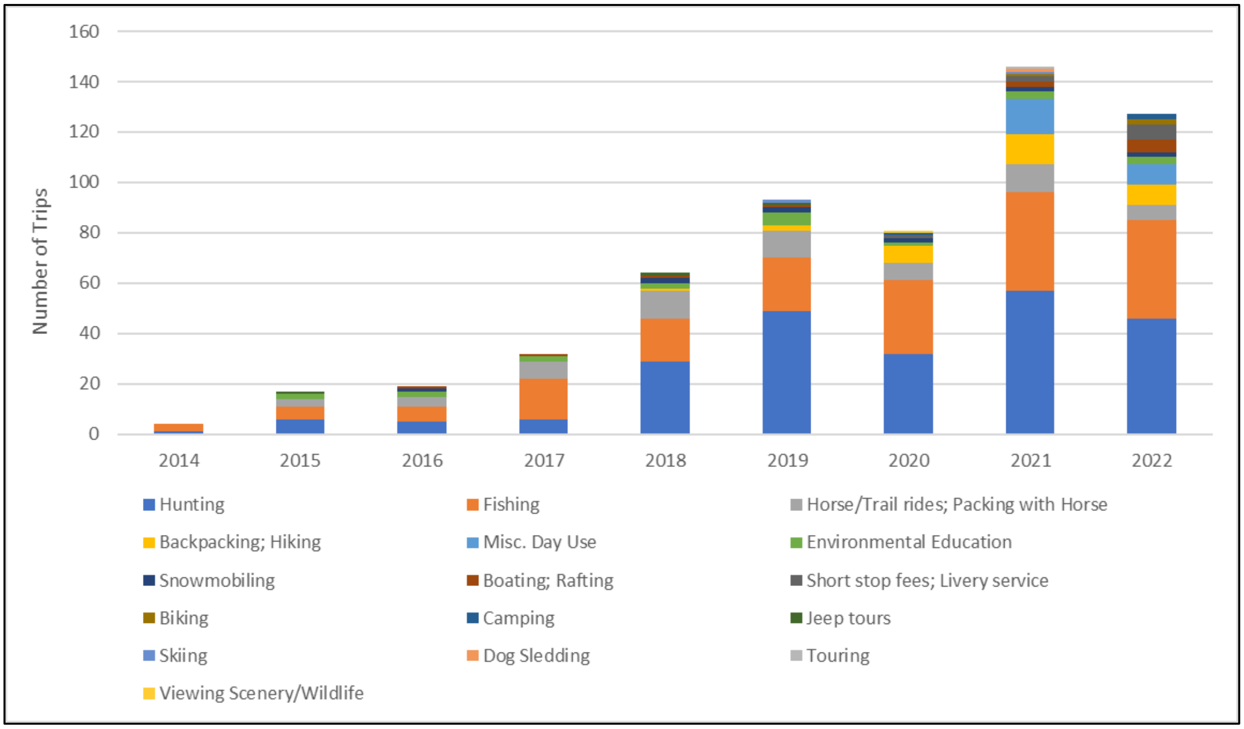


**Figure 37—Activity types and the number of outfitter and guide supported trips (2014-2022).**

Outfitter and guiding permits include a certain number of authorized client days based on anticipated number of trips and clients supported by their services. They are required to report actual use days at the end of the fiscal year to ensure accurate billing and an understanding of their use of across the Forest. As of 2019, the number of trips reported rose to 432. Likely impacted by travel constraints and the Covid-19 pandemic, there was a decrease in the number of trips in 2020 before rebounding to and continuing to increase through 2022. Authorized client days and actual client days used varies over the years but on average, outfitter and guides use about 64 percent of their authorized days (Figure 38).

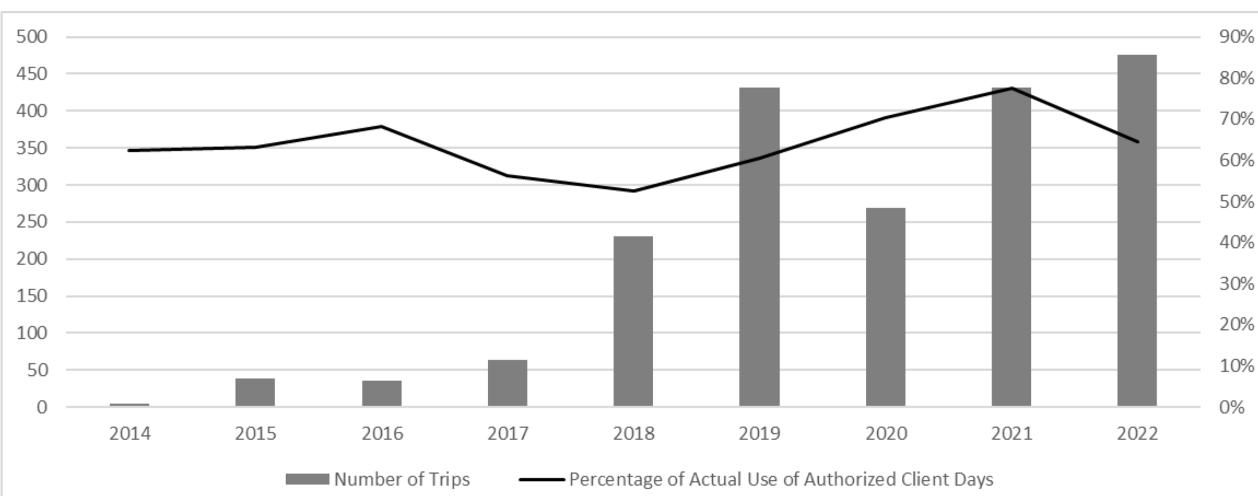

**Figure 38—Number of trips reported by all outfitter and guiding service providers (columns) and the percentage of authorized client days that they used (trend line) between 2014 and 2022.**

# 3.6 Scenery

## 3.6.1 Key Takeaways

- Scenery is important to visitors' overall experience when visiting the Forest. People prefer natural settings when visiting public lands (Ryan 2005). Statistics from the National Visitor Use Monitoring surveys (U.S. Department of Agriculture 2021a) show that the second highest activity visitors participate in nationally is viewing natural features, with 43 percent of visitors participating in this activity. This high percentage emphasizes the importance of maintaining natural appearing landscapes so the expectations of these visitors can be met.
- Currently, the scenic integrity of about 40% of the Lolo National Forest is classified as high or very high, and 51% is rated as moderate. Only 9% is classified with low scenic integrity.

## 3.6.2 Summary

When developing forest plan components, the Responsible Official must consider scenic character (36 CFR 219.8(b)(2)) and aesthetic values, geologic features, scenery, and viewsheds (36 CFR 219.10 (a)(1)). The 1986 Forest Plan used the Visual Management System to describe and determine the effects of management to scenery. Since then, the agency has shifted to the Scenery Management System, which integrates many of the same concepts while updating terminology and increasing the role of constituents throughout the inventory and planning processes. It also borrows from concepts of ecosystem management and improves the integration of other biological, physical, and social and cultures resources into scenery management planning (U.S. Department of Agriculture 1995a). The Scenery Management System represents the agency's latest science in fulfilling it legal requirements for managing scenic resources. This system provides a systematic approach to inventory, analyze, and monitor these resources and used in the context of ecosystem management to determine the relative value, stability, resiliency, and importance of scenery and assist in establishing resource objectives and ensure high-quality scenery for future generations.

Other guidance to support the requirements of the 2012 Planning Rule include Forest Service Manual 2380 and Landscape Aesthetics - A Handbook for Scenery Management (Agriculture Handbook 701). These documents describe the framework and additional information on the Scenery Management System. Additionally, concepts detailed in Forest Service Manual 2310, Chapter 10 - Sustainable Recreation Planning further complement the Scenery management system. Ecological processes and disturbance patterns provide a foundation for scenic character. Valued aspects of the built environment are integral to Scenery Management System and contributes to a landscape's sense of place. Public engagement and stakeholder input is included to ensure that public values inform decision-making for desired scenic integrity objectives and plan components.

The Forest Service Washington Office developed a National Scenery Management System Inventory Mapping Protocol (U.S. Department of Agriculture 2020)to meet the intent of the planning rule requirements and supporting Forest Service Manual and Handbook direction. The protocol ensures that the same processes and considerations are folded into each plan development or revision effort. Products from the National Inventory Mapping Protocol include:

- Scenic character descriptions – a combination of the physical, biological, and cultural images that give an area its scenic identity and contribute to its sense of place.
- Scenic attractiveness – degree of scenic diversity across the landscape.

- Concern levels – importance of scenery to those viewing it at points and travelways across the forest or nearby on non-Forest Service lands.
- Landscape visibility – landscape sensitivity and how/where people view scenery.
- Scenic classes – a combination of concern levels and visibility, assigns the importance of scenery for comparison with other resources.
- Existing scenic integrity – intactness of scenic character attributes.

Additional information regarding the mapping protocol is provided in appendix 6.

## 3.6.3 Status and Trends

### Scenic Character

Scenic character is 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 provides a frame of reference from which to determine scenic attractiveness and to measure scenic integrity (36 CFR 219.19). Scenic character descriptions for ecological subregions across the Lolo National Forest include:

- How the landscape has developed over time using information from archeologist, historians, ecologist, and others familiar with the influences of the Lolo National Forest;
- Potential landscape character, informed by potential vegetation inventories;
- Existing scenic attributes such as landform, vegetative patterns, water characteristics, and cultural features; and
- Existing scenic attributes which affect the senses of the aesthetic experience other than sight, such as sound, small, taste, touch.

Earlier planning efforts did not complete scenic character description narratives and these are being developed as part of this assessment. To capture scenic character descriptions, we began with the Provinces and Ecological Subregions of the United States (McNab and Avers 1996) to understand the diversity of landscapes represented across the Forest (Table 63 and Table 64). The Lolo National Forest is in the Northern Rocky Mountain Forest-Steppe – Coniferous Forest – Alpine Meadow and Middle Rocky Mountain Steppe – Coniferous Forest – Alpine Meadow ecological provinces. Scenic character description narratives are based on these delineations with supplemental section and subregion information. While much of the vegetation (patterns, existing, potential), geological, landform, and water characteristics are supported from section and subregion summaries and other existing information, we integrated local knowledge and cultural influences to understand what these areas mean to local communities and how they interact with the landscape in these settings. Detailed Scenic Character Narratives are included in appendix 6 and figures A1-21, A1-22, A1-23, A1-24, and A1-25.

**Table 63—Ecological provinces found on the Lolo National Forest**

| Province | GIS Acres within Lolo National Forest Administrative Boundary | Percentage of Lolo National Forest Administrative Boundary |
|---|---|---|
| Northern Rocky Mountain Forest-Steppe - Coniferous Forest - Alpine Meadow Province (M333) | 1,796,596 | 69% |

| | | |
|---|---|---|
| Middle Rocky Mountain Steppe - Coniferous Forest - Alpine Meadow Province (M332) | 825,844 | 31% |
| **Total** | **2,622,440** | **100%** |

Total acres differ from the Lolo National Forest administrative boundary due to ArcGIS data processing tools and the coarseness of the EcoMap province dataset. Both National Forest System and non-NFS lands are included.

**Table 64—Acres and proportions of section and subsections across the Lolo National Forest**

| Subsection Number | Subsection Name | Acres | Percentage |
|---|---|---|---|
| M333D - Bitterroot Mountains | | 1,510,487 | 58 |
| M333Da | Coeur d'Alene Mountains | 91,219 | 3 |
| M333Db | St. Joe-Bitterroot Mountains | 405,897 | 15 |
| M333Dc | Clark Fork Valley and Mountains | 1,013,143 | 39 |
| M333De | Clearwater Mountains and Breaks | 227 | 0 |
| M333B - Flathead Valley | | 195,053 | 7 |
| M333Bb | Salish Mountains | 177,462 | 7 |
| M333Bc | Flathead River Valley | 17,592 | 1 |
| M333C - Northern Rockies | | 91,056 | 3 |
| M333Cb | Canadian Rockies-Whitefish-Swan Mountains | 86,923 | 3 |
| M333Ce | Flathead Thrust Faulted Mountains | 1,504 | 0 |
| M333Ch | Southern Rocky Mountain Front | 2,629 | 0 |
| M332B - Bitterroot Valley | | 825,826 | 31 |
| M332Ba | Bitterroot Glaciated Canyons | 13,993 | 1 |
| M332Bb | Bitterroot-Frenchtown Valleys | 42,905 | 2 |
| M332Bg | Garnet-Sapphire Mountains | 276,000 | 11 |
| M332Bh | Whitefish-Swan Mountains | 216,891 | 8 |
| M332Bl | Clark Fork Valley and Mountains | 195,460 | 7 |
| M332Bp | Avon-Nevada Valleys | 80,577 | 3 |
| M332A - Idaho Batholith | | 18 | 0 |
| M332Ab | Central Idaho Glaciated Mountains | 18 | 0 |
| **Total** | | **2,622,441** | **100** |

## Concern Level Points and Travelways

Concern levels help us capture public importance placed on landscapes viewed from travelways and use areas. Travelways are linear features with concentrations of public viewing, such as roads, trails, railroads, and streams. Use areas are spots that receive concentrated public viewing such as campgrounds, scenic overlooks, visitor centers, lakes, interpretive sites, and so on. Concern levels provide a foundation for other aspects of the Scenery Management System such as landscape visibility and distance zones. They also influence the development of existing and desired Scenic Integrity Objectives, which guide the management of scenery resources.

Concern Levels are divided into three categories. Level 1 represents travelways and use areas of high concern for scenery management. Level 2 are locations of moderate concern. Areas assigned to Level 3 represent locations of low concern. Data used to identify concern level points and travelways have substantially updated since earlier revision efforts; therefore, these inventories were re-created and validated. Landscape Aesthetics, A Handbook for Scenery Management, Agriculture Handbook 701, provides more information (U.S. Department of Agriculture 1995a, pp. 4-8 through 4-10).

**Concern level 1.** All primary and secondary travel routes, use areas and water bodies where the level of interest in scenery is high is a concern level 1 regardless of use level. Initial concern level 1 points and travelways included:

- All designated wilderness areas and primary access roads and trails,
- Rattlesnake National Recreation Area and primary access roads and trails,
- Administrative designated areas, including Pattee Canyon and Blue Mountain Recreation Areas, Montana Snowbowl and Lookout Pass Ski Areas, and Lolo Pass Visitor Center and Nordic ski area,
- Research natural areas,
- National Historic Trails and National Recreation Trails,
- Scenic Byway, the Saint Regis-Paradise Cutoff (MT-135),
- Primary roads (includes all maintenance level 5 roads),
- Eligible and Suitable Wild and Scenic Rivers,
- All other recreation sites with development scale 4 and 5, as well as historic sites, lookouts and cabins, resorts, interpretive sites, and viewing areas, and
- Nearby non- Forest Service points of interest, including historical sites, interpretive sites, campgrounds, lookouts, and resorts.

**Concern level 2.** Concern level 2 includes all seen areas from primary travel routes, use areas, and water bodies where the forest or grassland visitors have a moderate interest in scenic qualities or low interest in scenic qualities if the area receives moderate to high use. Initial concern level 2 points and travelways included:

- All secondary access roads (includes all maintenance level 4 roads),
- Trail class levels 3 through 5,
- All recreation sites at development scale 3, and
- Nearby non- Forest Service points of interest, including viewing areas and picnic areas.

**Concern level 3.** All remaining roads, trails, and recreation sites not included in Concern Levels 1 and 2. These landscapes and secondary travelways and use areas have local importance only and generally get low to moderate recreation use.

## Scenic Attractiveness

Scenic attractiveness is the primary indicator of the intrinsic scenic beauty of a landscape and of the positive responses it evokes in people. It helps identify landscapes important for scenic beauty, based on commonly held perceptions of the beauty of landform, vegetation pattern, composition, surface water characteristics, land use patterns, and cultural features. The scenic importance of a landscape based on human perception of the intrinsic beauty of landform, rock form, water form, and vegetation pattern. The scenic attractiveness inventory breaks the landscape into three classifications (Table 65). The most common scenery class found on the Lolo is Class B, common.

- Class A – Distinct (extraordinary or special landscapes which stand out from common landscape): Areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide unusual, unique, or outstanding scenic quality. These landscapes have strong positive attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, patterns, and balance.
- Class B – Typical or common (refers to landscapes with ordinary and routine scenic attractiveness): Areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide ordinary or common scenic quality. These landscapes have positive yet common attributes of variety, unity, vividness, mystery intactness, order, harmony, uniqueness, patterns, and balance.
- Class C – Undistinguished: Areas where landform, 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. These landscapes have weak or missing attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern, and balance.

**Table 65—Scenic attractiveness classification for the Lolo National Forest**

| Scenic attractiveness classification | Total acres | Percent analysis area |
|---|---|---|
| Class A - Distinctive | 1,002,389 | 38 |
| Class B - Common | 1,464,748 | 56 |
| Class C - Indistinctive | 150,437 | 6 |
| **Total[1]** | **2,617,574** | **100** |

[1]These acres were derived from the existing 2006 Scenic Attractiveness coverage, as updated according to Appendix C of the National SMS Mapping Inventory Protocol (U.S. Department of Agriculture 2020 Nat'l SMS Mapping Inventory Protocol), adjacent area classification, and knowledge of these areas. Difference in acres from the total Lolo National Forest Administrative Boundary is due to recent acquisitions that may not yet be classified.

## Landscape Visibility

Landscape visibility inventory helps identify important viewshed across the Forest. The planning handbook (FSH 1909.12, 23.23f) states that viewsheds are elements to consider when developing plan components in the Scenery Management System because they describe areas seen from certain view locations such as roads, trails, or campgrounds. This inventory provides a reflection of the public concern (importance) of scenery along travel ways and at use areas as captured in the concern levels inventory. It also considers the degree of discernible detail (sensitivity) of the landscape and the distance from the viewer. Distance zones are identified as foreground (up to ½ mile from the viewer), middleground (1/2 mile to 4 miles from the viewer), and background (4 miles from viewer to the horizon). Areas not visible from assigned concern level travel ways and use areas are identified as 'seldom seen' areas.

Based on the assigned concern levels, about 467,992 acres (18 percent) of the Forest is visible in the foreground from concern level 1 and 2 points and travelways. About 39 percent of the Forest is visible from these locations and areas as the middleground and just over one-quarter is visible in the background. The landscape visibility analysis showed that about 472,896 acres (18 percent) of the Forest is seldom seen from the locations and areas identified in the concern level points and travelways (See figure A1-24).

## Scenic Classes

Scenic classes are a measure of the value of scenery in a national forest and used during land management planning to compare the importance of scenery along with the importance of other resources, such as timber, wildlife, old growth, and minerals (U.S. Department of Agriculture 1995a). These classes are a combination of scenic attractiveness and landscape visibility, which take into consideration the sensitivity and importance of scenic resources. Represented by 7 values, scenic classes 1 and 2 have high value for scenery, 3 through 5 have moderate value, and classes 6 and 7 have low value. This inventory does not take into consideration existing scenic integrity or desired conditions. It helps inform the revised plan development and desired scenic integrity objectives across the landscape.

After applying the landscape visibility analysis using concern level points and travelways, information was analyzed with the scenic attractiveness data to create a forest-wide scenic class coverage to help information development of desired scenic integrity. Most of the Forest has a high value for scenery, covering 1,864,573 (71 percent) of lands in the administrative boundary. About 720,539 acres (28 percent) have a moderate value for scenery and 34,384 acres (1 percent) had low value (Table 66).

**Table 66—Current scenic classes for the Lolo National Forest**

| Scenic Class | Total Acres | Percent of the Plan Area |
|---|---:|---:|
| Class 1 | 789,211 | 30 |
| Class 2 | 1,075,362 | 41 |
| Class 3 | 292,384 | 11 |
| Class 4 | 127,284 | 5 |
| Class 5 | 300,870 | 11 |
| Class 7 | 34,384 | 1 |
| **Total** | **2,619,495** | **100** |

Scenic class are a compilation of landscape visibility from concern level points and travelways and scenic attractiveness data. Total acres differ from the Lolo National Forest administrative boundary due to ArcGIS data processing tools. Both National Forest System and non-NFS lands are included.

## Existing Scenic Integrity

Existing scenic integrity objectives are developed in coordination with the recreational setting, management direction, and the scenic class that were developed from the scenic inventory. 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”. 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. 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.

There are areas across the Forest with low to moderate scenic integrity. Some of these lands show contrast in shape, form, and texture with the surrounding natural appearing environment. These include past vegetation treatments, ski corridors, built utility corridors, and road corridors. Areas with low scenic integrity should be analyzed for potential improvement, particularly in areas that have growth in population and in recreation use.

Based on applying the guidance from the National Scenery Management System Inventory Mapping Protocol, we compared the existing scenic integrity classification to the visual quality objectives in the 1986 Forest Plan (Table 67). Most management areas with a preservation visual quality objective showed high or very high existing scenic integrity. Over three-quarters of management areas with a retention objective had a high existing scenic integrity, while about 20 percent had a moderate existing scenic integrity. As the allowance for modification or the intensity of management activities increased towards the modification/maximum modification visual quality objective, these areas showed mostly a moderate existing scenic integrity (62-66 percent) and only a small percentage of these areas (10-16 percent) showed a low existing scenic integrity classification. No lands showed a very low or unacceptable existing scenic integrity. Acres for each existing scenic integrity classification are summarized in Table 68. Full existing scenic integrity descriptions and additional information described in appendix 6.

**Table 67—Visual quality objectives from the 1986 Forest Plan (existing information) compared to existing scenic integrity based on current data as mapped through the National Scenery Management System Inventory Mapping Protocols (U.S. Department of Agriculture 2020)**

| Visual quality objective | Total acres | Plan area (%) | Very high (%) | High (%) | Moderate (%) | Low (%) | Un-acceptable (%) |
|---|---|---|---|---|---|---|---|
| No value assigned or from maps on file | 293,399 | 13 | 0 | 24 | 69 | 7 | 0 |
| Modification and maximum modification | 687,642 | 31 | 0 | 18 | 66 | 16 | 0 |
| Modification | 315,772 | 14 | 0 | 28 | 62 | 10 | 0 |
| Partial retention | 87,984 | 8 | 0 | 13 | 75 | 12 | 0 |
| Retention and partial retention | 115,380 | 5 | 0 | 39 | 51 | 10 | 0 |
| Retention | 244,747 | 11 | 0 | 77 | 20 | 3 | 0 |
| Preservation | 371,788 | 17 | 25 | 74 | 1 | 0 | 0 |
| **Total** | **2,216,712** | **n/a** | **n/a** | **n/a** | **n/a** | **n/a** | **n/a** |

These acres were derived from the current Management Area GIS data supporting the 1986 Forest Plan and do not reflect the total acreages for the Lolo National Forest administrative boundary due to recent acquisitions that may not be assigned a Management Area at the time of this assessment.

**Table 68—Existing scenic integrity of all lands on the Lolo National Forest**

| Existing scenic integrity classification | Acres | Percent plan area |
|---|---|---|
| Very High | 93,412 | 4 |
| High | 814,468 | 36 |
| Moderate | 1,150,742 | 51 |
| Low | 211,665 | 9 |
| **Total** | **2,270,286** | **100** |

Total acres differ from the Lolo National Forest administrative boundary due to ArcGIS data processing tools. Both National Forest System and non-National Forest System lands are included.

# 3.7 Land Ownership, Status, Special Uses, and Access

## 3.7.1 Key Takeaways

- The Lolo National Forest has an active land acquisition program that has resulted in hundreds of thousands of acres being added to the administrative land base over the last several decades. Although acquisitions may continue, the recent pace and scale might not be sustained because many of the readily available tracts have been addressed. The legacy of vegetation management and the existing road network on acquired lands are important management considerations.
- Authorized non-recreation special uses on the Forest include industrial or commercial uses, private uses, and a variety of recreational uses. The trend in the number and array of special use permits has been stable, but there is potential for a trend of increasing requests for permits particularly for communication sites and for infrastructure to support potential future energy uses.
- Access to National Forest System lands is important. In general, there has been a trend of decreasing motorized access. There has been an increase in access to some locations made available through land acquisitions, but also an increase in development and privatization of lands that makes access more difficult in other locations. There is increasing demand to address access issues as they relate to private land and easements. There is a trend of private landowners becoming reluctant to grant full easements to the Forest Service, resulting in some access being allowed for administrative purposes only rather than allowing for public access across those lands.

## 3.7.2 Summary

This section addresses land ownership status, use, and access in the plan area and the contribution of these elements to ecological, social, and economic sustainability. Management of these elements include surveying, marking, and posting of ownership boundaries, acquisition, conveyance and exchange of lands and interests in lands, disposition of title claims and encroachments, acquisition of rights-of-way, and authorization and management of land use authorizations to protect resource values and interest of the public managed by the Forest Service.

### Lands Ownership and Status

Management of the ownership and status of National Forest System lands on the Lolo National Forest is important to protect the public's estate interest in its national forest.

- Land ownership is defined as the condition of title of land or interest in land under the jurisdiction of the Forest Service. The following conditions are also included under this definition: the manner in which these lands came into federal ownership; encumbrances and restrictions that affect the administration of the land; interest owned by the government in private lands; and the interest in government lands held by others.
- Land status is the zoning for private lands and formal management status of public lands. Land ownership is the basic pattern of public and private ownership.

Land ownership status on National Forest System lands can change over time through land adjustments that result in a change of legal ownership. Adjustments of ownership occur through land exchange, land purchase, land donation, conservation easements, and disposals such as Small Tracts Act sales and administrative site disposals. There may also be congressionally mandated landownership adjustments. The Lolo National Forest has an active land acquisition program that has resulted in hundreds of thousands of acres of land being added to the administrative land base over the last several decades. Many of these lands have a history of management for timber production and recreation uses. Although site specific conditions vary, the legacy of vegetation management practices and the existing road network are important considerations in determining the appropriate management framework for these lands.

Surveying and posting the national forest boundary, maintaining posted property lines, and defending public lands from trespass or encroachment are activities that maintain the integrity of the National Forest System. The Lolo National Forest has many instances of inholdings or near the forest boundary. These private properties that include vestiges of the gold rush era in the form of patented mining claims, railroad reservations, and the Homestead Act present management challenges.

Public lands are generally retained in federal ownership to provide long-term values. The vision for the plan area is to retain in public ownership all lands currently under its administration that meet the long-term needs of maintaining the integrity of contiguous natural ecosystems, river frontage, riparian areas and wetland ecosystems, recreation and open space, scenery, clean air and water, and habitat for plant and animal populations. The Forest Service may also acquire lands and/or mineral estates that enhance this vision. Lands and mineral estates that do not meet these needs would be disposed of. In all such cases, the primary guiding principle is the greater public benefit.

## Non-Recreation Special Uses

Some uses of National Forest System lands are covered by special use authorizations, including permits, leases, and easements that allow occupancy, use, rights, or privileges in the plan area. All occupancy, use, or improvements on National Forest System lands that are not directly related to timber harvest, forest products, grazing, mining activities, and recreation are referred to as ‘lands special uses.’ Land occupancy and use by private parties and other government entities is managed through the issuance of special use authorizations. Authorized non-recreation special uses on the Lolo National Forest include both industrial (commercial uses) and private uses. Lands special uses include road easements, water supply infrastructure and facilities, communication sites, utility corridors, and other private or commercial uses that cannot be accommodated on private lands. Recreation special uses and events include resorts, ski areas, outfitter and guides, and a variety of uses that provide access and use of National Forest System lands by commercial ventures (see section 3.7.3).

Special use authorizations are legal instruments whose terms and conditions are enforceable when reasonable and consistent with law, regulations, and policy. The mission of the Forest Service special use program is to manage the use and occupancy of National Forest System lands in a manner that protects natural resources, promotes public health and safety, and is consistent with forest land management plans. All authorized uses on public lands are required, by law, to meet applicable environmental protection measures. For all activities that have the potential for disturbance to lands and resources, a project design is required and is subject to environmental analysis, review, and monitoring.

## Access

The pattern and access to public lands on the Lolo National Forest influences the economic sustainability and quality of life for rural communities and the urban center of Missoula. The ease of access and the proximity of natural landscapes to communities is an important role of the Forest. Forest visitors can experience a variety of recreational opportunities essentially in their backyard, from motorized and highly used landscapes to remote, primitive experiences. The proximity and access to public lands is a source of pride for local communities and a key element of economic sustainability from multiple sectors, including but not limited to recreation tourism, forest products industry, and overall quality of life. Recreation access to and through the Forest is facilitated in many ways. Most often, primary access is provided via Forest System roads and easements over private lands. Once on Forest, direction for access is provided through travel management plans. Roads, motorized trails, nonmotorized trails, and rivers provide access for visitors to walk, bike, ride, drive, or boat to their destinations. Trails occur across all settings, depending upon the mode of transport used for the trail use and whether an area is designated for motorized or nonmotorized uses.

## 3.7.3 Status and Trends

### Lands Ownership and Status

The acres of National Forest System lands that are the administrative responsibility of the Lolo National Forest are a result of the original Congressionally designated lands and conveyances (acquisitions, disposals, and exchanges) that have occurred. The land ownership pattern varies with location, and can generally be characterized as:

- Large blocks of uninterrupted, contiguous National Forest System lands,
- National Forest System lands that surround and isolate tracts of private lands, and
- National Forest System lands surrounded by tracts of private lands.

In 1986 when the current forest plan went into effect, the Lolo National Forest included approximately 2,083,192 acres of National Forest System lands. Since then, the Lolo has acquired over 200,000 acres. Much of this increase occurred since the year 2000 and has consisted of lands previously managed by commercial timber companies. There have been land acquisitions using appropriated funds, typically through the Land and Water Conservation Fund. Additionally, the Forest periodically exchanges lands for the mutual benefit of each party and the public. The land acquisition program remains active and more acquisitions are expected in the future. Several key acquisition efforts are currently ongoing:

- Missoula Valley Frontcountry Access (5,372 acres purchased, 5,949 acres in progress, and 6,095 acres potentially available for future acquisition).
- Fawn Peak which could include up to roughly 9,000 acres is in preliminary discussions.
- Potential for exchanges based on the Montana Water Rights Protection Act of 2019. This act includes a provision for the exchange of certain State Trust lands located in the Flathead Indian Reservation for federal lands on several national forests in Montana. It is currently unknown how many acres, if any, of lands managed by the Lolo National Forest may be included because this exchange process is just beginning.

There are multiple kinds of reserved and outstanding rights (collectively known as ‘separated rights’) on the Lolo National Forest. Separated rights can be held by the U.S. on non-National Forest System lands or can be held by other parties on National Forest System lands. Many of these separated rights are related to outstanding or reserved mineral rights, but some are related to features such as roads, trails, fences, and water lines. There are over 246,000 acres on the Lolo National Forest with separated mineral rights held by private or non-Federal government entities; many of these are found on acquired lands. Privately held surface rights can be found on over 16,000 acres and rights-of-way rights on over 5,000 acres. Maps of known outstanding rights and rights-of-way are provided in Appendix 1 (figures A1-33 and A1-34).

The National Forest System lands managed by the Lolo National Forest are adjacent to lands managed by other agencies and governments (e.g., notably the State of Montana, the Bureau of Land Management, and the Confederated Salish and Kootenai Tribes); in addition, the Forest is a neighbor to many private landowners, both small individual family parcels and larger blocks of lands held by corporations. There are also private inholdings within the administrative boundary. In total, there are over 980,000 acres of non-National Forest System land within the plan area boundary. Coordination of management across ownerships is important to achieving common objectives (such as mitigating wildfire hazard and providing connectivity of habitat, to name a few).

## Non-Recreation Special Uses

All uses of National Forest System lands, improvements, and resources, except those authorized by the regulations governing sharing use of roads (36 CFR 212.9); grazing and livestock use (36 CFR 222); the sale and disposal of timber and special forest products, such as greens, mushrooms, and medicinal plants (36 CFR 223); and minerals (36 CFR 228) are designated “special uses”. These uses benefit people every day and contribute substantially to the socio-economic health of smaller rural communities and larger metropolitan areas.

The transmission and distribution of electricity, oil, and gas (collectively called “energy uses”) has the most profound impact to our daily lives. These uses include powerlines and oil and gas pipelines. Energy uses on National Forest System lands help address the Nation’s growing energy needs. Solar and wind energy generation, although not prevalent at this time, may be future energy uses in the plan area.

Communication facilities link people together over vast distances. Many communication sites are located on National Forest System lands and provide emergency services in areas where no alternative exists, such as telephone lines, communication towers, and fiber optic cable lines. Communication sites connect us on a global scale by providing wireless communications, internet services, television, and public radio. Mobile radio systems on National Forest System lands allow highway workers and railroads to operate more efficiently, improving interstate commerce. In some cases, communication systems connect the electric grid which allows early detection of system malfunctions, preventing large-scale power outages. Occupancy at communication facilities allows citizen-based organizations such as the Search and Rescue.

Special use authorizations on National Forest System lands also allow municipalities to provide clean drinking water and enable farmers and ranchers the ability to convey water to crops and livestock. The support of military training operations also contributes to the effectiveness and safety of our troops which strengthens our national security. Other land uses include those for research studies, fences, signs, and service buildings.

The Lolo National Forest currently administers over 600 lands non-recreational special use authorizations (Table 69). These include current authorizations and expired authorizations where the use is still occurring and annual fees are being collected. The trend in the number and array of these permits is stable.

**Table 69—Non-recreational special use permits or easements with an approved application, authorization pending signature, or issued on the Lolo National Forest (April 2023)**

| Category | Special Use Permit or Site Type | Number of Permits |
|---|---|---|
| Road related permits or easements | Forest Road and Trail Act or Federal Land Policy and Management Act Easements | 301 |
| | Federal Land Policy and Management Act Permit (Authorized private road right of ways) | 76 |
| | Department of Transportation Easement | 25 |
| Water supply infrastructure and utilities | Water Conveyance Easement (PL 99-545) | 34 |
| | Water transmission pipeline, less than 12-inch diameter | 33 |
| | Irrigation water ditch or Irrigation water transmission pipeline | 18 |

| Category | Special Use Permit or Site Type | Number of Permits |
| --- | --- | --- |
| | Dam or Reservoir | 5 |
| | Wildlife water supply | 1 |
| | Stream gauging station | 1 |
| | Water treatment plant | 1 |
| Communication Sites | Communication sites (can be co-located) | 72 |
| | Airway Beacon | 2 |
| Energy-related Utility Rights-of-way | Powerline or Powerline, REA Financed | 7 |
| | Oil and Gas Pipeline | 3 |
| | Other Utility Improvements | 1 |
| Sanitation Related Permits | Sewage Transmission Line | 3 |
| | Transfer Station | 1 |
| | Debris Disposal Area | 1 |
| Other Private Improvements | Residence, Government-owned building | 2 |
| | Other improvement | 2 |
| | Monument | 1 |
| | Shelter | 1 |
| | Residence | 1 |
| Research and Training | Research Study | 3 |
| | Weather Station | 2 |
| | Military Training Area | 2 |
| | Non-disturbing use | 2 |
| | Experimental and demonstration | 1 |
| | Observatory | 1 |
| Industrial storage and uses | Warehouse and Storage Yard | 3 |
| | Temporary Construction Activities | 2 |
| | Truck and Equipment Depot | 1 |
| | Log Landing | 1 |
| Agriculture related permits | Livestock Area | 4 |
| | Cultivation | 2 |
| | Fence | 2 |
| | Barn, Shed | 1 |
| **Total** | **n/a** | **619** |

All five of the dams listed in Table 69 are in the Rattlesnake Wilderness Area. There are ten dams located within the Rattlesnake Wilderness Area boundary; five are managed under an easement and 5 are privately owned by the City of Missoula, operated and management under a special use authorization or permit. These easements and permits allow for the right of access to operate and maintain these structures.

## Access

Access to National Forest System lands is important to local communities and people living outside the plan area. Access provides opportunities for a variety of motorized and non-motorized uses. Conflicts over access issues can be emblematic of conflicting values for National Forest System lands and their management. Values around access include the influence that access has on desired experiences, opportunities, impacts to rural economics, cultural and spiritual values, traditional uses, and other socioeconomic considerations. Concerns around how access impacts the biophysical environment, including but not limited to ecosystem integrity, soil, water quality, riparian area health, visual quality, wildlife habitat, and values people hold to an area such as an unroaded character, limited accessibility, or solitude are also important.

Forest users can be local community members, non-local visitors using the area for economic, recreational, aesthetic, or subsistence purposes, and passive users that value the existence and availability of the national forest. Communities and individuals have social and economic dependencies on forest roads and the resources provided by access to them. Changes to a road system or in road management may affect (positively or negatively) local commuting patterns, lifestyles, forest resource-related businesses, the collection of special forest products; school bus routes; firefighting access needs in the wildland-urban interface; and access to municipal water supplies, power lines, and other local infrastructure. In addition, people owning or working in businesses in ‘gateway’ communities may benefit from tourism associated with people visiting the Lolo National Forest. Local businesses may also benefit through resource activities including timber harvest, grazing, road development and maintenance, water projects, and other special uses in terms of potential economic activity. As population increases, expected trends include a greater use of National Forest System lands by the recreating public, particularly those areas close to population centers.

Access includes easements administered by the Forest Service across non-National Forest System land. This generally and preferably includes access by the public across these lands. We expect more development of private lands adjacent to forest and on private inholdings in the forest boundary, and therefore both private access needs and easements across these lands will likely increase. This may also result in challenges from other landowners to existing and perceived access to National Forest System lands, as private landowners are becoming more reluctant to grant easements. In general, obtaining access through easements is becoming more difficult. There will likely be more challenges to historic access that currently exists and a greater need to perfect access to National Forest System lands. The Forest Service continues to pursue reciprocal right of way opportunities to continue securing access.

Since the 1986 Forest Plan was adopted, the general trend over time has been a reduction in the miles of roads open for motorized public use. However, the land acquisition program has also increased access to and across some lands previously held in private ownership.

# 3.8 Infrastructure

## 3.8.1 Key Takeaways

- Maintaining infrastructure to meet the needs of the forest users is important to the local economies and quality of life for those living in surrounding communities. National Forest System roads provide important access that supports a variety of resource management activities including timber harvest, vegetation management, fuel reduction, and fire suppression as well as access for a variety of recreational opportunities for the public. Forestwide, there are approximately 3,165 miles of road open for public use either seasonally or year-round.
- Overall, there has been a trend of reducing the miles of road since 1986. For example, decommissioning of not-needed roads to address specific resource concerns has averaged between 20-50 miles annually for the last four years. Road maintenance with limited funding available is focused on roads open to public travel that access administrative sites and high use recreation sites.
- There are currently over 2,500 miles of trail on the Lolo National Forest, 74 percent of which are terra trails and 26 percent of which are snow trails. The trails program has demonstrated a consistent commitment to maintaining and working towards each trails management objective.
- There are currently 231 administrative facilities on the Lolo National Forest, some of which (roughly 42 percent) are either listed or eligible for listing on the National Register of Historic Places. In total, about 47 percent of facilities are in a poor condition. Roughly 12 percent of the administrative facilities on the Lolo are planned for decommissioning to improve alignment with the administrative needs and budget capacity the Forest.
- There are nearly 200 road bridges and 14 dams present on the Lolo National Forest.

## 3.8.2 Summary

Infrastructure on the Lolo National Forest includes roads, trails, recreation infrastructure, administrative facilities, bridges, and dams. The transportation system is defined as the system of National Forest System roads, trails, and airfields (36 CFR 212.1). The Lolo National Forest expects to maintain an appropriately sized and environmentally sustainable transportation system that is responsive to ecological, economic, and social concerns. The transportation system should provide access for recreation and resource management, as well as support watershed restoration and resource protection to sustain healthy ecosystems. Recreation infrastructure includes facilities and infrastructure such as developed campgrounds, picnic areas, rental cabins, and associated facilities (e.g., outhouses), boat launches, trailheads. Recreation infrastructure is addressed in section 3.5.1.

### Roads

National Forest System roads are under the jurisdiction of the Forest Service and are wholly or partly within or adjacent to National Forest System lands. The Forest Service determines the necessity of these roads for the protection, administration, and utilization of National Forest System lands and the use and development of its resources. Roads managed by other public agencies (such as states, counties, and municipalities) that provide access to National Forest System lands are also considered part of the overall regional transportation system, but do not fall under the jurisdiction or direction of the Forest Service.

National Forest System roads are designated by their intended use. Roads are grouped into use categories to provide a hierarchy that allows for the development of an efficient transportation system. Three categories of use outlined in the 1986 Forest Plan are:

- Arterial Roads – Roads comprising the basic access network for National Forest System administrative and management activities.
- Collector Roads – Roads constructed to serve two or more elements, but which do not fit into arterial or local road categories.
- Local Roads – Roads constructed and maintained for, and frequented by, the activities of a given resource element. These roads connect terminal facilities with collector or arterial roads.

Intended use helps define the design and maintenance standards for each road, which in turn defines the level of safety for the transportation system. Roads are generally constructed and maintained wide enough (>12 feet) for typical cars and trucks. Because many roads were initially designed and constructed for use in achieving vegetation management objectives, design-basis vehicles were lowboys or logging trucks. Roads are built to grades usually less that 12 percent to allow grade-ability for most highway vehicles.

The Forest Service uses five maintenance levels to define the general use and type of maintenance. These five maintenance levels are:

- Maintenance level 1. These are roads that have been placed in storage between intermittent uses. The period of storage must exceed one year. Basic custodial maintenance is performed to prevent damage to adjacent resources and to perpetuate the road for future resource management needs. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur. Roads managed at this maintenance level are in basic custodial care.
- Maintenance level 2. These roads are open for use by high clearance vehicles. Passenger car traffic, user comfort, and user convenience are not considerations. Warning signs and traffic control devices are generally not provided. Motorists should have no expectations of being alerted to potential hazards while driving these roads. Traffic is normally minor, usually consisting of one or more of a combination of administrative, permitted, dispersed recreation, or other specialized uses. Roads managed at this maintenance level are high clearance vehicle roads.
- Maintenance level 3. These roads are open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not priorities. These roads are typically low speed with single lanes and turnouts and are included in the term “passenger car” roads.
- Maintenance level 4. These roads provide a moderate degree of user comfort and convenience at slow to moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated. Maintenance level 4 roads are collectively maintained for travel by a prudent driver in a standard passenger car.
- Maintenance level 5. These roads provide a high level of user comfort and convenience at slow to moderate travel speeds. The roads are normally double lane, paved facilities. Some may be aggregate-surfaced, and dust abated. These roads are collectively maintained for travel by a prudent driver in a standard passenger car. These roads fall under the requirements of the National Highway Safety Act and the Manual of Uniform Traffic Control Devices. Warning signs and traffic control devices are provided to alert motorists of situations that may violate expectations.

The 1986 plan was developed under 1982 planning regulations, which included a requirement to identify where off-road vehicle use would be planned, implemented, and permitted. The travel management regulations at 36 CFR 212.52(a) and 212.81(b) allow for publication of motor vehicle use maps with public notice if a unit has made previous administrative decisions under other authorities restricting motor vehicle use. Based on previous decision-making, the Lolo National Forest has been publishing motor vehicle and over-snow motor vehicle use maps since 2014. The previous decision-making that informs these maps includes the 1986 plan decision and subsequent project-level decisions with travel management elements and is supported by annual publications of travel management plan maps under the Forest Supervisor's signature beginning in 1987.

The 1986 Forest Plan contains management direction for roads, trails, cross-country travel, and snowmobile use through goals, objectives, and standards. The management direction for trails is relatively general, and provides emphasis on maintenance and construction, while providing the necessary resource protection measures. Project-level travel analyses have been completed to inform project decisions related to the forest transportation system and implement some opportunities identified in the 2015 and subsequent travel analysis reports, which are discussed in more detail in the travel analysis section below. To date, the Lolo has not completed the environmental review to identify the minimum road system.

Subpart A of the Travel Management Rule is intended to address the need to better manage funds for road construction, reconstruction, maintenance, and decommissioning, and requires science-based transportation analysis when making road management decisions. The Lolo completed a broad forestwide travel analysis and report in 2015 addressing all National Forest System Roads in the transportation atlas at that time. The travel analysis report provides an assessment of the known roads and a set of findings and opportunities for change to the forest transportation system. Travel analysis is not a decision-making process. The 2015 Travel Analysis Report was organized around a series of questions related to benefits (access, vegetation management, recreation, and wildfire hazard response) and risks (aquatic ecology and terrestrial ecology including wildlife habitat).

The 2015 report provides an assessment of the road infrastructure and a set of findings and opportunities for change regarding the road system needed for safe and efficient travel and for administration, utilization, and protection of National Forest System lands. The report sets the foundation for site-specific travel planning work, prioritizes maintenance needs, and identifies opportunities for decommissioning roads, or putting them in intermittent stored service as the Forest works to identify the minimum number of routes needed for an efficient transportation system as directed in 36 CFR 212 subpart A. The travel analysis report identified some roads as "not likely needed for future use". These roads may be considered candidates for conversion to another use, storage for future use, or removal through decommissioning. Other roads that were rated as "high risk" were identified as candidates for storage for future use, reconstruction or relocation, or additional road maintenance. Roads considered as "low risk" are the first to be considered for reduced road maintenance (i.e., change to a lower maintenance level).

The Lolo National Forest has acquired large acreages of land over the last few decades (see section 3.7), and these acquisitions have included road infrastructure. A portion of these roads have been evaluated in one or more project-specific travel analyses, with some roads subsequently added to the transportation atlas during project decision-making. Forestwide, there are over 4,100 miles of roads mapped that are in an "undetermined" status, and roughly half of these occur on recently acquired lands. In 2023, a supplement to the 2015 travel analysis was produced to evaluate roads on lands that were acquired between 2001 and 2021, using the same methodologies and evaluation factors used in 2015.

Neither the travel analysis report nor the plan revision process makes site-specific travel management decisions. Site-specific, project level analysis is required to make travel management decisions, including road closure, storage, or decommissioning.

## Trails

Forest Service trails are categorized by trail type, trail class, and the managed use of each trail. Trail type reflects predominant trail surface and general mode of travel for each trail. The three trail types are standard (or "terra") trails, which have a surface consisting predominantly of earth; snow trails, which have a surface consisting predominantly of snow or ice; and water trails, which have a surface consisting predominantly of water (but may include portage routes over land). Most trails on the Lolo National Forest are terra trails, and in some cases, a trail may be classified as a terra trail in the summer and a snow trail in the winter. All Forest Service trails must also be categorized by trail class, which are general categories reflecting the prescribed scale of development.

There are currently over 2,500 miles of trail recorded on the Forest, 74 percent of which are terra trails and 26 percent of which are snow trails. There is also one water trail found on the Forest, representing less than 1 percent of the total trail miles.

