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U.S. Forest Ownership and Management: Background and Issues for Congress

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SUMMARY

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U.S. Forest Ownership and Management: Background and Issues for Congress

The 765 million acres of forests across the United States provide many social, economic, and ecological resources and uses. A forest's *health*—generally, the status of its ecological integrity and functioning—influences its ability to provide resources and uses, including air and water resources, fish and wildlife habitat, opportunities for recreation and cultural use, timber resources, and more. As a result, Congress may be interested in the health and management of the nation's forest resources. The potential scope of congressional involvement in U.S. forest resources varies, based primarily on ownership; Congress has a direct role in the management of forests owned by the federal government but a more indirect role regarding forests in nonfederal ownership.

As of 2017, the federal government managed 238 million acres (31%) of U.S. forests; the rest were in nonfederal (private, state, or local) ownership. Private forest owners can be classified as corporate or noncorporate, and noncorporate forest owners can be further classified as family, tribal, and other. Private noncorporate forests account for approximately 38% of U.S. forest area (272 million acres), and corporate forests account for 20% (156 million acres). State and local governments manage 84 million acres (11%) of U.S. forestland. The distribution of forest ownership varies regionally: most of the forests in the eastern United States are privately owned, whereas most forests in the western regions are publicly owned. Nationwide, more privately owned forests than publicly owned forests contain *timberlands*, a subset of forestland capable of producing crops of industrial wood.

The resources and uses that a forest provides can be complementary or competing. As such, forest management and use are perennially complex, often contentious issues. Forest owners may *manage* forests—intervene in their processes and composition—to promote desired objectives, which vary; there is no single management objective across all U.S. forests or ownerships. Private forest owners have nearly complete discretion over which management objectives to pursue. Conversely, public forest management decisions are stipulated by laws and regulations, including requirements for transparency in the decisionmaking process and opportunities for the public to comment on and challenge decisions. Most forest owners manage their lands for multiple objectives, often with a primary objective. For example, some owners manage their forests principally for timber production, undertaking specific management activities to promote productivity and timber growth. Most federal forests are managed for a balance of multiple of uses, with no single or primary use as a principal management objective. Because forests may be managed for different objectives, methods for measuring and assessing forest outcomes vary considerably.

U.S. forest resources are heterogeneous, as are the biophysical conditions in forests and the management objectives, constraints, and capabilities of forest owners. Biophysical characteristics (e.g., climate) determine a forest's baseline potential to support different tree species, growth, and productivity. Other factors, such as exposure to disturbances (e.g., hurricanes, wildfires, pest infestations), can further affect forest conditions. Management choices can influence or mediate the effects of some—but not all—biophysical factors and disturbances (e.g., by choosing which species to grow or whether to treat pest infestations). The measurable outcomes for any given forest—such as timber production, forest health, or other metrics—result from the merging of biophysical factors, disturbances, and management decisions. However, forest conditions may produce resources and outcomes in ways that specific management activities, regardless of ownership, cannot mitigate or overcome. For example, though forest management activities may focus on preventing, treating, or facilitating recovery from various forest health stressors, the extent to which management practices can demonstrably improve health conditions is difficult to assess. Although it is not possible to draw definitive conclusions regarding forest outcomes by ownership class, some distinct ownership trends exist. For example, the South produces the most timber of any region; because most forests in the South are privately owned, little of that timber production originates from public forests.

Congress's interest in the nation's forest resources is multifold. Across all ownerships, Congress may be interested in the capacity of the nation's forests to survive and recover from disturbance events and to adapt to changing climatic conditions. Congress also may be interested in mitigating risks associated with adverse health conditions and otherwise ensuring forests continue to provide benefits to surrounding communities. Issues for Congress may include whether and how to address those interests and concerns, regardless of ownership. Congress also may have ownership-specific interests, such as federal forest management or the federal government's role in providing assistance for nonfederal forests. In addition, Congress has expressed interest in understanding the extent, if any, to which nonfederal forests have better forest management and forest health outcomes relative to federally managed forests.

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Introduction

One-third of U.S. land area is forested, and forests provide many public benefits. As such, Congress is broadly interested in the health and management of the nation's forest resources. The potential scope of congressional involvement varies, in part based on ownership; Congress has a direct role in the management of forests owned by the federal government but a more indirect role regarding forests in nonfederal ownership. Congress also has expressed interest in the extent, if any, to which nonfederal forests have better *forest management*—human intervention into forest processes and composition—and forest outcomes relative to federal forests.

To inform congressional deliberations regarding U.S. forest resources, this report examines nationwide and regional trends in forest ownership, health, and management.[1] Forest management outcomes generally, and forest health outcomes specifically, are difficult to measure, compare, or attribute to any specific factor. As a result, it is not possible to definitively assess the specific influence of individual forest attributes (e.g., forest ownership) on forest management outcomes. Instead, this report analyzes forest outcomes that arise from the confluence of regional biophysical, ownership, and management trends.

The report begins with an overview of the methodological approach for presenting the data and analysis contained herein and an introduction to Congress's roles with regard to the nation's forests. It then provides background on forestry concepts such as types, uses, health, and management. The background section also introduces forest management principles specific to timber production, a topic of congressional interest. The report then describes the extent, distribution, uses, and management of federal and nonfederal forests and timber resources across the United States, by ownership, and includes separate discussions of forest health and timber production by ownership. Next, the report summarizes and highlights management and ownership trends and their implications, to the extent possible, and discusses the challenges associated with comparing forest management across ownership classes. The report concludes with a discussion of some general, crosscutting issues related to U.S. forests that may be of interest to Congress.

Methods for Analyzing U.S. Forests

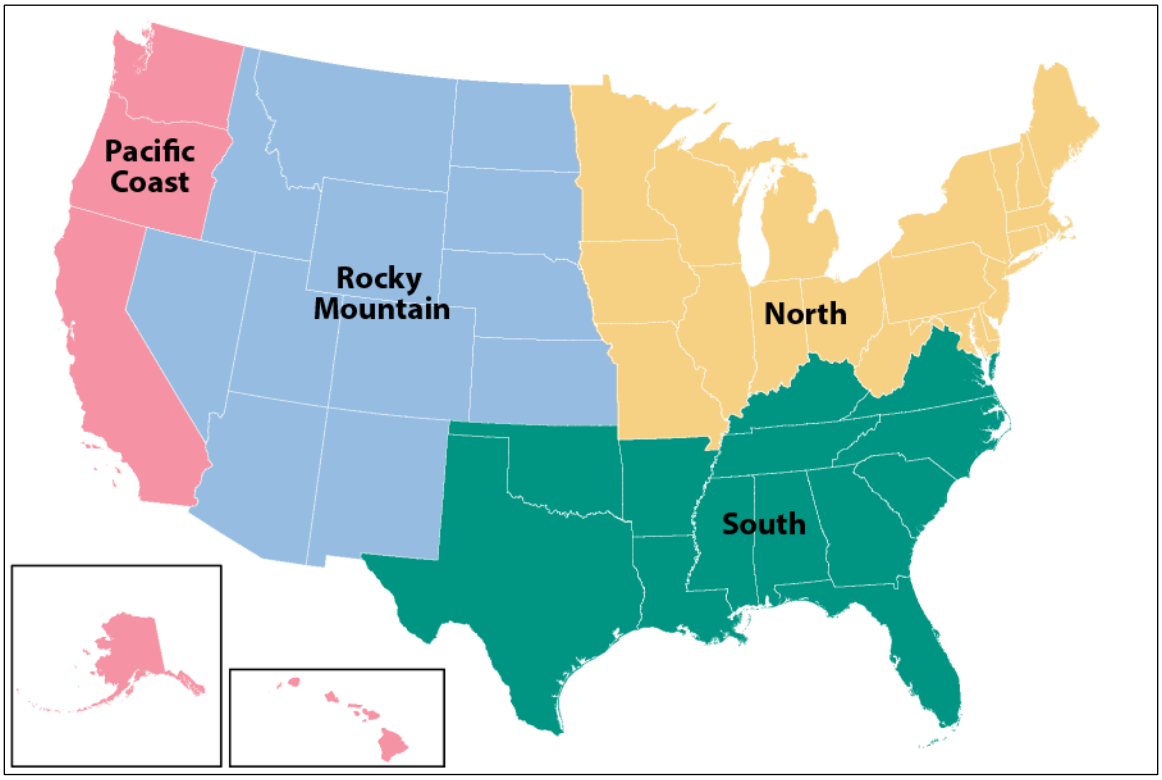
The nationwide overview of forests in this report generally examines forest characteristics across four regions within the United States: North, South, Rocky Mountains (or Rockies), and Pacific Coast (or Pacific). (See **Figure 1**.) These regions correspond to those in the *Forest Resources of the United States* report (hereinafter, *FRUS*), a decennial assessment of forest resources prepared by the U.S. Forest Service (FS, within the U.S. Department of Agriculture) pursuant to the Forest and Rangeland Renewable Resources Planning Act.[2] In a few cases, the report combines the four regions or presents data at different regional scales. For example, some of the CRS analysis compares forests in the eastern United States, which generally encompasses the North and South