Maintenance to keep trails in good condition may include, among other tasks, clearing encroaching vegetation and fallen trees, as well as repair; preventive maintenance; and replacement of trail signs, water drainage features, trail bridges, and other trail structures. For reporting purposes, the agency divides trail maintenance activities into three categories: (1) miles maintained, (2) miles achieving standard, and (3) miles improved. The Forest Service defines these categories as follows:

- Miles maintained: miles of trail on which at least one maintenance task was performed to quality standards during a given year, indicating that one or more—but not necessarily all—needed maintenance tasks were completed.
- Miles improved: all trail miles where any improvements were made during a given year through activities such as widening the trail and adding or improving trail bridges or trail components, such as barriers, trail surfacing, kiosks, and wildlife viewing platforms.
- Miles achieving standard: all trail miles that are achieving quality standards and have been maintained in accordance with a specific maintenance cycle associated with each trail's management objective. Maintenance cycles vary by trail; some trails, for example, may be on annual maintenance cycles, and others may be on 3- or 5-year cycles. Thus, a trail can achieve the Forest Service's standards even if it was not maintained each year.

As reported in the 2021 Biennial Monitoring report, the Forest Service's trails program aims to ensure recreation opportunities, public safety, and backcountry access through operation maintenance, rehabilitation, and improvement of forest trails.

### Administrative Facilities

Administrative facilities include buildings and their appurtenances necessary to support the employees, equipment, and activities necessary for the management of national forests. These are separate from recreation facilities. Administrative facilities include fire stations, offices, warehouses, and shops as well as living quarters such as barrack and individual residences. Living quarters are partially supported by rental receipts, while administrative and other facilities are financially supported through annual budget appropriations. The management of buildings and other structures is held under FSM 7310. Forests must develop a facilities master plan as a guide to facilities planning. These documents are continuously updated. A primary goal of facilities planning is to provide safe, clean, attractive, efficient, and accessible facilities for employees and the public.

The Lolo National Forest is comprised of five ranger districts: The Missoula Ranger District, with the office located at Fort Missoula in Missoula; the Ninemile Ranger District, with the office located just outside Alberton; the Plains-Thompson Falls Ranger District, with the office located in Plains; the Seeley Lake Ranger District, with the office located just north of Seeley Lake; and the Superior Ranger District, with the office located in Superior. The Supervisor's Office is located at Fort Missoula in Missoula, Montana and is co-located with the Missoula Ranger District. In addition, the Forest has several remote administrative facilities including the 14th and Catlin Work Center, the Bonita Work Center, the Clear Water Crossing Work Center, the Thompson Falls Work Center, the Bend Work Center, the St Regis Work Center, the Plains Tree Improvement Area, the Monture Guard Station, the Quartz Guard Station, Camp Paxson Historic Site, the Savenac Historic Site, and multiple lookouts and remote communication sites. Each of these sites has an associated utility infrastructure. All buildings are owned except for the Superior Ranger District Office which is leased.

According to the 2021 draft facilities master plan, the Lolo facilities portfolio includes a total of 231 administrative and former administrative buildings now used or planned to use for recreation purposes. The property in Missoula at 14th and Catlin which serves both the Regional Office and Lolo National Forest is planned to be conveyed soon. There are also 32 buildings planned for decommissioning.

### Bridges and Dams

There are nearly 200 road bridges present on the Lolo National Forest and approximately 14 dams, some of which are owned by the Forest Service and some of which are in place through special use permits. Many bridges in the planning area were constructed to support the timber program and are over 30 years old. Older bridges were often built with the abutments at the very edge of streams, often encroaching on the stream, and are no longer in compliance with best management practices. Bridge replacements are designed to replace under-sized culverts and bridges with structures that allow for aquatic organism passage. In many instances, safe design practices, that also meet best management practices, dictate that the only suitable replacement structure for a site is a bridge. The result is a potentially increasing inventory of bridges in need of maintenance.

## 3.8.3 Status and Trends

### Roads

**Roads on the landscape.** Forestwide, there are approximately 3,165 miles of road open for public use either seasonally or year-round (Table 70). Roughly 55% of this mileage is maintained for high clearance vehicles (maintenance level 2) and 42% is maintained for passenger cars (maintenance level 3). There are only approximately 113 miles maintained for moderate or high degrees of user comfort (maintenance levels 4 and 5).

**Table 70—Miles of National Forest System roads open to public use (year-round or seasonally) on the Lolo National Forest, by Ranger District and maintenance level**

| Ranger district | Operational maintenance level 2 | Operational maintenance level 3 | Operational maintenance level 4 | Operational maintenance level 5 | Total miles |
|---|---|---|---|---|---|
| Missoula Ranger District | 244 | 216 | 11 | 3 | 473 |
| Ninemile Ranger District | 372 | 234 | 24 | 0 | 631 |
| Plains/Thompson Falls | 627 | 246 | 7 | 0 | 880 |
| Seeley Ranger District | 75 | 195 | 4 | 8 | 281 |
| Superior Ranger District | 420 | 423 | 48 | 9 | 900 |
| **Total** | **1,738** | **1,313** | **93** | **20** | **3,165** |

Maintenance levels are: 2 (high clearance vehicles); 3 (suitable for passenger cars); 4 (moderate degree of user comfort); and 5 (high degree of user comfort). Data source is the INFRA database, April 2023.

In the 2015 travel analysis report, over 9,000 miles of roads were identified on the Lolo, of which just over 6,000 miles were National Forest System routes, and over 3,000 miles were undetermined routes. The miles of undetermined routes has grown since that report due to recent acquisition of lands to just over 4,100 miles. As shown above, just over 3,000 miles of roads on the Lolo are currently open to public use. Currently, over 1,100 miles of National Forest System roads are in the plan area that are in custodial care (closed to public motorized use).

Many undetermined routes are legacies of past management that are discovered during project planning and implementation activities and have not been evaluated with respect to their inclusion in the transportation system. As they are encountered, these routes are evaluated in site-specific travel planning. Roughly 42 percent of the undetermined routes occur on recently acquired lands. Some roads under the jurisdiction of the Forest Service fall outside of the administrative boundary. These roads are owned or maintained by the Forest Service on private lands, have easements in place with private landowners, or are situations where necessary easements are being pursued by the Forest Service.

As reported in the 2015 travel analysis, the miles of National Forest System roads in the planning area has steadily declined since 1995. Between 1995 and 2015, about 1,008 miles of system roads and unauthorized roads were decommissioned (Figure 39). There have also been additions to the National Forest Road system, including new local roads constructed for vegetation management, acquisition of roads related to cooperative road right-of-way agreements with the Montana Department of Natural Resource Conservation and Plum Creek Timber Company, National Forest System Road database cleanup, and mostly from the acquisition of previously Plum Creek Timber Company lands.

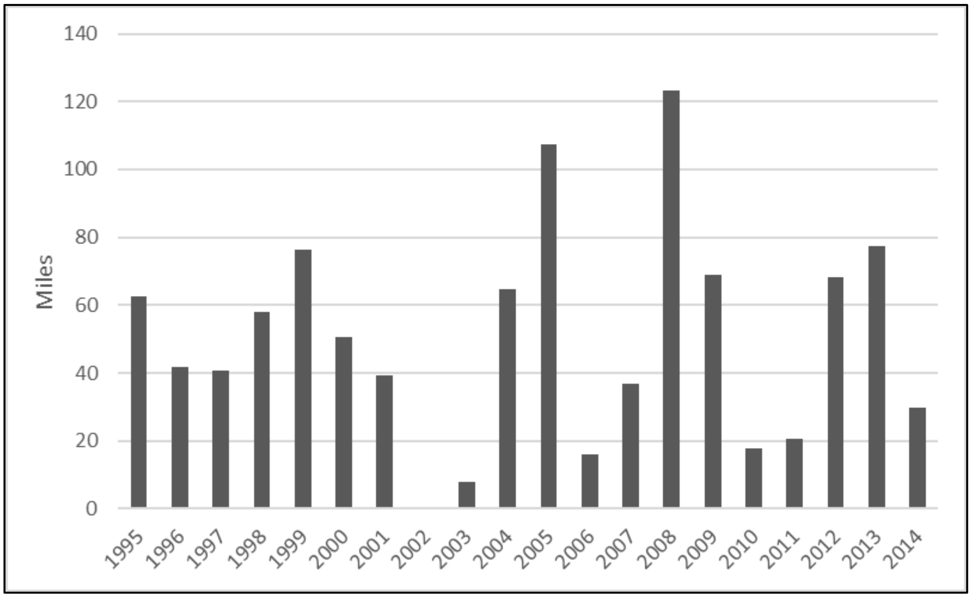


**Figure 39—Miles of road decommissioned on the Lolo National Forest 1995-2014 (no data for 2002)**

The Lolo National Forest implements State of Montana water quality best management practices and many other design features and resource protection measures when implementing projects. Use of the water quality best management practices ensures compliance with the Clean Water Act. Forestry activities in Montana are audited every 2 years. The Forest also engages with the agency's National Best Management Practice Monitoring Program. Application of these practices on Montana timber lands has grown from 78 percent successful in 1990 to 98 percent successful in 2012 (2015 Travel Analysis Report). Percentages of best management practices providing adequate protections for soil and water resources has improved from 80 percent in 1990 to 99 percent in 2012 (ibid). The Forest continues to support monitoring efforts by providing timber sales for audit and technical assistance to audit teams.

The Lolo National Forest has existing cross-country off-highway vehicle use limits in place. Existing trails can be user made trails that already exist on the ground with the caveat that the wheels must be within the existing trail tread. This decision was necessary to avoid future impacts from increasing cross-country off-highway vehicle travel on resource values. Snowmobiles were exempted from this decision. Snowmobile use has generally been allowed to occur cross-country with higher concentrated use on groomed trails. Population and associated recreation use across the planning zone has increased dramatically since adoption of the current forest plans. In addition, technology has advanced for off-road vehicles, snowmobiles, and off-highway vehicles that has enabled these vehicles to access new areas.

**Road maintenance.** The maintenance level of roads and the amount of attention roads receive annually varies widely. Some roads are in poor locations, which increases maintenance needs and the risk that sediment from the road surface could enter adjacent streams. The Forest Service works to prioritize road maintenance in annual maintenance plans. These plans are based on projected budgets, the amount of traffic individual roads receive, and damage created by environmental factors such as flooding and erosion.

Routine road and bridge maintenance work (brushing, blading, ditch, culvert cleaning, deck cleaning, etc.) is periodically performed on maintenance level 2, 3, 4, and 5 roads as funding allows and in most cases they are kept in a drivable condition for their designed use. However, they do not all receive routine maintenance work. According to the 2021 Biennial Monitoring Report, in 2019 and 2020 approximately

531 and 461 miles of road were maintained respectively. The decommissioning of not-needed roads for specific resource concerns has averaged between 20-50 miles annually for the last four years and is expected to continue as funding allows. Currently, road maintenance funds are focused on roads open to public travel that access administrative sites and high use recreation sites. The primary maintenance items are regulatory and warning signage, surface blading, and roadside brushing. Maintenance of closure devices is also a priority and occurs consistently across the forest.

**Travel analysis findings.** Key findings from the 2015 Travel Analysis included:

- The over 6,000 miles of road identified as “likely needed for future use” could be considered as an approximation of the minimum road system given present needs based on Forest Plan direction, statutory and regulatory requirements, and funding expectations while ensuring that adverse impacts associated with road construction, reconstruction, decommissioning and maintenance are minimized. The minimum road system will continue to change as forest needs change.
- Over 100 miles of road were identified as “likely not needed for future use by any resource area. Removing roads from the system requires an area analysis as defined in Forest Service Manual 7700 and National Environmental Policy Act analysis. The greatest opportunity to remove roads from the system is found at the extremities of the road network. Of the road segments considered for “remove, storage, or conversion,” the highest priority for removal would be those segments considered high risk and located in a high priority watershed.
- Current and projected road budgets do not fund road maintenance needs. One possible result will be that more road miles placed in storage (maintenance level 1). Road maintenance emphasis will be placed on promoting safety, aquatic organism movement, and protecting water quality. A road system that is not fully funded may increase the risk of impacts on water quality and aquatic ecosystems. Best Management Practices designed into projects will reduce much of this impact.
- Road construction needs may arise in areas where there is a need to reestablish access for vegetation management, where existing roads need to be relocated to mitigate impacts, or where access is needed for fire fuels treatments in wildland urban interface areas.
- Road decommissioning has been ongoing for nearly 20 years. As decommissioning continues, there will likely be fewer opportunities to remove roads from the transportation system. Unauthorized travel routes are not considered as part of the managed transportation system and are generally considered unneeded. Unauthorized routes represent additional opportunities for ecological restoration and are evaluated at the project level.

In addition, the draft travel analysis conducted in 2023 on acquired lands found that:

- There are over 2,000 miles of road on recently acquired lands (2001-2021), and of these, just over 1,900 miles (94%) are in an undetermined status, while just over 124 miles have been specified as National Forest System roads through project-level analysis and designation. Of these roads, less than 50 miles were identified in the travel analysis as not likely needed.
- The risk and benefit analysis showed that the most common benefit category on the roads found on acquired lands was a medium benefit (45%), followed by low benefit (38%). The most common risk categories were also medium (45%) and low (34%). Only 3% of roads had both a high benefit and a low risk, while 21% have both a high risk and low benefit. See Figure 40.

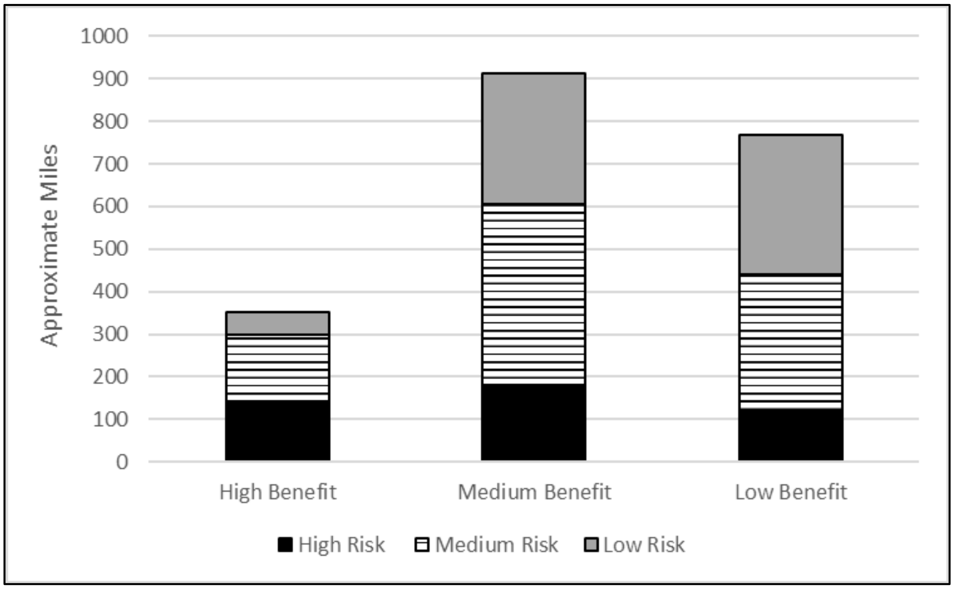


**Figure 40—Summary of risks and benefits of roads on recently acquired lands, draft 2023 travel analysis**

While travel analysis and decision making has occurred during project-level NEPA on some acquired parcels, a full assessment of the acquired transportation system has not been completed. These routes were not automatically added to the National Forest System when the lands were acquired. Route-specific travel analysis and planning is outside the scope of the Lolo's revision process; however, this assessment recognizes the need to continue the process of more specific analysis and travel planning for routes on acquired lands. Similarly, as described above, the status and condition of many other undetermined routes across the Lolo is unknown at the writing of this assessment; these routes are identified, analyzed, and addressed as appropriate during project-level planning and analysis.

## Trails

There are over 2,500 miles of trail on the Lolo National Forest, most of which are terra-trails (over 1,800 miles). Trail class ranges from high developed to minimally developed. The most common designated uses for trails include hiker and pedestrian, pack and saddle, and snowmobile. A developed trail is defined by tread continuous and obvious. A highly developed trail is defined by tread wide and relatively smooth with few irregularities. Use on many trails has increased in recent years because of the COVID pandemic. Some of the trails on the Forest are nationally designated trails.

During the 5-year period from 2016 to 2020, according to the 2021 Biennial Monitoring report, an average of 1,224 miles of trails were maintained yearly, 22 miles per year on average were improved, and an average of 1,008 miles achieved trail standards. The trails program has demonstrated a consistent commitment to maintaining and working towards each trails management objective. Most trails maintained in 2020 were Class 2, Class 3, and Class 4, where 65 percent of the trails are developed or highly developed (class 3 or 4).

## Administrative Facilities

There are 231 facilities currently distributed across the Lolo National Forest according to the 2021 Draft Facilities Master Plan. The Seeley District contains the highest number of facilities (approximately 59) while the Ninemile District contains the least (32). Of all facilities on the Forest, roughly 12 percent are planned for decommissioning to improve alignment with administrative needs and reduce operating costs. The draft facilities master plan also identifies the condition of facilities. This condition rating is an industry standard based on the formula to show a percentage of the repairs needed compared to the replacement value. Nearly half (47%) of the facilities are rated in a poor condition, while 44% are in a good or fair condition. The other facilities are not currently rated.

The facilities plan also provides information on the historical status of the facilities, based on the Forest's assessment and consultation with the State Historic Preservation Office. Approximately 24% of the facilities on the Lolo are listed in the National Register of Historic Places, and another 18% are eligible for listing. The remaining facilities are not eligible or have not been evaluated. Of the facilities that are either listed or eligible for listing in the National Register of Historic Places, roughly half are currently rated in poor condition, and the other half are rated as good, fair, or are not currently rated.

### Bridges and Dams

There are approximately 197 road bridges under the jurisdiction of the Forest Service on the Lolo National Forest. Most of these structures meet or exceed the minimum criteria for bridge condition. Forest Service policy requires two-year inspections on every bridge under Forest Service jurisdiction. Bridges must be repaired and replaced with road maintenance funding, with a small number of structures being replaced through the capital investment program. Many bridges in the plan area were constructed to support the timber program and are over 30 years old. Older bridges were often built with the abutments at the very edge of streams, encroach on the stream, and are no longer in compliance with Best Management Practices.

There are 14 dams on the Lolo National Forest identified in the infrastructure database, most of which are considered fully operational although at least one is listed with a status of "breached". These dams are inspected by the Forest Service or by private contractor. Records are held at the supervisor's office and in the infrastructure database. These dams are maintained and operated by the Forest Service or private entities. As described in section 3.7, ten dams are in the Rattlesnake Wilderness Area. Five of these are managed under an easement associated with their ownership and five that are privately owned by the City of Missoula, operated and management under a special use authorization or permit.

The City of Missoula acquired the ten dams on eight mountain lakes in the Rattlesnake Wilderness Area during the 2017 acquisition of the Mountain Water Company. The dams were built in the 1920s as part of the Rattlesnake Creek water supply, which no longer services Missoula. The dams have not been used for water delivery in more than 30 years, suffer from a lengthy maintenance backlog and are largely non-operational. The Forest Service requires annual monitoring and maintenance as part of the special use permits for ownership of the dams. The City has neither the staff nor financial resources to repair and maintain the dams and strategic decisions need to be made to alleviate inspection requirements, operation and financial obligations, and risk associated with the aged structures. In 2018, Missoula Water completed an engineering and cost benefit evaluation of dam ownership and the study concluded with preliminary recommendations to potentially repair the dams with the largest water rights for long-term water storage and decommission the other dams with smaller water rights. Over the long-term, the City intends to complete either decommission or rehabilitation of the ten dams. In the short-term, the City, in partnership with Trout Unlimited, is moving forward with a pilot dam decommissioning project at McKinley Lake. More assessment work is needed to address other dams on the Lolo.

# 3.9 Designated Areas

This chapter assesses current conditions and trends for designated areas on the Lolo National Forest including wilderness, wild and scenic rivers, research natural areas, inventoried roadless areas, botanical areas, and others, and identifies the opportunity for additional designated areas (36 CFR 219.6(b)).

Some designated areas may be designated by statute and some categories may be established administratively in the land management planning process or by other administrative processes of the Federal executive branch. For this assessment, there are two categories of designated area, statutorily designated (national heritage areas, national monuments, national recreation areas, national scenic areas, national scenic and historic trails, wild and scenic rivers, wilderness or wilderness study areas and interstate highways), and administratively designated (critical habitat under Endangered Species Act, experimental forest or range, inventoried roadless areas, national natural landmarks, national historic landmarks, national monuments, national recreational trails, research natural areas, significant caves or wild horse and burro territories). Not all these designations are present on the Lolo National Forest.

## 3.9.1 Wilderness

### Overview

The Wilderness Act of 1964 (Section 2 (a)) describes Congress' intent and purpose for the establishment of the national wilderness preservation system as follows: In order to assure that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States leaving no lands designated for preservation and protection in their natural condition, it is hereby declared to be the policy of the Congress to secure for the American people of present and future generations the benefits of an enduring resource of wilderness." Wilderness is "as area where the earth and its community of life are untrammeled by man" that "generally appears to have been affected primarily by the forces of nature, retaining its primeval character and influence". Wilderness is "an area of undeveloped Federal land without permanent improvements which is managed to preserve its natural condition, generally appears to have been affected primarily by the forces of nature, with outstanding opportunities for solitude or a primitive and unconfined type of recreation. Wilderness may also contain ecological, geological, scientific, educational, scenic, or historical values.

General prohibitions have been implemented for all national forest wildernesses in applying the provisions of the Wilderness Act of 1964. The Wilderness Act requires the Forest Service to manage human-caused impacts and protect wilderness character to ensure that it is "unimpaired for the future use and enjoyment as wilderness." Motorized and mechanized equipment and mechanical transport is generally prohibited on all federal lands designated as wilderness. This includes motor vehicles, motorboats, motorized equipment, bicycles, hang gliders, wagons, carts, portage wheels; and landing aircraft, including helicopters, unless provided for in specific legislation. Under the agency's minimum requirement analysis process, we may consider the use of motorized equipment or mechanical transport at a project level with review at the Regional Office level.

Under the 1986 Forest Plan, both designated wilderness and recommended wilderness fall under Management Area 12. As the Forest developed wilderness-specific management plans, plan amendments were completed to integrate this updated guidance. These amendments were developed following the General Technical Report INT-176 - The Limits of Acceptable Change system for Wilderness Planning (Stankey et al. 1985). This framework established acceptable and appropriate resource and social conditions to help managers ensure that conditions desired within the Wilderness areas (as well as the Rattlesnake National Recreation Area) were being met given changes in recreation resource use.

Amendment 2 (April 1987) updated the 1986 Forest Plan management direction for the Scapegoat Wilderness as it is managed as part of the Bob Marshall Wilderness Complex (Appendix O-2). Amendment 14 (February 1994) incorporated the Bitterroot National Forest's general management direction for the Selway-Bitterroot Wilderness into the 1986 Forest Plan (Appendix O-1). Amendment 16 (December 1992) pertains to the updated the management direction (Appendix O-4) for the Rattlesnake National Recreation Area and Wilderness. Finally, Amendment 38 (February 2013) incorporated the Limits of Acceptable Change system into management of the Welcome Creek Wilderness into the Forest Plan and updated Appendix O-3. For additional detailed agency policy regarding the management of uses in wilderness, see Forest Service Manual 2300, Chapter 2320.

## Designated Wilderness

**Key takeaways:**

- Four congressionally designated wilderness areas are within, or partially within the Lolo National Forest administrative boundary. These wilderness areas make up approximately 7 percent of the Forest. Welcome Creek and Rattlesnake Wilderness areas are wholly within the Lolo National Forest. The Scapegoat Wilderness is part of the Bob Marshall Wilderness Complex and is partially on the Lolo National Forest. While administered by the Bitterroot National Forest, a portion of the Selway-Bitterroot Wilderness also falls within the Lolo National Forest.
- Designated wilderness provides primitive and semi-primitive non-motorized recreation settings that support forest visitors seeking solitude, closeness with natural landscapes, challenge and self-reliance.
- Overall satisfaction is generally high for visitors recreating in designated wilderness. The Forest is performing well in several important elements associated with Wilderness visits including the condition of the environment, feeling of safety, scenery, and trail conditions. Other elements, such as interpretive displays, parking availability and parking lot conditions, and road condition, were less important to wilderness visitors indicated yet the Forest was performing well in these areas.
- While the average rating of crowding was generally consistent between 2006, 2011, and 2016 surveys, the percent of visits with higher crowding ratings increased and lower crowding ratings decreased. Given the overall estimates of visitors to designated wilderness, it may be that these visitors have a higher expectation of encountering less people than earlier survey respondents or that use may be more concentrated in more popular areas and access points into wilderness.

**Summary.** Four congressionally designated wilderness areas are within, or partially within the Lolo National Forest administrative boundary (Table 71 and figure A1-14). Congress designated these areas prior to the 1986 Forest Plan. Based on current National Forest System spatial data reflecting these areas, the Lolo National Forest contains about 147,893 acres of designated wilderness. These areas make up approximately 7 percent of the Forest. Welcome Creek and Rattlesnake Wilderness areas are wholly within the Lolo National Forest administrative boundary. The Scapegoat Wilderness is managed as part of the Bob Marshall Wilderness Complex. The Bob Marshall Wilderness Complex management is coordinated between the Lolo, Flathead, and Helena-Lewis and Clark National Forests.

A portion of the Selway-Bitterroot Wilderness falls within the Lolo National Forest. In 1992, the Forest transferred the administrative responsibility for their portion of the Selway-Bitterroot Wilderness to the Bitterroot National Forest. The Bitterroot took over trail maintenance and wilderness management while the Lolo retained responsibility to manage the trailhead for South Lolo Creek Trail, which leads into the

Wilderness and into the Bitterroot National Forest. The Lolo also maintained responsibility for any necessary fire management and land status record within that designated wilderness area.

**Table 71—Designated wilderness within the Lolo National Forest administrative boundary**

| Designated Wilderness Name | Acres |
|---|---|
| Rattlesnake Wilderness | 34,273 |
| Welcome Creek Wilderness | 28,215 |
| Scapegoat Wilderness | 75,574 |
| Selway-Bitterroot Wilderness | 9,831 |

The Scapegoat Wilderness is part of the Bob Marshall Wilderness Complex and falls within both the Helena-Lewis and Clark and Lolo National Forests. Acres here pertain to those on the Lolo National Forest, as calculated within the Forest administrative boundary. The Selway-Bitterroot extends into the Bitterroot and Nez Perce-Clearwater National Forests. Acres here pertain to those on the Lolo National Forest, as calculated within the Forest administrative boundary.

**Status and trends.** Visits to designated wilderness are summarized in the 2006, 2011, and 2016 National Visitor Use Monitoring Surveys. There was a disruption in this survey schedule due to the COVID pandemic, resulting in more recent data being unavailable. The data from 2006 to 2016 show a decline between 2006 and 2011. There was a slight increase between 2011 and 2016. The Forest was not able to fully complete the 2021 cycle of the National Visitor Use Monitoring surveys due to the pandemic. Collecting information about use levels for a subset of survey sites was completed however this information is challenging to translate into trends between 2016 and 2021 and not presented specific to Designated Wilderness survey summaries and trends. The 2016 National Visitor Use Monitoring estimated that the Forest received about 18,000 annual wilderness visits. Forest visitors reported relatively consistent average visit durations to Designated Wilderness between the 2006, 2011, and 2016 National Visitor Use Monitoring surveys (Table 72 and Table 73).

**Table 72—Estimated annual visits to Designated Wilderness based on 2006, 2011, and 2016 National Visitor Use Monitoring Surveys**

| Year | Annual visits in the 1,000s | 90% Confidence Interval |
|---|---|---|
| 2006 | 26 | +/- 54.2 |
| 2011 | 16 | +/- 34.6 |
| 2016 | 18 | +/- 24.5 |

**Table 73—Average and median duration of Designated Wilderness visits in terms of hours**

| Year | Average duration (hours) | Median duration (hours) |
|---|---|---|
| 2006 | 5.1 | 2.7 |
| 2011 | 4.5 | 2 |
| 2016 | 5.6 | 2.1 |

An important element of outdoor recreation program delivery is understanding visitor satisfaction with the recreation setting, facilities, and services provided. This allows managers to understand where to focus resources and staff efforts to ensure that recreation opportunities are meeting the needs and expectations of visitors coming to the Lolo National Forest. Overall satisfaction of visitors to designated wilderness has generally been high across all four elements surveyed: Developed facilities, Access, Services, and Feeling of Safety (Table 74). Except for the 'Developed facilities' element in the 2006

National Visitor Use Monitoring survey summary, 80 percent or more of visitors rated these elements as Good or Very Good in regard to their level of satisfaction. Results showed substantial or slight improvements in satisfaction of Developed facilities and Access. Satisfaction in services provided has decreased, but most of designated wilderness visitors are still satisfied. All visitors (100 percent) were satisfied with their feelings of safety while visiting in both 2006 and 2016 survey results, but in 2011, only about 80 percent were satisfied in this element.

**Table 74—Percent of satisfied survey respondents visiting designated wilderness. This percentage is a composite of good or very good ratings.**

| Survey element | 2006 | 2011 | 2016 |
|---|---|---|---|
| Developed facilities | 71 | 100 | 96 |
| Access | 86 | 93 | 90 |
| Services | 96 | 83 | 82 |
| Feeling of safety | 100 | 80 | 100 |

Looking into trends of importance-performance index, we can better understand areas where the Forest may choose to focus efforts to improve overall satisfaction. Table 75 shows these ratings for several elements that designated wilderness visitors were asked about during the 2006, 2011, and 2016 National Visitor Use Monitoring surveys. 'Possible overkill' ratings mean that these elements are not highly important to visitors, but the forest's performance is quite good. These could be items where efforts could be reduced without impacts to visitor satisfaction. For all three rounds of the survey, this rating was consistent for interpretive displays, parking availability and parking lot conditions, and road condition. 'Keep up the good work' rated items mean that these elements are important to forest visitors and that the forest is performing well. Forest visitors consistently rated the condition of the environment, feeling of safety, scenery, and trail condition with this rating during all rounds of the survey. Forest visitors rated recreation information availability as important and meeting their needs in 2006, but possible overkill in 2016. This could reflect that the Forest's earlier emphasis on providing recreation information was sufficient and trended towards too much information or a change in the level of importance to visitors. This trend was similar for adequate signage. Conversely, developed facilities were rated as ‘possible overkill’ in 2006, but ‘keep up the good’ work in 2016. This could mean that the importance of this element decreased over the years or that the level of effort the Forest was giving to these facilities was sufficient to meet the expectations of visitors.

**Table 75—Importance-performance ratings for designated wilderness**

| Survey element | 2006 | 2011 | 2016 |
|---|---|---|---|
| Developed facilities | Possible overkill | Not enough responses | Keep up the good work |
| Condition of the environment | Keep up the good work | Keep up the good work | Keep up the good work |
| Interpretive displays | Possible overkill | Possible overkill | Possible overkill |
| Parking availability | Possible overkill | Possible overkill | Possible overkill |
| Parking lot condition | Possible overkill | Possible overkill | Possible overkill |
| Recreation info availability | Keep up the good work | Not enough responses | Possible overkill |
| Road Condition | Possible overkill | Possible overkill | Possible overkill |
| Feeling of safety | Keep up the good work | Keep up the good work | Keep up the good work |
| Scenery | Keep up the good work | Keep up the good work | Keep up the good work |
| Signage adequacy | Keep up the good work | Keep up the good work | Possible overkill |
| Trail Condition | Keep up the good work | Keep up the good work | Keep up the good work |

During the National Visitor Use Monitoring survey, Designated Wilderness visitors were asked about their perception of crowding. This information is useful when looking at those visiting designated wilderness as these areas managed to provide opportunities for solitude. Crowding was reported on a scale of 1 to 10, where 1 represents ‘hardly anyone was there’ and 10 represents ‘overcrowded’. While the average rating of crowding was generally consistent between 2006, 2011, and 2016, the percent of visits with higher crowding ratings increased and lower crowding ratings decreased (Table 76). Given the overall estimates of visitors to designated wilderness, it may be that these visitors have a higher expectation of encountering less people than earlier survey respondents or that use may be more concentrated in more popular areas and access points.

**Table 76—Percent of visits by crowding rates as reported by Designated Wilderness visitors**

| Crowding Rate | 2006 | 2011 | 2016 |
|---|---|---|---|
| 10 (Overcrowded) | 1.2 | 0 | 0 |
| 9 | 2.5 | 0 | 0 |
| 8 | 3.7 | 6.3 | 10 |
| 7 | 3.7 | 0 | 10 |
| 6 | 2.5 | 7.2 | 0 |
| 5 | 0 | 7.2 | 22 |
| 4 | 27.2 | 6.3 | 10 |
| 3 | 27.2 | 27 | 14 |
| 2 | 32.1 | 45.9 | 5 |
| 1 (Hardly anyone there) | 0 | 0 | 29 |
| Average rating | 3.6 | 3.3 | 3.8 |

Wilderness character narratives for the Scapegoat (2022), Rattlesnake (2023), and Welcome Creek (2023) Wilderness Areas are summarized below; these documents can be found in the planning record. The wilderness character assessments address five major elements of wilderness character: untrammeled, natural, undeveloped, solitude or primitive and unconfined recreation, and other attributes (integral cultural features).

**Scapegoat Wilderness character.** The land that is now the Bob Marshall Wilderness Complex is and will continue to be deeply entwined with the histories and cultures of indigenous peoples. Overall, the size of the Bob Marshall Wilderness Complex and history of managerial restraint combined with the high natural quality of wilderness mean that the trammeling actions in the complex have been limited, and there are no known unauthorized actions documented between 2018-2020. There are very few places in the country with such an active fire regime. The naturalness factor is impacted by the presence of nonindigenous plants and aquatic species; however, overall, the air quality is good, there are currently no known streams or lakes in the complex with impaired water quality according to the 303(d) database, and most of its watersheds are functioning properly. Due to its early designation, there are no roads or discernable mines, and there are no non-federal inholdings. There have been minimal administrative authorizations to use motor vehicles, motorized equipment, or mechanical transport. The opportunity for unconfined recreation—going into the wilderness whenever and wherever a visitor wants—is a longstanding and significant characteristic.

**Rattlesnake Wilderness character.** The Rattlesnake Wilderness is the ancestral homelands of The Confederated Salish and Kootenai Tribes of the Flathead Nation. The habitat and plant communities that exist are intact and primarily exist in their natural state devoid of management influence. Although, since designation in 1980, the area shows moderate evidence of trammeling actions; steps are being taken to reduce future trammeling. All fires are managed under an immediate suppression strategy, and because noxious weeds and non-native plants pose a threat to ecosystem health and function, trammeling has been allowed to prevent their spread. The Rattlesnake Wilderness is home to many species of wildlife that benefit from its natural conditions. It contains the headwaters of Rattlesnake Creek and has served as the municipal watershed for Missoula since the City's founding. The only sources of emission come from local dust from trails and smoke from wildland fire. This landscape has long been used by humans and yet has largely remained undeveloped. The surrounding Rattlesnake National Recreation Area insulates the Rattlesnake Wilderness from much of the pressure of overcrowding.

**Welcome Creek Wilderness character.** The Welcome Creek Wilderness lies in the traditional lands of the Salish and Kalispel peoples. With respect to trammeling, intentional management action and modern human manipulation have been restrained with the exception of fire suppression and the treatment of noxious weeds. Welcome Creek Wilderness favors the natural quality of wilderness character, and the best examples are paradoxically found in the areas once dominated by man and his works. The once heavily used Welcome Creek trail has reverted to near game trail condition and scars from early placer mines are healing. Welcome Creek Wilderness had multiple old placer mining cabins along Welcome Creek, yet because of recent fires, the cabin remains have burned, leaving no permanent structures. Opportunities for solitude are easily found minutes away from the main trailhead on Rock Creek and are achieved even easier when the wilderness is accessed from the trailhead near Welcome Mountain.

## Recommended Wilderness

**Key takeaways:**

- The 1986 Lolo Forest Plan recommended 223,915 acres for wilderness designation across the Forest. Recommended wilderness areas included the Great Burn (90,392 acres), the Bob Marshall Additions (70,995 acres), the Selway-Bitterroot Addition (3,702 acres), and Sliderock (58,826 acres). None of these areas have received congressional designation to date.
- Management Area 12 from the 1986 Plan included the goal that these areas would be managed to protect their wilderness characteristics pending a decision as to their classification and standards have been applied during project level analyses to ensure consistency with the National Forest

Management Act and Forest Plan direction for recommended wilderness. Public motorized uses, as well as mechanical uses, are not currently allowed in these areas.

- As part of the wilderness recommendation process associated with this plan revision effort, all previously recommended wilderness areas will be included in the inventory of lands that may be suitable for inclusion in the National Wilderness Preservation System and evaluated for wilderness characteristics to provide consistent documentation per this process under the 2012 Planning Rule.

**Summary.** During plan development or revision, the responsible official is required to “identify and evaluate lands that may be suitable for inclusion in the National Wilderness Preservation System and determine whether to recommend to the Chief of the Forest Service any such lands for wilderness designation” (36 CFR Part 219 and Forest Service Land Management Planning Handbook 1909.12). The process by which lands are recommended for inclusion in the National Wilderness Preservation system is described in 2012 Forest Service Planning Rule and Chapter 70 of Handbook 1909.12. Recommended wilderness areas are only preliminary administrative recommendations; Congress has reserved the authority to make final decisions on wilderness designation. Legislation passed by Congress must be signed by the President to finalize designation and incorporate these lands into the National Wilderness Preservation system.

The 1986 Lolo Forest Plan recommended wilderness designations in the Great Burn, Bob Marshall Additions, the Selway-Bitterroot Addition/Lolo Peak, and Sliderock. These areas have not received congressional designation to date; however, since 1986, the Lolo National Forest has had a rich history of being included in wilderness legislative proposals.

- In 1988, President Reagan used a pocket veto to end the bipartisan Montana Natural Resources Protection and Utilization Act, which would have designated the Stony Mountain, Selway-Bitterroot Addition, Bob Marshall Additions, Swan Front, Cataract Creek/Cube Iron-Silcox Roadless Complex, Great Burn, and Quigg Peak roadless areas as wilderness.
- In 1990, the Kootenai and Lolo Accords were signed by a diversity of interest groups and led to a corresponding bill identifying wilderness and timberlands being introduced in Congress in 1991, but the bill didn't make it through 65 Congress. On the Lolo, the Accords proposal closely followed the 1988 Wilderness Bill.
- A year later, the Montana National Forest Management Act of 1992 passed both the 66 House and Senate but did not make it to the President's desk. A similar bill passed the 67 House one session later, the Montana Wilderness Act of 1994. These bills would have designated the Cataract Creek/Cube Iron-Silcox Roadless Complex, Great Burn, Sheep Mountain, Selway-Bitterroot Addition, Quigg Peak, Stony Mountain, and Bob Marshall Additions as wilderness.
- In 2009, Senator Tester introduced the Forest Jobs and Recreation Act which would have added 83,000 acres of Wilderness to the Bob Marshall and Mission Mountains Wilderness areas. The bill was reintroduced in 2011 and in 2013 but was never passed.
- The Blackfoot Clearwater Stewardship Act is currently under consideration by Congress which would designate most of the Bob Marshall additions recommended in the 1986 Forest Plan as wilderness.

**Status and trends.** The 2012 planning rule uses the term ‘recommended wilderness’, which is synonymous with wilderness used in the 1986 Forest Plan. These federal lands are those that have been inventoried, evaluated, and analyzed for inclusion in the National Wilderness Preservation system, but have not received designation through congress-supported legislation signed by the President. For consistency, we will use recommended wilderness throughout the assessment, plan development, and environmental analysis supporting this plan revision effort.

The 1986 Forest Plan recommended an additional 223,915 acres for wilderness designation across the Forest (figure A1-14). Recommended wilderness areas included the Great Burn (90,392 acres), the Bob Marshall Additions (70,995 acres), the Selway-Bitterroot Addition (3,702 acres), and Sliderock (58,826 acres). None of these areas have received congressional designation to date. Management Area 12 from the 1986 Plan included the goal that these areas would be managed to protect their wilderness characteristics pending a decision as to their classification and standards have been applied during project level analyses to ensure consistency with the National Forest Management Act and Forest Plan direction for recommended wilderness. Public motorized uses, as well as mechanical uses, are not allowed within recommended wilderness as part of the management direction for MA 12 in the 1986 Forest Plan.

*Selway-Bitterroot Addition.* This area, covering about 3,702 acres, is located on the southern portion of the Missoula Ranger District adjacent to the Selway-Bitterroot Wilderness Area that extends through the Bitterroot and Nez Perce-Clearwater National Forests. One National Forest System trail, South Fork Lolo Creek Trail (Trail #311) runs through this recommended wilderness area and is managed by the Bitterroot National Forest. The Lolo National Forest manages the trailheads for this trail, which support both equestrian and other trail users. This recommended wilderness overlaps with a portion of the Lolo Creek Inventoried Roadless Area. The eligible/suitable wild and scenic river South Fork Lolo Creek falls in this area. This area provides contiguous wildlife connectivity between the Bitterroot National Forest and other important landscapes to the north and contains the Carleton Ridge RNA.

*Great Burn.* The Great Burn area is two separate polygons that overlap with the Hoodoo Inventoried Roadless Area, which is divided by a National Forest System Rd #7734 (Surveyor Creek). Covering over 90,000 acres, most this recommended wilderness area falls within the Ninemile Ranger District. A small portion on the northern end is located on the Superior Ranger District and a small southern portion is located on the Missoula Ranger District. There are about 160 miles of trails within the recommended wilderness area that support hiker and pack and saddle use. Several trailheads serve as access points the trail systems. A portion of Stateline National Recreation Trail (Trail #738) falls along the western boundary of this recommended wilderness. Eligible/suitable wild and scenic river segments associated with the Cache Creek and West Fork Fish Creek all fall within the Great Burn recommended wilderness. Additionally, numerous mountain lakes within the Great Burn are popular designations for visitors to this area. The Great Fire of 1910 and subsequent burns have given this area its characteristic appearance and name. It also contains exceptionally wild country that provides for both wildlife and quiet recreation. Portions of the Great Burn have been included in more than twenty legislative proposals.

*Sliderock*, also referred to as the Quigg Peak area, is located within the Rock Creek area of the Missoula Ranger District, on the east side of Rock Creek Road. Covering nearly 60,000 acres, this area provides hiking and horseback trail riding along about 60 miles of trail. Several trailheads and developed recreation sites are located along the western boundary of this recommended wilderness. Rock Creek, which runs along the western boundary of the recommended wilderness, was found eligible for designation as a wild and scenic river in the 1992 Eligibility Study completed as Amendment 12 to the 1986 Forest Plan. Broad glaciated ridges rise steeply from Rock Creek, and Quigg Peak is the highest point. This recommended wilderness is adjacent to the Bureau of Land Management's Quigg West Wilderness Study Area. The adjoining wild lands on the Beaverhead-Deerlodge National Forest were recommended for wilderness in the 2008 Revised Beaverhead-Deerlodge Forest Plan.

*Bob Marshall Additions.* The 1986 Forest Plan recommended two additions to the Bob Marshall Wilderness Complex, both on the Seeley Lake Ranger District. The northern area covers about 3,713 acres and includes Morrell Creek, a previously studied river found eligible and suitable for designation in the National Wild and Scenic River system. One hiking trail traverses about 5 miles of this area. The larger addition includes over 67,282 acres along the boundary with the Flathead National Forest portion of the Bob Marshall Wilderness area and the Scapegoat Wilderness area. A segment of the eligible and suitable North Fork Blackfoot River is located within this area. Approximately 150 miles of hiking and pack and saddle trails access the area from several trailheads. Many of these trails continue onto adjacent designated wilderness areas. The mapping of this area as depicted in Appendix 1 and the initial wilderness inventory included an error excluding the addition the area added by Amendment 7 of the 1986 Forest Plan. This error has been identified and is being rectified for plan development and the wilderness evaluation process.

## 3.9.2 Eligible and Suitable Wild and Scenic Rivers

### Key Takeaways

- There are currently no rivers designated as wild and scenic on the Lolo National Forest. In 1991 a total of nine rivers and streams were identified as eligible. In 1996 a suitability study was completed on eight of those rivers, and all eight rivers, along with additional major tributaries were determined to be suitable for designation.
- To date, none of the suitable river and stream segments have been congressionally designated or added to the National Wild and Scenic River system. However, necessary protections and management direction included in Amendment 12 of the 1986 Forest Plan have been applied to protect the outstandingly remarkable values for which they were found eligible.
- As required by the 2012 Planning Rule, a wild and scenic rivers eligibility study will be conducted as part of the plan revision process. There are four phases to this process: inventory, evaluation, analysis, and recommendation. While the results are preliminary, the initial inventory resulted in 682 named rivers and streams in the planning area to evaluate for eligibility. Evaluation criteria and methods for the new eligibility study will primarily use existing information, but site-specific information gaps could be identified. In anticipation of this evaluation there is some ongoing data collection on the Lolo that may help inform individual areas characteristics.

### Summary

The Lolo National Forest adopted the current Forest Plan in 1986. As required under Section 5(d) of the 1968 Wild and Scenic Rivers Act (as amended), the Forest conducted an eligibility study to identify rivers for inclusion in the National Wild and Scenic Rivers system. The eligibility study was completed as an environmental assessment, finding of no significant impact, and decision notice in August 1991 and incorporated into the Forest Plan as Amendment 12 (United States Department of Agriculture 1991). The evaluation found nine rivers and streams eligible (see also figure A1-18).

- Cache Creek
- North Fork Blackfoot River
- South Fork Lolo River
- West Fork Fish Creek
- Rock Creek
- Morrell Creek
- Rattlesnake Creek
- Clearwater River
- Clark Fork (2 segments)

Prior to the Forest Service recommending rivers and streams for congressional designation, rivers and streams found eligible for potential classification and inclusion in the National Wild and Scenic Rivers system are further evaluated through a suitability study. In 1995-1996, the Forest completed Legislative Environmental Impact Statement to study the suitability of all eligible river segments, except Rock Creek because it crosses other federal ownerships. All were found suitable for designation, and the preferred alternative included some major tributaries of certain sections to be included as suitable as well. The

Bureau of Land Management and Beaverhead-Deerlodge National Forest found some Rock Creek stream segments eligible within their jurisdictions; however, no suitability study has been completed for Rock Creek on the Lolo National Forest.

At this time, none of the suitable river and stream segments on the Lolo National Forest have been congressionally designated or added to the National Wild and Scenic River system. However, necessary protections and management direction included in Amendment 12 have been applied to protect the outstandingly remarkable values for which they were found eligible.

## Status and Trends

Congress passed the National Wild and Scenic Rivers System Act in 1968 (Public Law 90-542; 16 U.S.C. 1271 et seq.) for the purpose of preserving rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The Act is recognized for safeguarding the special character of these rivers, while also allowing for their appropriate use and development. The Act promotes river management across political boundaries and public participation in developing goals for river protection.

Eligible and/or suitable wild, scenic, or recreational rivers retain their free-flowing status, their preliminary classification, and the outstandingly remarkable values for which they have been identified. For management purposes, river segments are classified as wild, scenic, or recreational.

- 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 that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

Each river in the National System is administered with the goal of protecting and enhancing the outstanding remarkable values for which it was designated. Recreation, agricultural practices, transportation development, and other uses may generally continue after designation.

Following the adoption of the 1986 Forest Plan the Lolo National Forest conducted a wild and scenic river eligibility study. The Forest identified nine rivers as eligible for further study for wild and scenic river classification. Determinations for eligibility were made using the process outlined in the National Wild and Scenic Rivers System Act. The designation of eligible wild and scenic rivers pertains only to federally owned lands. Rivers or segments of rivers on state and private lands were not considered in the 1991 eligibility study; only the segments of those rivers on National Forest System lands were considered (United States Department of Agriculture 1991). Wild and scenic river eligibility is only a preliminary administrative recommendation; Congress has reserved the authority to make final decisions on wild and scenic river designation. The results of these studies were documented in forest plan amendments to the existing forest plan. Table 77 lists each eligible or suitable river/stream segment by geographic area, description, length, and the outstanding remarkable values identified for each.

**Table 77—River segments previously determined eligible (1991) and/or suitable (1996) for wild and scenic rivers classification**

| River Name | Potential Classification | Outstandingly Remarkable Values | Segment Length (miles) |
|---|---|---|---|
| Cache Creek | Wild | Geologic, Fisheries, Natural | 21.8 |
| Morrell Creek | Wild | Scenery, Recreation | 3 |
| North Fork Blackfoot | Wild | Fisheries, Recreation, Scenery, Natural | 68.5 |
| Rattlesnake Creek | Wild | Recreation, Fisheries | 12.1 |
| South Fork Lolo Creek | Wild | Recreation, Scenery | 12.8 |
| West Fork Fish Creek | Wild | Natural | 23.8 |
| | | **Total Wild** | **142.0** |
| Cache Creek | Scenic | Recreation | 1.5 |
| Morrell Creek | Scenic | Scenery, Recreation | 3.1 |
| Rattlesnake Creek | Scenic | Recreation, Fisheries | 27 |
| Rock Creek* | Scenic | Fisheries, Recreation, Cultural, Scenery | 36.3 |
| | | **Total Scenic** | **67.9** |
| Clark Fork (Slowey Cutoff) | Recreational | Scenery, Recreation | 26.9 |
| Clearwater River | Recreational | Recreation, Wildlife, Scenery | 20.9 |
| | | **Total Recreational** | **47.8** |
| | | **Total River Miles** | **257.7** |

Many of the eligible rivers have potential classifications of recreation and are heavily used for recreational purposes. The Recreation Settings, Opportunities and Access portion of this assessment outlines use, patterns, and trends associated with recreation. The draw of recreationists to water to experience challenge, view scenery, relax, fish or any combination of lifestyle and recreational endeavors is worth noting. Currently, only Rock Creek and segments of the Clark Fork have outfitted floating, fishing, or float fishing use. Some of the eligible rivers are adjacent to major roadways, communities, and infrastructure such as powerlines. As those communities encroach on the river corridors, municipal projects, special use authorizations, and other safety-related projects have increased.

Rivers are a somewhat unique resource in that they can be accessed from many locations including the National Park, Bureau of Land Management, state, and private lands. The Forest Service's role in river management beyond recreations and access points is discussed in the watershed and fisheries section. Discussions of biophysical trends and drivers are found in the Watershed and Fisheries reports. Social trends and drivers associated with recreation are included in that discussion.

**Eligible wild and scenic rivers inventory.** An inventory of eligible rivers for inclusion in the wild and scenic rivers system is also required under the 2012 Planning Rule for forest plan revision and will be completed as a part of the revision process. Rivers that have already been identified as eligible will receive another hard look to determine if additional outstanding and remarkable values are present or if the extent of the eligible area may be expanded. The preliminary inventory, the first phase in this process, includes all types of watercourses identified as streams (perennial, intermittent, or ephemeral) and connecting channels or artificial flowlines representing river and streams with a name associated with it either within the National Hydrography Dataset or on U.S. Geographic Service 7.5-minute quadrangle maps. The interdisciplinary team reviewed each 7.5-minute within the planning area to ensure no potentially eligible stream was omitted or extraneous segment were included prior to beginning the evaluation. While the results are preliminary, the initial inventory resulted in 682 named rivers and streams in the Lolo National Forest plan area.

## 3.9.3 Inventoried Roadless Areas

### Key Takeaways

- The intent of the Roadless Rule is to provide lasting protection for inventoried roadless areas within the National Forest System in the context of multiple-use management. Prohibitions and restrictions established under this rule are not subject to reconsideration, revision, or rescission under plan revisions (36 CFR 294.14(e)).
- The unique contribution of inventoried roadless areas is important in maintaining habitats, natural processes, and remote recreation opportunities in the regional and national network of protected lands. There are about 757,930 acres of inventoried roadless areas on the Lolo National Forest, approximately 34 percent of the land administered by the Forest.
- The Responsible Official is required to identify these administratively designated areas and must ensure that plan components applicable to inventoried roadless areas are compliant with restrictions included in the Roadless Rule.

### Summary

The Roadless Rule established prohibitions and permissions on road construction, road reconstruction, and timber harvesting on 58.5 million acres of National Forest System lands across the United States. The intent of the Roadless Rule is to provide lasting protection for inventoried roadless areas within the National Forest System in the context of multiple-use management. The Roadless Rule prohibits activities that have the greatest likelihood of altering and fragmenting landscapes, resulting in immediate, long-term loss of roadless area values and characteristics, eliminates permanent road construction and reconstruction, thereby reducing fiscal demands and responsibilities, and reduces controversy over management of roadless areas. Inventoried roadless areas are important to maintaining habitats, natural processes, and remote recreation opportunities in the regional and national network of protected lands. Management activities shall follow direction found in the 2001 Roadless Area Conservation Rule (U.S. Department of Agriculture 2001). The Roadless Rule allows some exceptions to road construction, reconstruction, and timber harvesting in specific circumstances, which require additional project review and public notification (36 CFR 294 Subpart B, 294.12 and 294.13).

### Status and Trends

There are about 757,930 acres of inventoried roadless areas on the Lolo National Forest (Table 78, figure A1-16). These areas constitute approximately 34 percent of the land administered by the Forest.

**Table 78—Inventoried roadless areas on the Lolo National Forest**

| Inventoried roadless area name | Ranger district(s) | Acres |
|---|---|---|
| Baldy Mountain | Plains-Thompson Falls | 6,475 |
| Bear-Marshall-Scapegoat-Swan | Seeley Lake | 118,753 |
| Burdette | Ninemile | 15,999 |
| Cataract | Plains-Thompson Falls | 9,432 |
| Cherry Peak | Superior and Plains-Thompson Falls | 37,818 |
| Clear Creek | Plains-Thompson Falls | 5,532 |
| Cube Iron - Silcox | Plains-Thompson Falls | 36,998 |
| Deep Creek | Missoula | 7,858 |

| Inventoried roadless area name | Ranger district(s) | Acres |
|---|---|---|
| Evans Gulch | Plains-Thompson Falls | 8,049 |
| Garden Point | Ninemile | 6,315 |
| Gilt Edge - Silver Creek | Superior | 10,043 |
| Hoodoo | Ninemile, Missoula, and Superior | 105,129 |
| Lolo Creek | Missoula | 14,318 |
| Maple Peak | Plains-Thompson Falls | 6,462 |
| Marble Point | Superior | 12,607 |
| Marshall Peak | Seeley Lake | 9,058 |
| McGregor - Thompson | Plains-Thompson Falls | 27,183 |
| Meadow Creek - Upper North Fork | Superior | 6,897 |
| Mount Bushnell | Superior and Plains-Thompson Falls | 41,750 |
| North Siegel | Plains-Thompson Falls | 9,197 |
| Patricks Knob - North Cutoff | Superior and Plains-Thompson Falls | 16,950 |
| Petty Mountain | Missoula and Ninemile | 16,158 |
| Quigg | Missoula | 67,037 |
| Rattlesnake | Missoula | 2,878 |
| Reservation Divide | Ninemile | 16,888 |
| Sheep Mountain - Stateline | Superior | 37,849 |
| Silver King | Missoula | 12,774 |
| South Siegel - South Cutoff | Plains-Thompson Falls and Superior | 13,458 |
| Stark Mountain | Ninemile and Superior | 12,585 |
| Stevens Peak | Superior | 646 |
| Stony Mountain | Missoula | 32,477 |
| Sundance Ridge | Plains-Thompson Falls | 7,550 |
| Teepee - Spring Creek | Plains-Thompson Falls | 13,887 |
| Ward Eagle | Superior | 8,546 |
| Welcome Creek | Missoula | 1,062 |
| Wonderful Peak | Superior | 1,311 |
| | **Total** | **757,929** |

The 2021 Lolo National Forest Biennial Monitoring Report provides a summary of projects in inventoried roadless areas between 2008 and 2021 to reflect forest plan monitoring requirements that align with the 2012 planning rule. Project proposals were reviewed in accordance with agency policy and implemented as permitted under the exceptions allowed under the Roadless Rule. Please refer to this report for additional details regarding activities within inventoried roadless areas and the applicable exceptions supporting the project level development, decision, and implementation.

## 3.9.4 Research Natural Areas

### Key Takeaways

- Research natural areas are permanently established to maintain areas of natural ecosystems and areas of special ecological significance. The Lolo National Forest includes nine established research natural areas with a total size of approximately 4,180 acres.
- In 2017, Carlton Ridge and Pyramid Peak burned in the Lolo and Rice Ridge fire, respectively.
- High priority target recommendations for research natural areas on the Lolo National Forest include several ponderosa pine and western redcedar forest types as well as rough fescue grasslands.

### Summary

The Organic Administration Act of June 4, 1897, authorizes the Secretary of Agriculture to designate research natural areas. Special designations, 36 CFR 219.23 and 36 CFR 219.25, advise that forest planning shall provide for the establishment of research natural areas. Areas of important forest, scrubland, grassland, alpine, aquatic, and geologic types that have special or unique characteristics of scientific interest and importance will be identified and as lands needed to complete the national research natural area network. Additionally, research natural area identification, establishment and management are outlined in Forest Service Manual 4063.

Research natural areas are permanently established to maintain natural ecosystems and areas of special ecological significance. These protective designations attempt to maintain natural ecosystem components and processes and are cooperatively identified, established, and managed with the Forest Service Rocky Mountain Research Station. The designated areas form a long-term network of ecological reserves established as baseline areas for non-manipulative research, education, and the maintenance of biodiversity. They are administratively designated by the Regional Forester with research station director concurrence. Stewardship management may be needed to maintain or restore the target plant communities in research natural areas, including actions such as invasive weed control or prescribed fire.

### Status and Trends

There are nine established research natural areas on the Lolo National Forest, which total approximately 4,180 acres. These research natural areas are part of a national network of ecological areas designated in perpetuity for research, education, and/or to maintain biological diversity of National Forest System lands. The regional natural areas assessment from 1996 (Chadde et al. 1996) details which habitat types, community types, and aquatic features were filled with the nine research natural areas. Barktable Ridge Research Natural Area and Shoofly Meadows Research Natural Area, listed in this report, were since established. Squaw Creek Research Natural Area has been renamed to Ferry Landing Research Natural Area and has also been established. Remaining target recommendations listed as high priority for the Lolo National Forest include several ponderosa pine and western redcedar forest types as well as rough fescue grasslands (Chadde et al. 1996).

Table 79 displays the existing designated research natural areas in the plan area, geographic location, principal distinguishing features, and area size. The Carlton Ridge Research Natural Area burned in 2017 in the Lolo Peak Fire. Research on the impact on subalpine larch is ongoing. In the same year, the Pyramid Peak Research Natural Area burned in the Rice Ridge fire. Refer also to section 2.4.3 for additional discussion on the subalpine larch community on Carlton Ridge.

**Table 79—Research natural areas on the Lolo National Forest**

| Research natural area | Geographic area | Principal distinguishing features | Date designated | Acres from Establishment record | GIS acres |
|---|---|---|---|---|---|
| Barktable Ridge | Lower Clark Fork | Mountain hemlock forests | 29-Jul-97 | 341 | 346 |
| Carlton Ridge | Lolo Creek | Subalpine larch and whitebark pine on well-developed soils | 16-Jul-87 | 933 | 955 |
| Council Grove | Greater Missoula | Major river segment with associated black cottonwood, willow and ponderosa pine riparian communities | 13-Jun-91 | 157 | 160 |
| Ferry Landing | Lower Clark Fork | Forested scree ecosystems and deciduous riparian forests | 29-Jul-97 | 630 | 619 |
| Petty Creek | Ninemile/ Petty Creek | Douglas fir and grand fir forests | 16-Jul-87 | 310 | 317 |
| Plant Creek | Greater Missoula | Western larch and Douglas fir forests | 16-Jul-87 | 258 | 313 |
| Pyramid Peak | Upper Blackfoot Clearwater | Western larch and Douglas fir forests | 16-Jul-87 | 520 | 490 |
| Sheep Mountain Bog | Greater Missoula | Sphagnum fen and associated wet sedge meadows | 16-Jul-87 | 105 | 125 |
| Shoofly Meadows | Greater Missoula | Unique fen complex and multiple subalpine fir habitat types | 29-Jul-97 | 926 | 959 |

## 3.9.5 Special Areas (Botanical Areas)

### Key Takeaways

- Special areas are certain limited areas of National Forest System lands not designated as wilderness and containing outstanding examples of plant and animal communities, geological features, scenic grandeur, or other special attributes that merit special management.
- The 1986 Lolo Forest Plan included the botanica areas Mary's Frog Pond and Shoofly Meadows. The latter is now a part of an established research natural area. The establishment of a third botanical area, Elk Meadow, was approved April 30, 1986.

### Summary

Forest Service Manual Chapter 2370 provides direction for special recreation designations, also known as special areas or special interest areas. Special areas are certain limited areas of National Forest System lands not designated as wilderness and containing outstanding examples of plant and animal communities, geological features, scenic grandeur, or other special attributes that merit special management. These areas can be designated administratively. An analysis of the need and desirability for special areas should be included in the forest plan (FSM 2372.2).

### Status and Trends

The 1986 Land Management Plan identified two botanical areas on the Lolo National Forest: Mary's Frog Pond and Shoofly Meadow (Table 80).

**Table 80—Special areas (botanical areas) on the Lolo National Forest**

| Botanical area | Geographic area | Description | Acres | GIS acres |
|---|---|---|---|---|
| Shoofly Meadows | Greater Missoula | Included the uppermost meadow and marsh complex of the subsequent established research natural area. | 76 | n/a |
| Elk Meadow | Upper Blackfoot Clearwater | Alkaline spring-fed marsh with Scorpidium Moss, arrow-grasses, and sedges. | 85 | 102 |
| Mary's Frog Pond | Lolo Creek | Floating and anchored mats of sphagnum moss with sundew and other uncommon vascular plants. | 30 | 39 |

Mary's Frog Pond (30 acres) contains species of sphagnum moss of limited occurrence in Montana along with relict populations of roundleaf sundew (*Drosera rotundifolia*), western huckleberry (*Vaccinium occidentale*) and buckbean (*Menyanthis trifoliata*). Mary's Frog Pond was within the Lolo fire boundary in 2017. Upland vegetation burned with mostly high severity. The fire effects on wetland vegetation at the pond's margin are not known.

The Shoofly Meadows botanical area is now part of the established Shoofly Meadows Research Natural Area, which supersedes designation as botanical area.

Elk meadow is a spring-fed alkaline marsh with floating mats of Scorpidium moss (*Scorpidium scorpioides*) and other species with limited occurrence, such as lesser bladderwort (*Utricularia minor*) and pale sedge (*Carex livida).* The pH level of the springs has been measured as 8.0 to 9.6. The marsh is influenced by surface water resulting in seasonal variation of the water table. Prominent wetland species include Buxbaum's sedge (*Carex buxbaumii*), beaked sedge (*Carex utricularia*), tufted hairgrass (*Deschampsia cespitosa*), sharp-stemmed bulrush *(Scirpus acutus*) and baltic rush (*Juncus balticus*).

## 3.9.6 Travel Ways: Nationally Designated Trails and Scenic Byways

### Key Takeaways

- There are two national historic trails, the Nez Perce (Nee-Me-Poo) and the Lewis and Clark National Historic Trails, and ten national recreation trails designated on the Lolo National Forest. Nationally designated trails can help provide focus and commitments of resources in the context of a sustainable trails program.
- The Lolo Trail National Historic Landmark is partially on the Lolo National Forest. The Lolo Trail is an ancient route that follows the ridgetops parallel and to the north of Highway 12. This trail provided access to buffalo on the eastern plains for those on the Columbia Plateau and led people living east of the mountains to salmon-rich waters in the west. The Nez Perce (Nee-Me-Poo) and Lewis and Clark National Historic Trails lie within the Lolo Trail National Historic Landmark.
- Montana state highway 135 is also located on the Lolo National Forest and is designated as the St. Regis-Paradise Scenic Byway. Developing management direction for the St. Regis-Paradise Scenic Byway in the future would contribute to management that is consistent with the purposes of the designations to enhance or preserve the qualities for which it was designated.

### Summary

The National Trails System Act (Public Law 90-543) was signed into law by President Lyndon B. Johnson on October 2, 1968. The purpose of the act was "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." This act authorized three types of trails: 1) National Scenic Trails, 2) National Recreation Trails, and 3) connecting-and-side trails. In 1978 National Historic Trails were also added to the national trail system. While national scenic trails and national historic trails may only be designated by Congress, national recreation trails may be designated by the regional forester on Forest Service lands to recognize exemplary trails of local and regional significance in response to an application from the trails managing agency or organization. Through designation, these trails are recognized as part of America's National Trail System.

There are two congressionally designated trails in the plan area, the Nez Perce (Nee-Me-Poo) and the Lewis and Clark National Historic Trails. Both trails are co-located with the Lolo trail as they traverse the Lolo National Forest. The Lolo National Forest also has ten national recreation trails, designated by the regional forester, as part of the national system of trails authorized by the National Trails Systems Act. National recreation trails provide a variety of outdoor recreation uses.

Table 81 lists the nationally designated trails in the plan area (figure A1-15). The Lolo received earmark funding annually for both the Lewis and Clark and Nez Perce (Nee-Me-Poo) National Historic Trails. This funding helps prioritize maintenance work and projects along these trails and within trail corridors.

**Table 81—Nationally designated trails on the Lolo National Forest**

| Trail number | Trail name | Trail type | National trail designation | Length |
|---|---|---|---|---|
| 15 | Lolo (Nez Perce (Nee-Me-Poo) and Lewis and Clark)[1] | Standard Terra Trail | National Historic Trail | 35.5 |
| 340-A | Baldy Lake Spur | Standard Terra Trail | National Recreation Trail | 0.2 |
| 9 | Sam Braxton | Standard Terra Trail | National Recreation Trail | 3.4 |

| Trail number | Trail name | Trail type | National trail designation | Length |
|---|---|---|---|---|
| 340 | Baldy Mountain | Standard Terra Trail | National Recreation Trail | 2.7 |
| 242 | Iron Mountain | Standard Terra Trail | National Recreation Trail | 1.3 |
| 242-A | Overlook at Cascade Falls | Standard Terra Trail | National Recreation Trail | 0.1 |
| 738 | Stateline | Standard Terra Trail | National Recreation Trail | 47.4 |
| 4.01 | Blue Mountain Nature | Standard Terra Trail | National Recreation Trail | 0.4 |
| 30 | Morrell Falls | Standard Terra Trail | National Recreation Trail | 2.7 |
| 3.01 | Blue Mountain Hiking & Equestrian | Standard Terra Trail | National Recreation Trail | 9.9 |
| 304 | Skookum Butte | Standard Terra Trail | National Recreation Trail | 1.4 |
| | | | **Total** | **104.9** |

[1]The Lolo Trail itself is not a National Historic Trail, however the Nez Perce (Nee-Me-Poo) and Lewis & Clark National Historic Trails are aligned with the Lolo Trail on the Lolo National Forest. Additionally, the Lolo Trail is the centerline for the Lolo Trail National Historic Landmark, which is a separate designation, from Nationally Designated Trails.

*Lewis and Clark National Historic Trail.* The Lewis and Clark National Historic Trail commemorates the Lewis and Clark Expedition of 1804 to 1806. The entire route is 3,700 miles long and extends from Wood River, Illinois, to the mouth of the Columbia River in Oregon. The overall trail is administered by the National Park Service, but individual sites along the trail are managed by different federal, state, local, tribal, and private organizations, and agencies. This historic trail is not a traditional hiking-only trail and can also be traveled by car, boat, and/or horseback. Many interpretive centers, signs, and recreation facilities are located along the entire length of the trail.

The Lewis and Clark National Historic Trail is co-located with the Lolo trail and the Nez Perce (Nee-mee-Poo) National Historic trail, as it crosses the Lolo National Forest. Approximately 35.6 miles of the trail are located on forested lands in the planning area. The Lewis and Clark National Historic trail is administered by the National Park Service; guidance for management of the trail on other federal lands can be found in the 2012 Lewis and Clark National Historic Trail Foundation Document.

*Nez Perce (Nee-Me-Poo) National Historic Trail.* The Nez Perce (Nee-Me-Poo) National Historic Trail stretches from Wallowa Lake, Oregon, to the Bear Paw Battlefield near Chinook, Montana, and was added to this system by Congress as a National Historic Trail in 1986. The 1877 War and Flight of the Nez Perce defines the route of the Nez Perce (Nee-Me-Poo) National Historic Trail. Approximately 750-800 Nez Perce, 2,000 horses, and hundreds of dogs traveled nearly 1,170 miles more than 110 days. There is no single trail that accurately captures the route of the 1877 War and Flight of the Nez Perce. For most of the flight, the Nez Perce traveled as five distinct bands that sometimes traveled and camped together, and thus took multiple paths across the landscape during the flight. The U.S. Army in pursuit also divided into multiple units that took multiple trails. As a result, there are multiple routes and segments of the Nez Perce (Nee-Me-Poo) National Historic Trail.

The overall trail is administered by the Forest Service, but individual sites along the trail are managed by different federal, state, local, tribal, and private organizations, and agencies. This historic trail is not a traditional hiking-only trail and can also be traveled by car, foot, or horseback. Many interpretive centers, signs, and recreation facilities are located along the entire length of the trail.

Co-located with the Lewis and Clark National Historic Trail and the Lolo Trail, approximately 36 miles of the trail are in the planning area. In addition to the 2021 comprehensive trail plan, the Nez Perce (Nee-Me-Poo) National Historic Trail Interpretive Plan was published in 2015 and identifies interpretive goals and objectives and help managers determine which stories are key for interpreting along the Nez Perce (Nee-Me-Poo) National Historic Trail. This plan will present adopted themes and storylines for the Trail, list what projects have been accomplished, list potential projects as identified in prior planning efforts and through this planning process, and present criteria to prioritize future projects for implementation.

Recreation sites in the plan area that specifically tie to the Nez Perce (Nee-Me-Poo) National Historic Trail include Howard Creek, Fort Fizzle. Howard Creek is a unique site as it is one of the few sites where the Nez Perce Trail comes down to a confluence of 2 rivers where both the Nez Perce and the US military camped. Near this site you can see trees showing the scars of bark peeling as a food source. Fort Fizzle is a very popular spot for travelers along Highway 12. In addition to having a restroom, parking area, and open grass area for picnicking there are two different interpretive sites at this location. Although this site is across the road from the actual site of Fort Fizzle, interpretive signs and a replica of the fort have been constructed to give visitors a sense of the history and feel for the events that occurred.

*Lolo Trail National Historic Landmark.* The Lolo Trail is an ancient route that follows the ridgetops parallel and to the north of Highway 12. For centuries an East-West ridge line in the North Central portion of the Bitterroot Mountains has provided a travel and trade route across the mountains between peoples in the Columbia River Basin and the Northern Plains. The Lolo Trail System is the collection of travel routes and sites used over the centuries by the many different travelers; the Lolo trail system can be broken into three eras of travel routes. This trail provided access to buffalo on the eastern plains for those on the Columbia Plateau and led people living east of the mountains to salmon-rich waters in the west. During the Nez Perce War of 1877, Chief Joseph and nearly 750 Nez Perce fled General Howard's army along this trail to reach the Bitterroot Valley.

This corridor of interwoven trails was designated a National Historic Landmark in 1960. The Lolo Trail National Historic Landmark was created by the Department of Interior on October 9, 1960, as an outgrowth of congressional direction found in the 1935 Historic Sites Act. It was subsequently listed on the National Register of Historic Places on October 15, 1966, upon the National Register’s creation that year following the passage of the National Historic Preservation Act. The routes followed by Lewis and Clark in 1805-1806 and by Chief Joseph and the Nez Perce in 1877 were further designated as National Historic Trails in 1978 and 1986 respectively. Until US Highway 12 was completed in 1962, the east-west ridge the Lolo Trail followed through the Bitterroot Mountains was the only way to travel from the valleys of western Montana to the camas prairies of eastern Oregon and Washington.

The first trail era was the Northern Nez Perce (Nee-Mee-Po) Trail which is a pre-white contact route across the mountains ascending steep ridge lines the route appeared to "serpentine" up the hill. Remnants today appear as erosion worn ditches a few inches to two feet deep. The route changed locations due to fire, windstorms, and season of the year. It was used by the Nez Perce Indians to cross from their home in the Snake River basin to the buffalo hunting grounds of the northern plains and by Montana tribes to cross to salmon fishing streams. Until 1866 this was the only route across the mountains and was followed by early white explorers such as Lewis and Clark. Some of the names given to this centuries old route include the following: Q'ueseyn'eisskit, Buffalo Trail, Northern Nez Perce Trail, Lewis and Clark Trail.

Following the same ridge line as the Northern Nez Perce Trail, but on an engineered grade often going from saddle to saddle, the Lolo Trail was the first constructed trail across the Bitterroot mountains. It was financed by the US Government and constructed by Wellington Bird and Major Truax in 1866. In 1877 the Nez Perce flight followed the trail as did General Howard's troops in pursuit. In 1907 the Forest Service reopened it and maintained it for 30 years as a main line pack trail. Names commonly associated include the following: Bird-Truax trail, and Nez Perce (Nee-Me-Poo) Trail.

Completed in 1935, the Lolo Motorway, was the first road across the Bitterroot mountains, and provided a relatively quick crossing between the Clearwater River country and the Bitterroot Valley. It followed the old ridge line travel route and provided access to the interior mountains. Narrow and rocky, it was and is a slow, difficult crossing of the mountains. Reconstructed to a higher standard on both ends, the center 70 miles remains in the original standard.

Although there is no formal management plan developed for the Lolo National Forest for the Lolo Trail National Historic Landmark, there are multiple guidance documents developed by the Clearwater National Forest including the 1993 Clearwater National Forest Lolo Trail System Guidelines and the 2006 Clearwater National Forest Lolo Trail National Historic Landmark Heritage Preservation Plan. These documents include management standards and direction as well as guidelines and recommendations for resource protection.

*St. Regis-Paradise Scenic Byway.* Originally a meandering trail which followed the Clark Fork River between St. Regis and Paradise, the St. Regis - Paradise National Forest Scenic Byway, with the motto: The River, The People, The Land, takes motorists through varying terrain, from spacious, rolling flats to steep canyon walls where it winds through the Coeur d'Alene Mountains.

The byway has long been considered an alternate route for travelers on Interstate 90, whose destination is Flathead Lake or Glacier National Park. It also serves as a route to the National Bison Range. However, with the spectacular scenery, plentiful wildlife, and many recreational opportunities the byway is a destination unto itself. Known as the "shortcut to Glacier National Park", Montana state highway 135, the St. Regis-Paradise Scenic Byway provides for many opportunities along its 22 miles. Beginning in the town of St. Regis and traveling through a diverse array of landscapes for its relatively short distance, the route provides a glimpse of wild Montana country while remaining near civilization.

The Clark Fork River follows the byway and provides rapids for all skill levels of rafters and floaters. Fishing opportunities exist in the river's waters providing opportunities to catch mountain whitefish, smallmouth bass, northern pike, or one of four different trout species. A variety of trails linked to the route provide opportunities for hiking, horseback riding, or mountain biking. Winter months find the countryside blanketed with high quality snow, perfect for backcountry skiing or snowmobiling.

Whether on the trail or on the road, diverse landscapes and vegetation are available along byway; the rolling Donlan Flats towards high canyon walls with the distant green mountains and the comforting rumble of Clark Fork River are high lights along the byway as you travel through the Lolo National Forest. Elk, white-tailed and mule deer, and the occasional bighorn sheep roam the mountain faces, and bald eagles also frequent the area.

## Status and Trends

The National Recreation Trails Program supports designated national recreation trails with an array of benefits, including promotion, technical assistance, networking, and access to funding. Its goal is to promote the use and care of existing trails and stimulate the development of new trails to create a national network of trails and realize the vision of "Trails for All Americans" National recreation trails provide for numerous outdoor recreation activities in a variety of urban, rural, and remote areas.

The Nez Perce (Nee-Me-Poo) and Lewis and Clark National Historic Trails are stand-alone resources. The trails provide for high-quality scenic, primitive hiking and horseback riding opportunities in the context of conserving the natural, historic, and cultural resources along its corridor. They also provide for high quality scenic driving tours, providing interpretive and accessible opportunities for all. National recreation trails benefit from the prestige and increased visibility of being a part of the National Trail

System. National recreation trails can often compete well for additional funding or state and Federal grant opportunities. National trails systems and sustainable trails have been an increased focus area of the agency, partners, and the public for connecting the public with their national forest.

The St. Regis-Paradise Highway receives the highest levels of vehicle traffic during the summer season, with highest use in August. Scenic byway road recognition carries with it not only a heightened awareness of the highway route as one of the premier destination roads in the U.S., but also recognition of the agencies, organizations, and communities that sought designation. Scenic byway road designation helps to expand the number and types of partnerships that are formed. These partnerships may extend beyond Montana.

## 3.9.7 Rattlesnake National Recreation Area

### Key Takeaways

- Designated under the Rattlesnake National Recreation Area and Wilderness Act of 1980, the Rattlesnake National Recreation Area covers about 60,103 acres of the Lolo National Forest. The Rattlesnake Wilderness area is located within the National Recreation Area boundary.
- Consistently popular for hiking, running, and biking, the Rattlesnake National Recreation area is a unique recreation asset in the backyard of the Missoula, Montana community. While use levels and interest in a variety continue to increase across the Forest, especially within the greater Missoula area, ensuring the National Recreation Area continues to provide sustainable recreation opportunities will be a critical consideration during the plan revision process.

### Summary

Designated under the Rattlesnake National Recreation Area and Wilderness Act of 1980, the Rattlesnake National Recreation Area covers about 60,103 acres. The Rattlesnake Wilderness area (34,273 acres) is located in the National Recreation Area boundary. Just outside of Missoula, this area serves as a recreation destination for both local populations and forest visitors. Outside of the designated wilderness portion of the National Recreation Area, about 96 miles of trail support a variety of uses including hiking, pack and saddle use, and bicycling. Several trailheads support access to wilderness and non-wilderness trail systems. Dispersed camping also occurs throughout the area.

Rattlesnake Creek and associated streams have been found eligible and suitable for wild and scenic river designation. Shoofly Meadows, a Research Natural Area covers over 900 acres within the National Recreation Area. Notable peaks within or just outside the area include McLeod, Murphy, Mosquito, Stuart, Sheep Mountain, Mineral, and Boulder Peaks. Montana Snowbowl is located just west of the National Recreation Area and provides year-round recreation opportunities on National Forest System lands under a special use permit. Although outside the National Recreation Area boundary and only partially on National Forest System lands, the Marshall Mountain area is another popular destination for all-season recreation opportunities that draws people to this area.

The 1986 Forest Plan designates the National Recreation Area under Management Area 28 and incorporated Amendment 16 (December 1992) as updated the management direction for the Rattlesnake National Recreation Area and Wilderness to adopt the Limits of Acceptable Change. This framework established acceptable and appropriate resource and social conditions to help managers ensure that conditions desired within the area were being met given the increase in recreation resource use.

### Status and Trends

The Lolo National Forest produces an annual Limits of Acceptable Change report for the Rattlesnake National Recreation Area and Wilderness. The monitoring plan associated with Amendment 16 of the 1986 Forest Plan ensure regular assessments of conditions within the National Recreation Area and Wilderness to help manager understand if use and changes within the landscape are meeting standards to support desired conditions(U.S. Department of Agriculture 1992). Information presented here is a summary of a subset of monitoring elements and trends specific to the non-wilderness portion of the National Recreation Area (U.S. Department of Agriculture 2022d).

Hiking, running, and biking are consistently the most encountered uses (Table 82). Campsite condition standards, monitored on a 3-year rotation basis, are based both on David Cole’s 1983 rating index (to incorporate impact index weightings used on campsite inventory sheets) and the condition standards found on page 30 of Amendment 16. Although the number of camping areas change from year to year depending on new or relisted use areas or discontinued use after two surveys, about 36 areas were included in the most recent list of dispersed camp sites. These are user created areas and not directly managed by the Forest.

**Table 82—Annual use types based on ranger encounters within the Rattlesnake National Recreation Area (2002-2022)**

| Use Type | 2021 | 2020 | 2019 | 2018[1] | 2017[1] | 2016[1] | 2014[1] | 2012[1] | 2011[1] | 2010[1] | 2009 | 2008 | 2007 | 2006 | 2005 | 2004 | 2003 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hike | 97 | 95 | 75 | 138 | 192 | 254 | 170 | 348 | 141 | 180 | 11 | 15 | 11 | 16 | 24 | 34 | 25 | 59 |
| Run | 39 | 29 | 16 | 58 | 47 | 32 | 36 | 55 | 18 | 70 | 10 | 5 | 18 | 7 | 5 | 18 | 6 | 7 |
| Bike | 52 | 70 | 50 | 100 | 141 | 130 | 230 | 192 | 90 | 140 | 31 | 14 | 71 | 63 | 80 | 29 | 44 | 72 |
| Horseback | 1 | 4 | 0 | 1 | 5 | 6 | 2 | 1 | 6 | 3 | 0 | 2 | 2 | 1 | 0 | 9 | 1 | 8 |
| Bike/Fish | 2 | 1 | 1 | 0 | 4 | 1 | 1 | 18 | 5 | * | 1 | 4 | 1 | 4 | * | * | * | * |
| Bike/Camp | 1 | 4 | 3 | 3 | 24 | 20 | * | * | * | * | * | * | * | * | * | * | * | * |
| Hike/Fish | 1 | 0 | 0 | 1 | 6 | 4 | 0 | 0 | 2 | * | 1 | 0 | 1 | 0 | * | * | * | * |
| Bike/Hike[2] | 1 | 4 | 2 | 0 | 12 | 9 | 0 | 0 | 0 | * | 0 | 0 | 6 | 3 | * | * | * | * |
| Bike/Run[2] | 0 | 1 | 0 | 0 | * | 1 | * | * | * | * | * | * | * | * | * | * | * | * |
| Bike/Hunt | 0 | 0 | 1 | 1 | 17 | 0 | 0 | 4 | 14 | * | 2 | 0 | 1 | * | * | * | * | * |
| Hike/Hunt | 0 | 1 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | * | * | * | * | * |
| **Total** | **194** | **209** | **148** | **301** | **453** | **343** | **439** | **616** | **276** | **395** | **56** | **40** | **112** | **94** | **109** | **90** | **76** | **146** |

*Indicates item not recorded

[1]2010-2012 and 2014 includes encounters before and beyond Milepost 3. Many factors contribute to the variance in trail encounters from year to year. Increases and decreases in trail encounters do not necessarily reflect an increasing or decreasing trend in use. Some variables which lead to fluctuations in user counts include: the time of day Rangers patrol, the day Rangers patrol (holiday/weekend), and the total amount of time allocated to patrol within the RNRAW which is based upon priorities across the District. There was no data collected for 2013.

[2]Data for bike/hike and bike/run trail users can be difficult to determine without talking to every individual or group, especially for day use. Many users bike National Forest System Road 99 to the wilderness boundary and begin to hike or run from there. While 2018 shows 0 entries for either of these user groups, the reality is many of the entries counted as bike fell into these categories without the Wilderness Ranger's knowledge.

Overall, 19 of the 36 (52%) areas are in a naturalized condition. During the last rotation of campsite condition inventories, 17 user created dispersed camping areas continued to be naturalized and two areas improved to a naturalized condition (Table 83). One site remained in the same condition as the previous survey within a minimum impact index rating. There are 9 sites with a Moderate impact index rating. About half of these sites showed an increase in impacts and the remaining 5 showed decreased impacts. Of the 5 sites rated as High or Extreme impacts (14 percent of all sites inventoried), 3 areas saw an increase rating and two showed an impact rating decrease.

**Table 83—Campsite condition inventory information from the rotation of surveys in the Rattlesnake National Recreation Area and Wilderness**

| Year last inventoried | Site number | Mile marker from main trailhead bollard | Condition index | Condition index change | Trend | Impact index |
|---|---|---|---|---|---|---|
| 2021 | 99-1 | 3 | NAT | -29 | Site Naturalized | Naturalized |
| 2021 | 99-2 | 3 | NAT | NAT | Same condition as last survey | Naturalized |
| 2021 | 99-3 | 3 | 54 | 6 | Increased impacts | Extreme |
| 2021 | 99-4 | 6.1 | NAT | NAT | Same condition as last survey | Naturalized |
| 2021 | 99-5 | 3 | 43 | 5 | Increased impacts | High |
| 2021 | 99-6 | 3 | 46 | 1 | Increased impacts | Extreme |
| 2021 | 99-7 | 3 | 28 | 8 | Increased impacts | Moderate |
| 2021 | 99-8 | 3.2 | NAT | NAT | Same condition as last survey | Naturalized |
| 2021 | 99-9 | 3.4 | 33 | NAT to 33 | Naturalized to increased impacts | Relisted, Moderate |
| 2021 | 99-10 | 3.4 | NAT | NAT | Same condition as last survey | Naturalized |
| 2021 | 99-11 | 3.4 | NAT | NAT | Same condition as last survey | Naturalized |
| 2021 | 99-12 | 3.4 | NAT | NAT | Same condition as last survey | Naturalized |
| 2022 | 99-13 | 4.7 | 31 | NAT to 31 | Naturalized to increased impacts | Relisted, Moderate |
| 2022 | 99-14 | 4.6 | 38 | -2 | Decreased impacts | High |
| 2022 | 99-15 | 4.3 | NAT | NAT | Same condition as last survey | Naturalized |
| 2022 | 99-16 | 4.2 | NAT | NAT | Same condition as last survey | Naturalized |
| 2022 | 99-17 | 3.9 | 29 | -3 | Decreased impacts | Moderate |
| 2022 | 99-20 | 4.3 | 27 | -5 | Decreased impacts | Moderate |
| 2022 | 99-21 | 4.3 | NAT | -35 | Site Naturalized | Naturalized |
| 2022 | 99-22 | 6 | NAT | NAT | Same condition as last survey | Naturalized |
| 2022 | 99-23 | 6 | 25 | -4 | Decreased impacts | Moderate |

| Year last inventoried | Site number | Mile marker from main trailhead bollard | Condition index | Condition index change | Trend | Impact index |
|---|---|---|---|---|---|---|
| 2022 | 99-24 | 6.3 | NAT | NAT | Same condition as last survey | Naturalized |
| 2020 | 99-25 | 6.3 | 21 | 0 | Same condition as last survey | Minimum |
| 2020 | 99-26 | 6.3 | NAT | NAT | Same condition as last survey | Naturalized |
| 2020 | 99-27 | 6.6 | NAT | NAT | Same condition as last survey | Naturalized |
| 2020 | 99-28 | 6.6 | 30 | -7 | Decreased impacts | Moderate |
| 2020 | 99-29 | 6.6 | NAT | NAT | Same condition as last survey | Naturalized |
| 2020 | 99-30 | 6.8 | NAT | NAT | Same condition as last survey | Naturalized |
| 2020 | 99-31 | 6.8 | 32 | 2 | Increased impacts | Moderate |
| 2020 | 99-32 | 7.8 | NAT | NAT | Same condition as last survey | Naturalized |
| 2020 | 99-33 | 8 | 45 | -1 | Decreased impacts | High |
| 2020 | 99-34 | 8 | 34 | -15 | Decreased impacts | Moderate |
| 2020 | 99-35 | 8 | NAT | NAT | Same condition as last survey | Naturalized |
| 2020 | 99-36 | 11.7 | NAT | NAT | Same condition as last survey | Naturalized |
| 2020 | 99-37 | 11.7 | 44 | NAT to 44 | Naturalized to increased impacts | Moderate |
| 2020 | 99-38 | 11.7 | 32 | NAT to 32 | Naturalized to increased impacts | Moderate |

The following scale of the weighted impact index is used in part to assess campsite condition: Minimum impact: 20-23; Moderate impact: 24-34; High impact: 35-45; Extreme impact: 46-60. NAT indicates a site remained unused and an inventory with rating score was not completed.

# 3.10 Production of Natural Resources

This section provides information on key products and services that result from multiple uses provided by the Lolo National Forest.

## 3.10.1 Timber Suitability, Production, and Harvest

### Key Takeaways

- Timber harvest from the Lolo National Forest has been an important source of jobs, income, and economic development for over 150 years. Timber harvested from the Lolo National Forest is used for a wide variety of wood products including lumber, plywood, particleboard, pulpwood, posts and poles, firewood, furniture, and energy.
- The 1986 Forest Plan identified an allowable sale quantity of 107-131 million board feet annually. From 1986 to 2021, only an average of 35 million board feet of timber products were sold per year. Recent trends in accelerated volume sold is primarily related to post-fire salvage harvest.
- The 1986 Forest Plan identifies approximately 50% of the Lolo National Forest as suitable for timber production; however, a portion of the area considered suitable in 1986 (20%) is now located in inventoried roadless areas.
- Timber harvest is increasingly used as a tool to achieve multiple resource objectives including fuels reduction, enhancing wildlife habitat, and ecological restoration. Timber harvest activities are designed to support the economic structure of local communities, provide timber to meet regional and national lumber demands, and promote a diverse mosaic of vegetation distributed across the Forest to support ecological integrity of forested ecosystems.

### Summary

This section focuses on the status and trends of timber suitability, production, and harvest. The role of timber harvest on ecological elements such as vegetation and wildlife are primarily assessed in other areas including the terrestrial vegetation and wildlife sections. Section 3.1 provides additional information on the economic importance of the timber sector to the plan area including federal land payments to states, assessing the economic contribution of major industries in the Lolo National Forest plan area, and the Forest's contributions to the plan area economy.

Timber production is the purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use (36 CFR 219.19). More broadly, timber harvest is the removal of trees for wood fiber use and other multiple-use purposes (ibid). Whether conducted for timber production for other multiple use purposes, timber harvesting results in modifications to forest vegetation and in timber volume outputs. Ultimately, lands that are suitable for timber production in a land management plan are lands that meet the following criteria (FSH 1909.12, 61.2):

- Timber production is a primary or secondary use of the land,
- Timber production is anticipated to continue after desired conditions have been achieved,
- A flow of timber can be planned and scheduled on a reasonably predictable basis,
- Regeneration of the stand is intended, and

- Timber production is compatible with the desired conditions or objectives for the land designed to fulfill the requirements of 36 CFR 219.8 to 219.10.

The Lolo National Forest contains many lands with productive growing conditions for conifer forests, and these forests provide a variety of goods and services. Timber harvest from these forests provides wood materials for a variety of uses such as, fuelwood, sawlogs, house logs, posts and poles, and fencing materials. Timber harvest is also used to move vegetation towards desired conditions and meet other resource objectives such as improving watershed condition, improving wildlife habitat, and reducing wildfire risk. A viable forest industry helps provide capacity to undertake forest restoration activities that require a trained workforce and mills to process resulting wood products. Timber harvest also provides jobs and income in logging and manufacturing of wood products.

The 1986 Forest Plan established an allowable sale quantity and long-term sustained yield capacity using the timber volume metric of million board feet. Allowable sale quantity is the volume of timber that can be harvested from the lands classified as suitable for timber production per decade while complying with all forest plan standards, goals, and objectives. This is the maximum level of harvest consistent with the 1986 forest plan's standards and guidelines. Although this is a decadal limit, it is usually expressed as an average annual figure. The long-term sustained yield capacity is the highest uniform wood yield from lands being managed for timber production that may be sustained under specified management intensity consistent with multiple-use objectives.

Neither the allowable sale quantity nor the long-term sustained yield capacity defines output levels in themselves. Rather, they are calculated limits that ensure that the timber harvest from suitable land is sustainable in the long-term. Actual harvest levels may vary based on budgets and site-specific resource management objectives. The 1986 Forest Plan identified a long-term sustained yield capacity of 178 million board feet and an average annual allowable sale quantity of 107 million board feet from suitable lands in the first decade that increased to 131 million board feet in subsequent decades (1996-2035). Timber harvest may occur on lands that are not suitable for timber production, but that volume was considered incidental to resource management objectives and not included in the allowable sale quantity. The 1986 Forest Plan also stated the expectation of 30 million board feet of firewood per year. The Lolo National Forest has not produced timber outputs that approach the allowable sale quantity; on average, from 1986 to 2021, the Lolo sold an average of 35.3 million board feet per year.

## Status and Trends

Use and development of natural resources on the Lolo National Forest and surrounding lands has played an essential role in the economy and growth of the area over the past 150 years, since the early settlement of the area by European-origin Americans. The area has a long history of extractive use including gold mining and logging since the late 1800s. In the early 1880s, the Northern Pacific Railroad arrived in Missoula facilitating harvest and transport of an insatiable demand for timber, for railroad ties, but more so for the for mining and smelter timbers. Much of the area settlement was driven by mining and timber harvest. In 1886 the Bonner mill was established at the confluence of the mouth of the Blackfoot River and the Northern Pacific Railroad providing infrastructure and access to timber as never before.

In the early 1900s the agency's first timber sales and management efforts occurred near present day Seeley Lake with logs forced through rivers with a series of splash dams enroute to the Bonner mill. During this era, Anaconda Copper Mining Company established their logging headquarters in the Ninemile Valley and laid railroad tracks up most major tributaries and valleys to meet the demand for mine and smelter timber. The importance of wood products and use of natural resources has been foundational to the communities that developed. That trend continues today with timber harvested from the Lolo National Forest used for a wide variety of wood products including lumber, plywood, particleboard, pulpwood, posts and poles, firewood, furniture, and energy.

Timber harvest direction in the 1986 Forest Plan is focused on managing lands classified as suitable for timber production. Although the National Forest Management Act allows for timber harvest from lands classified as unsuitable for timber production to meet specific resource objectives, the current plan provides little direction on when and under what conditions timber harvest from unsuitable lands would be appropriate. However, it is now recognized that leaving lands previously classified as not suited for timber production untouched by vegetation management may not always achieve the resource objectives for fuels reduction, wildlife habitat, recreation, or landscape resilience. Timber harvest may be a tool to manipulate vegetation composition and structure to achieve other resource objectives on unsuited lands.