[1] This report primarily includes forest data and issues relevant to U.S. forests a whole. In-depth discussion of issues specific to certain forests (e.g., federal forests) or concerns that may not be unique to forests (e.g., wildlife, outdoor recreation, water) are beyond the scope of this report.

[2] Forest and Rangeland Renewable Resources Planning Act, P.L. 93-378, 16 U.S.C. §1601. Sonja Oswalt et al., *Forest Resources of the United States, 2017: A Technical Document Supporting the Forest Service 2020 RPA Assessment*, Forest Service (FS), GTR-WO-97, 2019, at https://www.nrs.fs.fed.us/pubs/57903 (hereinafter cited as Oswalt et al., *FRUS 2017*). Unless specifically noted, the report and data herein reflect forest resources in the conterminous United States, Alaska, and Hawaii but do not reflect forest resources in U.S. territories. Some of the figures in the report do not include Alaska and Hawaii due to data availability issues.

regions, with forests in the western United States, which generally encompasses the Rocky Mountain and Pacific Coast regions. The national and regional trends discussed in this report are general and may mask site-specific differences or deviations from such trends. Most data in this report derive from the decennial *FRUS* reports.[3]

Figure 1. U.S. Forest Regions in the *Forest Resources of the United States* Report



Source: Congressional Research Service (CRS), adapted from Sonja Oswalt et al., *Forest Resources of the United States, 2017: A Technical Document Supporting the Forest Service 2020 RPA Assessment*, Forest Service (FS), GTR-WO-97, 2019 (hereinafter, Oswalt et al., *FRUS 2017*), Figure I-1.

Notes: U.S. territories are not included. The conterminous United States, Hawaii, and Alaska are represented at different scales. The Rocky Mountain region is the largest region in terms of land area, consisting of 759 million acres, followed by the Pacific Coast region at 575 million acres. The South region consists of 552 million acres, and the North region is the smallest, at 414 million acres.

The report compares forest management across different *ownership classes*. At the broadest level, forest ownership is classified as either public (e.g., governmental) or private.[4] There is considerable variation within both classes. Public ownership is further classified into *federal* and *other public* (e.g., state and local) ownership, and private ownership is further classified into *private corporate* and *private noncorporate*, consistent with *FRUS* classes. This classification system does not fully represent the heterogeneity within the private corporate, private noncorporate, and other public forest ownership classes. This report primarily focuses on comparing federal and nonfederal (private and other public) forests, due to the different

[3] Because of this report's reliance on decennial *Forest Resources of the United States* (*FRUS*) data, it is not intended to be updated until, at minimum, new *FRUS* data are published.

[4] For purposes of this report, an *owner* of a public forest generally refers to the governmental agency charged with managing the forest resources.

congressional roles in relation to forests in these ownership classes. It includes other comparisons (e.g., between public and private forests) when circumstances warrant.

Role of Congress

Congress's role with regard to the nation's forests varies based on numerous factors, including forest ownership. Congress has a direct role in the management of forests owned by the federal government, for example, but may have a more general interest in nonfederally owned forests. Congress also supports forestry research, which applies across all ownerships.