In recent decades, emphasis on ecological integrity and sustainability have led to a higher priority on integrating non-timber resource considerations in harvest projects, compared to the forest regulation approach used in the development of the 1986 Forest Plan. Timber growth and yield considerations do not influence harvest prescriptions as strongly as originally envisioned. While timber harvesting is conducted in response to social and economic needs, it is also a tool for fuel reduction and managing plant communities and wildlife habitats more closely within natural range of variability. Timber harvest may also be used to achieve specific resource objectives with the focus of many harvest prescriptions on what is left rather than what is removed. Even-aged harvest prescriptions of today typically have a notable component of reserve trees left onsite for wildlife, aesthetics, and other resource values. In addition, fire salvage has provided a higher percentage of timber volume than anticipated in the 1986 Forest Plan.

Forest conditions on adjacent non-National Forest System lands may also limit harvesting opportunities to provide for multiple resource requirements such as aquatic or wildlife habitat. Harvest activities on Bureau of Land Management, State, or private ownership would result in forest structure conditions and are taken cumulatively into account when assessing the environmental impacts of treatments on nearby National Forest System lands. A substantial proportion of the counties influenced by the timber produced on the Lolo National Forest are comprised of other ownerships. Other regulatory agencies also provide direction that limits management activities to protect threatened and endangered species to meet their responsibility under the Endangered Species Act. Similarly, additional resource regulations and policies influence treatments to improve timber production or provide timber products from suitable lands.

Broadly, timber production and volume outputs from the Lolo have been limited by:

- The physical and biological capability of the land to grow trees and other forest products on a sustainable basis. Downward trends in productivity are associated with climate change where soil moisture is most limiting is ongoing and evident.
- Requirements to provide and protect diverse habitats sufficient to insure species viability. Species listed under the Endangered Species Act has changed over time, as has our understanding of their habitat requirements. There have also been in riparian area management direction and standards (INFISH) to protect aquatic habitat.
- Social and economic tensions between the demand for wood products and the desire for other ecosystem services and ecological integrity, as well as an upward trend in litigation on timber projects which has increased project-level analysis requirements and implementation delays.
- Desire to create certain patterns of vegetation composition, structure, and function to achieve multiple – and sometimes competing - values, goals, and objectives from National Forest System lands.

- Budget limitations and downward trends that affect timber program size and capacity.
- Other regulatory changes, such as the 2001 Roadless Area Conservation Rule that restricts opportunities to utilize harvest in inventoried roadless areas.

**Suitability and growth.** Approximately 50% of the Lolo National Forest is classified as suitable for timber production by the 1986 Forest Plan (just over 1 million acres; see figure A1-17). Over time, site specific project planning has resulted in minor management area changes that have updated suitability. A proportion of lands that were considered suitable for timber production in the 1986 Forest Plan became inventoried roadless areas in 2001; this overlap occurs on roughly 200,000 acres or 20% of the lands identified as suitable for timber production in the 1986 plan. Of all inventoried roadless areas located on the Forest, roughly one-third of them overlap with lands suitable for timber production in the 1986 Forest Plan. Suitability will be reassessed during the plan revision process in accordance with the National Forest Management Act and 2012 planning rule.

Forest growth rates also influence timber production over time, and the value of the timber based on tree size. Site productivity is considered constant and based upon biophysical site attributes such as topography, soil type, and climate. On the Lolo National Forest, site productivity in terms of tree growth is estimated to be between 40 and 140 cubic feet per acre per year on suitable lands with average rotation ages ranging from 90 to 150 years, depending on the species and site. Practitioners have observed trends in lowered productivity and reforestation success associated with climate change on sites where soil moisture is most limiting is ongoing and evident.

**Volume sold.** The allowable sale quantity and fuelwood expectations have not been achieved during the life of the 1986 Forest Plan due to the factors described in the section above. Allowable sale quantity estimates in the 1986 Forest Plan were developed using an economic optimization model that did not reflect spatial considerations or multiple competing objectives. National direction at the time established that the objective function of the modeling effort was to maximize present net value. However, decisions on harvest location, intensity, and prescriptions are frequently driven by factors other than present net value. Indeed, when timber harvest is used as a tool to achieve other multiple use objectives, such as to reduce fuels or improve wildlife habitat, it often occurs in areas that provide some of the lowest potential net values. The 1986 Forest Plan was also developed at the end of a mild mesic period when fires did not drive large scales shifts in forest structure and composition, regeneration difficulties, or forest retreat due to climate change. The Plan did not consider loss in forest productivity due to long-term drought and climate change. Also, the designation of inventoried roadless areas in 2001 is an example of a regulatory shift that resulted in the ability of some lands to be managed for timber production.

Figure 41 displays the trend in total volume of timber products (all convertible forest products) sold by fiscal year on the Lolo National Forest from 1986 to 2021. Over the 36-year period since the 1986 Forest Plan was signed an average of 35.3 million board feet of timber products were sold per year. The largest volume sold was in 1989 with 101.0 million board feet. Two other peaks are evident since the 1986 forest plan went into effect, one in 1997 with 53.9 million board feet sold, and a recent, more sustained peak from with 54.2 million board feet sold from 2017-2021. Volume sold accelerated over previous decades and remained stable through the five years following 2017 due primarily to post-fire salvage projects. The lowest volume sold 5-year moving average was 8.7 million board feet and occurred from 1999 to 2003. Two other low periods occurred in 2007 and 2013 when 7.8 and 6.4 million board feet were sold, respectively. During each of these years the Lolo National Forest experienced extreme fire events in the fourth quarter impacting the timber program and years' volume sold.

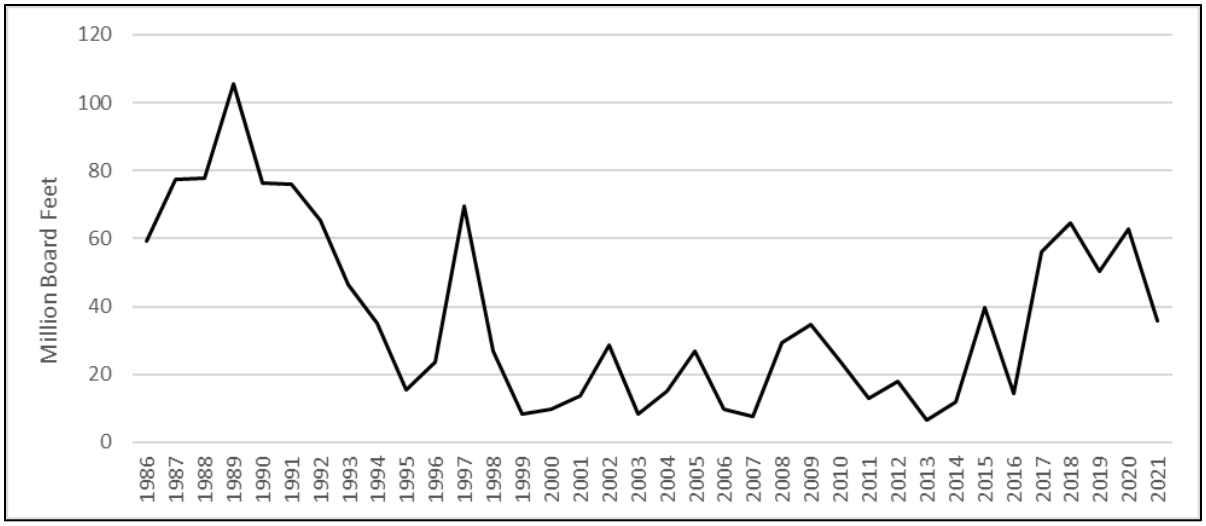


**Figure 41—Total volume sold (including fuelwood) on the Lolo National Forest 1986 to 2021, based on data from the Forest Service's Automated Timber Sale Accounting System**

The period of 2007 to 2011 also represents the worst operating environment experienced by the North American and Montana forest products industry since the Great Depression. It involved a two-year recession from 2007 to 2009, the related financial crisis, and a housing collapse with the lowest levels of new home construction since the Second World War (Keegan et al. 2012). Low prices for lumber and other wood products have accompanied this broad economic downturn. There was an increase in U.S. housing starts every year from 2009 through 2021, with a slight decline in 2022 (Figure 42). Modest upticks are expected in domestic lumber markets if U.S. home building recovers and global demand continues to increase. Still low stumpage prices and mill closures may continue to impact lumber markets. Consumption of manufactured wood products is projected to show only modest growth through 2060, while the consumption of wood for fuel is expected to increase substantially. How this trend affects the area surrounding the Forest depends on factors such as the price difference between wood fuel and fossil fuels; technological changes; and changes in regulations or incentives (Skog et al. 2012).

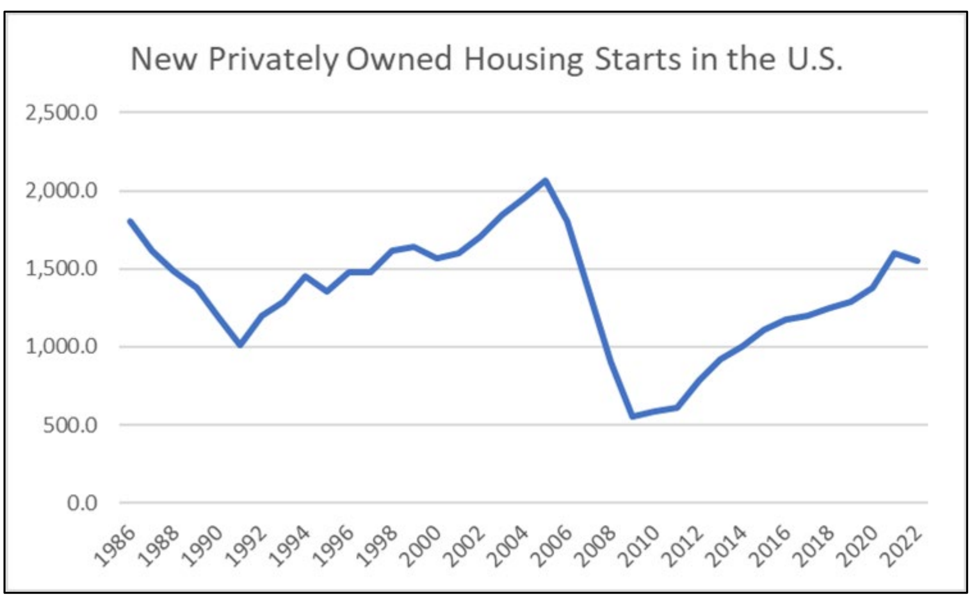


**Figure 42—Privately owned housing starts in the U.S.**

Overall, trends in average annual timber product volume sold show declines followed by peaks associated with landscape scale fire and disturbance mortality followed by a corresponding spike in volume sold through harvest of green, damaged, and dead salvage timber. Changing landscapes have driven spikes in volume sold since the inception of the plan with the most recent occurring following the widespread fires in 2017 with the highest five-year average since the first decade of the 1986 plan. Notably during this period of high volume offered and sold, the Idaho Forest Group suspended operations indefinitely and closed the mill is St. Regis, Montana in the planning area at the end of 2021. Idaho Forest Group cited the falling timber market, poor production, and dated technology as their rationale. Despite these downturns, there currently is a recent trend of accelerated and stable volume production and harvest.

**Acres harvested and reforested.** Timber harvest is a tool used not only to provide timber products and contribute to the local economy but also to achieve multiple resource objectives. These include reducing insect or disease hazard and impacts, improving wildlife habitat, increasing tree growth, improving timber productivity, and reducing fuel complexes, fire hazard and associated risk, and altering forest structure and composition to improve forest resistance, resilience, and ecological sustainability. The amount of timber harvested is influenced by a variety of factors, including site-specific environmental analyses, stakeholder involvement, choice of harvest methods, effects of administrative objections and litigation as well as available budgets and workforce capacity needed to complete associated environmental analyses and timber sales.

Figure 43 shows the trend of harvest from the 2005 to 2020, which mirrors the trend of volume sold. Roughly 30,000 acres of harvest have been recorded on the Lolo National Forest during that period averaging 1,875 acres per year. Though economic conditions and oscillating timber values are partially responsible for the peaks and valleys in timber harvest levels, wildfires and insect or disease outbreaks are prominent ecological factors that have influenced harvest trends, as well as the other factors discussed in the summary section (e.g., litigation and budget limitations). See also section 2.2 for additional information on the acres of harvest by type since the 1970s. Since the 1990s the number of harvested acres has declined and trended toward more intermediate treatments.

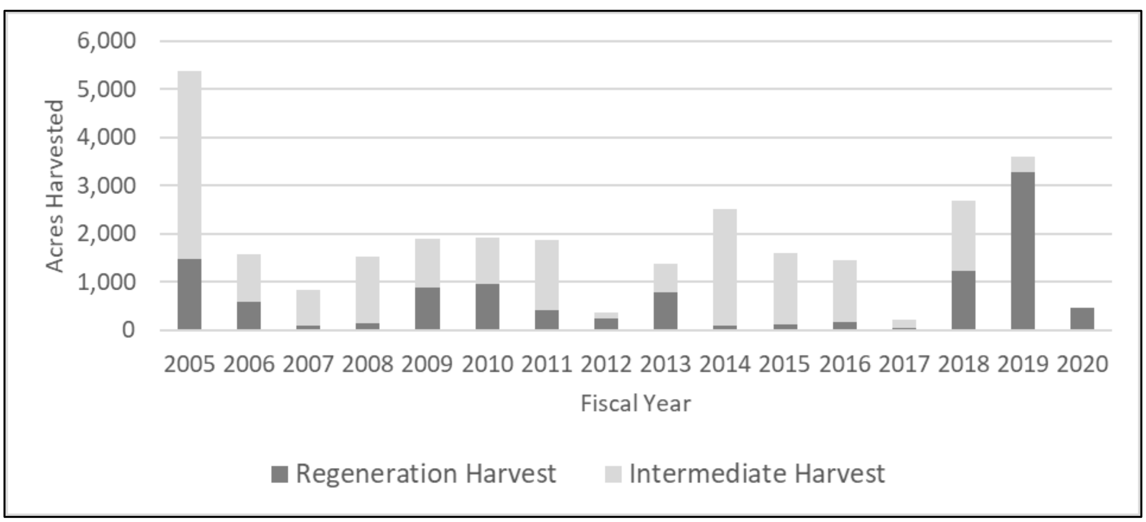


**Figure 43—Total acres of completed harvest on the Lolo National Forest 2005 to 2020. Data source: Forest Activity Tracking System (FACTS)**

The 2001 Biennial Monitoring Report for the Lolo includes a comparison of timber harvest acres from the period of 1987-2001 as compared to the 2018-2020. The annual average acres of intermediate and regeneration harvest accomplished per year recently (2018-2020) represent roughly a twelve-fold increase from the average annual acres harvested from 1987-2001. This increase corresponds to the peak in timber volume sold recently as discussed in the section above. The acceleration of harvest in recent decades is in part due to post-fire salvage projects.

Reforestation and supporting tasks (such as seed and propagule collections) is a critical component of a successful timber harvest program. The National Forest Management Act requires that regeneration harvest units be adequately re-stocked within five years of the final harvest activity. As disclosed in the 2021 Biennial Monitoring report, at the Forest level the Lolo National Forest generally achieves this reforestation timeframe requirement based on reforestation progress data. Reforestation data was reviewed for the trend from 1976, and very few stands are considered not stocked or still progressing toward meeting reforestation certification standards.

Timber harvest is increasingly used as a tool to achieve multiple resource objectives including fuels reduction, enhancing wildlife habitat, and ecological restoration. Timber harvest activities are designed to support the economic structure of local communities, provide timber to meet regional and national lumber demands, and promote a diverse mosaic of vegetation distributed across the Forest to support ecological integrity of forested ecosystems.

## 3.10.2 Non-Timber Forest Products

### Key Takeaways

- Fuelwood is the main non-timber product produced in the Lolo National Forest and its demand is expected to rise. The removal of forest biomass for heating or power generation is an emerging use.
- Other products offered for personal use or commercial permits include Christmas trees, mushrooms, boughs, transplants, and posts and poles.

### Summary

Gathering of non-timber forest and botanical products occurs for both commercial and non-commercial personal use reasons. The five categories of gathered materials are: edibles, medicinals, florals, horticulturals, and crafting materials. As a group, these are referred to as "non-timber forest products." Each non-timber forest product is considered individually to assess if there is a need for limiting collection permits. Because the entire plant is harvested in some cases, recovery time can be very slow and impacts from over-collection have been documented. If plants are threatened with over-collection, the current plan would not prevent limitations from being imposed. The 1986 Forest Plan primarily addresses traditional forest products, such as sawlogs, roundwood, and firewood. It is largely silent with respect to miscellaneous forest products. Demand for these products has grown and the removal of forest biomass for heating or power generation is an emerging use.

### Status and Trends

Non-timber products sold on the Lolo National Forest for personal or commercial use include fuelwood, Christmas trees, mushrooms, boughs, transplants, and posts and poles. Fuelwood is the primary non-timber product sold on the Lolo National Forest at an average of 10 million board feet per year. During the last 15 years, the Forest produced approximately 244 million board feet of firewood. In 2017 alone, the Forest sold at least 50 million board feet. Spikes like these are typically associated with large disturbance events. From 2003-2013, demand for fuelwood has steadily increased (Figure 44). The rise in fuelwood demand since 2007 could be attributed to the increased number of dead trees available for harvesting following wildfire events, insect or disease outbreaks and the economic downturn that occurred in 2008. Christmas trees are also a consistent and popular product sold by the Lolo National Forest. They are tracked by quantity rather than volume. Approximately 30,235 Christmas trees were sold over the last 15 years at an average of about 2,000 trees per year.

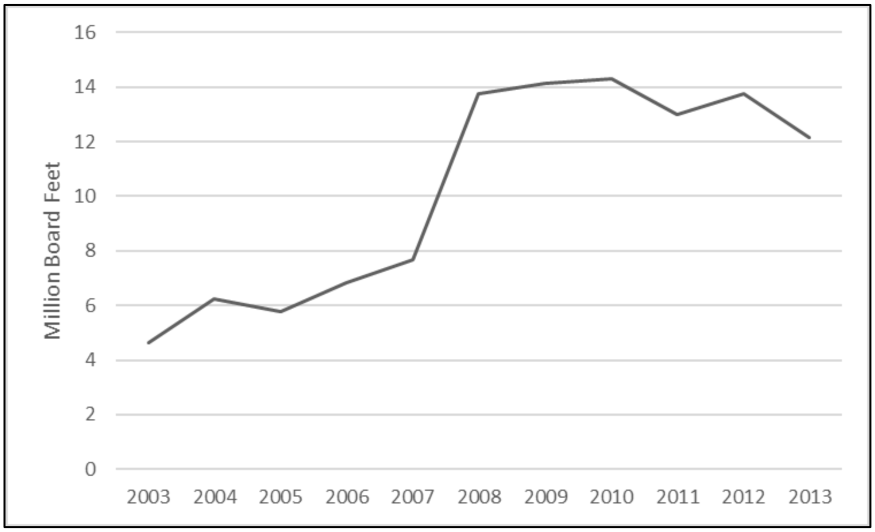


**Figure 44—Fuelwood sold by the Lolo National Forest from 2003-2013. Fuelwood data from other time periods is not as consistent or complete and is omitted here.**

## 3.10.3 Livestock Grazing and Range Management

### Key Takeaways

- Livestock grazing on National Forest System lands contributes to the social and economic sustainability of rural communities. Grazing use has generally been declining since the 1950s. There are 11 active cattle grazing allotments currently on the Lolo National Forest, covering just over 200,000 acres. Capable and suitable rangelands are limited.
- Allotment management plans are routinely revised to ensure that livestock grazing management is based on existing and future ecological, social, cultural, and economic conditions. Successful management of livestock grazing relies on the maintenance of healthy, functioning rangelands, and current management seeks to maintain grazing opportunities at current levels on active allotments and special use pastures while maintaining rangeland conditions.
- Livestock use is managed within the carrying capacity of the existing allotments and the Forest has been successful with managing and updating existing permits to achieve 1986 Forest Plan direction.

### Summary

Historically, livestock ranches were located on the valley floor and lower foothills of the Clark Fork valley. Many ranches had grazing permits on National Forest System land. Capable and suitable rangelands are limited on the Lolo National Forest. Most of the open rangelands are also located in big game winter range areas. The steep, mountainous, forested terrain is not conducive to intensive livestock grazing. Much of the livestock grazing occurs on small grassland areas, under sparse forest canopies, along roadsides, and on transitory rangelands created by timber harvesting or wildland fire. The key challenge to managing livestock is rangeland conversions to other land uses and maintaining resilient productive rangeland ecosystems with associated multiple uses and climate.

Livestock grazing is considered a privilege on National Forest System lands and authorized through Forest Service term grazing permits issued to eligible commercial livestock owners. Permitted livestock grazing and rangeland management is a component of multiple use on National Forest System lands. Livestock grazing on these lands, if responsibly done, provides a valuable resource to the livestock owners. According to the Multiple Use Sustained-Yield Act of 1960, "It is the policy of the Congress that the National Forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes."

Livestock grazing has been a use of public lands since the inception of the Forest Service and has become an import part of the culture of the rural western U.S. The objectives for Forest Service management of rangelands include managing rangeland vegetation to provide ecosystem diversity and environmental quality while maintaining relationships with allotment permittees; meeting the public's needs for rangeland uses; providing for livestock forage; maintaining wildlife food and habitat; and providing opportunities for economic diversity. The goal of rangeland management is to ensure that rangelands provide essential ecosystem services such as wildlife habitat and related recreation opportunities, and watershed functions as well as livestock forage. Forage is a provisioning service. Forage is managed to be sustainable, ensuring that it will be available for future generations while still providing the other rangeland's ecosystem services required by their multiple use strategy.

Rangeland ecosystem goods and services affect people across economic, social, cultural, and environmental boundaries. For example, people profit from the sale of ecosystem goods such as food and fiber, biofuels, feedstocks, and biochemicals extracted from plants. Rangelands also generate intangible benefits such as the pleasure that people take in observing plants and wildlife, studying natural systems, and hunting and fishing (Maczko and Hidinger 2008).

Livestock grazing supports a considerable amount of economic activity across the United States. Federal grazing permits support numerous ranching operations by providing relatively low-cost grazing on federal lands. While grazing supports employment, labor income, and economic activity within a given state, the extent to which federal grazing permits play a role remains uncertain.

Areas with suitable rangelands are divided into grazing allotments, oftentimes along watershed boundaries. Rangeland and transitory range within these allotments provide forage for grazing opportunities. Transitory range is defined as forested lands that are suitable for grazing for a limited time following a timber harvest, fire, or other landscape events (Spreitzer 1985). Livestock grazing is authorized through Forest Service term grazing permits issued to eligible commercial livestock owners. Livestock grazing management is established through forest plans, Forest Service grazing guidelines, and individual allotment management plans. These plans are developed to be comprehensive using sound science and incorporating public involvement. Plans are revised to ensure that livestock grazing management decisions are based on existing and future ecological, social, cultural, and economic conditions.

Livestock grazing on the Lolo National Forest probably peaked in the mid-1950s. Since that time, grazing has declined due to reduced timber harvests and subsequent plant succession decreasing the amount of available transitory range. In addition, conversion of lands adjacent to National Forest System land has created vacant allotments with no active livestock grazing. Rangeland ecosystem conditions, multiple-uses, and management constraints to protect threatened and endangered or at-risk species have all contributed to the decline in grazing since the 1950s.

## Status and Trends

All the grazing allotments on the Forest support cattle grazing; there are no active allotments for sheep or goat grazing. There are 11 active grazing allotments currently on the Lolo National Forest (Table 84 and figure A1-26). On the Seeley Ranger District, there is 1 allotment, located in Dunham Creek. There are two allotments on the Missoula Ranger District (Tyler Creek and La Valle Creek), and two on the Superior Ranger District (Tamarack Creek, and Fourmile Creek). The Tyler Creek allotment is administered by the Beaverhead-Deerlodge National Forest. Lastly, there are 6 allotments on the Plains/Thompson Falls Ranger District (McGinnis Creek, Little Thompson, Cougar Gulch, Swamp Creek, Henry Creek, and Lower Thompson River). The Lower Thompson River allotment is administered by the State through a cooperative agreement between the State, US Fish and Wildlife Service, Bureau of Land Management, and the Forest Service.

**Table 84—Active grazing allotments within the Lolo National Forest Plan area**

| Allotment status | Administrative organization | Allotment name | Acres |
|---|---|---|---|
| Active | Swan lake Ranger District | Holland | 20,805 |
| Active | Missoula Ranger District | O'keefe | 1,997 |
| Active | Plains/Thompson Falls Ranger District | Blue Slide | 80 |
| Active | Plains/Thompson Falls Ranger District | Henry Creek | 7,708 |
| Active | Plains/Thompson Falls Ranger District | Little Thompson | 18,555 |
| Active | Plains/Thompson Falls Ranger District | Mcginnis | 11,363 |

| Allotment status | Administrative organization | Allotment name | Acres |
|---|---|---|---|
| Active | Plains/Thompson Falls Ranger District | Swamp Creek | 24,013 |
| Active | Plains/Thompson Falls Ranger District | Thompson River | 65,760 |
| Active | Seeley Lake Ranger District | Dunham creek | 222 |
| Active | Superior Ranger District | Four Mile | 13,485 |
| Active | Superior Ranger District | Tamarack Creek | 10,772 |
| | | **Total** | **205,268** |

As discussed in section 2.1.8, improper grazing can have undesirable impacts, including riparian area impacts and the spread of invasive plants. Current management seeks to maintain livestock grazing opportunities at current levels on active allotments and special use pastures while maintaining rangeland conditions. Where opportunities arise, with consideration of rangeland resources and other uses, there could be potential to graze vacant allotments in the future. In some areas, recreation pack and saddle stock grazing areas are allowed while care is taken to maintain established and desirable rangeland conditions.

Livestock grazing on National Forest System lands is an important contribution to the social and economic sustainability of some rural communities. Forest grazing allotments are managed to be responsive to current federal and state environmental laws and regulations. Allotment management plans describe the kind and amounts of livestock, season of use, structural improvement maintenance, resource management objectives, and standards and guidelines to move towards desired conditions for the appropriate resources. Adaptive management practices used in allotment management plans include deferment and rest from grazing, cultural and mechanical vegetation treatments, infrastructure to control livestock, and conservation measures to protect federally listed plants and animal species.

Livestock grazing is an important source of income along with other diverse agricultural enterprises in the planning area. During the past several decades, livestock numbers have been declining across the western United States. Though, agriculture is an important industry in the planning area that contributes to the economic stability and open space. Counties with the Lolo National Forest have had stable farm and ranch earnings in the last 2 decades (Headwaters Economics 2021). Other agencies, local conservation districts, conservation and civic organizations, livestock industry, and rural communities participate in rangeland management planning. Forest Service policy direction for permitted livestock use are found in agency manuals and handbooks.

Monitoring for range management under the 1986 Forest Plan is conducted; according to the 2021 Biennial Monitoring Report for the Lolo National Forest, livestock use is being managed with the carrying capacity of the existing allotments and that the Lolo National Forest has been successful with managing and updating the existing permits and achieving Forest Plan direction. The Lolo National Forest Plan (1986) projected grazing on the Lolo National Forest land at 14,000 animal unit months. As of 2023, data from the range management database shows that permitted livestock grazing has remained stable over the past 15 years with active grazing permitted at 2,652 animal unit months on active allotments, and 6 vacant allotments with 1,267 animal unit months potentially available for future grazing.

There are gaps in available information. As opportunities arise, information needs related to the analysis of vegetative composition and trends for examining specific management practices to ensure management is moving towards or achieving desired conditions should be identified.

## 3.10.4 Energy and Mineral Resources

### Key Takeaways

- The Lolo National Forest has a long history of mining and mineral development across and adjacent to the administrative boundary.
- Legacy mining has resulted in a cascade of environmental impacts across the Forest that now comprises an important component of the Forest's program of rehabilitation work involving substantial partner cooperation and coordination.
- Current and forecasted interest in mineral development across the Forest is relatively limited. The current regulatory framework in tandem with 1986 Forest Plan direction has provided an effective framework for managing mining requests and mitigating or avoiding legacy effects at the scope and scale seen historically.

### Summary

The General Mining Law of 1872 legalized hardrock mineral exploration across most federally managed lands in the U.S. This law, along with a variety of others, direct mineral and energy extraction on Federal lands. Those other laws and acts include, but are not limited to:

- Mineral Leasing Act of 1920
- Mining Act of 1955
- Mining and Minerals Policy Act of 1970

The 1986 Forest Plan includes a series of standards directing how and when mineral resources may be developed across the forest. Among the stipulations contained in these standards are the need for any minerals development to align with other direction contained in the plan, such as that related to management area direction. All areas of the forest are open to mineral entry unless they have been withdrawn. Areas withdrawn from mineral entry include designated National Wilderness Preservation System lands and administrative and recreation sites with an investment in facilities. Exploration permits require environmental review and the plan directs interdisciplinary coordination in reviewing proposals. The plan further directs interagency coordination when and where appropriate.

The Forest Service shares administrative responsibilities with the Bureau of Land Management. This agency is mainly responsible for administering U.S. mining laws and mineral leasing acts, while the Forest Service is responsible for managing the occupancy and use of the surface as well as the disposal of certain mineral materials.

Renewable energy sources include biomass, hydroelectric, hydrokinetic, solar, and wind. Power site classification withdrawals and utility corridors are also included. Nonrenewable energy resources include things like geothermal energy, crude oil, natural gas, coal, tar sand, and oil shale. Although the Forest Service manages the surface resources and disturbances, the Bureau of Land Management typically manages the actual energy resources, via their agency regulations at 43 CFR 3100 (oil and natural gas), 43 CFR 3420 (coal), 43 CFR 3140 (tar sand), and 43 CFR 3900 (oil shale). Forest Service management of surface disturbances associated with these resources is guided by agency regulations at 36 CFR 228, Subpart B (solid leasable minerals) and Subpart E (oil and gas).

The Forest Service has a minerals management mission to encourage, facilitate, and administer the orderly exploration, development, and production of mineral and energy resources on National Forest

System lands to help meet the present and future needs of the Nation. Existing Federal laws, regulations, and legal decisions guide much of how or if minerals and energy management actions should take place. The right of access for purposes of prospecting, locating, and mining is provided by statute. Such access must be in accordance with the rules and regulations of the Forest Service. Plan components do not reiterate overarching Federal law, regulation, and policy that must be implemented. All mineral and energy management activities on National Forest System lands are required to meet applicable environmental protection measures as required by law, regulation, and policy.

There are three types of mineral and energy resources:

- Locatable minerals: includes commodities such as gold, silver, copper, zinc, nickel, lead, platinum, rare earth elements and some nonmetallic minerals such as asbestos, gypsum, and gemstones. U.S. citizens are guaranteed the right to prospect and explore lands reserved from the public domain and open to mineral entry. The disposal of locatable minerals is nondiscretionary.
- Salable minerals: includes common varieties of sand, stone, gravel, cinders, clay, pumice, and pumicite. The Forest Service has the authority to dispose of these materials on public lands through a variety of methods. The disposal of these materials is discretionary.
- Leasable minerals: includes commodities such as oil, gas, coal, geothermal, potassium, sodium phosphates, oil shale, sulfur, and solid leasable minerals on acquired lands. Areas of the Forest are open to leasable minerals exploration, development, and production. A leasing decision will not be a part of this draft plan. The disposal of these mineral resources is discretionary.

Mineral encumbrances for subsurface mineral estates include both reserved and outstanding private mineral rights on acquired lands, and oil and gas leases and mining claims under the 1872 Mining Law.

The reserved and outstanding mineral rights occur on acquired lands that are split estate, federal surface, and private subsurface. Reserved mineral rights are those that a private landowner kept when the property was sold to the United States. Reserved minerals are managed based on the Secretary of Agriculture's rules and regulations. Outstanding minerals are those minerals that were separated from the surface estate sometime in the past. Outstanding minerals are subject to state laws and conditions stated in the original deed conveying the minerals. In both cases, the Forest Service has little control over the access and mineral activities for these private mineral rights.

As described in section 3.7.3, there are multiple kinds of reserved and outstanding rights (collectively known as "separated rights." Many of these separated rights are related to outstanding or reserved mineral rights. There are over 246,000 acres on the Lolo National Forest with separated mineral rights held by private or non-Federal government entities; many of these are likely found on recently acquired lands. Maps of known outstanding rights, including minerals, are provided in Appendix 1 (figures A1-33 and A1-34).

## Status and Trends

Hargrave et al. (2003) provided a concise synopsis of historic mining activity across the Forest:

- As with many of the other metal mining areas in the state, the mining districts in the Lolo National Forest were discovered and most intensely mined from the 1860s to the turn of the 20th Century. By 1870, most of the major mining districts had been discovered. A resurgence of mining started in 1926 and lasted until about 1944. Exploration and mining activity generally focused on precious metals although copper, lead, zinc, antimony, sand and gravel, and building stone have also been produced (Wallace and Hosterman 1956, Crowley 1963)). Many of the mining districts are associated with the major northwest-trending geologic structures: the Osburn Fault, the Ninemile Fault, and the Silver Creek Fault to the south of Interstate 90.

- Mining began with the discovery of placer gold deposits in the 1860s. Many streams were placered but production statistics are generally unavailable since most of the activity was in the 1880s to early 1900s, before records were kept by the U.S. Bureau of Mines. The Ninemile and tributary placers were discovered in 1874 and production from 1908 to 1957 was estimated at $480,000 (Sahinen 1957). Other placer deposits were located along many of the small drainages of the St. Regis River.
- Hard-rock mining consisted of numerous small underground mines explored mainly for gold and silver, especially south of the I-90 corridor, but also to the north of I-90 for polymetallics such as copper, lead and zinc. At present, the most significant mineral deposits actively being worked in the Lolo National Forest are those associated with the placer mines. No lode mines in the categories "with production of greater than 100 tons per day" or "less than 100 tons per day" are known to occur within the Lolo National Forest boundaries. Placers included the Buddy Ellis placer near the mouth of Favorite Gulch on McCormick Creek, the Cedar Creek placer south of Superior with development but no production, and another, smaller deposit known as the "lower Cedar Creek placer" between Montreal and Rabbit Creeks near the old settlement of Cinkers. Quartz Creek, on I-90 near Quartz, is located on patented land but is surrounded by Lolo National Forest-administered land. In recent years, it has been intermittently productive. The Tammy Lynn placer is a past producer and the gold was recovered from bench gravels and flood debris on hillsides. It is also private, but it is near Lolo National Forest-administered land.
- Another intermittently active deposit includes the U.S. Antimony Smelter and Refinery at Stibnite Hill on Prospect Creek in Sanders County. The company last listed annual production at 7,000,000 pounds with a processing capacity of 15 tons per day. Presently, the antimony smelted here is not produced from Montana ores, but in the past, many mines were associated with the site.

Gold prospecting, mineral exploration, and mining activity fluctuates with rising and falling metals prices. Some areas on the Lolo National Forest have a moderate to high occurrence and development potentials for metallic minerals including the Alps and Quigg Peak areas, Upper Ninemile valley, Quartz Creek to Cedar Creek south of Superior, a large area of lead, zinc, and silver extending from north of Superior to the Idaho border, and the Cube Iron/Mount Silcox area northeast of Thompson Falls.

In fiscal year 2022 the Lolo National Forest administered 13 Notices of Intent for mineral prospecting and five Plans of Operation for mineral exploration/mining operations located on the Superior, Ninemile, Missoula, and Plains/Thompson Falls Ranger Districts. According to the Montana Bureau of Mines and Geology, approximately 307 historic abandoned mine sites lie within the borders of the Lolo National Forest. Most of these mine sites are small or were never developed.

While there have been no economic discoveries of oil and gas resources west of the Continental Divide in western Montana, the areas underlying and immediately adjacent to the west flanks of the Glacier Park and Swan Ranges have long been recognized as an area with a high potential for the occurrence of oil and gas resources. The Lolo National Forest has 21 suspended oil and gas lease applications which were suspended in 1985 following the Connor versus Burford lawsuit. Coal bearing units also exist, either at the surface or at depth, west of Missoula near Frenchtown and in the Ninemile valley area. There is no evidence that these areas have any potential for further development, nor is there any evidence to suggest coalbed methane is present. There is low potential for geothermal development.

Administration of mining activity under the 1986 plan in tandem with other relevant regulatory authorities has somewhat limited the magnitude and extent of resource adverse resource effects compared to mining administered prior to the plan's existence. Cumulative effects of continuous small mining operations continues to be an issue as projects are evaluated individually. There have only been three Best Management Practice reviews of minerals management activities conducted between 2014 and 2022 across the Forest. Those reviews found composite (combined implementation and effectiveness) ratings of "Excellent" or "Good" for two of the three reviews and one "Poor" rating. The "Poor" rating was related to a review of placer mining operations occurring in a waterbody or an aquatic management zone. Though data is limited, this suggests that continued interdisciplinary coordination is warranted to ensure future minerals development activities are conducted to minimize adverse resource effects.

## 3.10.5 Hunting, Fishing, and Wildlife Viewing

### Key Takeaways

- Hunting, wildlife viewing, fishing, and trapping are important to Montanans and others in many ways: as traditional activities going back generations, as an important cultural activity for the tribes, as a means of subsistence, as income through sale of pelts or through outfitting and guiding, and as a connection to nature, to name a few.
- The Lolo National Forest provides extensive and readily accessible opportunities for both consumptive and non-consumptive use of wildlife resources. Key species related to these uses include a variety of big game species, black bears, furbearers, gray wolves, mountain lions, game birds, and trout.
- Fishing, hunting, and other wildlife-related recreation represent significant economic return for communities in and around the Lolo National Forest, exceeding $10-$20 million dollars annually.

### Summary

Hunting, wildlife viewing, fishing, and trapping are important to Montanans and others in many ways: as traditional activities going back several generations, as an important cultural activity for the tribes in the area, as a means of subsistence, as income through sale of pelts or through outfitting and guiding, as a connection to nature, to name a few.

**Hunting and wildlife viewing.** The wide array of species found on the Lolo National Forest, and the Forest's proximity to population centers, provide numerous opportunities for recreational opportunities involving wildlife within the plan area. Hunting and fishing bring people to Montana from other states and countries as well, providing sources of income in many communities. Wildlife viewing and photography are considered non-consumptive recreational activities, which are difficult to quantify. This is not meant to convey that non-consumptive use of wildlife are less important. Additional information associated with developed recreation sites providing specific wildlife view opportunities, as well as the environmental education efforts associated with wildlife, is described in section 3.2. Also, see section 3.5.2 for information related to recreational special uses and trends, such as outfitter and guiding service permits, that support hunting, fishing, environmental education, and wildlife related activities. Specific wildlife viewing opportunities on the Forest include several Bighorn sheep observation points at the Petty Creek, Spring Creek and Koo-Koo-Sint viewing sites. A wildlife viewing blind on the Seeley Lake District offers the opportunity to observe and photograph a variety of riparian birds and waterfowl. Hiking trails with interpretive signs, such as the Maclay Flat Nature Trail and Babcock Mountain Trail, are also located throughout the Forest.

Wildlife and habitat management occur at many scales, dependent on the species. Although some species, such as elk, are managed by the state at the scale of Elk Management Units, others are managed at the scale of the Herd Unit or Hunting District. The diversity of management units, which do not align with forest administrative boundaries, makes summarizing hunting and trapping information across the plan area a challenging task.

Because hunting effort and outcome is reported by Montana Fish, Wildlife, and Parks by Region and District, we chose that scale for discussing hunting effort and harvest totals. The size and boundaries of the associated district or unit varies based on the species being considered. Furbearer trapping and bird hunting data are summarized by region, as that is the way the information is reported. Hunting Districts vary by species: although deer, elk and lion share districts, and separate hunting districts are delineated by Montana Fish, Wildlife, and Parks for bighorn sheep, black bears, and moose. Wolf hunting and trapping occurs and is reported by Wolf Management Unit, and trapping is managed and reported by Trapping Districts that correspond to Montana Fish, Wildlife, and Parks Regions.

**Fishing.** The Lolo National Forest helps support a robust fishing industry by facilitating angler access and providing habitat conditions that are conducive to supporting healthy fisheries. While most designated fishing access sites within the assessment area are managed by Montana Fish, Wildlife, and Parks, the Lolo National Forest also provides access at several developed and developed recreation sites. These sites are utilized directly by members of the angling public and/or by outfitters and guides that operate under special use permits from the Lolo National Forest. Many other access opportunities are available by trails across the plan area that lead to fish-bearing streams and lakes. Lower elevation rivers and lakes remain accessible in winter months to provide year-round angling opportunities. This is particularly true of valley bottom lakes and reservoirs that develop thick ice to support ice fishing December through February.

## Status and Trends: Hunting and Wildlife Viewing

In 2005, a cooperative study sponsored by Montana Fish, Wildlife & Parks and the Forest Service Northern Region was completed that looked at the relationship between fish and wildlife conservation and economic prosperity in Montana (Montana Fish Wildlife and Parks 2005). This study highlighted the importance of wildlife-related activities to residents of Montana, as well as those visiting the state. Though the report stated that participation in hunting is declining slightly nationally, the percent of Montana’s population participating in wildlife-related activities (hunting, fishing, wildlife viewing, bird watching) was substantially higher than for the nation or for the Rocky Mountain Region of the west (the states of Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, South Dakota, Utah, Wyoming) (ibid).

The following sections provide information on big game hunting, trapping, and bird hunting on and adjacent to the plan area. In most cases the information is presented by Montana Fish, Wildlife, and Parks Region and Hunting District, for those hunting districts that overlap with the Lolo National Forest. These statistics do not reflect the hunting and trapping that occurs only on National Forest System land, as that was not available. Hunting and trapping that occurred other public and private land is therefore also included in these statistics. These statistics present a larger perspective and are only meant to convey the amount of hunting and fishing that occur in the general area of the Lolo National Forest as an indicator of the importance of hunting and trapping to the public. The data used to populate these tables can be found at https://myfwp.mt.gov/fwpPub/harvestReports.

**Big game** species hunted on the Lolo National Forest include elk, mule deer, white-tailed deer, bighorn sheep, moose, and black bear. Most big game species vary their use of habitat by season, with some using markedly different habitat types or ecosystems in different seasons and making lengthy migrations between winter and summer ranges.

*Elk* typically summer in higher elevation areas providing good forage (grasses, forbs, and occasional browse) and thermal cover, often on National Forest System land. Winter habitat for elk usually occurs at lower elevation in forests intermingled with shrubfields and meadows, or on private, usually agricultural lands. Elk are habitat generalists; movement patterns, migration routes, and locations of both summer and winter ranges may change over time in response to forest management activities as well as to natural occurrences such as fire, drought, or insect infestations. Winter habitat may be less stable and resilient than summer habitat because it occurs at lower elevation on private lands where competition with livestock, or permanent changes such as conversion to cropland or private development may occur.

Table 85 provides statistics on elk hunting on the hunting districts that intersect with the Lolo NF land. The hunting districts included are as follows (by MTFWP Region): Region 1 – 120, 121, 122, 123, and 124; Region 2 - 200, 201, 202, 204, 210, 216, 280, 281, and 285. Elk hunting occurring on districts containing Lolo National Forest land accounted for approximately 14% of the elk hunting activity within the state, averaged over the 10 years between 2011 and 2121. During the same period, these districts accounted for approximately 5% of the total harvest.

**Table 85—Statistics on elk hunting on MTFWP districts intersection the Lolo National Forest. Numbers reflect average values over 10 years, 2011-2021**

| MTFWP Region | MTFWP Elk District | Management Unit Name | Total district acres | Average # hunters per year | Average number of hunter-days per year | Average annual elk harvest |
|---|---|---|---|---|---|---|
| 1 | 120 | Salish | 315,450 | 1,127 | 8,571 | 35 |
| 1 | 121 | Lower Clark Fork | 624,689 | 2,513 | 23,006 | 260 |
| 1 | 122 | Salish | 456,460 | 1,496 | 12,169 | 65 |
| 1 | 123 | Lower Clark Fork | 155,886 | 679 | 5,282 | 54 |
| 1 | 124 | Lower Clark Fork | 83,755 | 345 | 2,564 | 23 |
| 2 | 200 | Lower Clark Fork | 152,000 | 548 | 4,814 | 29 |
| 2 | 201 | Ninemile | 668,845 | 1,361 | 10,426 | 110 |
| 2 | 202 | Lower Clark Fork | 614,049 | 940 | 7,691 | 60 |
| 2 | 204 | Rock Creek | 257,923 | 1,050 | 7,161 | 99 |
| 2 | 210 | Rock Creek | 312,492 | 1,503 | 10,489 | 274 |
| 2 | 216 | Rock Creek | 189,603 | 476 | 3,251 | 59 |
| 2 | 280 | Bob Marshall Wilderness Complex | 194,951 | 237 | 1,574 | 27 |
| 2 | 281 | Bob Marshall Wilderness Complex | 242,333 | 1,400 | 10,159 | 112 |
| 2 | 285 | Bob Marshall Wilderness Complex | 423,419 | 1,539 | 11,658 | 86 |

*Deer*. Mule deer and white-tailed deer both occur throughout the plan area. Mule deer generally use higher elevation areas largely on National Forest System lands, but most winter ranges occur on lower-elevation open forests or shrubfields that may occur partly or entirely off National Forest System lands. White-tailed deer occur at lower elevations, often in denser forest and riparian areas. Wintering areas for both mule deer and white-tailed deer often occur on non-National Forest System lands, on private lands adjoining or near to public lands where they summer. Both species of deer are somewhat general in habitat use and therefore able to effectively respond to changes in habitats caused by management activities or natural occurrences. Winter ranges that occur on private land may be less stable over time than those on public land, due to competition with livestock or the potential for permanent changes such as conversion to cropland, or private development. There has been an overall trend toward reduction of winter range statewide, particularly for mule deer, due to these influences.

Table 86 and

Table 87 provide statistics on mule and whitetail deer hunting on the MTFWP hunting districts that intersect with the Lolo National Forest land. The hunting districts included are as follows (by MTFWP Region): Region 1 – 120, 121, 122, 123, and 124; Region 2 - 200, 201, 202, 204, 210, 216, 280, 281, and 285. Deer hunting on these districts accounted for only a small percentage of statewide deer hunting activity; ~1% of hunters, ~2% of hunting days, and ~1% of total harvest.

**Table 86—Statistics on mule deer hunting on MTFWP districts that intersect the Lolo National Forest. Numbers reflect average values over 10 years, 2011-2021**

| MTFWP Region | MTFWP Hunt District | Hunt District Name | Total district acres | Average # hunters per year | Average number of hunter-days per year | Average annual mule deer harvest |
|---|---|---|---|---|---|---|
| 1 | 120 | Salish | 315,450 | 2,298 | 13,716 | 39 |
| 1 | 121 | Lower Clark Fork | 624,689 | 2,912 | 24,046 | 113 |
| 1 | 122 | Salish | 456,460 | 2,132 | 15,323 | 130 |
| 1 | 123 | Lower Clark Fork | 155,886 | 689 | 4,935 | 37 |
| 1 | 124 | Lower Clark Fork | 83,755 | 561 | 3,580 | 43 |
| 2 | 200 | Lower Clark Fork | 152,000 | 684 | 5,377 | 29 |
| 2 | 201 | Ninemile | 668,845 | 1,987 | 13,584 | 74 |
| 2 | 202 | Lower Clark Fork | 614,049 | 1,252 | 8,577 | 87 |
| 2 | 204 | Rock Creek | 257,923 | 1,260 | 7,869 | 133 |
| 2 | 210 | Rock Creek | 312,492 | 897 | 5,551 | 54 |
| 2 | 216 | Rock Creek | 189,603 | 430 | 2,942 | 68 |
| 2 | 280 | Bob Marshall Wilderness Complex | 194,951 | 171 | 1,200 | 11 |
| 2 | 281 | Bob Marshall Wilderness Complex | 242,333 | 1,019 | 6,511 | 52 |
| 2 | 285 | Bob Marshall Wilderness Complex | 423,419 | 2,253 | 15,153 | 46 |

**Table 87—Statistics on whitetail deer hunting on MTFWP districts that intersect the Lolo National Forest. Numbers reflect average values over 10 years, 2011-2021**

| MTFWP Region | MTFWP Hunt District | Hunt District Name | Total district acres | Average # hunters per year | Average number of hunter-days per year | Average annual whitetail deer harvest |
|---|---|---|---|---|---|---|
| 1 | 120 | Salish | 315,450 | 2,298 | 13,716 | 755 |
| 1 | 121 | Lower Clark Fork | 624,689 | 2,912 | 24,046 | 1,003 |
| 1 | 122 | Salish | 456,460 | 2,132 | 15,323 | 604 |
| 1 | 123 | Lower Clark Fork | 155,886 | 689 | 4,935 | 167 |
| 1 | 124 | Lower Clark Fork | 83,755 | 561 | 3,580 | 182 |
| 2 | 200 | Lower Clark Fork | 152,000 | 684 | 5,377 | 160 |
| 2 | 201 | Ninemile | 668,845 | 1,987 | 13,584 | 497 |
| 2 | 202 | Lower Clark Fork | 614,049 | 1,252 | 8,577 | 348 |
| 2 | 204 | Rock Creek | 257,923 | 1,260 | 7,869 | 314 |
| 2 | 210 | Rock Creek | 312,492 | 897 | 5,551 | 240 |
| 2 | 216 | Rock Creek | 189,603 | 430 | 2,942 | 69 |
| 2 | 280 | Bob Marshall Wilderness Complex | 194,951 | 171 | 1,200 | 14 |
| 2 | 281 | Bob Marshall Wilderness Complex | 242,333 | 1,019 | 6,511 | 239 |
| 2 | 285 | Bob Marshall Wilderness Complex | 423,419 | 2,253 | 15,153 | 623 |

*Bighorn sheep* may be found throughout the Lolo National Forest, however they typically persist in 'metapopulations': small, semi-isolated herd groups that experience very little intermingling and therefore limited opportunity for genetic interchange or for re-population where a herd may have been reduced or eliminated. Their distribution is therefore patchy across the forest, with herds currently located in the Lower Clark Fork, Ninemile, Greater Missoula, and Rock Creek geographic areas. Bighorn sheep require escape terrain, including steep open slopes or cliffs that are adjacent to open, grassy foraging areas. These specific requirements mean that bighorn sheep habitat is more limited than that of other big game species, and therefore the species may be more vulnerable to certain changes. Where grasslands are encroached by conifer growth due to fire exclusion or lack of similar disturbance, sheep habitat may be restricted. Bighorn sheep are extremely vulnerable to diseases transmitted by domestic sheep and goats; therefore, the proximity of bighorn sheep habitats to domestic sheep and goat allotments and grazing areas will impact the value and stability of those areas to bighorns.

Table 88 provides statistics on bighorn sheep hunting on the hunting districts that intersect the Lolo NF. The hunting districts included are as follows (by MTFWP Region): Region 1 – Districts 203 and 210; Region 2 – Districts 121 and 124. Average harvest on these four districts was 24 bighorn per year between 2011 and 2021, which represents approximately 12% of statewide harvest. This percentage varied annually, ranging between 9% and 19% over 10 years. These districts accounted for approximately 6% (range 3% to 10%) of the statewide hunter activity each year.

**Table 88—Statistics on bighorn sheep hunting on districts intersection the Lolo National Forest. Numbers reflect average values over 10 years, 2011-2021**

| MTFWP Region | MTFWP District | Total district acres | Average # hunters per year | Average number of hunter-days per years | Average annual bighorn harvest |
|---|---|---|---|---|---|
| 2 | 210 | 120,281 | 3 | 25 | 3 |
| 2 | 203 | 263,535 | 11 | 71 | 10 |
| 1 | 124 | 37,879 | 10 | 86 | 9 |
| 1 | 121 | 603,563 | 2 | 30 | 2 |

*Moose* are distributed throughout the plan area, with suitable habitat occurring in all geographic areas. Moose may make long distance movements across landscapes relatively devoid of suitable habitat, allowing demographic and genetic interchange among populations. 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. Moose foraging habitat may have increased in some portions of the plan area due to increased wildfire activity, however this may come at the cost of summer thermal cover. There have been declines in the moose population in Montana and elsewhere in recent years, however the causes of these declines are not yet well understood.

Table 89 provides statistics on moose hunting on the hunting districts that intersect with Lolo NF land. The districts included are as follows (by MTFWP Region): Region 1 – Districts 112, 121, 122, 125, and 126; Region 2 – Districts 210, 220, 230, 261, 280, 285, and 293. Between 2011 and 2021, these districts accounted for approximately 9% of statewide moose hunting activity annually, in both the number of hunters and total harvest.

**Table 89—Statistics on moose hunting on districts intersection the Lolo National Forest. Numbers reflect average values over 10 years, 2011-2021.**

| MTFWP Region | MTFWP District | Total district acres | Average # hunters per year | Average number of hunter-days per years | Average annual moose harvest |
|---|---|---|---|---|---|
| 2 | 220 | 301,233 | 3 | 42 | 2 |
| 2 | 230 | 571,338 | 4 | 68 | 4 |
| 2 | 293 | 551,622 | 2 | 17 | 2 |
| 2 | 280 | 194,269 | 1 | 12 | 1 |
| 2 | 261 | 376,352 | 2 | 31 | 2 |
| 2 | 210 | 614,800 | 4 | 37 | 3 |
| 2 | 285 | 539,256 | 2 | 50 | 1 |
| 1 | 125 | 308,336 | 3 | 52 | 3 |
| 1 | 112 | 349,232 | 3 | 58 | 2 |
| 1 | 121 | 367,274 | 4 | 58 | 2 |
| 1 | 126 | 340,253 | 1 | 15 | 1 |
| 1 | 122 | 433,476 | 4 | 45 | 3 |

*Black bears* are found throughout the plan area. Black bears tend to use forested habitats and feed on a wide variety of plant and animal species as those are available. They are habitat generalists, although they may be somewhat vulnerable to disturbances, such as large, stand-replacing fires, that remove large areas of cover and forage. As these areas recover, they may increase in value to black bears, depending on the presence of forage and adequate cover.

Table 90 provides statistics on black bear hunting on the hunting districts intersecting with the National Forest. The hunting districts included are as follows: Region 1 – Bear Management Units 120, 121, 122, and 123; Region 2 – Bear Management Units 200, 216, 240, 280, and 290. The number reflect annual totals, including both spring and fall totals. Black bear hunting on districts containing Lolo National Forest System lands accounted for around 25 percent of animals harvested statewide over a 5-year period between 2017 and 2021.Two-thirds of the bears taken were male bears.

**Table 90—Statistics on black bear hunting on MTFWP districts that intersect with the Lolo National Forest. Numbers reflect total annual harvest, including spring and fall.**

| MTFWP region | MTFWP bear management unit | Total bear management unit acres | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|
| 1 | 120 | 315,450 | 0 | 0 | 0 | 0 | 0 |
| 1 | 121 | 624,689 | 0 | 0 | 0 | 0 | 0 |
| 1 | 122 | 456,460 | 0 | 0 | 0 | 0 | 0 |
| 1 | 123 | 239,641 | 0 | 0 | 0 | 0 | 0 |
| 2 | 200 | 1,211,156 | 114 | 120 | 118 | 174 | 176 |
| 2 | 216 | 2,270,691 | 103 | 96 | 92 | 77 | 87 |
| 2 | 240 | 948,448 | 23 | 31 | 23 | 58 | 53 |
| 2 | 280 | 929,548 | 19 | 31 | 46 | 36 | 64 |
| 2 | 290 | 1,016,400 | 58 | 74 | 67 | 81 | 114 |
| | | **Percentage of total state harvest** | **23%** | **24%** | **24%** | **31%** | **25%** |

**Furbearers and gray wolves.** Furbearers are animals generally trapped for the value of their pelts, and include marten, bobcat, beaver, and others. These species occupy very different habitats that vary in their stability or resiliency. Marten rely on mature, closed canopy forest, which is vulnerable to fire, disease and insects. Bobcat are generalists, using many different habitats where enough cover is presence for concealment while hunting, and where small mammal prey species are available. Beaver occur in association with forested streams and wetlands. Beaver are unique in the impact they have on their habitat, altering hydrology in ways that increases stability of water flows and promotes growth of willow and aspen, which are among their preferred forage species. Wolves require only adequate distribution and availability of prey species, which include elk, moose, both species of deer, and smaller mammals as available. Therefore, wolves do not rely on specific habitats and are instead affected indirectly by the stability and resiliency of habitats that support their prey.

Table 91 and Table 92 provide information on trapping in MTFWP trapping districts intersecting with the Lolo National Forest plan area. Trapping information is provided by MTFWP by trapping district, which equates to the MTFWP regions. The Lolo intersects with MTFWP Regions 1 & 2, which cover 8,534,535 ac and 6,748,586 ac, respectively. Trapping in counties in the plan area account for just under one quarter of all animals trapped in the state in 2021. Over half of all the long-tailed weasel, least weasel, marten, otter, and short-tailed weasel trapped in the state in 2021 were captured in trapping districts intersecting with the Lolo NF. However, because of the large size of the MTFWP trapping districts, it is difficult to determine how many of these animals were captured on the Lolo National Forest.

**Table 91—Furbearer trapping statistics, 2021, for MTFWP trapping districts intersecting with the Lolo National Forest. Trapping District 1: Flathead, Lincoln, Lake, and Sanders Counties**

| Species | Number active Trappers | Active Trapping days | Total Harvest | Percent of statewide harvest |
|---|---|---|---|---|
| All species | 318 | 20,690 | 2,135 | 6 |
| Bobcat | 147 | 4,112 | 183 | 21 |
| Beaver | 71 | 1,385 | 373 | 7 |
| Badger | 0 | 0 | 0 | 0 |
| Coyote | 79 | 2,647 | 615 | 6 |

| Species | Number active Trappers | Active Trapping days | Total Harvest | Percent of statewide harvest |
|---|---|---|---|---|
| Fisher | 0 | 0 | 0 | 0 |
| Long-tailed Weasel | 28 | 972 | 28 | 33 |
| Least Weasel | 12 | 266 | 16 | 100 |
| Marten | 44 | 1,076 | 135 | 14 |
| Mink | 36 | 460 | 71 | 13 |
| Muskrat | 52 | 599 | 306 | 7 |
| Otter | 52 | 893 | 36 | 7 |
| Porcupine | 4 | 20 | 0 | 0 |
| Raccoon | 32 | 560 | 16 | 0 |
| Red Fox | 56 | 1,127 | 135 | 6 |
| Swift Fox | 8 | 131 | 0 | 0 |
| Spotted Skunk | 4 | 20 | 0 | 0 |
| Striped Skunk | 56 | 1,211 | 115 | 6 |
| Short-tailed Weasel | 24 | 881 | 44 | 46 |

**Table 92—Furbearer trapping statistics, 2021, for MTFWP trapping districts intersecting with the Lolo NF. Trapping District 2: Deer Lodge, Mineral, Missoula, Powell, and Ravalli Counties**

| Species | Number active trappers | Active trapping days | Total harvest | Percent of statewide harvest |
|---|---|---|---|---|
| All species | 270 | 35,463 | 5,433 | 16 |
| Bobcat | 119 | 4,183 | 44 | 5 |
| Beaver | 123 | 2,683 | 917 | 18 |
| Badger | 36 | 710 | 83 | 13 |
| Coyote | 127 | 5,398 | 730 | 7 |
| Fisher | 12 | 163 | 4 | 50 |
| Long-tailed Weasel | 12 | 274 | 24 | 29 |
| Least Weasel | 4 | 159 | 0 | 0 |
| Marten | 71 | 1,588 | 520 | 55 |
| Mink | 75 | 1,504 | 119 | 22 |
| Muskrat | 79 | 1,349 | 1,080 | 23 |
| Otter | 64 | 1,846 | 437 | 84 |
| Porcupine | 8 | 258 | 0 | 0 |
| Raccoon | 44 | 1,500 | 131 | 3 |
| Red Fox | 107 | 4,648 | 790 | 37 |
| Swift Fox | 0 | 0 | 0 | 0 |
| Spotted Skunk | 12 | 778 | 8 | 29 |
| Striped Skunk | 52 | 2,747 | 448 | 23 |
| Short-tailed Weasel | 12 | 278 | 44 | 46 |

Table 93 provides harvest statistics for gray wolves taken in MTFWP wolf management units that intersect with the Lolo National Forest. The management units included are as follows (by MTFWP Region): Region 1 – 101 and 121; Region 2 – 200, 210, 250, 280, and 290. Wolves taken in these units accounted for over half the total statewide harvest, however it is worth noting that wolf management unit 101, which consistently produces the most wolves harvested each year, only includes a very small portion of the Lolo. This wolf management unit extends northward to the Canadian border, encompassing a significant portion of the Cabinet-Yaak ecosystem.

**Table 93—Harvest rates of gray wolves, 2019-2021, in MTFWP wolf management units intersecting with the Lolo National Forest**

| MTFWP Region | MTFWP Wolf Management Unit | Total Wolf Management Unit Acres | 2019 Harvest: Hunt | 2019 Harvest: Trap | 2020 Harvest: Hunt | 2020 Harvest: Trap | 2021 Harvest: Hunt | 2021 Harvest: Trap |
|---|---|---|---|---|---|---|---|---|
| 1 | 101 | 1,941,154 | 14 | 31 | 16 | 38 | 23 | 29 |
| 1 | 121 | 1,321,144 | 9 | 18 | 8 | 31 | 4 | 16 |
| 2 | 200 | 1,211,185 | 14 | 4 | 9 | 5 | 1 | 11 |
| 2 | 210 | 1,809,867 | 2 | 4 | 11 | 3 | 4 | 4 |
| 2 | 250 | 1,890,985 | 11 | 8 | 5 | 11 | 3 | 17 |
| 2 | 280 | 194,541 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2 | 290 | 1,753,660 | 20 | 25 | 14 | 19 | 19 | 9 |
| **Percentage of total state harvest** | | | **43%** | **69%** | **38%** | **67%** | **36%** | **69%** |

**Mountain lion.** Table 94 provides statistics on mountain lion hunting on the hunting districts that intersect with the Lolo National Forest. The hunting districts included are as follows (by MTFWP Region): Region 1 – 120, 121, 122, 123, and 124; Region 2 – 201, 202, 204, 210, 211, 240, 280, 285, and 299. Mountain lion hunting on the districts containing Lolo National Forest System land accounted for 16% to 22% of the annual statewide harvest between 2017 and 2021. Approximately 60% of the lions harvested were male and 40% were female.

**Table 94—Total annual harvest of mountain lion on MTFWP districts that intersect with the Lolo National Forest.**

| MTFWP region | MTFWP Lion hunting unit | Total lion hunting unit acres | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|
| 1 | 120 | 315,450 | 10 | 5 | 7 | 6 | 9 |
| 1 | 121 | 624,689 | 16 | 9 | 13 | 15 | 12 |
| 1 | 122 | 456,460 | 11 | 12 | 10 | 11 | 13 |
| 1 | 123 | 155,886 | 6 | 4 | 5 | 7 | 4 |
| 1 | 124 | 83,755 | 3 | 2 | 2 | 3 | 5 |
| 2 | 201 | 436,824 | 10 | 9 | 7 | 10 | 10 |
| 2 | 202 | 591,086 | 18 | 25 | 14 | 22 | 16 |
| 2 | 204 | 449,349 | 1 | 2 | 1 | 2 | 3 |
| 2 | 210 | 312,492 | 3 | 4 | 3 | 4 | 5 |
| 2 | 211 | 450,215 | 0 | 2 | 1 | 4 | 5 |
| 2 | 240 | 536,419 | 6 | 8 | 7 | 6 | 6 |

| MTFWP region | MTFWP Lion hunting unit | Total lion hunting unit acres | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|
| 2 | 280 | 746,542 | 0 | 1 | 1 | 1 | 2 |
| 2 | 285 | 423,419 | 9 | 9 | 8 | 7 | 3 |
| 2 | 299 | 477,264 | 0 | 0 | 0 | 0 | 12 |
| **Percentage of total state harvest** | | | **19%** | **17%** | **16%** | **19%** | **22%** |

**Game birds.** Table 95 provides information on upland bird hunting in MTFWP Upland Game Bird hunting units 1 & 2, which intersect with the Lolo NF. Upland gamebirds reported in these units include the following species: Pheasant, Chukar Partridge, Ruffled Grouse, Gray partridge, and Spruce Grouse. Upland bird hunting is managed and reported by MTFWP Region. Upland bird hunting in the districts overlapping with the Lolo NF account for approximately 17% of the total upland game bird harvest statewide and approximately 25% of the total statewide upland game bird hunting effort over the past 5 years.

**Table 95—Harvest rates of upland birds 2017-2021, in MTFWP bird hunting districts intersecting with the Lolo National Forest: MTFWP Region 1**

| Species | Average number of hunters | Average number of hunting days | Average annual harvest | Percentage of statewide harvest |
|---|---|---|---|---|
| Chukar partridge | 3 | 3 | 0 | 0 |
| Dusky grouse | 1,613 | 12,604 | 3,177 | 26 |
| Gray partridge | 122 | 716 | 451 | 3 |
| Pheasant | 707 | 3,684 | 2,119 | 3 |
| Ruffed grouse | 2,623 | 19,776 | 8,010 | 42 |
| Spruce grouse | 989 | 7,549 | 2,249 | 44 |

**Table 96—Harvest rates of upland birds 2017-2021, in MTFWP bird hunting districts intersecting with the Lolo National Forest: MTFWP Region 2**

| Species | Average number of hunters | Average number of hunting days | Average annual harvest | Percentage of statewide harvest |
|---|---|---|---|---|
| Chukar partridge | 19 | 53 | 35 | 6 |
| Dusky grouse | 1,635 | 10,919 | 3,292 | 27 |
| Gray partridge | 97 | 440 | 203 | 1 |
| Pheasant | 297 | 1,239 | 922 | 1 |
| Ruffed grouse | 1,811 | 12,275 | 4,906 | 25 |
| Spruce grouse | 762 | 5,322 | 1,324 | 26 |

**Forest Service management actions affecting or affected by wildlife and habitats.** Harvest of timber for commercial or other purposes may result in the loss of thermal or hiding cover, and in areas of heavy snowfall results in deep snow interfering with foraging opportunities by removing canopy that intercepts snow. Conversely, certain harvest activities may increase production of forb and browse species used by big game, may increase abundance and productivity of berry-producing shrubs used by bears, and may increase the population density and diversity of small mammals, which provide prey for many furbearing species.

Fire exclusion, particularly on winter ranges, may result in loss of shrubfields used by elk, mule deer, and moose. Conifer encroachment resulting from lack of fire may reduce grasslands used by bighorn sheep for foraging, and may reduce visibility, thereby reducing the likelihood that sheep will use those areas. Use of fire (both naturally occurring and prescribed fire) as a management action may improve the abundance and palatability of grass, forb, and shrub species used by big game, and may reduce conifer encroachment. Fire may remove dense forest used by black bears but may also increase abundance and productivity of some foods used by bears.

Roads providing access onto National Forest System lands facilitate hunting, trapping, and other non-consumptive wildlife use, but also increase the potential for human-wildlife encounters that can result in illegal mortality or, in the case of bears, human-bear conflicts that increase risk of mortality to bears. The potential for roads to impact wildlife depends heavily on the spatial pattern of open roads relative to specific wildlife habitats, as well as on the season and type of use allowed. Recent and ongoing travel management planning and decisions in the plan area have considered potential impacts to wildlife species, and generally reduced open road mileage where potential negative impacts may occur.

Recreation management has the potential to impact wildlife by the specific locations where recreation activities or sites occur, and by where specific activities are allowed or encouraged. Limitations on certain types of activity, such as snowmobiling on big game winter ranges or in key spring bear habitats, can benefit wildlife populations by reducing disturbance and displacement to less favorable habitats.

**Influence of non-National Forest System lands or other conditions on wildlife and habitats.** Big game winter habitat quantity and quality has generally decreased in Montana, due to increased residential and industrial subdivision, which generally occurs to a greater degree where National Forest System lands are in proximity to population centers. Fire exclusion has also caused changes in winter ranges on non-National Forest System lands and in the wildland-urban interface, by altering vegetation. In some portions of the plan area, conversion of native grassland to agriculture has either removed winter range, or created areas of seasonal wildlife concentration, such as on irrigated alfalfa fields. Residential development in deer winter range can also increase conflict and therefore potential mortality to deer when they become nuisances, feeding on ornamental plants, gardens, etc. These activities have the potential to eventually impact big game populations if not appropriately managed.

Increased residential development in proximity to National Forest System lands increases risk of mortality to bears, because bears may be drawn to food and attractants (garbage, bird feeders, pet food, livestock food, apple trees, chickens, etc.) associated with those residences. Bears exploring those attractants or exploiting those food sources may become food-conditioned and habituated to humans, increasing the likelihood of conflict or property damage, and consequently increasing risk of mortality to those bears. In some areas, residential developments have the potential to become population ‘sinks’, where ongoing mortality can impact the bear population.

There are six state-owned Wildlife Management Areas either within or adjacent to the plan area. These include the Mt. Silcox, Threemile, Blackfoot-Clearwater, Fish Creek, Marshall Creek, and Full Curl Wildlife Management Areas. These areas vary widely in size, are managed primarily as wildlife winter range, and help to offset some of the influence of private land development on big game winter range. A variety of wildlife-focused recreational opportunities, including hunting, fishing, and wildlife viewing are permitted in these areas. Coordination between MTFWP and the Forest Service regarding management across boundaries where these Wildlife Management Areas occur varies.

**Economic value of hunting and wildlife-related activities.** A survey by MTFWP provides estimates of resident and nonresident hunter and angler expenditures in Montana (Montana Fish Wildlife and Parks 2015). With values adjusted for inflation, this survey estimated that resident hunters spend from $89 per day (waterfowl hunting) up to $294 per day (mountain goat hunting) on trip-related expenditures. Nonresident hunters spend from $464 per day (pheasant, grouse, and partridge hunting) up to $1,521 per day (mountain goat hunting). It was estimated that hunters in Montana spend around $428.3 million annually in the state for trip-related expenditures. In 2016, MTFWP estimated that big game hunting in Missoula County accounted for over $11 million spent with the county. Estimates for Sanders and Mineral counties were $12.7 million and $4.4 million, respectively (https://mtfwp.maps.arcgis.com/apps/Cascade/index.html?appid=0fa1de4222074cdeb7dbf0710ecb2ee0). Adjusted for inflation, this represents an economic influx of $13.4, $15.4, and $5.3 million annually into Missoula, Sanders, and Mineral counties, respectively.

### Status and Trends: Fishing

Fish species commonly targeted in large streams and rivers within the plan area include brown trout and rainbow trout because they are abundant and grow to large sizes. In fact, four streams/rivers that flow through the assessment area (Rock Creek, Blackfoot River, Clark Fork River, Bitterroot River) have achieved 'blue ribbon' status for their abundance of trout and overall high-quality fishing experience. Smaller streams primarily offer abundant westslope cutthroat trout and brook trout. Low-elevation lakes provide the opportunity to catch kokanee, northern pike, smallmouth bass, and yellow perch in addition to trout, while many high-elevation lakes primarily provide another opportunity for westslope cutthroat trout and brook trout. These diverse fisheries cater to an array of angler preferences as they can be caught with a variety of different methods to include motorboats, driftboats/rafts, by wading/walking, and through the ice. The most common angling method is perhaps flyfishing in streams and rivers because trout in the plan area live in clear water and feed primarily on small insects which are ideal conditions for the type of equipment. Conventional spinning tackle is also effective, particularly on large rivers and lakes, for species like northern pike and smallmouth bass. Montana Fish, Wildlife, and Parks currently stock fish into lakes and ponds to support angling opportunities, but not into flowing streams/rivers to protect natural-spawning fish populations.

The picturesque settings found within the plan area not only contribute to an enjoyable fishing experience but also provide key ecosystem functions that fisheries rely on. For example, most large trout that anglers enjoy catching in mainstem rivers originally came from smaller tributary streams where cold water and clean habitat are vital to trout reproduction. Complex habitat that includes a variety of large logs, rocks, pools, and riffles are also important for trout to thrive and grow in number and size. Very cold water in tributary streams from snow melt and ground water is becoming an increasingly important component of trout fisheries because trout require cold-water refuges where they can take shelter as climate change creates warmer summertime water temperatures in large rivers and lakes.

The economic value of recreational fishing is a crucial part of communities in and around the assessment area. This is particularly true because of the 'blue ribbon' status of several streams/rivers that makes these trout fisheries a popular fishing destination for both local and non-local anglers. Anglers spend money not only on fishing licenses and fishing tackle, but also gas, food, and lodging. These direct and indirect expenditures provide substantial revenue and support local employment opportunities within communities surrounding the Lolo National Forest. In fact, an economic report by the Forest Service found that recreational angling in Region 1 (Idaho, Montana, and western Dakotas) contributed a total of $24,468,201 worth of value added to the economy in 2021 (Winter and Eichman 2022). And a similar study that focused more specifically within the assessment area (middle Clark Fork River) found that anglers spent $18.6 million on fishing-related expenses in 2017. Although economic studies are complicated and methodologies vary among economists, it is clear recreational angling is a substantial economic component in and around the assessment area.

## 3.10.6 Municipal Watersheds and Source Water Protection Areas

### Key Takeaways

- Water is one of the most important natural resources flowing from forests, and national forests are the largest source of municipal water supply in the Nation. In cooperation with the states, the Forest Service manages public water supplies to assure water source protections are established to maintain water quality and natural-based quantities.
- In the State of Montana, source water protection areas are delineated for ground water and surface water sources and considers characteristics of the aquifer or watershed as elements that affect various public water system intake. The land area that contributes recharge to the hydrologic or hydrogeologic system above or upgradient from the public water system well or intake structure are called protection areas and are part of the State's Source Water Protection Program.
- The Forest Service manages watersheds that supply municipal water under multiple management scenarios and sections in forest plans (36 CFR 251.9). When a municipality desires protective actions or restrictions of use not specified in the forest plan, within agreements, and/or special use authorizations, the municipality must apply to the Forest Service for consideration of these needs.
- The Lolo has many watersheds that provide public water supply ranging from relatively large municipalities to small domestic use. Additional efforts are needed to institute a consistent framework for identification and classification of source water protection areas and municipal watersheds and augment existing management direction for these areas.

### Summary

Water is one of the most important natural resources flowing from forests. National forests and Grasslands provide approximately 13 percent of surface water supply for the continental United States. National Forest System lands contribute approximately 46 percent of surface water supply from 19.2 percent of the land area in the western U.S. (Liu et al. 2022). Forest Service lands are in source areas for many important rivers as well as local and regional aquifer systems.

The Safe Drinking Water Act of 1974 (amended 1986 and 1996) regulates the nation's public drinking water supplies. The Act authorizes the Environmental Protection Agency to set national standards for drinking water quality for any public water system servicing greater than 25 people for more than 60 days per year or having at least 15 service connections. The Safe Drinking Water Act outlines multiple strategies for maintaining drinking water safety, including source water protection, treatment, distribution system integrity, and public information. The Montana Department of Environmental Quality is the Environmental Protection Agency-designated regulatory for the Safe Drinking Water Act in the Montana.

Montana Department of Environmental Quality has delineated source water protection areas for ground water and surface water sources, taking into consideration how characteristics of the aquifer or watershed may affect public water system intakes. These areas that contributes recharge to the hydrologic or hydrogeologic system above or upgradient from the public water system well or intake structure are part of the State's Source Water Protection Program.

Per 36 CFR part 251.9, the Forest Service may enter into agreements with municipalities to restrict the use of National Forest System lands from which water is derived to protect the municipal water supplies (Forest Service Manual 2542). When a municipality desires protective actions or restrictions of use not specified in the forest plan, within agreements, and/or special use authorizations, the municipality must apply to the Forest Service for consideration of these needs. When deemed appropriate by the Regional Forester, requested restrictions and/or requirements shall be incorporated in the forest plan without written agreements. Written agreements with municipalities to assure protection of water supplies are appropriate when requested by the municipality and deemed necessary by the Regional Forester. A special use authorization may be needed to affect these agreements. Conversely, active forest vegetation management may be desired to abate adverse water resource effects stemming from wildfire. This activity may be conducted collaboratively between municipalities, the Forest Service, and other partners (such as Montana Department of Natural Resources and Conservation).

The Bipartisan Infrastructure Law and Inflation Reduction Act have enacted multiple programs that explicitly focus management resources on maintaining source water integrity, be it through protective or proactive management actions. Through these programs and broader agency direction, it is anticipated that source water protection will remain a focus for the foreseeable future.

## Status and Trends

A variety of source water protection designations are currently used by the Lolo National Forest. These existing designations can generally be classified as follows and are listed in Table 97 and figure A1-05:

- Forest Plan-designated municipal watersheds,
- Watersheds with public water supplies without municipal agreements, and
- Watersheds with A-1 beneficial uses designation

In addition, several state-designated source water protection areas fall in the Lolo National Forest's administrative boundary. As of 2022, 59 source water protection areas fall within or intersected the forest administrative boundary. Geospatial representation of where source water protection areas intersect Lolo watersheds can be found in the Forest Service's Northern Region Geospatial Library.

**Table 97—Municipal watersheds on the Lolo National Forest**

| Watershed (HUC12 Name) | District | Designation | Notes |
|---|---|---|---|
| Upper Rattlesnake Creek | D3 | Municipal | Identified in Lolo NF Plan. Water supply for City of Missoula. |
| Middle Rattlesnake Creek | D3 | Municipal | Identified in Lolo NF Plan. Water supply for City of Missoula. |
| Butler Creek | D3 | Active PWS | State designated active public water supply and Lolo Plan designation. Active public water supply for MT Snowbowl Ski Area (surface water or spring). |
| Ashley-Clark Fork | D5 | Municipal | Identified in Lolo NF Plan. Water supply for town of Thompson Falls. |
| Seeley-Archibald | D6 | Active PWS | Designated by State subsequent to Lolo NF Plan. Active public water supply for town of Seeley Lake and the Lodges at Seeley (surface water or spring). |
| Thompson-Flat | D7 | Active PWS | Designated by State subsequent to Lolo NF Plan. Flat Creek was the primary water supply for the town of Superior, but there are health concerns over elevated metals. Clean-up and investigation is currently under CERCLA. Alternate supply source may be designated in the future. |
| Packer Creek | D7 | A-1 | Designated in Montana Administrative Rule 17.30.622-623 from headwaters of the Packer and Silver Creek drainages to the intake of the Saltese water supply. Although the Saltese public water supply is not currently operating, A-1 standards remain in effect for these watersheds. A-1 water quality classification has lower allowances than B-1 (majority of Lolo NF waters), for Escherichia coli bacteria (E-coli), turbidity/suspended sediment, and color changes. The basic premise is that A-1 waters should only require treatment for "naturally present impurities" to support the drinking water beneficial use. |
| Silver Creek | D7 | A-1 | |

Pertinent to the Lolo Forest Plan designation of Ashley Creek as a municipal water supply, the Thompson Falls public water supply currently uses three sources of water. The historic, and future main source, of water is a group of springs within the Ashley Creek watershed (located north of town in the Cabinet Mountains. The second water source for Thompson Falls is two shallow production wells located near the Clark Fork River just east of town and south of the high school. These wells tap into the unconfined alluvial aquifer and are currently considered backup wells. The third source is two newer production wells located northeast of the high school.

The towns of Alberton, Superior, Seeley Lake, currently have municipal source water that is dependent on watershed management. Three municipalities, Missoula, Plains, and Superior, were formerly dependent on watershed-related source water or springs but have changed to well systems supplied by groundwater.

Boyer Spring in Plains was discontinued as a public water source for the city because of suspected surface water contamination. Rattlesnake Creek watershed (creek, lakes, and dams) was the city of Missoula’s primary public water supply until 1983 when the supply was converted from open water sources served by dams to groundwater wells because of giardia concerns. In 2017, the City of Missoula acquired the private utility company providing the water supply and all the assets owned by that company. In 2020, the city, in partnership with Trout Unlimited and others, removed the lowermost dam, located only a few miles above Missoula. The remaining dams are under evaluation for decommissioning or rehabilitation.

Flat Creek was the water supply for the town of Superior, Montana until 1997 when the town government became concerned about the potential public health effects from the Iron Mountain Mine. A water sample from the town's well two miles downstream of the mine tested at 31 micrograms per liter, above the Environmental Protection Agency's maximum contaminant level for antimony of 6.0 micrograms per liter. The abandoned Iron Mountain Mine operated from 1909 to 1930 and again from 1947 to 1953 producing silver, gold, lead, copper, and zinc ores and was deemed the primary source of contamination. While the mine was in operation, tailings were disposed along Flat Creek using gravity drainage, which resulted in tailings distributed along Flat Creek as far as the confluence with the Clark Fork River. Tailings were also imported into Superior for fill material in yards, roadways, and other locations. Regulatory and government activities became aware of the situation in the 1990s. In 2000 the State requested Environmental Protection Agency involvement following significant dispersal of contaminated tailings during a large post-wildfire runoff. Currently Flat Creek is actively under Superfund Cleanup.

Packer and Silver Creek have been designated A-1 in Montana Administrative Rule 17.30.622-623 from their headwaters to the intake of the Saltese water supply upstream of St. Regis, Montana. Although the Saltese public water is supplied by groundwater wells, A-1 standards remain in effect for these watersheds. A-1 water quality classification has lower allowances than B-1 (majority of Lolo National Forest waters), for Escherichia coli bacteria (E-coli), turbidity/suspended sediment, and color changes. A-1 waters should only require treatment for "naturally present impurities" to support the drinking water beneficial use.

The Lolo National Forest manages other public water supplies that are not watershed-related sources, such as groundwater wells for campgrounds and spring developments for individual landowners executing water rights. The watershed areas upstream of spring developments poses additional considerations for water source protections.

Currently there is no single data source representing source water protection areas and/or municipal watersheds for the Lolo National Forest. As evidenced above, there are multiple source water designations currently in use, lending to some confusion as to the applicability of overlapping regulatory authorities. In light of the current and anticipated future agency focus on maintenance of source water values, additional efforts are needed to institute a consistent framework for identification and classification of source protection areas and municipal watersheds and augment existing management direction for these areas.

# Literature Cited

Abatzoglou, J. T., and A. P. Williams. 2016. Impact of anthropogenic climate change on wildfire across western US forests. Proceedings of the National Academy of Sciences of the United States of America 113:11770-11775.

Abrams, J. 2019. The emergence of network governance in U.S. National Forest Administration: Causal factors and propositions for future research. Forest Policy and Economics 106:1-11.

Acuna, V., T. Datry, J. Marshall, D. Barcelo, C. N. Dahm, A. Ginebreda, G. McGregor, S. Sabater, K. Tockner, and M. A. Palmer. 2014. Why should we care about temporary waterways? Pages 1080-1081 *in* Science.

Adhikari, A., L. J. Rew, K. P. Mainali, S. Adhikari, and B. D. Maxwell. 2020. Future distribution of invasive weed species across the major road network in the state of Montana, USA. Regional Environmental Change 20:1-14.

Agee, J. K. 1993. Fire ecology of Pacific northwest forests. Island Press, Island Press Suite 300, 1718 Connecticut Avenue, NW, Washington, DC, 20009.

_____. 1994. Fire and weather disturbances in terrestrial ecosystems of the eastern Cascades. Gen. Tech. Rep. PNW-GTR-320, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

_____. 2003. Historical range of variability in eastern Cascades forests, Washington, USA. Landscape Ecology 18:725-740.

_____. 2005. The complex nature of mixed severity fire regimes. Pages 10 *in* L. Taylor, J. Zelnik, S. Cadwallader, and B. Hughes, editors. Mixed Severity Fire Regimes: Ecology and management Symposium Proceedings: Washington State University, Spokane Washington, 17-19 November 2004. Asociation of Fire Ecology MISC03, Pullman, WA.

Ager, A. 2013. Spatial optimization for accelerated restoration: The landscape treatment designer. Draft edition.

Ager, A. A., P. Palaiologou, C. R. Evers, M. A. Day, C. Ringo, and K. Short. 2019. Wildfire exposure to the wildland urban interface in the western US. Applied Geography 111:1-13.

Ager, A. A., N. M. Valliant, and M. A. Finney. 2010. A comparison of landscape fuel treatment strategies to mitigate wildland fire risk in the urban interface and preserve old forest structure. Forest Ecology and Management 259:1556-1570.

Ahl, R., and S. Brown. 2017. The Bitterroot and Lolo National Forests Region 1 existing vegetation database (VMap) revision of 2016. NRGG PR BITLO VMAP2016, U.S. Department of Agriculture, Forest Service, Northern Region Geospatial Group, Missoula, MT.

Aizen, M. A., and P. Feinsinger. 1994. Forest fragmentation, pollination, and plant reproduction in a Chaco dry forest, Argentina. Ecology 75:330-351.

Aizen, M. A., and P. Feinsinger. 2003. Bees not to be? Responses of insect pollinator faunas and flower pollination to habitat fragmentation. Pages 111-129 *in* G. A. Bradshaw, and P. A. Marquet, editors. How landscapes change. Springer-Verlag, Berlin, Heidelberg.

Al-Chokhachy, R., B. B. Roper, and E. K. Archer. 2010a. Evaluating the status and trends of physical stream habitat in headwater streams within the interior Columbia River and upper Missouri River basins using an index approach. Transactions of the American Fisheries Society 139:1041-1059.

Al-Chokhachy, R., B. B. Roper, T. Bowerman, and P. Budy. 2010b. A review of bull trout habitat associations and exploratory analyses of patterns across the interior Columbia River basin. North American Journal of Fisheries Management 30:464-480.

Allen-Wardell, G., P. Bernhardt, R. Bitner, A. Burquez, S. Buchmann, J. Cane, P. A. Cox, V. Dalton, P. Feinsinger, M. Ingram, D. Inouye, C. E. Jones, K. Kennedy, P. Kevan, H. Koopowitz, R. Medellin, S. Medellin-Morales, and G. P. Nabhan. 1998. The potential consequences of pollinator declines on the conservation of biodiversity and stability of food crop yields. Conservation Biology 12:8-17.

Allendorf, F. W., R. F. Leary, N. P. Hitt, K. L. Knudsen, M. C. Boyer, and P. Spruell. 2005. Cutthroat trout hybridization and the U.S. Endangered Species Act: One species, two policies. Conservation Biology 19:1326-1328.
Allendorf, F. W., and L. L. Lundquist. 2003. Introduction: Population biology, evolution, and control of invasive species. Conservation Biology 17:24-30.
Allied Engineering Services, Inc. 2022. Route of the Olumpian culverts: Final Feasibility Report. Project #18-200.04. Allied Engineering Services, Inc. Bozeman, MT.
Amaranthus, M. P., R. Molina, and D. A. Perry. 1990. Soil organisms, root growth and forest regeneration. Pages 89-93 *in* Forestry on the frontier, proceedings of the 1989 Society of American Foresters National Convention, Spokane, Washington, September 24-27, 1989. Society of American Foresters, Bethesda, MD.
Anderson, H. E. 1982. Aids to determining fuel models for estimating fire behavior. Gen. Tech. Rep. INT-GTR-122, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.
Anderson, N., J. Young, K. Stockmann, K. E. Skog, S. Healey, D. Loeffler, J. G. Jones, and J. Morrison. 2013. Regional and forest-level estimates of carbon stored in harvested wood products from the United States Forest Service northern region, 1906-2010. Gen. Tech. Rep. RMRS-GTR-311, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.
Andreasen, J. K., R. V. O'Neill, R. Noss, and N. C. Slosser. 2001. Considerations for the development of a terrestrial index of ecological integrity. Ecological Indicators 1:21-35.
Andrew, J. P., E. Steven, C. L. Wayne, M. J. Trlica, and W. P. Clary. 2004. Steer Diets in a Montane Riparian Community. Journal of Range Management 57:546-552.
Ardren, W. R., and S. R. Bernall. 2017. Dams impact westslope cutthroat trout metapopulation structure and hybridization dynamics. Conservation Genetics 18:297-312.
Area, C. B. C. W. M. 2019. Columbia basin flowering rush management plan.
Arno, S., and J. R. Habeck. 1972. Ecology of alpine larch (larix lyallii parl.) in the Pacific Northwest. Ecological Monographs 42:417-450.
Arno, S. F. 1976. The historical role of fire on the Bitterroot National Forest. Gen. Tech. Rep. INT-GTR-187, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.
_____. 1980. Forest fire history in the northern Rockies. Journal of Forestry 78:460-465.
Arno, S. F., and C. E. Fiedler. 2005. Mimicking nature's fire restoring fire-prone forests in the west. Island Press.
Arno, S. F., and G. E. Gruell. 1983. Fire history at the forest-grassland eco-tone in southwestern Montana. Journal of Range Management 36:332-336.
_____. 1986. Douglas-fir encroachment into mountain grasslands in southwestern Montana. Journal of Range Management 39:272-276.
Arno, S. F., D. J. Parsons, and R. E. Keane. 2000. Mixed-severity fire regimes in the northern Rocky Mountains: Consequences of fire exclusion and options for the future. Pages 225-232 *in* D. N. Cole, S. F. McCool, W. T. Borrie, and J. O'Loughlin, editors. Wilderness science in a time of change conference - volume 5: Wilderness ecosystems, threats, and management; 1999 May 23–27; Missoula, MT. Proceedings RMRS-P-15-vol-5. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT.
Arno, S. F., D. G. Simmerman, and R. E. Keane. 1985. Forest succession on four habitat types in western Montana. Gen. Tech. Rep. INT-GTR-177, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.
Auble, G. T., and M. L. Scott. 1998. Fluvial disturbance patches and cottonwood recruitment along the upper Missouri River, Montana. Wetlands 18:546-556.
Aubry, K., C. Raley, and J. Rohrer. 2007. Distribution and ecology of wolverines in the North Cascades: Pilot project - year 2, year-end status report. Interagency Special Status/Senstive Species

Program, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Olympia, WA.

Averett, J. P., B. McCune, C. G. Parks, B. J. Naylor, T. DelCurto, and R. Mata-Gonzalez. 2016. Non-native plant invasion along elevation and canopy closure gradients in a middle Rocky Mountain ecosystem. PLoS One 11:24.

Averett, J. P., L. R. Morris, B. J. Naylor, R. V. Taylor, and B. A. Endress. 2020. Vegetation change over seven years in the largest protected Pacific Northwest Bunchgrass Prairie remnant. PLoS One 15:1-20.

Baker, G. H. 2002. Chapter 6: Helicidae and Hygromiidae as pests in cereal crops and pastures in South Australia. Pages 193-215 *in* G. M. Barker, editor. Molluscs as crop pests. CAB Publishing, New York, NY.

Barber, J., R. Bush, and D. Berglund. 2011. The Region 1 existing vegetation classification system and its relationship to Region 1 inventory data and map products. Numbered Report 11-10, U.S. Department of Agriculture, Forest Service, Region 1, Missoula, MT.

Barnett, K., G. H. Aplet, and R. T. Belote. 2023. Classifying, inventorying, and mapping mature and old-growth forests in the United States. Frontiers in Forests and Global Change 5:1-25.

Baron, J. N., S. E. Gergel, P. F. Hessburg, and L. D. Daniels. 2022. A century of transformation: fire regime transitions from 1919 to 2019 in southeastern British Columbia, Canada. Landscape Ecology 37:2707-2727.

Barrett, S. W. 1988. Fire regime classification for coniferous forests of the northwestern United States.

Barrett, S. W., and S. F. Arno. 1982. Indian fires as an ecological influence in the Northern Rockies. Journal of Forestry October:647-652.

Barringer, L. E., D. F. Tomback, M. B. Wunder, and S. T. McKinney. 2012. Whitebark pine stand condition, tree abundance, and cone production as predictors of visitation by Clark's nutcracker. PLoS One 7:11.

Barrios, E. 2007. Soil biota, ecosystem services and land productivity. Ecological Economics 64:269-285.

Bartel, R. A., N. M. Haddad, and J. P. Wright. 2010. Ecosystem engineers maintain a rare species of butterfly and increase plant diversity. Oikos 119:883-890.

Beckley, T. M. 1995. Community stability and the relationship between economic and social well-being in forest-dependent communities. Society & Natural Resources 8:261-266.

Beecham, J. J., C. P. Collins, and T. D. Reynolds. 2007. Rocky Mountain bighorn sheep (Ovis canadensis): A technical conservation assessment. U.S. Department of Agriculture, Forest Service, Rocky Mountain Region, Specied Conservation Project, Rigby, ID.

Beier, P., and B. Brost. 2010. Use of land facets to plan for climate change: conserving the arenas, not the actors. Conservation Biology 24:701-710.

Bell, D. A. 2022. Genetic Rescue Of Isolated Cutthroat Trout. Doctoral distertation, University of Montana, Missoula, MT.

Bell, D. A., R. P. Kovach, C. C. Muhlfeld, R. Al-Chokhachy, T. J. Cline, D. C. Whited, D. A. Schmetterling, P. M. Lukacs, and A. R. Whiteley. 2021. Climate change and expanding invasive species drive widespread declines of native trout in the northern Rocky Mountains, USA. Science Advances 7:12.

Bell, D. M., J. B. Bradford, and W. K. Lauenroth. 2014. Early indicators of change: Divergent climate envelopes between tree life stages imply range shifts in the western United States. Global Ecology and Biogeography 23:168-180.

Belote, R. T., K. Barnett, K. Zeller, A. Brennan, and J. Gage. 2022. Examining local and regional ecological connectivity throughout North America. Landscape Ecology 37:2977-2990.

Benda, L., N. L. Poff, D. Miller, T. Dunne, G. Reeves, G. Pess, and M. Pollock. 2004. The network dynamics hypothesis: how channel networks structure riverine habitats. BioScience 54:413-427.

Bennett, P., J. Egan, C. Cleaver, P. Zambino, and K. Costanza. 2022. Assessment of root disease occurrence and severity estimated from climate models with forest inventory and analysis (FIA) data. 22-01, U.S. Department of Agriculture, Forest Service, Forest Health Protection, Missoula, MT.

Benninger-Traux, M., J. L. Vankat, and R. L. Schaefer. 1992. Trail corridors as habitat and conduits for movement of plant species in Rocky Mountain National Park, Colorado, USA. Landscape Ecology 6:269-278.