The Property Clause of the U.S. Constitution (Article IV, §3, clause 2) authorizes Congress to acquire, dispose of, and manage federal property. As such, Congress has the authority to enact laws that address all aspects of managing federal forests and their resources. Much of Congress's legislative activity regarding federal forests primarily has focused on the four federal land management agencies: the FS, in the U.S. Department of Agriculture (USDA), and the Bureau of Land Management (BLM), National Park Service, and Fish and Wildlife Service in the Department of the Interior (see "Federal Forests" for more information).[5] Other federal agencies also own land containing forest resources, however. To fulfill its role under the Property Clause, Congress has passed numerous laws regarding federal forest management, from authorizing the federal land management agencies' general management missions to authorizing federal forests to be managed and used for specific purposes.[6] Congress also appropriates funding for managing federal forests.[7] Some of these laws directly relate to federal forest management, whereas others relate indirectly to federal forests (e.g., laws concerning wildlife or air and water resources).[8]

Congress's role in nonfederal forest management is less direct and generally relates to authorizing (and appropriating funding for) federal programs to provide assistance for nonfederal forest management, ownership, and use.[9] Such programs may provide federal assistance in the form of financial, technical, or other resources to a nonfederal entity, such as a state or individual. Often, federal assistance is for a specified purpose, such as to promote forest health, prevent conversion of forest to non-forest use, protect wildlife habitat, and meet other objectives. Congress has authorized such programs in several USDA agencies, including the FS, Natural Resource Conservation Service, and Farm Services Agency. Other federal agencies may administer assistance programs focused on other topics—such as watersheds, energy, or wildlife—that also may relate to nonfederal forest management.[10] In addition, Congress has authorized assistance

[5] For more information, see CRS In Focus IF10585, *The Federal Land Management Agencies*, coordinated by Katie Hoover.

[6] For example, Congress established general management missions for specified federal lands through the Multiple-Use Sustained Yield Act of 1960 (national forests; Act of June 12, 1960; P.L. 86-517, 16 U.S.C. §§528-531), the Federal Land Policy and Management Act of 1976 (BLM public lands; P.L. 94-579, 43 U.S.C. §§1701 et seq.), the National Wildlife Refuge System (NWRS) Improvement Act of 1997 (NWRS, P.L. 105-57, 16 U.S.C. §§668dd et seq.), and the National Park Service Organic Act of 1916 (National Park System, 39 Stat. 535).

[7] For more information, see CRS Report R46557, *Forest Service Appropriations: Ten-Year Data and Trends (FY2011-FY2020)*, by Katie Hoover.

[8] For example, Congress addressed federal forest health directly in the Healthy Forests Restoration Act (P.L. 108-148, 16 U.S.C. §§6501 et seq.). In contrast, the Endangered Species Act (P.L. 93-205, 16 U.S.C. §§1531 et seq.) may impact federal forest management but does not address it directly.

[9] For example, Congress authorized the USDA to provide nonfederal forest assistance through the Cooperative Forestry Assistance Act (P.L. 95-313, 16 U.S.C. §§2101 et seq.). For more information, see CRS Report R45219, *Forest Service Assistance Programs*, by Anne A. Riddle and Katie Hoover, and CRS Report R40763, *Agricultural Conservation: A Guide to Programs*, by Megan Stubbs.

[10] For example, federal assistance for Great Lakes water quality (P.L. 100-4, 33 U.S.C §1268) or federal outdoor

programs to address forest issues internationally, largely in the FS and the U.S. Agency for International Development.

Congress also authorizes and funds research related to forestry that can involve both federal and nonfederal lands. In particular, Congress directed the FS to "conduct, support, and cooperate" in forest and rangeland research, including basic and applied science, outreach, and cooperation with nonfederal researchers.[11] The FS also conducts and reports on the United States' comprehensive forest inventory, the results of which form the basis of the *FRUS* (among other products). Other agencies with research authorities also conduct research related to forests, sometimes due to indirect relationships with other topics (e.g., energy, the environment).[12] The FS, other USDA agencies (e.g., the National Institutes of Food and Agriculture), and other federal agencies (e.g., the National Aeronautics and Space Administration) also provide funding for extramural research on forestry topics.