Berger, J. 1990. Persistence of different-sized populations: An empirical assessment of rapid extinctions in bighorn sheep. Conservation Biology 4:91-98.

Beschta, R. L., and W. J. Ripple. 2005. Rapid assessment of riparian cottonwood recruitment: Middle Fork John Day River, northeastern Oregon. Ecological Restoration 23:150-156.

Bettaso, J. B., and D. H. Goodman. 2010. A Comparison of Mercury Contamination in Mussel and Ammocoete Filter Feeders. Journal of Fish and Wildlife Management 1:142-145.

Biden, J. R. 2022. Executive Order 14072 on April 22, 2022: Strengthening the Nations's Forests, Communities and Local Economies. Federal Register 87:5.

Biermann, C., and D. Havlick. 2021. Genetics and the question of purity in cutthroat trout restoration. Restoration Ecology 29:1-6.

Binkley, D. 1991. Connecting soils with forest productivity. Pages 66-69 *in* A. E. Harvey, and L. F. Neuenschwander, editors. Proceedings: Management and productivity of western-montane forest soils; 1990 April 10-12; Boise, ID. Gen. Tech. Rep. INT-280. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Birdsey, R., K. Pregitzer, and A. Lucier. 2006. Forest carbon management in the United States: 1600-2100. Journal of Environmental Quality 35:1461-1469.

Bisson, P. A., B. E. Rieman, C. Luce, P. F. Hessburg, D. C. Lee, J. L. Kershner, G. H. Reeves, and R. E. Gresswell. 2003. Fire and aquatic ecosystems of the western USA: current knowledge and key questions. Forest Ecology and Management 178:213-229.

Bobst, A. Hydrolic effects of beaver-mimicry stream restoration. 2019.

Bobst, A. L., R. A. Payn, and G. D. Shaw. 2022. Groundwater-Mediated Influences of Beaver-Mimicry Stream Restoration: A Modeling Analysis. Journal of the American Water Resources Association 58:1388-1406.

Bolitzer, B., and N. R. Netusil. 2000. The impact of open spaces on property values in Portland, Oregon. Journal of Environmental Management 59:185-193.

Bollenbacher, B., R. Bush, and R. Lundberg. 2009. Estimates of snag densities for western Montana forests in the northern region,Report 09-05 v1.3. Region One Vegetation Classification, Mapping, Inventory and Analysis Report, U.S. Department of Agriculture, Forest Service, Region One, Missoula, MT.

Bradley, B. A., D. S. Wilcove, and M. Oppenheimer. n.d. Climate change and plant invasions: restoration opportunities ahead? Manuscript submitted for publication. Global Change Biology.

Brissette, C. M. 2016. Stream restoration effects on hydraulic exchange, storage and alluvial aquifer discharge. Master's thesis, University of Montana, Missoula, MT.

Brown, J. K., E. D. Reinhardt, and K. A. Kramer. 2003. Coarse woody debris: Managing benefits and fire hazard in the recovering forest. Gen. Tech. Rep. RMRS-GTR-105, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT.

Brown, J. K., and T. E. See. 1981. Downed dead woody fuel and biomass in the northern Rocky Mountains. Gen. Tech. Rep. INT-GTR-117, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Brown, R. T., J. K. Agee, and J. F. Franklin. 2004. Forest restoration and fire: principles in the context of place. Conservation Biology 18:903-912.

Brown, V. R., R. A. Bowen, and A. M. Bosco-Lauth. 2018. Zoonotic pathogens from feral swine that pose a significant threat to public health. Transbound Emerg Dis 65:649-659.

Buckley, D. S., T. R. Crow, E. A. Nauertz, and K. E. Schulz. 2003. Influence of skid trails and haul roads on understory plant richness and composition in managed forest landscapes in Upper Michigan, USA. Forest Ecology and Management 175:509-520.

Bull, E. L., C. G. Parks, and T. R. Torgersen. 1997. Trees and logs important to wildlife in the interior Columbia River basin. Gen. Tech. Rep. PNW-GTR-391, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Burkle, L. A., and R. Alarcon. 2011. The future of plant-pollinator diversity: Understanding interaction networks across time, space, and global change. American Journal of Botany 98:528-538.

Burt, J. W., and K. J. Rice. 2009. Not all ski slopes are created equal: disturbance intensity affects ecosystem properties. Ecol Appl 19:2242-2253.

Bush, R., and B. Reyes. 2015. Overview of FIA and intensified grid data. Region One Vegetation Classification, Mapping, Inventory and Analysis Report Numbered Report 15-12 v3.0, U.S. Department of Agriculture, Forest Service, Region One, Missoula, MT.

Bush, R., B. Reyes, and J. Zeiler. 2016. Summary database reports and utilities user’s guide. Region One Vegetation Classification, Mapping, Inventory and Analysis Report 16-2 v3.2, U.S. Department of Agriculture, Forest Service, Region One, Missoula, MT.

Butkus, R., and G. Vaitonis. 2019. New records and distribution patterns of the invasive snail Potamopyrgus antipodarum (Gray, 1843) in Lithuanian inland water. BioInvasions Records 8:804-812.

Butts, T. W. 1992. Wolverine (*Gulo gulo*) biology & management: A literature review and annotated bibliography. U.S. Department of Agriculture, Forest Service, Northern Region, Threatened, Endangered, and Sensitive Program.

Byler, J. W., and S. K. Hagle. 2000. Succession functions of forest pathogens and insects ecosections M332a and M333d in northem Idaho and western Montana Summary. Report FHP Report No. 00-09.

Calkin, D. E., A. A. Ager, and J. Gilbertson-Day. 2010. Wildfire Risk and Hazard: Procedures for the First Approximation. Gen. Tech. Rep. RMRS-GTR-235. *in* U.S. Department of Agriculture,, Forest Service, Rocky Mountain Research Station, Missoula, MT.

Cambi, M., G. Certini, F. Neri, and E. Marchi. 2015. The impact of heavy traffic on forest soils: A review. Forest Ecology and Management 338:124-138.

Cameron, S. A., J. D. Lozier, J. P. Strange, J. B. Koch, N. Cordes, L. F. Solter, and T. L. Griswold. 2011. Patterns of widespread decline in North American bumble bees. Proceedings of the National Academy of Sciences of the United States of America 108:662-667.

Camp, A., C. Oliver, P. Hessburg, and R. Everett. 1997. Predicting late-successional fire refugia pre-dating European settlement in the Wenatchee Mountains. Forest Ecology and Management 95:63-77.

Campbell, C., A. Hadlow, and T. Sylte. 2019. Soil monitoring report monitoring update for 2014 to 2018, Lolo National Forest. U.S. Department of Agriculture, Forest Service, Missoula, MT.

Campbell, R. B., Jr., and D. L. Bartos. 2001. Aspen ecosystems: objectives for sustaining biodiversity. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, 13-15 June 2000, Fort Collins, CO.

Cane, J. H., B. Love, and K. Swoboda. 2012. Breeding biology and bee guild of Douglas'dustymaiden, Chaenactis douglasii (Asteraceae, Helenieae). Western North American Naturalist 72:563-569.

Cane, J. H., R. L. Minckley, L. J. Kervin, T. a. H. Roulston, and N. M. Williams. 2006. Complex responses within a desert bee guild (Hymenoptera: Apiformes) to urban habitat fragmentation. Ecological Applications 16:632-644.

Carim, K. J., L. A. Eby, C. A. Barfoot, and M. C. Boyer. 2016. Consistent loss of genetic diversity in isolated cutthroat trout populations independent of habitat size and quality. Conservation Genetics 17:1363-1376.

Carpenter, T. E., V. L. Coggins, C. McCarthy, C. S. O’Brien, J. M. O’Brien, and T. J. Schommer. 2014. A spatial risk assessment of bighorn sheep extirpation by grazing domestic sheep on public lands. Preventive Veterinary Medicine 114:3-10.

Cartwright, J., T. L. Morelli, and E. H. C. Grant. 2021. Identifying climate-resistant vernal pools: Hydrologic refugia for amphibian reproduction under droughts and climate change. Ecohydrology 15.

Cartwright, J. M., K. A. Dwire, Z. Freed, S. J. Hammer, B. McLaughlin, L. W. Misztal, E. R. Schenk, J. R. Spence, A. E. Springer, and L. E. Stevens. 2020. Oases of the future? Springs as potential hydrologic refugia in drying climates. Frontiers in Ecology and the Environment 18:245-253.

Casey, P. A., and R. L. Wynia. 2010. Culturally Significant Plants. U.S. Department of Agriculture,, Natural Resources Conservation Service, Manhattan, KS.

Castro, J., M. Pollock, C. Jordan, G. Lewallen, and K. Woodruff. 2017. The beaver restoration guidebook: Working with beaver to restore streams, wetlands, and floodplains v2.0. 30 June 2017 edition., U.S. Department of the Interior, Fish and Wildlife Service, Portland, OR.

Certini, G. 2005. Effects of fire on properties of forest soils: a review. Oecologia 143:1-10.

Chadde, S. W., S. F. Kimball, and A. G. Evenden. 1996. Research Natural Areas of the Northern Region: Status and needs assessment.

Chadde, S. W., J. S. Shelly, R. J. Bursik, R. K. Moseley, A. G. Evenden, M. Mantas, F. Rabe, and B. Heidel. 1998. Peatlands on National Forests of the northern Rocky Mountains: Ecology and conservation. Gen. Tech. Rep. RMRS-GTR-11, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT.

Chambers, J. C., D. A. Pyke, J. D. Maestas, M. Pellant, C. S. Boyd, S. B. Campbell, S. Espinosa, D. W. Havlina, K. E. Mayer, and A. Wuenschel. 2014. Using resistance and resilience concepts to reduce impacts of invasive annual grasses and altered fire regimes on the sagebrush ecosystem and greater sage-grouse: A strategic multi-scale approach. Gen. Tech. Rep. RMRS-GTR-326, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Chaudhury, S. R., L. Nafees, and B. Y. Perera. 2021. "For the Gram": An exploration of the conflict between influencers and citizen-consumers in the public lands marketing system. Journal of Macromarketing 41:570-584.

Chiarucci, A., M. B. Araujo, G. Decocq, C. Beierkuhnlein, and J. M. Fernandez-Palacios. 2010. The concept of potential natural vegetation: An epitaph? Journal of Vegetation Science 21:1172-1178.

Childs, M. L., J. Li, J. Wen, S. Heft-Neal, A. Driscoll, S. Wang, C. F. Gould, M. Qiu, J. Burney, and M. Burke. 2022. Daily Local-Level Estimates of Ambient Wildfire Smoke PM for the Contiguous US. Environmental Science and Technology 56:13607-13621.

Choromanska, U., and T. H. DeLuca. 2002. Microbial activity and nitrogen mineralization in forest mineral soils following heating: evaluation of post-fire effects. Soil Biology & Biochemistry 34:263-271.

Churchill, D. J., A. J. Larson, M. C. Dahlgreen, J. F. Franklin, P. F. Hessburg, and J. A. Lutz. 2013. Restoring forest resilience: from reference spatial patterns to silvicultural prescriptions and monitoring. Forest Ecology and Management 291:442-457.

Clayton, J. L. 1990. Soil disturbance resulting from skidding logs on granitic soils in central Idaho. Research Paper INT-436, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Coleman, K., and M. J. Stern. 2018. Exploring the functions of different forms of trust in collaborative natural resource management. Society & Natural Resources 31:21-38.

Colla, S. R., and L. Packer. 2008. Evidence for decline in eastern North American bumblebees (Hymenoptera: Apidae), with special focus on Bombus affinis Cresson. Biodiversity and Conservation 17:1379-1391.

Collen, B., J. Baillie, M. Böhm, and R. Kemp. 2012. Spineless: status and trends of the world's invertebrates. Zoological Society of London.

Collen, P., and R. J. Gibson. 2001. The general ecology of beavers (*Castor* spp.), as related to their influence on stream ecosystems and riparian habitats, and the subsequent effects on fish – a review. Reviews in Fish Biology and Fisheries 10:439-461.

Collins, B. D., D. R. Montgomery, K. L. Fetherston, and T. B. Abbe. 2012. The floodplain large-wood cycle hypothesis: A mechanism for the physical and biotic structuring of temperate forested alluvial valleys in the North Pacific coastal ecoregion. Geomorphology 139-140:460-470.

Comer, P., K. Goodin, G. Hammerson, S. Menard, M. Pyne, M. Reid, M. Robles, L. Sneddon, K. Snow, A. Tomaino, and M. Tuffly. 2005. Biodiversity values of geographically isolated wetlands: An analysis of 20 U.S. States. NatureServe, Arlington, VA.

Conservation Science Partners. 2021. Ecological value of lands in the Lolo National Forest: Final report.

Cook, K. A. 2022. Reproductive biology and phenology of western pearlshell mussels in Montana. Master's thesis, Montana State University, Bozeman, MT.

Cooke, H. A., and S. Zack. 2008. Influence of beaver dam density on riparian areas and riparian birds in shrubsteppe of Wyoming. Western North American Naturalist 68:365-373.

Coop, J. D., S. A. Parks, C. S. Stevens-Rumann, S. D. Crausbay, P. E. Higuera, M. D. Hurteau, A. Tepley, E. Whitman, T. Assal, B. M. Collins, K. T. Davis, S. Dobrowski, D. A. Falk, P. J. Fornwalt, P. Z. Fulé, B. J. Harvey, V. R. Kane, C. E. Littlefield, E. Q. Margolis, M. North, M.-A. Parisien, S. Prichard, and K. C. Rodman. 2020. Wildfire-Driven Forest Conversion in Western North American Landscapes. BioScience:15.

Cooper, D. J., and D. M. Merritt. 2012. Assessing the water needs of riparian and wetland vegetation in the western United States. Gen. Tech. Rep. RMRS-GTR-282, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Cooper, S. V., C. Jean, and B. L. Heidel. 1999. Plant associations and related botanical inventory of the Beaverhead Mountains Section, Montana. BLM Agreement Number 1422E930A960015

Task Order Number 16, Montana Natural Heritage Program, Helena, MT.

Cooper, S. V., P. Lesica, and D. Page-Dumroese. 1997. Plant community classification for alpine vegetation on the Beaverhead National Forest, Montana. Gen. Tech. Rep. INT-GTR-362, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Cooper, S. V., K. E. Neiman, and D. W. Roberts. 1991. Forest habitat types of northern Idaho: A second approximation. Revised edition. Gen. Tech. Rep. INT-GTR-236, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Copeland, J. P., J. M. Peek, C. R. Groves, W. E. Melquist, K. S. McKelvey, G. W. McDaniel, C. D. Long, and C. E. Harris. 2007. Seasonal habitat associations of the wolverine in central Idaho. Journal of Wildlife Management 71:2201-2212.

Copeland, J. P., and R. E. Yates. 2008. Wolverine population assessment in Glacier National Park: Comprehensive summary update.

Cordell, H. K. 2012. Outdoor recreation trends and futures: A technical document supporting the Forest Service 2010 RPA assessment. Gen. Tech. Rep. SRS-GTR-150, U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC.

Corporation, N. E. 2023. 2022 annual report fish passage project: Thompson Falls hydroelectric project. Northwestern Energy Corporation. Report FERC Project Number 1869.

Corsi, M. P., L. A. Eby, and C. A. Barfoot. 2013. Hybridization with rainbow trout alters life history traits of native westslope cutthroat trout. Canadian journal of fisheries and aquatic sciences 70:895-904.

Costante, D. M., A. M. Haines, and M. Leu. 2022. Threats to neglected biodiversity: Conservation success requires more than charisma. Frontiers in Conservation Science 2:11.

Costello, C. M., and L. L. Roberts. 2019. Northern Continental Divide Ecosystem, Grizzly Bear Population Monitoring Team, annual report, 2018. Montana Fish, Wildlife and Parks, Kalispell, MT.

_____. 2021. Northern Continental Divide Ecosystem, Grizzly Bear Population Monitoring Team, Annual Report, 2020. Montana Fish Wildlife and Parks, Kalispell, MT.

_____. 2022. Northern Continental Divide Ecosystem, Grizzly Bear population monitoring team, Annual Report, 2021. Montana Fish, Wildlife & Parks, Kalispell, MT.

Council on Environmental Quality. 1997. Environmental justice: Guidance under the National Environmental Policy Act.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Report FWS/OBS-79-31.

Cowie, R. H., R. T. Dillon, D. G. Robinson, and J. W. Smith. 2009. Alien non-marine snails and slugs of priority quarantine importance in the United States: a preliminary risk assessment. American Malacological Bulletin 27:113-132, 120.

Craigg, T. L., P. W. Adams, and K. A. Bennett. 2015. Soil matters: Improving forest landscape planning and management for diverse objectives with soils information and expertise. Journal of Forestry 113:343-353.

Crowley, F. A. 1963. Mines and mineral deposits (except fuels) Sanders County, Montana. Bulletin 34, State of Montana Bureau of Mines and Geology, Butte, MT.

D'Angelo, V. S., and C. C. Muhlfeld. 2013. Factors influencing the distribution of native bull trout and westslope cutthroat trout in streams of Western Glacier National Park, Montana. Northwest Science 87:1-11.

D'antonio, C. M., and P. M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23:63-87.

Dangora, A. J. 2022. Evaluating the management and consequences of hybridization between nonnative rainbow trout and native westslope cutthroat trout. Master's thesis, University of Montana, Missoula, MT.

Datry, T., N. Bonada, and A. J. Boulton. 2017. Chapter 1 - General Introduction. Pages 1-20 *in* T. Datry, N. Bonada, and A. Boulton, editors. Intermittent Rivers and Ephemeral Streams. Ecology and Management. Academic Press, San Diego, CA.

Datry, T., A. J. Boulton, N. Bonada, K. Fritz, C. Leigh, E. Sauquet, K. Tockner, B. Hugueny, and C. N. Dahm. 2018. Flow intermittence and ecosystem services in rivers of the Anthropocene. Journal of Applied Ecology 55:353-364.

Daubenmire, R., and J. B. Daubenmire. 1968. Forest vegetation of eastern Washington and northern Idaho. Report Technical bulletin 60.

David, G. C. L., B. P. Bledsoe, D. M. Merritt, and E. Wohl. 2009. The impacts of ski slope development on stream channel morphology in the White River National Forest, Colorado, USA. Geomorphology 103:375-388.

Davis, K. M., B. D. Clayton, and W. C. Fischer. 1980. Fire ecology of Lolo National Forest habitat types. Gen. Tech. Rep. INT-GTR-79, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Davis, K. T., S. Z. Dobrowski, P. E. Higuera, Z. A. Holden, T. T. Veblen, M. T. Rother, S. A. Parks, A. Sala, and M. P. Maneta. 2019. Wildfires and climate change push low-elevation forests across a critical climate threshold for tree regeneration. Proceedings of the National Academy of Sciences of the United States of America 116:6193-6198.

Davis, K. T., P. E. Higuera, S. Z. Dobrowski, S. A. Parks, J. T. Abatzoglou, M. T. Rother, and T. T. Veblen. 2020. Fire-catalyzed vegetation shifts in ponderosa pine and Douglas-fir forests of the western United States. Environmental Research Letters 15:1-13.

Deaver, S., and A. Kooistra-Manning. 1995. Ethnographic Overview of the Mckenzie, Medora, Sioux, Ashland and Beartooth Ranger Districts of the Custer National Forest. Prepared for Custer National Forest by Ethnoscience.

DeByle, N. V., and R. P. Winokur, editors. 1985. Aspen: Ecology and management in the western United States. Gen. Tech. Rep. RM-GTR-119. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

DellaSala, D. A., B. Mackey, P. Norman, C. Campbell, P. J. Comer, C. F. Kormos, H. Keith, and B. Rogers. 2022. Mature and old-growth forests contribute to large-scale conservation targets in the conterminous United States. Frontiers in Forests and Global Change 5:1-20.

DeLuca, T. H., and G. H. Aplet. 2008. Charcoal and carbon storage in forest soils of the Rocky Mountain west. Frontiers in Ecology and the Environment 6:18-24.

DeLuca, T. H., M. R. A. Pingree, and S. Gao. 2019. Chapter 16 - Assessing soil biological health in forest soils. Pages 397-426 *in* M. Busse, C. P. Giardina, D. M. Morris, and D. S. Page-Dumroese, editors. Developments in Soil Science. Elsevier.

Dettinger, M., and S. Earman. 2011. Potential impacts of climate change on groundwater resources – a global review. Journal of Water and Climate Change 2:213-229.

Dias, P. C. 1996. Sources and sinks in population biology. Trends in Ecology & Evolution 11:326-330.

Dobos, M. E. 2015. Movement, distribution, and resource use of westslope cutthroat trout in the South Fork Clearwater River basin. Master's thesis, University of Idaho.

Donovan, V. M., C. P. Roberts, C. L. Wonkka, J. L. Beck, J. N. Popp, C. R. Allen, and D. Twidwell. 2020. Range-wide monitoring of population trends for Rocky Mountain bighorn sheep. Biological Conservation 248:1-9.

Doughty, M., A. H. Sawyer, E. Wohl, and K. Singha. 2020. Mapping increases in hyporheic exchange from channel-spanning logjams. Journal of Hydrology 587:1-13.

Dudgeon, D., A. H. Arthington, M. O. Gessner, Z.-I. Kawabata, D. J. Knowler, C. Lévêque, R. J. Naiman, A.-H. Prieur-Richard, D. Soto, M. L. J. Stiassny, and C. A. Sullivan. 2006. Freshwater biodiversity: Importance, threats, status and conservation challenges. Biological Reviews 81:163-182.

Dwire, K. A., and J. B. Kauffman. 2003. Fire and riparian ecosystems in landscapes of the western USA. Forest Ecology and Management 178:61-74.

Dwire, K. A., K. E. Meyer, G. Riegel, and T. Burton. 2016. Riparian fuel treatments in the western USA: Challenges and considerations. Gen. Tech. Rep. RMRS-GTR-352, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Ebersole, J. L., W. J. Liss, and C. A. Frissell. 1997. Restoration of stream habitats in the western United States: Restoration as reexpression of habitat capacity. Environmental Management 21:1-14.

Ellison, A. M., M. S. Bank, B. D. Clinton, E. A. Colburn, K. Elliott, C. R. Ford, D. R. Foster, B. D. Kloeppel, J. D. Knoepp, G. M. Lovett, J. Mohan, D. A. Orwig, N. L. Rodenhouse, W. V. Sobczak, K. A. Stinson, J. K. Stone, C. M. Swan, J. Thompson, B. V. Holle, and J. R. Webster. 2005. Loss of foundation species: consequences for the structure and dynamics of forested ecosystems. Frontiers in Ecology and the Environment 3:479-486.

English, A., and R. Marvin. 2000. Hydrogeologic assessment of Gardiner public water supply for ground water under the direct influence of surface water. MBMG Open-File Report 401-I, Montana Bureau of Mines and Geology, Butte, MT.

Fahrig, L. 2002. Effect of habitat fragmentation on the extinction threshold: A synthesis. Ecological Applications 12:346-353.

Fairfax, E., and E. E. Small. 2018. Using remote sensing to assess the impact of beaver damming on riparian evapotranspiration in an arid landscape. Ecohydrology 11:1-14.

Fairfax, E., and A. Whittle. 2020. Smokey the Beaver: beaver-dammed riparian corridors stay green during wildfire throughout the western United States. Ecological Applications 30:1-8.

Farnes, P. E. 1990. SNOTEL and snow course data: Describing the hydrology of whitebark pine ecosystems. Pages 302-304 *in* W. C. Schmidt, and K. J. McDonald, editors. Proceedings - Symposium on whitebark pine ecosystems: Ecology and management of a high-mountain resource; 1989 March 29-31; Bozeman, MT. Gen. Tech. Rep. INT-GTR-270. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Federal Geographic Data Committee, Wetlands Subcommittee,. 2009. Wetlands mapping standard. Report FGDC-STD-015-2009.

Federal Interagency Committee for Wetland Delineation. 1989. Federal manual for identifying and delineating jurisdictional wetlands. U. S. Army Corps of Engineers,

U.S. Environmental Protection Agency,

U.S. Fish and Wildlife Service,

U.S.D.A. Soil Conservation Service,, Washington, DC.

Felicetti, L. A., C. C. Schwartz, R. O. Rye, K. A. Gunther, J. G. Crock, M. A. Haroldson, L. Waits, and C. T. Robbins. 2004. Use of naturally occurring mercury to determine the importance of cutthroat trout to Yellowstone grizzly bears. Canadian Journal of Zoology 82:493-501.

Fettig, C. J., J. M. Egan, H. Delb, J. Hilszczański, M. Kautz, A. S. Munson, J. T. Nowak, and J. F. Negrón. 2022. Chapter 11: Management tactics to reduce bark beetle impacts in North America and Europe under altered forest and climatic conditions. Pages 345-394 *in* K. J. K. Gandhi, and R. W. Hofstetter, editors. Bark Beetle Management, Ecology, and Climate Change. Academic Press.

Feuerstein, C. A. 2022. The Genetic and Demographic Outcomes of Mixed-Source Reintroductions of Westslope Cutthroat Trout in Montana. Master's thesis, University of Montana, Missoula, MT.

Fiedler, C. E., and S. T. McKinney. 2014. Forest structure, health, and mortality in two Rocky Mountain whitebark pine ecosystems: Implications for restoration. Natural Areas Journal 34:290-299.

Finklin, A. I. 1988. Climate of the Frank Church-River of No Return Wilderness, central Idaho:. Gen. Tech. Rep. INT-240, U.S. Department of Agriculture, Intermountain Research Station, Ogden, Utah.

Finney, M. A., C. W. McHugh, I. C. Grenfell, K. L. Riley, and K. C. Short. 2011. A simulation of probabilistic wildfire risk components for the continental United States. Stochastic Environmental Research and Risk Assessment 25:973-1000.

Fischer, W. C., and A. F. Bradley. 1987. Fire ecology of western Montana forest habitat types. Gen. Tech. Rep. INT-GTR-223, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Folch, D. C., D. Arribas-Bel, J. Koschinsky, and S. E. Spielman. 2016. Spatial variation in the quality of american community survey. Demography 53:1535-1554.

Forsyth, R. G., M. J. Oldham, E. Snyder, F. W. Schueler, and R. Layberry. 2015. Forty years later: distribution of the introduced Heath Snail, Xerolenta obvia, in Ontario, Canada (Mollusca: Gastropoda: Hygromiidae). Check List 11:1-8.

Foster, D. R., D. A. Orwig, and J. S. McLachlan. 1996. Ecological and conservation insights from reconstructive studies of temperate old-growth forests. Trends in Ecology & Evolution 11:419-424.

Franklin, J. F., and J. K. Agee. 2003. Forging a science-based national forest fire policy. Issues in Science and Technology 20:1-11.

Franklin, J. F., K. N. Johnson, D. J. Churchill, K. Hagmann, D. Johnson, and J. Johnston. 2013. Restoration of dry forests in eastern Oregon: A field guide. The Nature Conservancy, Portland, OR.

Franklin, J. F., and T. A. Spies. 1991. Ecological definitions of old-growth Douglas-fir forests. Pages 61-69 *in* L. F. Ruggiero, K. B. Aubry, A. B. Carey, and M. H. Huff, (tech. coord.), editors. Wildlife and vegetation of unmanaged Douglas-fir forests. Gen. Tech. Rep. PNW-GTR-285. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Frest, T. J., and E. J. Johannes. 1995. Interior Columbia Basin mollusk species of special concern: Final report, Interior Columbia Basin Ecosystem Management Project.

Frey, B. R., V. J. Lieffers, E. H. Hogg, and S. M. Landhausser. 2004. Predicting landscape patterns of aspen dieback: mechanisms and knowledge gaps. Canadian Journal of Forest Research 34:1379-1390.

Furniss, M. J., S. A. Flanagan, and B. McFadin. 2000. Hydrologically-connected roads: An indicator of the influence of roads on chronic sedimentation, surface water hydrology, and exposure to toxic chemicals.

Fusco, E. J., J. T. Finn, J. K. Balch, R. C. Nagy, and B. A. Bradley. 2019. Invasive grasses increase fire occurrence and frequency across US ecoregions. Proceedings of the National Academy of Sciences USA 116:23594-23599.

Fusi, F., F. Zhang, and J. Liang. Unveiling environmental justice through open government data: Work in progress for most US states. Public Administration n/a.

Garber-Yonts, B. E. 2004. The economics of amenities and migration in the Pacific Northwest: Review of selected literature with implications for national forest management. Gen. Tech. Rep. PNW-GTR-617, U.S. Department of Agriculture, Forest Service, Pacific Northewest Research Station, Portland, OR.

Garibaldi, L. A., and et al. 2013. Wild pollinators enhance fruit set of crops regardless of honey bee abundance. Science 339:1608-1611.

Geist, J., and K. Auerswald. 2007. Physicochemical stream bed characteristics and recruitment of the freshwater pearl mussel (Margaritifera margaritifera). Freshwater Biology 52:2299-2316.

Geist, J. A., J. L. Mancuso, M. M. Morin, K. P. Bommarito, E. N. Bovee, D. Wendell, B. Burroughs, M. R. Luttenton, D. L. Strayer, and S. D. Tiegs. 2022. The New Zealand mud snail (Potamopyrgus antipodarum): autecology and management of a global invader. Biological Invasions 24:905-938.

Gelbard, J. L., and J. Belnap. 2003. Roads as conduits for exotic plant invasions in a semiarid landscape. Conservation Biology 17:420-432.

Gier, J. M., K. M. Kindel, D. S. Page-Dumeroese, and L. J. Kuennen. 2018. Soil disturbance recovery on the Kootenai National Forest, Montana. Gen. Tech. Rep. RMRS-GTR-380, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Gilgert, W., and M. Vaughan. 2011. The value of pollinators and pollinator habitat to rangelands: Connections among pollinators, insects, plant communities, fish, and wildlife. Rangelands 33:14-19.

Gillan, B. J., J. T. Harper, and J. N. Moore. 2010. Timing of present and future snowmelt from high elevations in northwest Montana. Water Resources Research 46:1-13.

Glass, T. W., A. J. Magoun, M. D. Robards, and K. Kielland. 2022. Wolverines (gulo gulo) in the arctic: revisiting distribution and identifying research and conservation priorities amid rapid environmental change. Polar Biology 45:1465-1482.

Glasser, S., J. Gauthier-Warinner, J. Gurrieri, J. Keely, P. Tucci, P. Summers, M. Wireman, and K. McCormack. 2007. Technical guide to managing ground water resources. FS-881, U.S. Department of Agriculture, Forest Service, Minerals and Geology Management, Watershed, Fish, Wildlife, Air, and Rare Plants.

Goeking, S. A., and D. G. Tarboton. 2020. Forests and Water Yield: A Synthesis of Disturbance Effects on Streamflow and Snowpack in Western Coniferous Forests. Journal of Forestry 118:172-192.

Goeking, S. A., and M. A. Windmuller-Campione. 2021. Comparative species assessments of five-needle pines throughout the western United States. Forest Ecology and Management 496:11.

Golding, J. D. 2022. Rethinking rare: Novel approaches to rare species monitoringand conservation. Doctoral dissertation, University of Montana, Missoula, MT.

Golding, J. D., M. K. Schwartz, K. S. McKelvey, J. R. Squires, S. D. Jackson, C. Staab, and R. B. Sadak. 2018. Multispecies mesocarnivore monitoring: USDA Forest Service multiregional monitoring approach. Gen. Tech. Rep. RMRS-GTR-388, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Goulson, D., G. C. Lye, and B. Darvill. 2008. The decline and conservation of bumble bees. Annual Review of Entomology 53:191-208.

Graham, R. T., A. E. Harvey, M. F. Jurgensen, T. B. Jain, J. R. Tonn, and D. S. Page-Dumroese. 1994. Managing coarse woody debris in forests of the Rocky Mountains. INT-RP-477, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Graham, R. T., and T. B. Jain. 2005. Ponderosa pine ecosystems. Pages 1-32 *in* M. W. Ritchie, D. A. Maguire, and A. Youngblood, editors. Proceedings of the symposium on ponderosa pine: Issues, trends, and management; 2004 October 18-21; Klamath Falls, OR. Gen. Tech. Rep. PSW-GTR-198. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Grains Research and Development Corporation. 2003. Bash 'Em, Burn 'Em, Bait 'Em: Integrated snail management in crops and pastures. Australian Government Department of Agriculture, Fisheries and Forestry, Kingston, Australian Capital Territory.

Green, P., J. Joy, D. Sirucek, W. Hann, A. Zack, and B. Naumann. 2011. Old-growth forest types of the Northern Region (1992, with errata through 2011).

Habeck, J. R. 1976. Forests, fuels and fire in the Selway-Bitterroot wilderness, Idaho. Tall Timbers, Tallahassee, FL.

Hagle, S. K. 2010. Management guide for laminated root rot phellinus sulphurascens (pilat) [formerly phellinus weirii (murr.) gilb. Douglas-fir form].

Hagmann, R. K., P. F. Hessburg, S. J. Prichard, N. A. Povak, P. M. Brown, P. Z. Fulé, R. E. Keane, E. E. Knapp, J. M. Lydersen, K. L. Metlen, M. J. Reilly, A. J. Sánchez Meador, S. L. Stephens, J. T. Stevens, A. H. Taylor, L. L. Yocom, M. A. Battaglia, D. J. Churchill, L. D. Daniels, D. A. Falk, P. Henson, J. D. Johnston, M. A. Krawchuk, C. R. Levine, G. W. Meigs, A. G. Merschel, M. P. North, H. D. Safford, T. W. Swetnam, and A. E. M. Waltz. 2021. Evidence for widespread changes in the structure, composition, and fire regimes of western North American forests. Ecological Applications 31:1-34.

Hall, R. O., M. F. Dybdahl, and M. C. VanderLoop. 2006. Extremely high secondary production of introduced snails in rivers. Ecological Applications 16:1121-1131.

Halley, D., F. Rosell, and A. Saveljev. 2012. Population and distribution of Eurasian beaver (Castor fiber). Baltic Forestry:168-175.

Halofsky, J. E., D. C. Donato, D. E. Hibbs, J. L. Campbell, M. D. Cannon, J. B. Fontaine, J. R. Thompson, R. G. Anthony, B. T. Bormann, L. J. Kayes, B. E. Law, D. L. Peterson, and T. A. Spies. 2011. Mixed-severity fire regimes: Lessons and hypotheses from the Klamath-Siskiyou Ecoregion. Ecosphere 2:1-19.

Halofsky, J. E., and D. E. Hibbs. 2008. Determinants of riparian fire severity in two Oregon fires, USA. Canadian Journal of Forest Research 38:1959-1973.

Halofsky, J. E., D. L. Peterson, S. K. Dante-Wood, L. Hoang, J. J. Ho, and L. A. Joyce. 2018a. Climate change vulnerability and adaptation in the Northern Rocky Mountains: Part 1. Gen. Tech. Rep. RMRS-GTR-374, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

_____. 2018b. Climate change vulnerability and adaptation in the Northern Rocky Mountains: Part 2. Gen. Tech. Rep. RMRS-GTR-374, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Halofsky, J. E., D. L. Peterson, and B. J. Harvey. 2020. Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA. Fire Ecology 16.

Halterman, M., M. J. Johnson, J. A. Holmes, and S. A. Laymon. 2015. A natural history summary and survey protocol for the western distinct population segment of the Yellow-billed Cuckoo. H. T. Harvey & Associates Ecological Consultants, San Luis Obispo, CA.

Hamlet, A. F., and D. P. Lettenmaier. 2007. Effects of 20th century warming and climate variability on flood risk in the western U.S. Water Resources Research 43:1-17.

Hann, W. J., J. L. Jones, M. G. S. Karl, P. F. Hessburg, R. E. Keane, D. G. Long, J. P. Menakis, C. H. McNicoll, S. G. Leonard, R. A. Gravenmier, and B. G. Smith. 1997. Chapter 3: Landscape dynamics of the basin. Pages 337-1055 *in* T. M. Quigley, and S. J. Arbelbide, editors. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins, Vol. 2. Gen. Tech. Rep. PNW-GTR-405. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Miscellaneous Publication 54, University of Montana, School of Forestry, Montana Forest and Conservation Experiment Station, Missoula, MT.

Hansen, W. D., K. H. Braziunas, W. Rammer, R. Seidl, and M. G. Turner. 2018. It takes a few to tango: changing climate and fire regimes can cause regeneration failure of two subalpine conifers. Ecology 99:966-977.

Hargrave, P. A., M. D. Kerschen, C. McDonald, J. J. Metesh, and R. Wintergerst. 2003. Abandoned-inactive mines on lolo national forest-administered land. MBMG 476, U.S. Department of Agriculture, Forest Service.
Hart, M., and B. A. Mealor. 2021. Effects of Ventenata dubia removal on rangelands of northeast Wyoming. Invasive Plant Science and Management 14:156-163.
Hart, S. C., T. H. DeLuca, G. S. Newman, M. D. MacKenzie, and S. I. Boyle. 2005. Post-fire vegetative dynamics as drivers of microbial community structure and function in forest soils. Forest Ecology and Management 220:166-184.
Harvey, A. E. 1994. Integrated roles for insects, diseases and decomposers in fire dominated forests of the inland western united states. Journal of Sustainable Forestry 2:211-220.
Harvey, A. E., M. F. Jurgensen, M. J. Larsen, and R. T. Graham. 1987. Decaying organic materials and soil quality in the inland northwest: A management opportunity. Gen. Tech. Rep. INT-GTR-225, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.
Harvey, B. J., D. C. Donato, and M. G. Turner. 2016. Drivers and trends in landscape patterns of stand-replacing fire in forests of the US Northern Rocky Mountains (1984–2010). Landscape Ecology 31:2367-2383.
Hastie, L. C., and K. A. Toy. 2008. Changes in density, age structure and age-specific mortality in two western pearlshell (Margaritifera falcata) populations in Washington (1995-2006). Aquatic Conservation: Marine and Freshwater Ecosystems 18:671-678.
Hatfield, R. G., and G. LeBuhn. 2007. Patch and landscape factors shape community assemblage of bumble bees, Bombus spp. (Hymenoptera: Apidae), in montane meadows. Biological Conservation 39:150-158.
Head, B. W. 2008. Wicked problems in public policy. Public Policy 3:101-118.
Headwaters Economics. 2021. A demographic profile: Selected geographies: Missoula County, MT. *in* Headwaters Economics, Economic Profile System, Bozeman, MT.
Healey, S. P., C. L. Raymond, I. B. Lockman, A. J. Hernandez, C. Garrard, and C. Q. Huang. 2016. Root disease can rival fire and harvest in reducing forest carbon storage. Ecosphere 7:16.
Heath, L. S., J. E. Smith, C. W. Woodall, D. L. Azuma, and K. L. Waddell. 2011. Carbon stocks on forestland of the United States, with emphasis on USDA Forest Service ownership. Ecosphere 2.
Heckel IV, J. W., M. C. Quist, C. J. Watkins, and A. M. Dux. 2020. Distribution and abundance of Westslope Cutthroat Trout in relation to habitat characteristics at multiple spatial scales. North American Journal of Fisheries Management 40:893-909.
Heinemeyer, K., J. Squires, M. Hebblewhite, J. O'Keefe, J. D. Holbrook, and J. Copeland. 2019. Wolverines in winter: Indirect habitat loss and functional responses to backcountry recreation. Ecosphere 10:1-23.
Hessburg, P. F., and J. K. Agee. 2003. An environmental narrative of inland northwest United States forests, 1800–2000. Forest Ecology and Management 178:23-59.
Hessburg, P. F., J. K. Agee, and J. F. Franklin. 2005. Dry forests and wildland fires of the inland northwest USA : Contrasting the landscape ecology of the pre-settlement and modern eras. Forest Ecology and Management 211:117-139.
Hessburg, P. F., D. J. Churchill, A. J. Larson, R. D. Haugo, C. Miller, t. A. Spies, M. P. North, N. A. Povak, R. T. Belote, P. H. Singleton, W. L. Gaines, R. E. Keane, G. H. Aplet, S. L. Stephens, P. Morgan, P. A. Bisson, B. E. Rieman, R. B. Salter, and G. H. Reeves. 2015. Restoring fire-prone inland Pacific landscapes: seven core principles. Landscape Ecology 30:1805-1835.
Hessburg, P. F., R. G. Mitchell, and G. M. Filip. 1994. Historical and current roles of insects and pathogens in eastern Oregon and Washington forested landscapes. Gen. Tech. Rep. PNW-GTR-327, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.
Hessburg, P. F., S. J. Prichard, R. K. Hagmann, N. A. Pova, and F. K. Lake. 2021. Wildfire and climate change adaptation of western North American forests: a case for intentional management. Ecological Applications 31:1-17.

Hessburg, P. F., and B. G. Smith. 1999. Management implications of recent changes in spatial patterns of interior northwest forests. Pages 55-78 *in* R. E. McCabe, and S. E. Loos, editors. Transactions of the 64th North American wildlife natural resource conference March 26-30, 1999. Wildlife Management Institute, Washington D.C.

Hessburg, P. F., B. G. Smith, S. D. Kreiter, C. A. Miller, R. B. Salter, C. H. McNicoll, and W. J. Hann. 1999a. Historical and current forest and range landscapes in the interior Columbia River Basin and portions of the Klamath and Great Basins. Part 1: Linking vegetation patterns and landscape vulnerability to potential insect and pathogen disturbances. Gen. Tech. Rep. PNW-GTR-458, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Hessburg, P. F., B. G. Smith, C. A. Miller, S. D. Kreiter, and R. B. Salter. 1999b. Modeling change in potential landscape vulnerability to forest insect and pathogen disturbances: Methods for forested subwatersheds sampled in the midscale interior Columbia River Basin assessment. Quigley, Thomas M. (Ed.) Interior Columbia Basin Ecosystem Management Project: scientific assessment Gen. Tech. Rep. PNW-GTR-454, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Hessburg, P. F., B. G. Smith, R. B. Salter, R. D. Ottmar, and E. Alvarado. 2000. Recent changes (1930s-1990s) in spatial patterns of interior northwest forests, USA. Forest Ecology and Management 136:53-83.

Heyerdahl, E. K., R. F. Miller, and R. A. Parsons. 2006. History of fire and Douglas-fir establishment in a savanna and sagebrush–grassland mosaic, southwestern Montana, USA. Forest Ecology and Management 230:107-118.

Heyerdahl, E. K., P. Morgan, and J. P. Riser, II. 2008. Crossdated fire histories (1650 to 1900) from ponderosa pine-dominated forests of Idaho and western Montana. Gen. Tech. Rep. RMRS-GTR-214WWW, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Hicke, J. A., B. Xu, A. J. H. Meddens, and J. M. Egan. 2020. Characterizing recent bark beetle-caused tree mortality in the western United States from aerial surveys. Forest Ecology and Management 475.

Hicks, B. J., J. D. Hall, P. A. Bisson, and J. R. Sedell. 1991. Chapter 14: Responses of salmonids to habitat changes. Pages 483-518 *in* W. R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society, Bethesda, MD.

Higgins, S. N., and M. J. Vander Zanden. 2010. What a difference a species makes: a meta–analysis of dreissenid mussel impacts on freshwater ecosystems. Ecological Monographs 80:179-196p.

Higuera, P. E., and J. T. Abatzoglou. 2021. Record-setting climate enabled the extraordinary 2020 fire season in the western United States. Global Change Biology 27:1-2.

Hilty, J., G. L. Worboys, A. Keeley, S. Woodley, B. Lausche, H. Locke, M. Carr, I. Pulsford, J. Pittock, J. W. White, D. M. Theobald, J. Levine, M. Reuling, J. E. M. Watson, R. Ament, and G. M. Tabor. 2020. Guidelines for conserving connectivity through ecological networks and corridors. Volume Best Practice Protected Area Guidelines Series No. 30.International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

Hines, S. 2013. Return of the King: Western White Pine Conservation and Restoration in a Changing Climate. Rocky Mountain Research Station Science You Can Use Bulletin.

Hitt, N. P., C. A. Frissell, C. C. Muhlfeld, and F. W. Allendorf. 2003. Spread of hybridization between native westslope cutthroat trout, *Oncorhynchus* clarki lewisi, and nonnative rainbow trout, *Oncorhynchus* mykiss. Canadian journal of fisheries and aquatic sciences 60:1440-1451.

Hobbs, R. J., and S. E. Humphries. 1995. An integrated approach to the ecology and management of plant invasions. Conservation Biology 9:761-770.

Hoeve, J., and M. E. Scott. 1988. Ecological studies on Cyathocotyle bushiensis (Digenea) and Sphaeridiotrema globulus (Digenea), possible pathogens of dabbling ducks in southern Québec. J Wildl Dis. 24:407-421.
Hoffman Black, S., M. Shepherd, and M. Vaughan. 2011. Rangeland management for pollinators. Rangelands 33:9-14.
Holden, Z. A., A. Swanson, C. H. Luce, W. M. Jolly, M. Maneta, J. W. Oyler, D. A. Warren, R. Parsons, and D. Affleck. 2018. Decreasing fire season precipitation increased recent western US forest wildfire activity. Proceedings of the National Academy of Sciences of the United States of America 115:E8349-E8357.
Honeycutt, R. K., W. H. Lowe, and B. R. Hossack. 2016. Movement and survival of an amphibian in relation to sediment and culvert design. The Journal of Wildlife Management 80:761-770.
Hood, G. A., and S. E. Bayley. 2008. Beaver (*Castor canadensis*) mitigate the effects of climate on the area of open water in boreal wetlands in western Canada. Biological Conservation 141:556-567.
Hornocker, M. G., and H. S. Hash. 1981. Ecology of the wolverine in northwestern Montana. Canadian Journal of Zoology 59:1286-1301.
Huffman, J. E., and D. E. Roscoe. 1986. Acquired resistance in mallard ducks (anas platyrhynchos) to infection withsphaeridiotrema globulus (trematoda). The Journal of Parasitology 72:958-959.
Hunter, M. L., Jr., G. Jacobson, L., Jr., and T. Webb, lll. 1988. Paleoecology and the coarse-filter approach to maintaining biological diversity. Conservation Biology 2:375-385.
Hutson, S. S., N. L. Barber, J. F. Kenny, K. S. Linsey, D. S. Lumia, and M. A. Maupin. 2005. Estimated use of water in the United States in 2000. USGS Circular 1268, U.S. Department of the Interior, U.S. Geological Survey, Reston, VA.
Hutto, R. L. 1995. Composition of bird communities following stand-replacement fires in northern Rocky Mountain (U.S.A.) conifer forests. Conservation Biology 9:1041-1058.
_____. 2006. Toward meaningful snag-management guidelines for postfire salvage logging in North American conifer forests. Conservation Biology 20:984-993.
_____. 2008. The ecological importance of severe wildfires: Some like it hot. Ecological Applications 18:1827-1834.
Hyde, K. D., K. Jencso, A. C. Wilcox, and S. Woods. 2016. Influences of vegetation disturbance on hydrogeomorphic response following wildfire. Hydrological Processes 30:1131-1148.
Ingegno, A. S. 2017. Predicting habitat distribution for five rare plant species within the blackfoot swan landscape restoration project. Master's thesis, University of Montana, Missoula, MT.
Inman, R. M., S. Bergen, and J. P. Beckman. 2013. Wolverine connectivity in greater Yellowstone: A circuitscape analysis at the metapopulation scale.
Inman, R. M., K. H. Inman, M. L. Packila, and A. J. McCue. 2007. Chapter 4: Wolverine reproductive rates and maternal habitat in greater Yellowstone.
Inman, R. M., A. J. Magoun, J. Persson, and J. Mattisson. 2012a. The wolverine's niche: linking reproductive chronology, caching, competition, and climate. Journal of Mammalogy 93:634-644.
Inman, R. M., M. L. Packila, I. K. H., A. J. McCue, G. C. White, J. Persson, B. C. Aber, M. L. Orme, K. L. Alt, S. L. Cain, J. A. Fredrick, B. J. Oakleaf, and S. S. Sartorius. 2012b. Spatial ecology of wolverines at the southern periphery of distribution. Journal of Wildlife Management 76:778-7925.
Interagency Lynx Biology Team. 2013. Canada lynx conservation assessment and strategy (3rd ed.). 3rd edition. Forest Service Publication R1-13-19, U.S. Department of Agriculture,, Forest Service and U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Land Management, and National Park Service, Missoula, MT.
Ireland, K. B., M. M. Moore, P. Z. Fule, T. J. Zegler, and R. E. Keane. 2014. Slow lifelong growth predisposes Populus tremuloides trees to mortality. Oecologia 175:847-859.
Isaak, D. J., S. Wollrab, D. Horan, and G. Chandler. 2012. Climate change effects on stream and river temperatures across the northwest U.S. from 1980-2009 and implications for salmonid fishes. Climatic Change 113:499-524.

Isaak, D. J., M. K. Young, D. L. Horan, D. Nagel, M. K. Schwartz, and K. S. McKelvey. 2022. Do metapopulations and management matter for relict headwater bull trout populations in a warming climate? Ecological Applications 32:26.

Isaak, D. J., M. K. Young, D. E. Nagel, D. L. Horan, and M. C. Groce. 2015. The cold-water climate shield: delineating refugia for preserving salmonid fishes through the 21st century. Global Change Biology 21:2540-2553.

Isaak, D. J., M. K. Young, C. Tait, D. Duffield, D. L. Horan, D. E. Nagel, and M. C. Groce. 2018. Chapter 5: Effects of climate change on native fish and other aquatic species. Pages 89-111 *in* J. E. Halofsky, D. L. Peterson, J. J. Ho, N. Little, J., and L. A. Joyce, editors. Climate change vulnerability and adaptation in the Intermountain Region Part 1 . Gen. Tech. Rep. RMRS-GTR-375. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Jain, T. B., and R. T. Graham. 2005. Restoring dry and moist forests of the inland northwestern U.S. Pages 463-480 *in* J. A. Stranhauf, and P. Madsen, editors. Restoration of Boreal and Temperate Forests. CRC Press, New York.

Jakober, M. J. 1998. Biological evaluation for sensitive fish species.

Jang, W., J. S. Crotteau, Y. K. Ortega, S. M. Hood, C. R. Keyes, D. E. Pearson, D. C. Lutes, and A. Sala. 2021. Native and non-native understory vegetation responses to restoration treatments in a dry conifer forest over 23 years. Forest Ecology and Management 481:14.

Jenkins, M. J., J. B. Runyon, C. J. Fettig, W. G. Page, and B. J. Bentz. 2014. Interactions among the mountain pine beetle, fires, and fuels. Forest Science 60.

Jennersten, O. 1988. Pollination in Dianthus deltoides (Caryophyllaceae): Effects of habitat fragmentation on visitation and seed set. Conservation Biology 2:359-366.

Jepsen, S., C. LaBar, and J. Zarnoch. 2010. *Margaritifera falcata* (Gould, 1850) western pearlshell bivalvia: Margaritiferidae. The Xerces Society for Invertebrate Conservation, Portland, OR.

Jin, L., D. I. Siegel, L. K. Lautz, and M. H. Otz. 2009. Transient storage and downstream solute transport in nested stream reaches affected by beaver dams. Hydrological Processes 23:2438-2449.

Johnson, C. G., Jr. 2004. Alpine and subalpine vegetation of the Wallowa, Seven Devils and Blue Mountains. Report R6-NR-ECOL-TP-03-04.

Johnson, E. A., K. Miyanishi, and J. M. H. Weir. 1995. Old-growth, disturbance, and ecosystem management. Canadian Journal of Botany 73:918-926.

Johnson, L., B. Anulacion, M. Arkoosh, O. P. Olson, C. Sloan, S. Y. Sol, J. Spromberg, D. J. Teel, G. Yanagida, and G. Ylitalo. 2013. Persistent organic pollutants in juvenile chinook salmon in the Columbia River basin: Implications for stock recovery. Transactions of the American Fisheries Society 142:21-40.

Jones, L. C., N. Norton, and T. S. Prather. 2018. Indicators of Ventenata (*Ventenata dubia*) Invasion in Sagebrush Steppe Rangelands. Invasive Plant Science and Management 11:1-9.

Jordan, P. 2016. Post-wildfire debris flows in southern British Columbia, Canada. International Journal of Wildland Fire 25:322-336.

Jurgensen, M. F., A. E. Harvey, R. T. Graham, D. S. Page-Dumroses, J. R. Tonn, M. J. Larsen, and T. B. Jain. 1997. Impacts of timber harvesting on soil organic matter, nitrogen, productivity, and health of inland northwest forests. Forest Science 43:234-251.

Jurjevich, J. R. 2019. Confronting Statistical Uncertainty in Rural America: Toward More Certain Data-Driven Policymaking Using American Community Survey (ACS) Data. Pages 115-133 *in* Population, Place, and Spatial Interaction.

Kaeding, L. R., and J. T. Mogen. 2022. Climate-driven stream-flow impacts on bull trout metapopulation dynamics revealed by quantitative assessment of 22 years of tag–recapture data. Freshwater Biology 68:301-311.

Kalies, E. L., and L. L. Yocom Kent. 2016. Tamm Review: Are fuel treatments effective at achieving ecological and social objectives? A systematic review. Forest Ecology and Management 375:84-95.

Kashian, D. M., M. G. Turner, W. H. Romme, and C. G. Lorimer. 2005. Variability and convergence in stand structural development on a fire-dominated subalpine landscape. Ecology 86:643-654.

Kasworm, W. F., T. G. Radandt, J. E. Teisberg, T. Vent, M. Proctor, H. Cooley, and J. K. Fortin-Noreus. 2022. Cabinet-Yaak grizzly bear recovery area 2021 research and monitoring progress report. U.S. Department of the Interior, Fish and Wildlife Service, Grizzly Bear Recovery Coordinator's Office, Missoula, MT.

Kasworm, W. F., T. G. Radandt, J. E. Teisberg, T. Vent, A. Welander, M. Proctor, H. Cooley, and J. K. Fortin-Noreus. 2020. Cabinet-yaak grizzly bear recovery area 2019 research and monitoring progress report. U.S. Department of the Interior, Fish and Wildlife Service, Grizzly Bear Recovery Coordinator's Office, Missoula, MT.

Kaushal, S. S., G. E. Likens, N. A. Jaworski, M. L. Pace, A. M. Sides, D. Seekell, K. T. Belt, D. H. Secor, and R. L. Wingate. 2010. Rising stream and river temperatures in the United States. Frontiers in Ecology and the Environment 8:461-466.

Keane, R. E., and S. F. Arno. 1993. Rapid decline of whitebark pine in western Montana: Evidence from 20-year remeasurements. Western Journal of Applied Forestry 8:44-47.

Keane, R. E., L. M. Holsinger, M. F. Mahalovich, and D. F. Tomback. 2017. Restoring whitebark pine ecosystems in the face of climate change. Gen. Tech. Rep. RMRS-GTR-361, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Keane, R. E., M. F. Mahalovich, B. L. Bollenbacher, M. E. Manning, R. A. Loehman, T. B. Jain, L. M. Holsinger, and A. J. Larson. 2018. Chapter 5: Effects of Climate Change on Forest Vegetation in the Northern Rockies. Pages 59-95 *in* J. E. Halofsky, and D. L. Peterson, editors. Climate Change and Rocky Mountain Ecosystems. Springer International Publishing, Switzerland AG.

Keane, R. E., P. Morgan, and J. P. Menakis. 1994. Landscape assessment of the decline of whitebark pine (*Pinus albicaulis*) in the Bob Marshall Wilderness Complex, Montana, USA. Northwest Science 68:213-229.

Keane, R. E., and R. A. Parsons. 2010. Management guide to ecosystem restoration treatments: Whitebark pine forests of the northern Rocky Mountains, U.S.A. Gen. Tech. Rep. RMRS-GTR-232, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Keane, R. E., D. F. Tomback, C. A. Aubry, A. D. Bower, E. M. Campbell, C. L. Cripps, M. B. Jenkins, M. F. Mahalovich, M. Manning, S. T. McKinney, M. P. Murray, D. L. Perkins, D. P. Reinhart, C. Ryan, A. W. Schoettle, and C. M. Smith. 2012. A range-wide restoration strategy for whitebark pine (*Pinus albicaulis*). Gen. Tech. Rep. RMRS-GTR-279, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Kearns, C. A., D. W. Inouye, and N. M. Waser. 1998. Endangered mutualisms: The conservation of plant-pollinator interactions. Annual Review of Ecology and Systematics 29:83-112.

Keegan, C. E., C. B. Sorenson, T. A. Morgan, S. W. Hayes, and J. M. Daniels. 2012. Impact of the Great Recession and housing collapse on the forest products industry in the western United States. Forest Products Journal 61.

Kemp, P. S., T. A. Worthington, T. E. L. Langford, A. R. J. Tree, and M. J. Gaywood. 2012. Qualitative and quantitative effects of reintroduced beavers on stream fish. Fish and Fisheries 13:158-181.

Kennedy, P., and K. A. Meyer. 2014. Trends in the abundance of Westslope Cutthroat Trout in Idaho. Pages 309-315 *in* Looking back and moving forward, wild trout symposium, proceedings of the wild trout XI symposium, Holiday Inn, West Yellowstone, Montana, September 22-25th, 2014. Idaho Department of Fish and Game, Boise, ID.

Kerns, B. K., C. Tortorelli, M. A. Day, T. Nietupski, A. M. G. Barros, J. B. Kim, and M. A. Krawchuk. 2020. Invasive grasses: A new perfect storm for forested ecosystems? Forest Ecology and Management 463:1-15.

Kershner, J. L., E. K. Archer, M. Coles-Ritchie, E. R. Cowley, R. C. Henderson, K. Kratz, C. M. Quimby, D. L. Turner, L. C. Ulmer, and M. R. Vinson. 2004. Guide to effective monitoring of aquatic and riparian resources. Gen. Tech. Rep. RMRS-GTR-121, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Kevan, P. G. 1977. Blueberry crops in Nova Scotia and New Brunswick - Pesticides and crop reductions. Canadian Journal of Agricultural Economics 25:61-64.

_____. 1999. Pollinators as bioindicators of the state of the environment: species, activity and diversity. Agriculture Ecosystems & Environment 74:373-393.

Khubba, S., K. Heim, and J. Hong. 2022. U.S. Census Bureau, 2020 Post-enumeration survey estimation report, national census coverage estimates for people in the United States by demographic characteristics. PES20-G-01, U.S. Government Printing Office, Washington, DC.

Kim, M.-S., J. W. Hanna, J. E. Stewart, M. V. Warwell, G. I. McDonald, and N. B. Klopfenstein. 2021. Predicting Present and Future Suitable Climate Spaces (Potential Distributions) for an Armillaria Root Disease Pathogen (Armillaria solidipes) and Its Host, Douglas-fir (Pseudotsuga menziesii), Under Changing Climates. Frontiers in Forests and Global Change 4:1-11.

Kimmerer, R. W., and F. Kanawha Lake. 2001. The role of indigenous burning in land management. Journal of Forestry 99:36-41.

King County. 2010. Best management practices: Fragrant Water Lily—Nymphaea odorata Nymphaeaceae. King County,, Noxious Weed Control Program.

Kivinen, S., P. Nummi, and T. Kumpula. 2020. Beaver-induced spatiotemporal patch dynamics affect landscape-level environmental heterogeneity. Environmental Research Letters 15:1-13.

Kliejunas, J. T. 2011. A risk assessment of cimate change and the impact of forest diseases on forest ecosystems in the western United States and Canada. Gen. Tech. Rep. PSW-GTR-236, U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Knopf, F. L., and R. W. Cannon. 1981. Structural Resilience of a Willow Riparian Community to Changes in Grazing Practices. Denver Wildlife Research Center.

Kortello, A., D. Hausleitner, and G. Mowat. 2019. Mechanisms influencing the winter distribution of wolverine Gulo gulo luscus in the southern Columbia Mountains, Canada. Wildlife Biology 2019:1-13.

Kosterman, M. K. 2014. Correlates of Canada lynx reproductive success in northwestern Montana. Master's thesis, University of Montana, Missoula, Montana.

Kosterman, M. K., J. R. Squires, J. D. Holbrook, D. H. Pletscher, and M. Hebblewhite. 2018. Forest structure provides the income for reproductive success in a southern population of Canada lynx. Ecological Applications.

Kovach, R. P., R. Al-Chokhachy, D. C. Whited, D. A. Schmetterling, A. M. Dux, C. C. Muhlfeld, and A. Strecker. 2016a. Climate, invasive species and land use drive population dynamics of a cold-water specialist. Journal of Applied Ecology:11.

Kovach, R. P., R. F. Leary, D. A. Bell, S. Painter, A. Lodmell, and A. R. Whiteley. 2022. Genetic variation in westslope cutthroat trout reveals that widespread genetic rescue is warranted. Canadian journal of fisheries and aquatic sciences 79:936-946.

Kovach, R. P., G. Luikart, W. H. Lowe, M. C. Boyer, and C. C. Muhlfeld. 2016b. Risk and efficacy of human-enabled interspecific hybridization for climate-change adaptation: response to Hamilton and Miller (2016). Conservation Biology 30:428-430.

Kovach, R. P., C. C. Muhlfeld, A. A. Wade, B. K. Hand, D. C. Whited, P. W. DeHaan, R. Al-Chokhachy, and G. Luikart. 2015. Genetic diversity is related to climatic variation and vulnerability in threatened bull trout. Global Change Biology.

Krawchuk, M. A., J. Hudec, and G. W. Meigs. 2023. Manager's brief, Integrating fire refugia concepts and data into vegetation management decisions: A case study on the Gifford Pinchot National Forest, Little White Salmon Project Area, Washington.

Krebs, J., E. C. Lofroth, and I. Parfitt. 2007. Multiscale habitat use by wolverines in British Columbia, Canada. Journal of Wildlife Management 71:2180-2192.

Krist, F. J., Jr, J. R. Ellenwood, M. E. Woods, A. J. McMahan, J. P. Cowardin, D. E. Ryerson, F. J. Sapio, M. O. Zweifler, and S. A. Romero. 2015. Chapter 6: 2013–2027 National insect and disease forest risk assessment: summary and data access. Pages 87-92 *in* K. M. Potter, and B. L. Conkling, editors. Forest Health Monitoring: National Status, Trends and Analysis, 2014. Gen. Tech. Rep. SRS-209. U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, North Carolina.

Krohner, J. M. 2020. Finding fishers: Determining the distribution of a rare forest mesocarnivore in the northern Rocky Mountains. Master's thesis, University of Montana, Missoula.

Krohner, J. M., P. M. Lukacs, R. Inman, J. D. Sauder, J. A. Gude, C. Mosby, J. A. Coltrane, R. A. Mowry, and J. J. Millspaugh. 2022. Finding fishers: Determining fisher occupancy in the Northern Rocky Mountains. Journal of Wildlife Management 86:20.

Krueger, J. M., and R. L. Sheley. 2002. Oxeye daisy (*Chrysanthemum leucanthemum*). Report MT200002 AG.

Krupp, F. 2015. Statement on Paris Agreement from Environmental Defense Fund President Fred Krupp. *in* Environmental Defense Fund.

Kuebbing, S. E., M. A. Nuñez, and D. Simberloff. 2013. Current mismatch between research and conservation efforts: The need to study co-occurring invasive plant species. Biological Conservation 160:121-129.

Kukutai, T., and J. Taylor. 2016. Chapter 1: Data sovereignty for indigenous peoples current practice and future needs. Pages 1-22 *in* T. Kukutai, and J. Taylor, editors. Indigenous Data Sovereignty. ANU Press.

Kurzweil, J. R., K. Metlen, R. Abdi, R. Strahan, and T. S. Hogue. 2021. Surface water runoff response to forest management: Low-intensity forest restoration does not increase surface water yields. Forest Ecology and Management 496:1-11.

Kusel, J. 2001. Assessing well-being in forest dependent communities. Journal of Sustainable Forestry 13:359-384.

Lackschewitz, K. 1991. Vascular plants of west-central Montana-identification guidebook. Gen. Tech. Rep. INT-277, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Fort Collins, CO.

Lalande, B. M., K. Hughes, W. R. Jacobi, W. T. Tinkham, R. Reich, and J. E. Stewart. 2020. Subalpine fir mortality in Colorado is associated with stand density, warming climates and interactions among fungal diseases and the western balsam bark beetle. Forest Ecology and Management 466:1-10.

Larsen, I. J., L. H. MacDonald, E. Brown, D. Rough, M. J. Welsh, J. H. Pietraszek, Z. Libohova, J. de Dios Benavides-Solorio, and K. Schaffrath. 2009. Causes of post-fire runoff and erosion: water repellency, cover, or soil sealing? Soil Science Society of America Journal 73:1393-1407.

Larsen, L. G. 2019. Multiscale flow-vegetation-sediment feedbacks in low-gradient landscapes. Geomorphology 334:165-193.

Larsen, L. G., and J. W. Harvey. 2010. How vegetation and sediment transport feedbacks drive landscape change in the everglades and wetlands worldwide. American Naturalist 176:E66-E79.

Larson, A. J., and D. Churchill. 2012. Tree spatial patterns in fire-frequent forests of western North America, including mechanisms of pattern formation and implications for designing fuel reduction and restoration treatments. Forest Ecology and Management 267:74-92.

Larson, B. M. H., P. G. Kevan, and D. W. Inouye. 2001. Flies and flowers: Taxonomic diversity of anthophiles and pollinators. Canadian Entomologist 133:439-465.

Larson, D. L. 2003. Native weeds and exotic plants: relationships to disturbance in mixed-grass prairie. Plant Ecology 169:317-333.

Laughlin, D. C., R. Strahan, D. W. Huffman, and A. Sanchez Meador. 2016. Using trait-based ecology to restore resilient ecosystems: Historical conditions and the future of montane forests in western North America. Restoration Ecology.

Lawrence, D. J., B. Stewart-Koster, J. D. Olden, A. S. Ruesch, C. E. Torgersen, J. J. Lawler, D. P. Butcher, and J. K. Crown. 2014. The interactive effects of climate change, riparian management, and a nonnative predator on stream-rearing salmon. Ecological Applications 24:895-912.

Laymon, S. A., and M. D. Halterman. 1987. Can the western subspecies of the yellow-billed cuckoo be saved from extinction? Western Birds:19-25.

_____. 1989. A proposed habitat management plan for yellow-billed cuckoos in California. Pages 272-277 *in* D. L. Abell, editor. Proceedings of the California Riparian Systems Conference: Protection Management, and Restoration for the 1990s, 22-24 September 1988, Davis, CA. Gen. Tech. Rep. PSW-GTR-110. U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Leach, H. 2020. Beaver habitat surveys in western Montana.

Lentile, L. B., F. W. Smith, and W. D. Shepperd. 2006. Influence of topography and forest structure on patterns of mixed severity fire in ponderosa pine forests of the South Dakota, Black Hills, USA. International Journal of Wildland Fire 15:557-566.

Lesica, P. 2012. Manual of Montana Vascular Plants. 30 June 2012 edition. Botanical Research Institute of Texas, Fort Worth, TX.

Lesica, P., S. V. Cooper, and G. Kudray. 2005. Big sagebrush shrub-steppe postfire succession in southwest Montana. Montana Natural Heritage Program, Helena, MT.

Levri, E. P., A. A. Kelly, and E. Love. 2007. The invasive New Zealand mud snail (potamopyrgus antipodarum) in lake erie. Journal of Great Lakes Research 33:1-6.

Lewis, S. A., A. T. Hudak, P. R. Robichaud, P. Morgan, K. L. Satterberg, E. K. Strand, A. M. S. Smith, J. A. Zamudio, and L. B. Lentile. 2017. Indicators of burn severity at extended temporal scales: a decade of ecosystem response in mixed-conifer forests of western Montana. International Journal of Wildland Fire 26:755-771.

Littell, J. S., E. E. Oneil, D. McKenzie, J. A. Hicke, J. A. Lutz, R. A. Norheim, and M. M. Elsner. 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. Climatic Change 102:129-158.

Littell, J. S., D. L. Peterson, K. L. Riley, Y. Liu, and C. H. Luce. 2016. A review of the relationships between drought and forest fire in the United States. Global Change Biology 22:2353-2369.

Liu, Z., Z. Deng, S. J. Davis, C. Giron, and P. Ciais. 2022. Monitoring global carbon emissions in 2021. Nature reviews earth & environment 3:217-219.

Lloyd, R. A., K. A. Lohse, and T. P. A. Ferre. 2013. Influence of road reclamation techniques on forest ecosystem recovery. Frontiers in Ecology and the Environment 11:75-81.

Lockman, I. B., and H. S. J. Kearns. 2016. Forest root diseases across the United States. Gen. Tech. Rep. RMRS-GTR-342, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT.

Lodge, D. M., R. A. Stein, K. M. Brown, A. P. Covich, C. Bronmark, J. E. Garvey, and S. P. Klosiewskt. 1998. Predicting impact of freshwater exotic species on native biodiversity: Challenges in spatial scaling. Austral Ecology 23:53-67.

Loehman, R. A., B. J. Bentz, G. A. DeNitto, R. E. Kean, M. E. Manning, J. M. E. Duncan, M. B. Jackson, S. Kegley, I. B. Lockman, D. E. Pearson, J. A. Powell, S. Shelly, B. E. Steed, and P. J. Zambino. 2018. Chapter 8: Effects of climate change on ecological disturbance. Pages 317-352 *in* J. E. Halofsky, D. L. Peterson, S. K. Dante-Wood, L. Hoang, J. J. Ho, and L. A. Joyce, editors, editors. Climate Change vulnerability and adaptation in the northern Rocky Mountains, Part 2. Gen. Tech. Rep. RMRS-GTR-374. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station., Fort Collins, CO.

Lofroth, E. C. 1997. Northern wolverine project: Wolverine ecology in logged and unlogged plateau and foothill landscapes.

Lofroth, E. C., and J. Krebs. 2007. The abundance and distribution of wolverines in British Columbia, Canada. Journal of Wildlife Management 71:2159-2169.

Logan, R. 2001. Water quality BMPs for Montana forests. Montana Department of Natural Resources and Conservation, Forestry Division, Montana Logging Association, Montana State University Extension Service. Report EB158.

Lokteff, R. L., B. B. Roper, and J. M. Wheaton. 2013. Do beaver dams impede the movement of trout? Transactions of the American Fisheries Society 142:1114-1125.

Loo, S. E., R. M. Nally, and P. S. Lake. 2007. Forecasting New Zealand Mudsnail Invasion Range: Model Comparisons Using Native and Invaded Ranges. Ecological Applications 17:181-189.

Lotts, K., and T. Naberhaus. 2021. Butterflies and moths of North America. *in*.

Luce, C. H. 2018. Chapter 4: Effects of climate change on snowpack, glaciers, and water resources in the Northern Rockies Region. Pages 66-85 *in* J. E. Halofsky, D. L. Peterson, S. K. Dante-Wood, L. Hoang, J. J. Ho, and L. A. Joyce, editors. Climate change vulnerability and adaptation in the Northern Rocky Mountains [Part 1]. Gen. Tech. Rep. RMRS-GTR-374. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Luce, C. H., J. M. Vose, N. Pederson, J. Campbell, C. Millar, P. Kormos, and R. Woods. 2016. Contributing factors for drought in United States forest ecosystems under projected future climates and their uncertainty. Forest Ecology and Management 380:299-308.

Lutz, J. A., T. J. Furniss, D. J. Johnson, S. J. Davies, D. Allen, A. Alonso, K. J. Anderson-Teixeira, A. Andrade, J. Baltzer, K. M. L. Becker, E. M. Blomdahl, N. A. Bourg, S. Bunyavejchewin, D. F. R. P. Burslem, C. A. Cansler, K. Cao, M. Cao, D. Cárdenas, L.-W. Chang, K.-J. Chao, W.-C. Chao, J.-M. Chiang, C. Chu, G. B. Chuyong, K. Clay, R. Condit, S. Cordell, H. S. Dattaraja, A. Duque, C. E. N. Ewango, G. A. Fischer, C. Fletcher, J. A. Freund, C. Giardina, S. J. Germain, G. S. Gilbert, Z. Hao, T. Hart, B. C. H. Hau, F. He, A. Hector, R. W. Howe, C.-F. Hsieh, Y.-H. Hu, S. P. Hubbell, F. M. Inman-Narahari, A. Itoh, D. Janík, A. R. Kassim, D. Kenfack, L. Korte, K. Král, A. J. Larson, Y. Li, Y. Lin, S. Liu, S. Lum, K. Ma, J.-R. Makana, Y. Malhi, S. M. McMahon, W. J. McShea, H. R. Memiaghe, X. Mi, M. Morecroft, P. M. Musili, J. A. Myers, V. Novotny, A. de Oliveira, P. Ong, D. A. Orwig, R. Ostertag, G. G. Parker, R. Patankar, R. P. Phillips, G. Reynolds, L. Sack, G.-Z. M. Song, S.-H. Su, R. Sukumar, I.-F. Sun, H. S. Suresh, M. E. Swanson, S. Tan, D. W. Thomas, J. Thompson, M. Uriarte, R. Valencia, A. Vicentini, T. Vrška, X. Wang, G. D. Weiblen, A. Wolf, S.-H. Wu, H. Xu, T. Yamakura, S. Yap, and J. K. Zimmerman. 2018. Global importance of large-diameter trees. Global Ecology and Biogeography 27:849-864.

Lutz, J. A., A. J. Larson, M. E. Swanson, and J. A. Freund. 2012. Ecological importance of large-diameter trees in a temperate mixed-conifer forest. PLoS One 7:e36131.

MacDougall, A. S., and R. Turkington. 2005. Are invasive species the drivers or passengers of change in degraded ecosystems? Ecology 86:42-55.

Mace, R. D., and C. J. Jonkel. 1986. Local food habits of the grizzly bear in Montana. Ursus 6:105-110.

Mace, R. D., and L. J. Roberts. 2012. Northern Continental Divide Ecosystem, Grizzly Bear Population Monitoring [Team], annual report, 2012. Montana Fish, Wildlife and Parks, Kalispell, MT.

Maczko, K., and L. Hidinger, editors. 2008. Sustainable rangelands ecosystem goods and services (Sustainable Rangelands Roundtable Monograph No. 3). Sustainable Rangelands Roundtable, Fort Collins, CO.

Majerova, M., B. T. Neilson, N. M. Schmadel, J. M. Wheaton, and C. J. Snow. 2015. Impacts of beaver dams on hydrologic and temperature regimes in a mountain stream. Hydrology and Earth System Sciences 19:3541-3556.

Mallet, J., and R. F. Thurow. 2021. Resurrecting an Idaho Icon: How Research and Management Reversed Declines of Native Westslope Cutthroat Trout. Fisheries 47:104-117.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. Climatic Change 102:187-223.

Marlin, J. C., and W. E. LaBerge. 2001. The native bee fauna of Carlinville, Illinois, revisited after 75 years: A case for persistence. Conservation Biology 5:1-19.

Martinson, E. J., M. E. Hunter, J. P. Freeman, and P. N. Omi. 2008. Chapter 13: Effects of Fuel and Vegetation Management Activities on Nonnative Invasive Plants. Pages 261-267 *in* K. Zouhar, J. Kapler Smith, S. Sutherland, and M. L. Brooks, editors. Wildland fire in ecosystems: fire and nonnative invasive plants. Gen. Tech. Rep. RMRS-GTR-42-vol. 6. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT.

Marvin, R. 2000. Hydrogeologic assessment of the Soda Butte Spring for ground water under the direct influence of surface water. MBMG Open-file Report 401-H, Montana Bureau of Mines and Geology, Butte, MT.

Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1991a. Food-habits of Yellowstone grizzly bears, 1977-1987. Canadian Journal of Zoology 69:1619-1629.

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

May, C. L., and B. S. Pryor. 2016. Explaining spatial patterns of mussel beds in a northern California river: The role of flood disturbance and spawning salmon. River Research and Applications 32:776-785.

Mayfield, M. P., T. E. McMahon, J. J. Rotella, R. E. Gresswell, T. Selch, P. Saffel, J. Lindstrom, and B. Liermann. 2019. Application of multistate modeling to estimate salmonid survival and movement in relation to spatial and temporal variation in metal exposure in a mining-impacted river. Canadian journal of fisheries and aquatic sciences 76:2057-2068.

McCaffery, M., and L. Eby. 2016. Beaver activity increases aquatic subsidies to terrestrial consumers. Freshwater Biology 61:518-532.

McCaffery, M. L. M. 2009. The influence of an ecosystem engineer on nutrient subsidies and fish invasions in southwestern Montana.

McDaniel, P. A., and M. A. Wilson. 2007. Physical and chemical characteristics of ash-influenced soils of inland northwest forests. Pages 31-45 *in* D. Page-Dumroese, R. Miller, J. Mital, P. McDaniel, and D. Miller, editors. Volcanic-ash-derived forest soils of the inland northwest: Properties and implications for management and restoration, 9-10 November 2005; Coeur d'Alene, ID (Proceedings RMRS-P-44). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

McDougall, K. L., J. Lembrechts, L. J. Rew, S. Haider, L. A. Cavieres, C. Kueffer, A. Milbau, B. J. Naylor, M. A. Nuñez, A. Pauchard, T. Seipel, K. L. Speziale, G. T. Wright, and J. M. Alexander. 2018. Running off the road: roadside non-native plants invading mountain vegetation. Biological Invasions 20:3461-3473.

McDowell, W., K. Racette, L. Eby, and A. Lahr. n.d. Lolo beaver mimicry feasibility project: Understanding the effects of beaver mediated restoration on fish habitat and populations. 2020 Accomplishment Lolo National Forest. Missoula, MT.

McKelvey, K. S., and P. C. Buotte. 2018. Climate change and wildlife in the northern Rocky Mountains[Chapter 9]. Pages 383-434 *in* J. E. Halofsky, D. L. Peterson, S. K. Dante-Wood, L. Hoang, J. J. Ho, and L. A. Joyce, editors. Climate change vulnerability and adaptation in the Northern Rocky Mountains [Part 2]. Gen. Tech. Rep. RMRS-GTR-374. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

McKelvey, K. S., M. K. Young, T. M. Wilcox, D. M. Bingham, K. L. Pilgrim, and M. K. Schwartz. 2016. Patterns of hybridization among cutthroat trout and rainbow trout in northern Rocky Mountain streams. Ecology and Evolution 6:688-706.

McKenzie, D., Z. e. Gedalof, D. L. Peterson, and P. Mote. 2004. Climatic change, wildfire, and conservation. Conservation Biology 18:890-902.

McKenzie, D., D. L. Peterson, and J. Littell. 2009. Global warming and stress complexes in forests of western North America. *in* A. Bytnerowicz, M. Arbaugh, C. Andersen, and A. Riebau, editors. Forest fires and air pollution issues. Elsevier, Ltd.

McKinney, S. T., and D. F. Tomback. 2007. The influence of white pine blister rust on seed dispersal in whitebark pine. Canadian Journal of Forest Research 37.

McNab, W. H., and P. E. Avers. 1996. Ecological subregions of the United States (WO-WSA-5). *in* U.S. Department of Agriculture, Forest Service, Washington, DC.

Meddens, A. J. H., C. A. Kolden, J. A. Lutz, A. M. S. Smith, C. A. Cansler, J. T. Abatzoglou, G. W. Meigs, W. M. Downing, and M. A. Krawchuk. 2018. Fire Refugia: What are they, and why do they matter for global change? BioScience 68:944-954.
Meng, X. J., D. S. Lindsay, and N. Sriranganathan. 2009. Wild boars as sources for infectious diseases in livestock and humans. Philos Trans R Soc Lond B Biol Sci 364:2697-2707.
Metlen, K. L., and C. E. Fiedler. 2006. Restoration treatment effects on the understory of ponderosa pine/Douglas-fir forests in western Montana, USA. Forest Ecology and Management 222:355-369.
Milburn, A., B. Bollenbacher, M. Manning, and R. Bush. 2015. Region 1 existing and potential vegetation groupings used for broad-level analysis and monitoring. Numbered Report 15-4 v1.0, USDA Forest Service, Northern Region, Missoula, MT.
Milburn, A., G. Carnwath, S. Fox, E. Henderson, and R. Bush. 2019. Region 1 Large-tree Structure Classification Used for Broad-level Analysis and Monitoring. Numbererd Report 19-3 v1.0, U.S. Department of Agriculture, Forest Service, Region 1, Forest and Range Management, Missoula, MT.
Millar, C. I., and N. L. Stephenson. 2015. Temperate forest health in an era of emerging megadisturbance. Pages 823-826 *in* Science.
Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.
Miller, J. R., M. L. Lord, L. F. Villarroel, D. Germanoski, and J. C. Chambers. 2012. Structural organization of process zones in upland watersheds of central Nevada and its influence on basin connectivity, dynamics, and wet meadow complexes. Geomorphology 139-140:384-402.
Milner, K. S. 1992. Site index and height growth curves for ponderosa pine, western larch, lodgepole pine, and Douglas-fir in western Montana. Western Journal of Applied Forestry 7:9-14.
Minckley, R. L., J. H. Cane, L. Kervin, and D. Yanega. 2003. Biological impediments to measures of competition among introduced honey bees and desert bees (Hymenoptera: Apiformes). Journal of the Kansas Entomological Society 76:306-319.
Miniat, C. F., J. M. Fraterrigo, S. T. Brantley, M. A. Callaham, S. Cordell, J. S. Dukes, C. P. Giardina, S. Jose, and G. Lovett. 2021. Chapter 3: Impacts of Invasive Species on Forest and Grassland Ecosystem Processes in the United States. Pages 41-55 *in* T. M. Poland, T. Patel-Weynand, D. M. Finch, C. F. Miniat, D. C. Hayes, and V. M. Lopez, editors. Invasive Species in Forests and Rangelands of the United States: A Comprehensive Science Synthesis for the United States Forest Sector. Springer International Publishing, Cham.
Mitchell, A. J., and R. A. Cole. 2008. Survival of the faucet snail after chemical disinfection, ph extremes, and heated water bath treatments. North American Journal of Fisheries Management 28:1597-1600.
Moldowan, P., M. Keevil, P. Mills, R. Brooks, and J. Litzgus. 2015. Diet and Feeding Behaviour of Snapping Turtles (Chelydra serpentina) and Midland Painted Turtles (Chrysemys picta marginata) in Algonquin Provincial Park, Ontario. Canadian Field Naturalist 129:403-408.
Montana Department of Agriculture. 2014. Final draft environmental assessment eastern heath snail management Cascade and Choteau Counties, Montana. Montana Department of Agriculture, Helena, Montana.
Montana Department of Fish Wildlife and Parks, and U.S. Department of Agriculture, Forest Service. 2007. Memorandum of understanding and conservation agreement for westslope cutthroat trout and Yellowstone cutthroat trout in Montana.
Montana Department of Natural Resources and Conservation. 2020. Montana forest action plan. Montana Forest Action Advisory Council, Helena, MT.
Montana Department of Natural Resources and Conservation, Forestry Assistance Bureau. 2006. Montana: Guide to the streamside management zone law and rules 2006. Montana Department of Natural Resources and Conservation.

Montana Fish Wildlife and Parks. 2005. Montana's comprehensive fish and wildlife conservation strategy.
_____. 2015. Montana's state wildlife action plan.
_____. 2019. Montana Statewide Comprehensive Outdoor Recreation Plan. Enhancing Montana's outdoor recreation legacy 2020 - 2024. Montana Department of Fish, Wildlife, and Parks, Helena, MT.
_____. 2022a. 2021 Montana State Parks Annual Visitation Report. Montana Fish Wildlife and Parks.
_____. 2022b. 2022 Region 1 AIS snapping turtle project final report. Montana Fish, Wildlife & Parks.
Montana National Heritage Program. 2021. Silene spaldingii (spalding's catchfly) predicted suitable habitat modeling. 24 October, 2021 edition., Montana Natural Heritage Program, Helena, Montana.
Montana Natural Heritage Program. 2020a. Athysanus pusillus (sandweed) predicted suitable habitat modeling. 29 June 2020 edition., Montana Natural Heritage Program, Helena, Montana.
_____. 2020b. Gentianopsis simplex (Hiker's Gentian) predicted suitable habitat modeling. 25 August 2020 edition., Montana Natural Heritage Program, Helena, MT.
_____. 2020c. Idahoa scapigera (scalepod) predicted suitable habitat modeling. 16 July 2020 edition., Montana Natural Heritage Program, Helena, Montana.
_____. 2022. Petasites frigidus var. Frigidus (arctic sweet coltsfoot) predicted suitable habitat modeling. 6 October 2022 edition., Montana Natural Heritage Program, Helena, Montana.
_____. 2023a. Noxious Weeds and Regulated Plants of Montana. retrieved on: 03/08/2023 edition. Custom Field Guide from https://FieldGuide.mt.gov for Noxious Weeds and Regulated Plants of Montana. Retrieved on 3/8/2023., Montana Natural Heritage Program, Helena, MT.
_____. 2023b. Pinus albicaulis (whitebark pine) predicted suitable habitat modeling.
Montana Natural Heritage Program, and M. F. W. a. Parks. 2023. American bullfrog-Lithobates catesbeianus. *in* Montana Field Guide.
Moorhouse, T. P., and D. W. Macdonald. 2014. Are invasives worse in freshwater than terrestrial ecosystems? WIREs Water 2:1-8.
Morelli, T. L., C. Daly, S. Z. Dobrowski, D. M. Dulen, J. L. Ebersole, S. T. Jackson, J. D. Lundquist, C. I. Millar, S. P. Maher, W. B. Monahan, K. R. Nydick, K. T. Redmond, S. C. Sawyer, S. Stock, and S. R. Beissinger. 2016. Managing climate change refugia for climate adaptation. PLoS One 11.
Morgan, P., S. C. Bunting, A. E. Black, T. Merrill, and S. Barrett. 1994. Past and present fire regimes in the interior Columbia River Basin. *in* K. Close, and R. A. Bartlette, editors. Fire management under fire (adapting to change) - proceedings of the 1994 interior west fire council meeting and program. Interior West Fire Council, USDA Forest Service, Intermountain Fire Sciences Laboratory.
Morgan, P., C. C. Hardy, T. W. Swetnam, M. G. Rollins, and D. G. Long. 2001. Mapping fire regimes across time and space: Understanding coarse and fine-scale fire patterns. International Journal of Wildland Fire 10:329-342.
Morgan, P., E. K. Heyerdahl, and C. E. Gibson. 2008. Multi-season climate synchronized forest fires throughout the 20th century, Northern Rockies, USA. Ecology 89:717-728.
Morse, R. A., and N. W. Calderone. 2000. The value of honey bees as pollinators of U.S. crops in 2000. Bee Culture 128:1-15.
Mortensen, D., E. Rauschert, A. Nord, and B. Jones. 2009. Forest Roads Facilitate the Spread of Invasive Plants. Invasive Plant Science and Management 2:191-199.
Mueggler, W. F., and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. Gen. Tech. Rep. INT-GTR-66, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.
Muhlfeld, C. C., R. P. Kovach, R. Al-Chokhachy, S. J. Amish, J. L. Kershner, R. F. Leary, W. H. Lowe, G. Luikart, P. Matson, D. A. Schmetterling, B. B. Shepard, P. A. H. Westley, D. Whited, A. Whiteley, and F. W. Allendorf. 2017. Legacy introductions and climatic variation explain

spatiotemporal patterns of invasive hybridization in a native trout. Global Change Biology 23:4663-4674.

Muhlfeld, C. C., R. P. Kovach, L. A. Jones, R. Al-Chokhachy, M. C. Boyer, R. F. Leary, W. H. Lowe, G. Luikart, and F. W. Allendorf. 2014. Invasive hybridization in a threatened species is accelerated by climate change. Nature Climate Change 4:620-624.

Mullen, L. B., H. A. Woods, M. K. Schwartz, A. J. Sepulveda, and W. H. Lowe. 2010. Scale-dependent genetic structure of the Idaho giant salamander (Dicamptodon aterrimus) in stream networks. Molecular Ecology 19:898-909.

Mullins, M. L., A. S. Whisenant, and J. A. Glass. 2005. Aquatic Life Assessment of an Intermittent Stream Experiencing Off-Road Vehicle Activity. WQTS-2005-01, Texas Parks and Wildlife Department.

Naiman, R. J., H. Decamps, M. E. McClain, and G. E. Likenes. 2005. Riparia Ecology, Conservation, and Management of Streamside Communities. Elsevier Inc, London, UK.

Naiman, R. J., C. A. Johnston, and J. C. Kelley. 1988. Alteration of North American streams by beaver. BioScience 38:753-754.

Naiman, R. J., J. M. Melillo, and J. E. Hobbie. 1986. Ecosystem alteration of boreal forest streams by beaver (*Castor canadensis*). Ecology 67:1254-1269.

National Academies Press. 2007. Chapter 3: Causes of pollinator declines and potential threats. Pages 75-103 *in* Status of Pollinators in North America. The National Academic Press, Washington, DC.

National Interagency Fire Center. 2019. Interagency standards for fire and fire aviation operations. NFES 2724, National Interagency Fire Center,, Boise, ID.

Neary, D. G., K. C. Ryan, and L. F. E. DeBano. 2005. Wildland fire in ecosystems: Effects of fire on soil and water. Gen. Tech. Rep. RMRS-GTR-42-vol.4, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT.

Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16:4-21.

Nelson, N. M. 2019. Enumeration of potential economic costs of dreissenid mussels infestation in Montana. Universtiy of Montana,, Montana Department of Natural Resources and Conservation.

Newland, J. A., and T. H. DeLuca. 2000. Influence of fire on native nitrogen-fixing plants and soil nitrogen status in ponderosa pine – Douglas-fir forests in western Montana. Canadian Journal of Forest Research 30:274-282.

Nie, M. 2008. The Use of Co-Management and Protected Land-Use Designations to Protect Tribal Cultural Resources and Reserved Treaty Rights on Federal Lands. Natural Resources Journal 48:2-63.

North, M., J. Innes, and H. Zald. 2007. Comparison of thinning and prescribed fire restoration treatments to Sierran mixed-conifer historic conditions. Canadian Journal of Forest Research 37:331-342.

Northern Continental Divide Ecosystem Subcommittee. 2018. Conservation strategy for the grizzly bear in the Northern Continental Divide Ecosystem. U.S. Department of Agriculture, Forest Service, Interagency Grizzly Bear Committee, Norhern Continental Divide Ecosystem Subcommittee, Missoula, MT.

Nyssen, J., J. Pontzeele, and P. Billi. 2011. Effect of beaver dams on the hydrology of small mountain streams: Example from the Chevral in the Ourthe Orientale basin, Ardennes, Belgium. Journal of Hydrology 402:92-102.

Obama, B. H. 2016. Executive Order 13751 of December 5, 2016: Safeguarding the nation from the impacts of invasive species. Federal Register 81:88609-88614.

Oh, B., K. J. Lee, C. Zaslawski, A. Yeung, D. Rosenthal, L. Larkey, and M. Back. 2017. Health and well-being benefits of spending time in forests: systematic review. Environmental Health and Preventive Medicine 22:1-11.

Oliver, C. D., and B. C. Larson. 1996. Forest stand dynamics. Update edition. John Wiley and Sons, New York, NY.

Olson, L. E., N. Bjornlie, G. Hanvey, J. D. Holbrook, J. S. Ivan, S. Jackson, B. Kertson, T. King, M. Lucid, D. Murray, R. Naney, J. Rohrer, A. Scully, D. Thornton, Z. Walker, and J. R. Squires. 2021. Improved prediction of Canada lynx distribution through regional model transferability and data efficiency. Ecology and Evolution 11:1667-1690.

Olson, L. E., J. S. Crotteau, S. Fox, G. Hanvey, J. D. Holbrook, S. Jackson, and J. R. Squires. 2023. Effects of compound disturbance on Canada lynx and snowshoe hare: Wildfire and forest management influence timing and intensity of use. Forest Ecology and Management 530:1-18.

Olson, L. E., J. D. Sauder, N. M. Albrecht, R. S. Vinkey, S. A. Cushman, and M. K. Schwartz. 2014. Modeling the effects of dispersal and patch size on predicted fisher (Pekania [Martes] pennanti) distribution in the U.S. Rocky Mountains. Biological Conservation 169:89-98.

Oschell, C., and N. P. Nickerson. 2008. Baseline information for region 1 needs assessments. University of Montana. Report 2008-4.

Ovaskainen, O., and I. Hanski. 2004. Chapter 4: Metapopulation dynamics in highly fragmented landscapes. Pages 73-103 *in* I. Hanski, and O. E. Gaggiotti, editors. Ecology, genetics and evolution of metapopulations. Elsevier Science, Burlington, MA.

Page-Dumroese, D. S., M. F. Jurgensen, and T. Terry. 2010. Maintaining soil productivity during forest or biomass-to-energy thinning harvests in the western United States. Western Journal of Applied Forestry 25:5-11.

Pansing, E. R., D. F. Tomback, and M. B. Wunder. 2020. Climate-altered fire regimes may increase extirpation risk in an upper subalpine conifer species of management concern. Ecosphere 11:26.

Parks, C. G., S. E. Radosevich, B. A. Endress, B. J. Naylor, D. Anzinger, L. J. Rew, B. D. Maxwell, and K. A. Dwire. 2005. Natural and land-use history of the Northwest mountain ecoregions (USA) in relation to patterns of plant invasions. Perspectives in Plant Ecology Evolution and Systematics 7:137-158.

Parks, S. A., S. Z. Dobrowski, J. D. Shaw, and C. Miller. 2019. Living on the edge: trailing edge forests at risk of fire-facilitated conversion to non-forest. Ecosphere 10:17.

Payne, C., J. M. Bowker, and P. C. Reed. 1992. The EconomicValue of Wilderness: Proceedings of the conference; 1991 May 8-11; Jackson, WY. Gen. Tech. Rep. SE-GTR-78, U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station, Asheville, NC.

Pearson, D. E., Y. K. Ortega, O. Eren, and J. L. Hierro. 2016. Quantifying "apparent" impact and distinguishing impact from invasiveness in multispecies plant invasions. Ecological Applications 26:162-173.

Peeler, J. L., and E. A. H. Smithwick. 2018. Exploring invasibility with species distribution modeling: How does fire promote cheatgrass (Bromus tectorum) invasion within lower montane forests? Diversity and Distributions 24:1308-1320.

Pellant, M. 1996. Cheatgrass: The invader that won the west. Bureau of Land Management, Idaho State Office, Boise, ID.

Pennick McIver, C., E. A. Simmons, and T. A. Morgan. 2022. Timber use, processing capacity and capability of mills to utilize timber by diameter size class within the Lolo and Bitterroot National Forests timber-processing area. Univeristy of Montana, Missoula, Montana.

Peterson, D., B. E. Reiman, and M. K. Young. 2009. Focus: Invasive Species Managing for native trout. 1523-1739 (Electronic)

0888-8892 (Linking), U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Air, Water and Aquatic Environments Science Program, Fort Collins, CO.

Peterson, D. P., B. E. Rieman, M. K. Young, and J. A. Brammer. 2010. Modeling predicts that redd trampling by cattle may contribute to population declines of native trout. Ecological Applications 20:954-966.

Pfister, R. D., and S. F. Arno. 1980. Classifying forest habitat types based on potential climax vegetation. Forest Science 26:52-70.

Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. Gen. Tech. Rep. INT-GTR-34, U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Piekielek, N. B., A. J. Hansen, and T. Chang. 2015. Using custom scientific workflow software and GIS to inform protected area climate adaptation planning in the greater Yellowstone ecosystem. Ecological Informatics 30:40-48.

Pierce, K. L., J. D. Obradovich, and I. Friedman. 1976. Obsidian hydration dating and correlation of Bull Lake and Pinedale Glaciations near West Yellowstone, Montana. Geological Society of America Bulletin 87:703-710.

Pierce, R., and C. Podner. 2013. Fisheries investigations in the Big Blackfoot River basin, 2011-2012. Montana Fish, Wildlife and Parks, Missoula, MT.

Pierson, D., H. Peter-Contesse, R. D. Bowden, K. Nadelhoffer, K. Kayhani, L. Evans, and K. Lajtha. 2021. Competing Processes Drive the Resistance of Soil Carbon to Alterations in Organic Inputs. Frontiers in Environmental Science 9.

Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics 52:273-288.

Platt, W. S. 1991. Livestock grazing. Pages 389-423 *in* W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society, Bethesda, MD.

Pollinator Health Task Force. 2016. Pollinator partnership action plan. U.S. Environmental Protection Agency, Washington, DC.

Pollnac, F. W., and L. J. Rew. 2014. Life after establishment: factors structuring the success of a mountain invader away from disturbed roadsides. Biological Invasions 16:1689-1698.

Pollock, M. M., T. J. Beechie, and H. Imaki. 2012. Using reference conditions in ecosystem restoration: an example for riparian conifer forests in the Pacific Northwest. Ecosphere 3:art98.

Pollock, M. M., T. J. Beechie, J. M. Wheaton, C. E. Jordan, N. Bouwes, N. Weber, and C. Volk. 2014. Using beaver dams to restore incised stream ecosystems. BioScience 64:279-290.

Pollock, M. M., M. Heim, and D. Werner. 2003. Hydrologic and geomorphic effects of beaver dams and their influence on fishes. American Fisheries Society Symposium 37:1-21.

Pollock, M. M., G. Lewallen, K. Woodruff, C. E. Jordan, and J. M. Castro. 2015. The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains, Version 1.0. U.S. Department of Interior, Fish and Wildlife Service, Portland, OR.

Polvi, L. E., and E. Wohl. 2012. The beaver meadow complex revisited - the role of beavers in post-glacial floodplain development. Earth Surface Processes and Landforms 37:332-346.

_____. 2013. Biotic Drivers of Stream Planform: Implications for Understanding the Past and Restoring the Future. BioScience 63:439-452.

Post-Leon, A. C., M. Dryak, E. Zhu, M. E. De Guzman, R. Salladay, M. A. Moritz, A.-M. L. Parkinson, and A. R. Ramirez. 2022. Integration of landscape-level remote sensing and tree-level ecophysiology reveals drought refugia for a rare endemic, bigcone Douglas-fir. Frontiers in Forests and Global Change 5.

Potyondy, J. P., and T. W. Geier. 2011. Watershed condition classification technical guide. Report FS-978.

Powers, P., and J. F. Orsborn. 1985. New concepts in fish ladder design: Analysis of bariers to upstream fish migration, volume IV of IV. Investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Final report 1982-1984. BPA Report DOE/BP-36523-1), Bonneville Power Administration, Portland, OR.

Powers, P. D., M. Helstab, and S. L. Niezgoda. 2018. A process-based approach to restoring depositional river valleys to Stage 0, an anastomosing channel network. River Research and Applications 35:3-13.

Powers, R. F. Are we maintaining the productivity of forest lands? Establishing guidlines through a network of long-term studies. April 10-12 1990.

Prabhakar, A., and B. Mallory. 2022. Memorandum for heads of Federal departments and agencies: guidance for Federal departments and agencies on indigenous knowledge. Executive Office of the President of the United States, Office of Science and Technology, Council on Enviornmental Quality, Washington, D.C.

Prichard, S. J., C. S. Stevens-Rumann, and P. F. Hessburg. 2017. Tamm Review: Shifting global fire regimes: Lessons from reburns and research needs. Forest Ecology and Management 396:217-233.

Puttock, A., H. A. Graham, J. Ashe, D. J. Luscombe, and R. E. Brazier. 2021. Beaver dams attenuate flow: A multi-site study. Hydrological Processes 35:1-18.

Quigley, T. M., and S. J. t. e. Arbelbide. 1997. An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins: Volume 2. Gen. Tech. Rep. PNW-GTR-405, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Ramsey, J., K. Carson, E. Almberg, M. Thompson, R. Mowry, L. Bradley, J. Kolbe, and C. Jourdonnais. 2016. Status of western Montana bighorn sheep herds and discussion of control efforts after all-age die-offs. Pages 19-37 *in* R. Harris, editor. Proceedings of the Biennial Symposium of the Northern Wild Sheep and Goat Council. Northern Wild Sheep and Goat Council, Bozeman, MT.

Reeves, D., D. Page-Dumroese, and M. Coleman. 2011. Detrimental soil disturbance associated with timber harvest systems on national forests in the northern region. Research Paper RMRS-RP-89, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Reeves, M. C., M. E. Manning, J. P. DiBenedetto, K. A. Palmquist, W. K. Lauenroth, J. B. Bradford, and D. R. Schlaepfer. 2018. Chapter 6: Effects of climate change on rangeland vegetation in the Northern Rockies. Pages 97-114 *in* J. E. Halofsky, and D. L. Peterson, editors. Climate change and Rocky Mountain ecosystems. Springer, Cham, Switzerland.

Reichel, J. D. 1995. Preliminary amphibian and reptile survey of the Sioux District of the Custer National Forest: 1994. Montana Natural Heritage Program, Helena, MT.

Reinhardt, E. D., R. E. Keane, D. E. Calkin, and J. D. Cohen. 2008. Objectives and considerations for wildland fuel treatment in forested ecosystems of the interior western United States. Forest and Ecology Management 256:1997-2006.

Retzlaff, M. L., S. B. Leirfallom, and R. E. Keane. 2016. A 20-year reassessment of the health and status of whitebark pine forests in the Bob Marshall Wilderness Complex, Montana, USA. Research Note RMRS-RN-73, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Rice, P. M., J. C. Toney, D. J. Bedunah, and C. E. Carlson. 1997. Elk winter forage enhancement by herbicide control of spotted knapweed. Wildlife Society Bulletin 25:627-633.

Rieman, B. E., and K. A. Apperson. 1989. Status and analysis of salmonid fisheries: Westslope cutthroat trout synopsis and analysis of fishery information. Report Project F·73·R·11, Subproject No. II, Job No. 1.

Rieman, B. E., and D. J. Isaak. 2010. Climate change, aquatic ecosystems, and fishes in the Rocky Mountain West: Implications and alternatives for management. Gen. Tech. Rep. RMRS-GTR-250, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Rieman, B. E., and J. D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. Gen. Tech. Rep. INT-GTR-302, U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Rittel, H. W. J., and M. M. Webber. 1973. Dilemmas in a General Theory of Planning. Policy Sciences 4:155-169.

Roberts, D. W. 2022. Potential Vegetation Types (PVT) for the Northern Region. Montana State University, Ecology Department. Bozeman, MT.

Rood, S. B., J. H. Braatne, and F. M. Hughes. 2003. Ecophysiology of riparian cottonwoods: stream flow dependency, water relations and restoration. Tree Physiology 23:1113-1124.

Roper, B. B., J. M. Capurso, Y. Paroz, and M. K. Young. 2018. Conservation of aquatic biodiversity in the context of multiple-use management on National Forest System lands. Fisheries 43:396-405.

Roper, B. B., W. C. Saunders, and J. V. Ojala. 2019. Did changes in western federal land management policies improve salmonid habitat in streams on public lands within the Interior Columbia River Basin? Environmental Monitoring and Assessment 191:574.

Rosenberger, R. S., E. M. White, J. D. Kline, and C. Cvitanovich. 2017. Recreation economic values for estimating outdoor recreation economic benefits from the national forest system. Gen. Tech. Rep. PNWGTR-957, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Rothbaum, J., J. Eggleston, A. Bee, M. Klee, and B. Mendez-Smith. 2021. Addressing Nonresponse Bias in the American Community Survey During the Pandemic Using Administrative. 2021 AMERICAN COMMUNITY SURVEY RESEARCH AND EVALUATION REPORT MEMORANDUM SERIES # ACS21-RER-05 SEHSD Working Paper #2021-24, Washington, DC.

Roulston, T. H., and K. Goodell. 2011. The role of resources and risks in regulating wild bee populations. Annual Review of Entomology 56:293-312.

Roy, C. L., V. St-Louis, and J. House. 2016. Seasonal distribution of the invasive snail, Bithynia tentaculata, within infested waterbodies in Minnesota, USA, including waterfowl migration. Biological Invasions 18:2923-2941.

Ruiz-Fons, F., J. Segales, and C. Gortazar. 2008. A review of viral diseases of the European wild boar: effects of population dynamics and reservoir role. Veterinary Journal 176:158-169.

Runge, C. A., A. J. Plantinga, A. E. Larsen, D. E. Naugle, K. J. Helmstedt, S. Polasky, J. P. Donnelly, J. T. Smith, T. J. Lark, J. J. Lawler, S. Martinuzzi, J. Fargione, and M. Maron. 2018. Unintended habitat loss on private land from grazing restrictions on public rangelands. Journal of Applied Ecology 56:52-62.

Running, S. W. 2006. Is global warming causing more, larger wildfires? Science 313:927-928.

Russell, K. R., D. H. Van Lear, and D. C. Guynn, Jr. 1999. Prescribed fire effects on herpetofauna: Review and management implications. Wildlife Society Bulletin 27:374-384.

Ryan, M. G., and J. M. Vose. 2012. Chapter 2: Effects of climatic variability and change. Pages 7-95 *in* J. M. Vose, D. L. Peterson, and T. Patel-Weynand, editors. Effects of climatic variability and change on forest ecosystems: A comprehensive science synthesis for the U.S. forest sector. Gen. Tech. Rep. PNW-GTR-870. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Ryan, R. L. 2005. Social science to improve fuels management: a synthesis of research on aesthetics and fuels management. Gen. Tech. Rep. NC-GTR-261, U.S. Department of Agriculture, Forest Service, North Central Research Station, St. Paul, MN.

Safranyik, L., R. Nevill, and D. Morrison. 1998. Effects of stand density management on forest insects and diseases. Technology Transfer Note 12, Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre., Victoria, BC.

Sahinen, U. M. 1957. Mines and mineral deposits Missoula and Ravalli County, Montana. Bulletin No. 8, State of Montana Bureau of Mines and Geology, Butte, MT.

Sallabanks, R., B. G. Marcot, R. A. Riggs, C. A. Mehl, and E. B. Arnett. 2001. Chapter 8: Wildlife of eastside (interior) forests and woodlands. Pages 213-224 *in* D. H. Johnson, and T. A. O'Neil, editors. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Sánchez-Montoya, M. M., M. Moleón, J. A. Sánchez-Zapata, and K. Tockner. 2016. Dry riverbeds: corridors for terrestrial vertebrates. Ecosphere 7:1-10.

Sasich, J., and K. Lamotte-Hagen. 1989. Lolo National Forest land systems inventory.

Sauder, J. D., and J. L. Rachlow. 2014. Both forest composition and configuration influence landscape-scale habitat selection by fishers (*Pekania pennanti*) in mixed coniferous forests of the Northern Rocky Mountains. Forest Ecology and Management 314:75-84.

Sauer, J. S., R. A. Cole, and J. M. Nissen. 2007. Finding the exotic faucet snail (Bithynia tentaculata) waterbird dieoffs upper Mississippi River national wildlife and fish refugee. Report 2007–1065.

Schaffers, A. P., I. P. Raemakers, and K. V. Sýkora. 2011. Successful overwintering of arthropods in roadside verges. Journal of Insect Conservation 16:511-522.

Schlosser, I. J. 1995. Dispersal, boundary processes, and trophic-level interactions in streams adjacent to beaver ponds. Ecology 76:908-925.

Schlosser, I. J., and L. W. Kallemeyn. 2000. Spatial variation in fish assemblages across a beaver-influenced successional landscape. Ecology 81:1371-1382.

Schmechel, J. 2015. An environmental and hydrogeological investigation in the South Hebgen Basin, Montana. University of Montana, Missoula, MT.

Schmetterling, D. A. 2003. Reconnecting a fragmented river: Movements of westslope cutthroat trout and bull trout after transport upstream of Milltown Dam, Montana. North American Journal of Fisheries Management 23:721-731.

Schmidt, K. M., J. P. Menakis, C. C. Hardy, W. J. Hann, and D. L. Bunnel. 2002. Development of course-scale spatial data for wildland fire and fuel management. Gen. Tech. Rep. RMRS-GTR-87, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Schmidt, M. W. I., M. S. Torn, S. Abiven, T. Dittmar, G. Guggenberger, I. A. Janssens, M. Kleber, I. Kogel-Knabner, J. Lehmann, D. A. C. Manning, P. Nannipieri, D. P. Rasse, S. Weiner, and S. E. Trumbore. 2011. Persistence of soil organic matter as an ecosystem property. Nature 478:49-56.

Schock, N. T., A. J. Reisinger, L. S. Reisinger, M. J. Cooper, J. J. H. Cibrowski, T. M. Gehring, A. H. Moerke, C. R. Ruetz, and D. G. Uzarski. 2019. Relationships between the distribution and abundance of the invasive faucet snail (Bithynia tentaculata) and environmental factors in Laurentian Great Lakes coastal wetlands. Biological Invasions 21:2613-2628.

Schoennagel, T., T. T. Veblen, and W. H. Romme. 2004. The interaction of fire, fuels, and climate across Rocky Mountain forests. BioScience 54:661-676.

Schwartz, C. C., S. D. Miller, and M. A. Haroldson. 2003. Grizzly bear (*Ursus arctos*). Pages 556-586 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, editors. Wild Mammals of North America: Biology, Management, and Conservation. Johns Hopkins University Press, Baltimore, MD.

Schwartz, M. K., N. J. DeCesare, B. S. Jimenez, J. P. Copeland, and W. E. Melquist. 2013. Stand- and landscape-scale selection of large trees by fishers in the Rocky Mountains of Montana and Idaho. Forest Ecology and Management 305:103-111.

Sepulveda, A. J., and W. H. Lowe. 2009. Local and landscape-scale influences on the occurrence and density of dicamptodon aterrimus, the Idaho Giant Salamander. Journal of Herpetology 43:469-484.

Servheen, C. 1981. Grizzly bear ecology and management in the Mission Mountains, Montana. PhD dissertation, University of Montana, Missoula, MT.

_____. 1983. Grizzly bear food habits, movements, and habitat selection in the Mission Mountains, Montana. Journal of Wildlife Management 47:1026-1035.

_____. 1996. Grizzly bear recovery plan. Supplement: Bitterroot ecosystem recovery plan chapter. U.S. Fish and Wildlife Service, Forestry Sciences Laboratory, University of Montana, Missoula, MT.

Servheen, C., and M. Cross. 2010. Climate change impacts on grizzly bears and wolverines in the Northern U.S. and transboundary Rockies: Strategies for conservation. Report on a workshop held Sept. 13-15, 2010 in Fernie, British Columbia. U.S. Fish and Wildlife Service and Wildlife Conservation Society. Missoula, MT.

Servheen, C., J. S. Waller, and P. Sandstrom. 2003. Identification and management of linkage zones for wildlife between the large blocks of public land in the northern Rocky Mountains.

Shanafield, M., S. A. Bourke, M. A. Zimmer, and K. H. Costigan. 2021. An overview of the hydrology of non-perennial rivers and streams. WIREs Water 8:1-25.

Shepard, B. B., B. E. May, and W. Urie. 2003. Status of westslope cutthroat trout (*Oncorhynchus clarki lewisi*) in the United States: 2002. Montana Department of Fish, Wildlife, and Parks and the Montana Cooperative Fishery Research Unit, Bozeman, MT.

_____. 2005. Status and conservation of westslope cutthroat trout within the western United States. North American Journal of Fisheries Management 25:1426-1440.

Shepperd, W. D., D. L. Bartos, and S. A. Mata. 2001. Above- and below-ground effects of aspen clonal regeneration and succession to conifers. Canadian Journal of Forest Research 31:739-745.

Sherwood, P., C. Villari, P. Capretti, and P. Bonello. 2015. Mechanisms of induced susceptibility to Diplodia tip blight in drought-stressed Austrian pine. Tree Physiology 35:549-562.

Silverman, N. L., B. W. Allred, J. P. Donnelly, T. B. Chapman, J. D. Maestas, J. M. Wheaton, J. White, and D. E. Naugle. 2019. Low-tech riparian and wet meadow restoration increases vegetation productivity and resilience across semiarid rangelands. Restoration Ecology 27:269-278.

Singer, F. J., L. C. Zeigenfuss, and L. Spicer. 2001. Role of patch size, disease, and movement in rapid extinction of bighorn sheep. Conservation Biology 15:1347-1354.

Skog, K. E., D. B. McKeever, P. J. Ince, J. L. Howard, H. N. Spelter, and A. T. Schuler. 2012. Status and trends for the U.S. forest products sector: A technical document supporting the Forest Service 2010 RPA assessment. Gen. Tech. Rep. FPL-GTR-207, U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, WI.

Smallidge, P. J., and D. J. Leopold. 1997. Vegetation management for the maintenance and conservation of butterfly habitats in temperate human-dominated landscapes. Landscape and Urban Planning 38:259-280.

Smith, D. M., K. P. Driscoll, S. D. Warren, and D. M. Finch. 2020. Riparian and groundwater-dependent ecosystems of the Bridger-Teton National Forest: An assessment of resources and current conditions. Report Gen. Tech. Rep. RMRS-GTR-407.

Smith, K. G., and R. J. Almeida. 2020. When are extinctions simply bad luck? Rarefaction as a framework for disentangling selective and stochastic extinctions. Journal of Applied Ecology 57:101-110.

Smith, T. S., J. T. Flinders, and D. S. Winn. 1991. A habitat evaluation procedure for Rocky Mountain bighorn sheep in the intermountain west. Great Basin Naturalist 51:205-225.

Smith, T. W. 2021. Management and conservation of westslope cutthroat trout in an impacted, connected river system. Master's thesis, University of Montana, Missoula, MT.

Somodi, I., Z. Molnar, and J. Ewald. 2012. Towards a more transparent use of the potential natural vegetation concept – an answer to Chiarucci et al. Journal of Vegetation Science 23:590-595.

Sperazza, L. J., and P. Banerjee. 2010. Boomers and seniors: The driving force behind leisure participation. Pages 70-74 *in* C. E. J. Watts, and C. L. Fisher, editors. Proceedings of the 2009 Northeastern Recreation Research Symposium; 2009 March 29-30; Bolton Landing, NY. Gen. Tech. Rep. NRS-P-66. U.S. Department of Agriculture, Forest Service, Northern Research Station, Newtown Square, PA.

Spies, T. A. 2004. Ecological concepts and diversity of old-growth forests. Journal of Forestry 102:14-20.

Spreitzer, P. N. 1985. Transitory range: A new frontier. Rangelands 7:33-34.

Squires, J. R., N. J. Decesare, J. A. Kolbe, and L. F. Ruggiero. 2010. Seasonal resource selection of Canada lynx in managed forests of the northern Rocky Mountains. Journal of Wildlife Management 74:1648-1660.

Squires, J. R., N. J. DeCesare, L. E. Olson, J. A. Kolbe, M. Hebblewhite, and S. A. Parks. 2013. Combining resource selection and movement behavior to predict corridors for Canada lynx at their southern range periphery. Biological Conservation 157:187-195.

Stagliano, D. M. 2015. Re-evaluation and trend analysis of western pearlshell mussel (SWG tier 1) populations across watersheds of western Montana.

_____. 2023. Western pearlshell mussel populations across USFA Lolo RD watersheds of western Montana: current viability and trend analysis.

Stanek, J. E., S. E. Mcneil, D. Tracy, J. R. Stanek, J. A. Manning, and M. D. Halterman. 2021. Western Yellow-Billed Cuckoo Nest-Site Selection and Success in Restored and Natural Riparian Forests. Journal of Wildlife Management n/a:1-12.

Stankey, G. H., D. N. Cole, R. C. Lucas, M. E. Petersen, and S. S. Frissell. 1985. The Limits of Acceptable Change (LAC) System for Wilderness Planning. Pages 1-34 *in* The Limits of Acceptable Change (LAC) System for Wilderness Planning. Gen. Tech. Rep. INT-176. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Steffan-Dewenter, I., and T. Tscharntke. 1999. Effects of habitat isolation on pollinator communities and seed set. Oecologia 121:432-440.

Stephens, S. L., B. M. Collins, C. J. Fettig, M. A. Finney, C. M. Hoffman, E. E. Knapp, M. P. North, H. Safford, and R. B. Wayman. 2018. Drought, tree mortality, and wildfire in forests adapted to frequent fire. BioScience 68:77-88.

Stephens, S. L., J. D. Mciver, R. E. Boerner, J., C. J. Fettig, J. B. Fontaine, B. R. Hartsough, P. L. Kennedy, and D. W. Schwilk. 2012. The effects of forest fuel-reduction treatments in the United States. BioScience 62:549-560.

Stern, M. J., and T. D. Baird. 2015. Trust ecology and the resilience of natural resource management institutions. Ecology and Society 20:1-12.

Stevens-Rumann, C. S., K. B. Kemp, P. E. Higuera, B. J. Harvey, M. T. Rother, D. C. Donato, P. Morgan, and T. T. Veblen. 2018. Evidence for declining forest resilience to wildfires under climate change. Ecology Letters 21:243-252.

Steward, A. L., D. von Schiller, K. Tockner, J. C. Marshall, and S. E. Bunn. 2012. When the river runs dry: human and ecological values of dry riverbeds. Frontiers in Ecology and the Environment 10:202-209.

Stewart, I. T., D. R. Cayan, and M. D. Dettinger. 2005. Changes toward earlier streamflow timing across western North America. Journal of Climate 18:1136-1155.

Stine, P., P. Hessburg, T. Spies, M. Kramer, C. J. Fettig, A. Hansen, J. Lehmkuhl, K. O'Hara, K. Polivka, P. Singleton, S. Charnley, A. Merschel, and R. White. 2014. The ecology and management of moist mixed-conifer forests in eastern Oregon and Washington: A Synthesis of the relevant biophysical science and implications for future land management. Gen. Tech. Rep. PNW-GTR-897, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Stoddard, J. L., D. P. Larsen, C. P. Hawkins, R. K. Johnson, and R. H. Norris. 2006. Setting expectations for the ecological condition of streams: the concept of reference condition. Ecological Applications 16:1267-1276.

Strait, J. T., L. A. Eby, R. P. Kovach, C. C. Muhlfeld, M. C. Boyer, S. J. Amish, S. Smith, W. H. Lowe, and G. Luikart. 2021. Hybridization alters growth and migratory life-history expression of native trout. Evolutionary Applications 14:821-833.

Strayer, D. L. 2006. Challenges for freshwater invertebrate conservation. Journal of the North American Benthological Society 25:271-287.

_____. 2010. Alien species in fresh waters: ecological effects, interactions with other stressors, and prospects for the future. Freshwater Biology 55:152-174.

Sturrock, R. N., S. J. Frankel, A. V. Brown, P. E. Hennond, J. T. Kliejunas, K. J. Lewis, J. J. Worrall, and A. J. Woods. 2011. Climate change and forest diseases. Plant Pathology 60:133-149.

Swanson, D. K., C. L. Schmitt, D. M. Shirley, V. Eickson, K. J. Schuetz, M. L. tatum, and D. C. Powell. 2010. Aspen biology, community classification, and management in the Blue Mountains. Gen. Tech. Rep. PNW-GTR-806, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Sylte, T. 2020. Reference conditions for unconstrained beaver populations in various stream habitats in zero to third order streams in Colorado, Montana, and Canada. U.S. Department of Agriculture,, Forest Service.

Theobald, D. M., C. Kennedy, B. Chen, J. Oakleaf, S. Baruch-Mordo, and J. Kiesecker. 2020. Earth transformed: detailed mapping of global human modification from 1990 to 2017. Earth System Science Data 12:1953-1972.

Thomas, J. W., L. F. Ruggiero, R. W. Mannan, J. W. Schoen, and R. A. Lancia. 1988. Management and conservation of old-growth forests in the United States. Wildlife Society Bulletin 16:252-262.

Thompson, W. L. 2004. Sampling rare or elusive species: concepts, designs, and techniques for estimating population parameters. Island Press, Washington D.C.

Tirmenstein, D. 2000. *Festuca altaica, F. campestris, F. hallii*. *in* Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Tomback, D. F., S. F. Arno, and R. E. Keane, (Eds.). 2001. Whitebark pine communities: Ecology and restoration. Inland Press, Washington, DC.

Tomback, D. F., and K. C. Kendall. 2001. Biodiversity losses: The downward spiral. Pages 243-262 *in* D. F. Tomback, S. F. Arno, and R. E. Keane, editors. Whitebark pine communities: Ecology and restoration. Island Press, Washington, DC.

Tomback, D. F., and E. Sprague. 2022. The National Whitebark Pine Restoration Plan: Restoration model for the high elevation five-needle white pines. Forest Ecology and Management 521:2-12.

Tremblay, M. E. M., T. J. Morris, and J. D. Ackerman. 2016. Loss of reproductive output caused by an invasive species. Royal Science Open Science 3:1-10.

Trosper, R. L., J. A. Parrotta, M. B. Agnoletti, Vladimir, S. A. Feary, M. Gabay, C. Gamborg, J. Garc a Latorre, E. Johann, A. Laletin, H. F. Lim, A. Oteng-Yeboah, M. A. Pinedo-Vasquez, P. S. Ramakrishnan, and Y.-C. Youn. 2012. The unique character of traditional forest-related knowledge: threats and challenges ahead. Pages 563-588 *in* J. A. Parrotta, and R. L. Trosper, editors. Traditional forest-related knowledge: sustaining communities, ecosystems and biocultural diversity. Springer Dordrecht.

Tubiello, F. N., M. Salvatore, S. Rossi, A. Ferrara, N. Fitton, and P. Smith. 2013. The FAOSTAT database of greenhouse gas emissions from agriculture. Environmental Research Letters 8:1-10.

Turner, M. G., K. H. Braziunas, W. D. Hansen, and B. J. Harvey. 2019. Short-interval severe fire erodes the resilience of subalpine lodgepole pine forests. Proceedings of the National Academy of Sciences 116:11319-11328.

Turner, M. G., D. C. Donato, and W. H. Romme. 2013. Consequences of spatial heterogeneity for ecosystem services in changing forest landscapes: Priorities for future research. Landscape Ecology 28:1081-1097.

Turner, M. G., R. H. Gardner, and R. V. O'Neill. 2001. Landscape ecology in theory and practice: Pattern and process. Springer Science+Business Media, Inc., New York, NY.

Tyser, R. W., and C. A. Worley. 1992. Alien flora in grasslands adjacent to road and trail corridors in Glacier National Park, Montana (U.S.A.). Conservation Biology 6:253-262.

U. S. Department of Agriculture, Forest Service. 2007. Recreation facility analysis.

_____. 2023a. Draft Lolo National Forest potential species of conservation concern list and rationale: animals. U. S. Department of Agriculture, Forest Service, Missoula, MT.

_____. 2023b. Draft Lolo National Forest potential species of conservation concern list and rationale: plants. U. S. Department of Agriculture, Forest Service, Missoula, MT.

U. S. Department of Agriculture, A. a. P. H. I. S. 2021. Predator damange and conflict management in Montana. U. S. Department of Agriculture, Animal and Plant Health Inspection Service.

U.S. Department of Agriculture, Forest Service. 1992. Limits of Acceptable Change based Management Direction - Rattlesnake National Recreation Area and Wilderness. U. S. Department of Agriculture,, Forest Service, Lolo National Forest, Missoula, Montana.

_____. 1995a. Landscape Aesthetics: A handbook for scenery management. Agriculture Handbook Number 701, U.S. Department of Agriculture, Forest Service, Mt. Shasta, CA.

_____. 2001. Special areas; roadless area conservation. Final rule and record of decision. Federal Register 66:3244-3273.

_____. 2003. An assessment of ecosystem components in the Upper Missouri River Basin. U.S. Department of Agriculture, Forest Service, Washington, DC.

_____. 2005. Biophysical classification- Habitat type groups and descriptions of northern Idaho and northwestern Montana, Lower Clark Fork and adjacent areas. Numbered Report 09-08 v1.0, U.S. Department of Agriculture, Forest Service, Northern Region, Missoula, MT.

_____. 2011a. Final supplemental environmental impact statement forest plan amendments for motorized access management within the Selkirk and Cabinet-Yaak grizzly bear recovery zones. U.S. Department of Agriculture, Forest Service, Coeur d'Alene, ID.

_____. 2011b. Watershed condition framework: A framework for assessing and tracking changes to watershed condition. FS-977, Washington, DC.

_____. 2012a. Groundwater-dependent ecosystems: Level 1 inventory field guide - inventory methods for assessment and planning. General Techical Report WO-86a, U.S. Department of Agriculture, Forest Service, Washington, DC.

_____. 2012b. National best management practices for water quality management on National Forest system lands. Volume 1: National Core BMP Technical Guide. FS-990a, Washington, DC.

_____. 2015a. Baseline estimates of carbon stocks in forests and harvested wood products for National Forest System units; Pacific Northwest Region. U.S. Department of Agriculture, Forest Service, Climate Change Advisor's Office, Office of the Chief, Washington, DC.

_____. 2016. Future of America's forests and rangelands: Update to the Forest Service 2010 resources planning act assessment. Gen. Tech. Rep. WO-94, U.S. Department of Agriculture, Forest Service, Research and Development, Washington, DC.

_____. 2020. National scenery management system inventory mapping protocols. U.S. Department of Agriculture, Forest Service.

_____. 2021a. U.S. Forest Service national visitor use monitoring survey results national summary report: data collected fy 2017 through fy 2021. U. S. Department of Agriculture, Forest Service.

_____. 2022a. Biennial Monitoring Evaluation Report (BMER) for the Idaho Panhandle National Forests. April edition., U.S. Department of Agriculture, Forest Service, Idaho Panhandle National Forests, Coeur d'Alene, ID.

_____. 2022b. Confronting the wildfire crisis: A strategy for protecting communities and improving resilience in America's forests. FS-1187a, U. S. Department of Agriculture, Forest Service, Washington, D.C.

_____. 2022c. Confronting the Wildfire Crisis: Initial landscape investments to protect communities and improve resilience in America's forests. April edition. Wildfire Crisis, Landscape Investments FS-1187d, U. S. Department of Agriculture, Forest Service, Washington, D.C.

_____. 2022d. Limits of acceptable change-based management historical report: Rattlesnake national recreation area and wilderness. U.S. Department of Agriculture, Forest Service, Missoula, Montana.

_____. 2023a. Visitor use report, Lolo NF, USDA Forest Service Region 1, national visitor use monitoring data collected FY 2006. U.S. Department of Agriculture,, Forest Service, Natural Resource Manager, National Visitor Use Monitoring Program, Washington, D.C.

_____. 2023b. Visitor use report, Lolo NF, USDA Forest Service Region 1, national visitor use monitoring data collected FY 2011. U.S. Department of Agriculture,, Forest Service, Natural Resource Manager, National Visitor Use Monitoring Program, Washington, D.C.

_____. 2023c. Visitor use report, Lolo NF, USDA Forest Service region 1, national visitor use monitoring data collected FY 2016. U.S. Department of Agriculture, Forest Service, National Visitor User Use Monitoring Program, Washington, D.C.

U.S. Department of Agriculture, Forest Service,. 2022e. Confronting the wildfire crisis: A chronicle from the national fire plan to the wildfire crisis strategy. USDA Forest Service.

U.S. Department of Agriculture, Forest Service, Bitterroot National Forest. 2021b. Biennial Monitoring Evaluation Report for the Bitterroot National Forest: Fiscal Year 2021. U.S. Department of Agriculture, Forest Service, Northern Region, Hamilton, MT.

U.S. Department of Agriculture, Forest Service, Intermountain, Northern, and Pacific Northwest Regions. 1995b. Decision Notice and Finding of No Significant Impact for the Inland Native Fish Strategy: Interim strategies for managing fish-producing watersheds in eastern Oregon and Washington, Idaho, western Montana, and portions of Nevada. M4-37, Couer D'Alene, ID.

U.S. Department of Agriculture, Forest Service, Lolo National Forest. 2015b. Travel analysis report for Lolo National Forest. Missoula, MT.

U.S. Department of Agriculture, Forest Service, Northern Region, and U.S. Department of the Interior, Fish and Wildlife Service, Montana Field Office. 2013. Conservation strategy for bull trout on USFS lands in western Montana.

U.S. Department of Agriculture, F. S. 2022f. Lolo National Forest 2021 Biennial Monitoring and Evaluation Report. February 2022 edition. R1-22-10, U.S. Department of Agriculture, Forest Service, Northern Region, Missoula, Montana.

U.S. Department of Agriculture, F. S., and B. o. L. M. U.S. Department of the Interior. 2023. Mature and Old-Growth Forests: Definition, Identification, and InitialInventory on Lands Managed by the Forest Service and Bureau of Land Management. Fulfillment of Executive Order 14072, Section 2(b). FS-1215a, U.S. Department of Agriculture, Forest Service, Washington D.C.

U.S. Department of the Interior, Fish and Wildlife Service. 1993. Grizzly bear recovery plan.

_____. 2007. Recovery plan for Silene spaldingii (Spalding's catchfly). U.S. Department of the Interior, Fish and Wildlife Service, Region 1, Portland, OR.

_____. 2013a. Draft recovery outline, North American wolverine (Gulo gulo luscus), contiguous United States distinct population segment. U.S. Department of the Interior, Fish and Wildlife Service, Montana Ecological Services Field Office, Helena, MT.

_____. 2013b. Endangered and threatened wildlife and plants; Threatened status for the distinct population segment of the North American wolverine occurring in the contiguous United States; Establishment of a nonessential experimental population of the North American wolverine in Colorado, Wyoming, and New Mexico; Proposed rules. Federal Register 78:7864-7890.

_____. 2014. Endangered and threatened wildlife and plants; threatened status for the distinct population segment of the North American wolverine occurring in the contiguous United States; establishment of a nonessential experimental population of the North American wolverine in Colorado, Wyoming, and New Mexico; Proposed rules; withdrawl. Federal Register 79:47522-47545.

_____. 2015. The National Wetlands Inventory. Pages 19 *in*, Washington, DC.

_____. 2016. Endangered and Threatened Wildlife and Plants; Proposed Rule for the North American Wolverine. Federal Register 81:71670-71671.

_____. 2017a. Northern Rockies Lynx Management Direction. 06E11000-2017-F-0198 NRLMD 2017 amended incidental take statement, U.S. Department of the Interior, Fish and Wildlife Service, Ecological Services, Montana Field Office, Helena, MT.

_____. 2017b. Species status assessment for the Canada lynx (Lynx canadensis) contiguous United States distinct population segment. Version 1.0. U.S. Fish and Wildlife Service, Regions 1, 3, 5 and 6, Lakewood, CO.

_____. 2018a. Species status assessment report for the North American wolverine (Gulo gulo luscus). Version 1.2. U.S. Department of the Interior, Fish and Wildlife Service, Mountain-Prairie Region, Lakewood, CO.

_____. 2018b. Species Status Assessment Report for the Whitebark Pine, *Pinus albicaulis*. Wyoming Ecological Services Field Office, U.S. Fish and Wildlife Service, Cheyenne, Wyoming.

_____. 2020a. 5-year review Spalding's catchfly (*Silene spaldingii)*. Current Classification: Threatened. U.S. Department of the Interior, Fish and Wildlife Service, Idaho Fish and Wildlife Office, Boise, ID.

_____. 2020b. Endangered and threatened wildlife and plants; Withdrawal of the proposed rule for the North American wolverine. Federal Register 85:64618-64648.

_____. 2020c. Monarch (Danaus plexippus) Species Status Assessment Report V2.1. U.S. Department of the Interior, FIsh and Wildlife Service SSA Core Team.

_____. 2022a. Endangered and threatened wildlifeand plants; threatened species status with section 4(d) rule for whitebarkpine (Pinus albicaulis). Final Rule. Federal Register 87:76882-76917.

_____. 2022b. Species status assessment for the grizzly bear (Ursus arctos horribilis) in the lower-48 states. Version 1.2, U.S. Department of the Interior, Fish and Wildlife Service, Grizzly Bear Recovery Office, Missoula, MT.

U.S. Department of the Interior, and U.S. Department of Agriculture. 1995. Federal wildland fire management policy & program review: Final report.

United States Department of Agriculture, Forest Service. 1991. Lolo National Forest Plan: Amendment 12 Wild and Scenic Rivers Eligibility Study DN, FONSI, and EA. United States Department of Agriculture, Forest Service, Lolo National Forest, Missoula, MT.

van Mantgem, P. J., N. L. Stephenson, J. C. Byrne, L. D. Daniels, J. F. Franklin, P. Z. Fule, M. E. Harmon, A. J. Larson, J. M. Smith, A. H. Taylor, and T. T. Veblen. 2009. Widespread increase of tree mortality rates in the western United States. Science 323:521-524.

Vavra, M., C. G. Parks, and M. J. Wisdom. 2007. Biodiversity, exotic plant species, and herbivory: The good, the bad, and the ungulate. Forest Ecology and Management 246:66-72.

Vigerstol, K., R. Abell, K. Brauman, W. Buytaert, and A. L. Vogl. 2021. Chapter 3: Addressing water security through nature-based solutions. Pages 37-62 *in* J. Cassin, J. H. Mathews, and E. L. Gunn, editors. Nature-based Solutions and Water Security. Elesevier Inc.

Vose, J. M., D. L. Peterson, G. M. Domke, C. J. Fettig, L. A. Joyce, R. E. Keane, C. H. Luce, J. P. Prestemon, L. E. Band, J. S. Clark, N. E. Cooley, A. D'Amato, and J. E. Halofsky. 2018. Chapter 6: Forests. Pages 232-267 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: Fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, DC.

Vose, J. M., D. L. Peterson, and T. Patel-Weynand. 2012. Effects of climatic variability and change on forest ecosystems: A comprehensive science synthesis for the U.S. forest sector. Gen. Tech. Rep. PNW-GTR-870, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Wade, A. A., C. Brick, S. Spaulding, T. Sylte, and J. Louie. 2016. Watershed climate change vulnerability assessment: Lolo National Forest. R1-16-05, U.S. Department of Agriculture, Forest Service, Northern Region, Lolo National Forest, Missoula, MT.

Wakkinen, W. L., and W. F. Kasworm. 1997. Grizzly bear and road density relationships in the Selkirk and Cabinet-Yaak recovery zones. Idaho Department of Fish and Game, Bonners Ferry, ID.

Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzing. 2004. Resilience, adaptability and transformability in social–ecological systems [Online]. Ecology and Society 9:5.

Wallace, R. E., and J. W. Hosterman. 1956. Reconnaissance geology of western Mineral County, Montana. Pages 575-611 *in* A contribution to economic geology: Geological survey bulletin 1027-M. U.S. Department of the Interior, Washington, DC.

Watanabe, M. E. 1994. Pollination worries rise as honey bees decline. Science 265:1170.

Wear, D. N., R. Huggett, R. Li, B. Perryman, and S. Liu. 2013. Forecasts of forest conditions in U.S. regions under future scenarios: A technical document supporting the Forest Service 2010 RPA assessment. U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC.

Wei, R., E. Knaap, and S. Rey. 2023. American Community Survey (ACS) Data Uncertainty and the Analysis of Segregation Dynamics. Population Research and Policy Review 42.

Wenger, S. J., D. J. Isaak, C. H. Luce, H. M. Neville, K. D. Fausch, J. B. Dunham, D. C. Dauwalter, M. K. Young, M. M. Elsner, B. E. Rieman, A. F. Hamlet, and J. E. Williams. 2011. Flow regime, temperature, and biotic interactions drive differential declines of trout species under climate change. Proceedings of the National Academy of Sciences of the United States of America 108:14175-14180.

Wenger, S. J., C. H. Luce, A. F. Hamlet, D. J. Isaak, and H. M. Neville. 2010. Macroscale hydrologic modeling of ecologically relevant flow metrics. Water Resources Research 46:1-10.

Westbrook, C. J., D. J. Cooper, and B. W. Baker. 2006. Beaver dams and overbank floods influence groundwater–surface water interactions of a Rocky Mountain riparian area. Water Resources Research 42:1-12.

Westerkamp, C., and G. Gottsberger. 2000. Diversity pays in crop pollination. Crop Science 40:1209-1222.

Wettstein, W., and B. Schmid. 1999. Conservation of arthopod diversity in montane wetlands: effect of altitude, habitat quality and habitat fragmentation on butterflies and grasshoppers. Journal of Applied Ecology 36:363-373.

Whitlock, C., W. F. Cross, B. Maxwell, N. Silverman, and A. A. Wade. 2017. 2017 Montana climate assessment. Montana University System, Montana Institute on Ecosystems, Bozeman and Missoula, MT.

Wiensczyk, A. M., S. Gamiet, D. M. Durall, M. D. Jones, and S. W. Simard. 2002. Ectomycorrhizae and forestry in British Columbia: A summary of current research and conservation strategies [Special Issue]. Journal of Ecosystems & Management 2:20.

Wiggins, D. A. 2005. Harlequin duck (*Histrionicus histrionicus*): A technical conservation assessment.

Williams, A. P., E. R. Cook, J. E. Smerdon, B. I. Cook, J. T. Abatzoglou, K. Bolles, S. H. Baek, A. M. Badger, and B. Livneh. 2020. Large contribution from anthropogenic warming to an emerging North American megadrought. Science 368:314-318.

Williamson, M. A., T. G. Creech, G. Carnwath, B. Dixon, and V. Kelly. 2020. Incorporating wildlife connectivity into forest plan revision under the United States Forest Service's 2012 planning rule. Conservation Science and Practice 2:15.

Winfree, R., R. Aguilar, D. P. Vazquez, G. LeBuhn, and M. A. Aizen. 2009. A meta-analysis of bees' responses to anthropogenic disturbance. Ecology 90:2068-2076.

Winter, E., and H. Eichman. 2022. USDA Forest Service wildlife related recreation contributions. Estimating economic contributions from recreational fishing, wildlife viewing, and hunting on USDA Forest Service lands in 2021 – Biological & Physical Resources (BPR) request. November edition., U.S. Department of Agriculture, Forest Service, Ecosystem Management Coordination, Social Science & Economics Group, Washington, D.C.

Wisdom, M. J., and L. J. Bate. 2008. Snag density varies with intensity of timber harvest and human access. Forest Ecology and Management 255:2085-2093.

Wohl, E., J. Castro, B. Cluer, D. Merritts, P. Powers, B. Staab, and C. Thorne. 2021. Rediscovering, Reevaluating, and Restoring Lost River-Wetland Corridors. Frontiers in Earth Science 9:1-21.

Wohl, E., K. B. Lininger, M. Fox, B. R. Baillie, and W. D. Erskine. 2017. Instream large wood loads across bioclimatic regions. Forest Ecology and Management 404:370-380.

Wohner, P. J., S. A. Laymon, J. E. Stanek, S. L. King, and R. J. Cooper. 2021. Challenging our understanding of western Yellow-billed Cuckoo habitat needs and accepted management practices. Restoration Ecology 29:12.

Wondzell, S. M., and J. G. King. 2003. Post-fire erosional processes in the Pacific Northwest and Rocky Mountain regions. Forest Ecology and Management 178:75-87.

World Bank. 2009. Public attitudes toward cimate change: findings from a multi-country poll. University of Maryland.

Wright, J., C. Jones, and A. Flecker. 2002. An ecosystem engineer, the beaver, increases species richness at the landscape scale. Oecologia 132:96-101.

Wu, H., J. S. Kimball, M. M. Elsner, N. Mantua, R. F. Adler, and J. Stanford. 2012. Projected climate change impacts on the hydrology and temperature of Pacific Northwest rivers. Water Resources Research 48:1-23.

Wurtzebach, Z., and C. Schultz. 2016. Measuring ecological integrity: History, practical applications, and research opportunities. BioScience 66:446-457.

Yau, M. M., and E. B. Taylore. 2013. Environmental and anthropogenic correlates of hybridization between westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) and introduced rainbow trout (*O. mykiss*). Conservation Genetics 14:885-900.

Yeats, S., and J. B. Haufler. 2020. Second assessment of wildlife habitat for the Southwestern Crown of the Continent CFLR project.

Young, M. K. 1995. Conservation assessment for inland cutthroat trout. Gen. Tech. Rep. RM-GTR-256, U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Young, M. K., D. J. Isaak, S. Spaulding, C. A. Thomas, S. A. Barndt, M. C. Groce, D. Horan, and D. E. Nagel. 2018. Chapter 4: Effects of Climate Change on Cold-Water Fish in the Northern Rockies. Pages 37-58 *in* J. E. Halofsky, and D. L. Peterson, editors. Climate Change and Rocky Mountain Ecosystems. Springer International Publishing, Switzerland AG.

Zedler, J. B., and S. Kercher. 2004. Causes and Consequences of Invasive Plants in Wetlands: Opportunities, Opportunists, and Outcomes. Critical Reviews in Plant Sciences 23:431-452.

Zhao, J., X. Wei, and L. Li. 2022. The potential for storing carbon by harvested wood products. Frontiers in Forests and Global Change 5.

Zlatnik, E. 1999. *Pseudoroegneria spicata*. *in* Fire Effects Information System. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Zouhar, K. 2000. *Festuca idahoensis*. *in* Fire Effects Information System. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

Zylstra, E. R., L. Ries, N. Neupane, S. P. Saunders, M. I. Ramirez, E. Rendon-Salinas, K. S. Oberhauser, M. T. Farr, and E. F. Zipkin. 2021. Changes in climate drive recent monarch butterfly dynamics. Nature Ecology and Evolution 5:1441-1452.