Background

The FRUS defines *forests* as lands dominated by trees.[13] Forests also are *ecosystems:* groups of living things (in this case, dominated by trees), the physical resources with which they interact, and the resulting biotic and abiotic processes and cycles.[14] Forests provide many ecological, economic, and social *resources* (physical materials available in the environment) and *uses* (human activities using forest resources or forest settings), many of which are listed below. A forest's *health*—generally, the status of its ecological integrity and ecosystem functioning—influences its ability to provide these resources and uses. Forests are further influenced by forest *management*—intentional, planned actions in forests to promote desired objectives.

This section discusses forest types, resources and uses, health, and management and introduces concepts relevant to timber production. The forest health subsection includes a discussion on wildfire but does not explore at length other factors influencing forest health (e.g., drought, insect or diseases, weather events). Broad-scale regional variations are noted throughout these background sections.

Forest Types

Forest ecosystems comprise *physical* characteristics (attributes of forest sites driven by nonliving phenomena such as climate, latitude, and elevation) and *biological* characteristics (attributes of the mix of species present on the site).[15] This report focuses on an ecosystem's physical characteristics and the biological characteristics of a forest's dominant tree species, although

recreation grants to states (P.L. 88-578, 54 U.S.C. §§200301 et seq.) may relate to nonfederal forests.

[11] Forests and Rangelands Renewable Resources Research Act, P.L. 95-307, 16 U.S.C. §1642.

[12] For example, see the National Aeronautics and Space Administration's Global Ecosystem Dynamics Investigation mission, at https://gedi.umd.edu/ or the U.S. Geological Survey's Forest and Rangeland Ecosystem Science Center, https://www.usgs.gov/centers/fresc.

[13] Oswalt et al., *FRUS 2017*, defines *forests* or *forestland* as parcels of land at least 120 feet wide and at least 1 acre in size, with at least 10% cover by live trees, including land that formerly had such trees where the trees will regrow (such as land where timber was recently harvested). Forestland does not include urban land or agricultural land that is covered with trees (such as an orchard). Lands with less than 10% cover by live trees are known as *woodlands*.

[14] David Perry, Ram Oren, and Stephen Hart, *Forest Ecosystems* (Baltimore, MD: Johns Hopkins University Press, 2008). Hereinafter referred to as Perry, Oren, and Hart, *Forest Ecosystems*.

[15] Perry, Oren, and Hart, *Forest Ecosystems*.

other forest organisms also have biological characteristics. To describe a forest ecosystem as a whole, physical and biological characteristics are jointly termed *biophysical* characteristics.

Physical characteristics vary according to both broad regional conditions and site-specific local conditions and may influence which species can grow on a given site. On broad scales, regional climate and latitude may determine factors such as average annual temperature, average annual precipitation, and growing season length. These regional characteristics may vary further as they interact with site-specific characteristics, such as elevation, soils, slope, and aspect; for example, a site on top of a ridge is likely to be drier than one in a valley, although the two sites may receive the same annual precipitation. Forests generally comprise species adapted to similar physical conditions or similar frequencies of ecosystem phenomena that cause tree damage or death.

Although there are thousands of different tree species in the United States, trees can be divided into two general types based on their biology. These biological differences influence their growth characteristics and ranges:

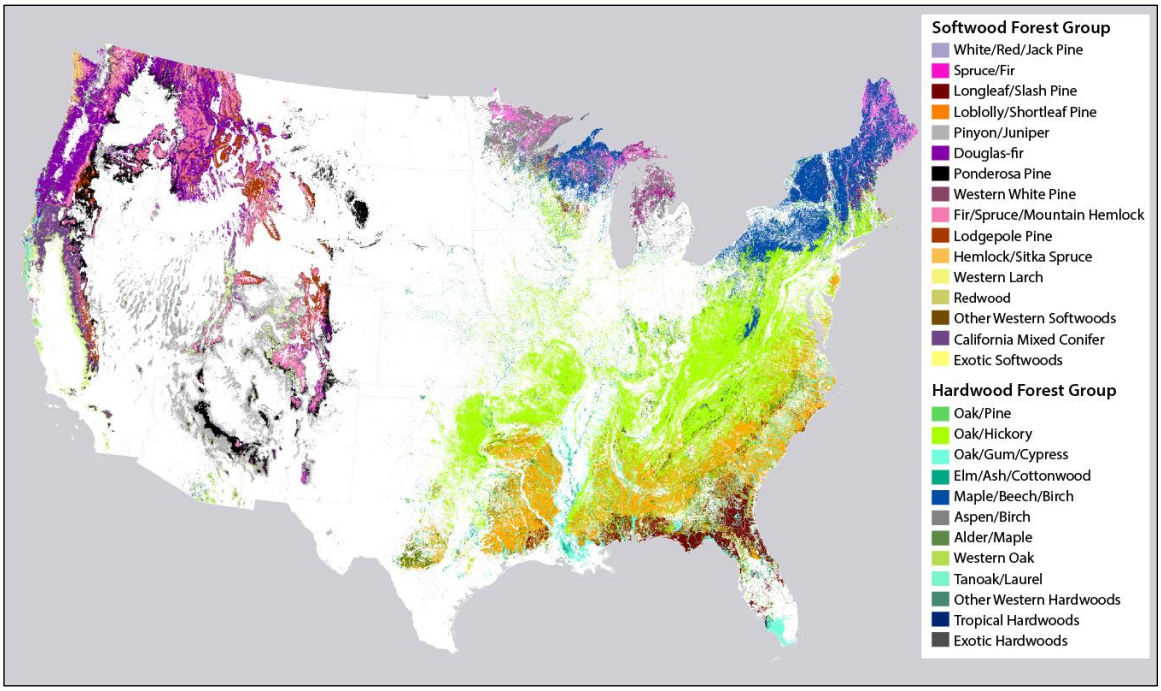
- *Softwoods* are coniferous trees such as pine (*Pinus* sp.), fir (*Abies* sp.), Douglas fir (*Pseudotsuga menziesii*), and spruce (*Picea* sp.). Softwood species grow throughout the United States and dominate forests in the Rocky Mountain and Pacific Coast regions and in some parts of the South.
- *Hardwoods* are non-coniferous, broadleaved trees such as oak (*Quercus* sp.), maple (*Acer* sp.), walnut (*Juglans* sp.), and ash (*Fraxinus* sp.). Hardwood-dominated forests grow almost exclusively in the North and South regions, with a few commercially important species growing in California, Oregon, and Washington.[16]

Hardwoods and softwoods may grow together in *mixed* forests, but one type grows exclusively in many parts of the United States. (See **Figure 2** for a map of forest types in the United States.)

Within the two types, forests come in groups of varying complexity, from forests dominated by one or two species to forests with dozens of species. Trees' biological characteristics also give rise to different properties of growth—such as annual rates of growth or properties of strength or stiffness—that influence their commercial desirability.

[16] Michael Wiemann, "Characteristics and Availability of Commercially Important Wood," in *Wood Handbook: Wood as an Engineering Material*, FS, Forest Products Laboratory, FPL-GTR-282, 2021, p. 2-1.

Figure 2. Forest Type Groups of the Contiguous United States, 2008



Source: CRS, using data from FS, "National Forest Type Dataset," at https://data.fs.usda.gov/geodata/rastergateway/forest_type/. This dataset does not include Alaska and Hawaii.

Forest Resources and Uses

Many factors influence the particular resources and uses a given forest provides. These factors include the forest's physical setting, its plant and animal species, and its ecological processes, as well as the activities humans undertake in the forest. Forest resources and uses may be complementary or in opposition to one another. As such, the management and use of forests are perennially complex and often contentious issues. Some forest resources and uses include the following:[17]

- **Air.** Through their growth processes, forests influence air, including carbon dioxide, oxygen, and pollutants. Forests reduce air pollution, create oxygen through photosynthesis, and consume carbon dioxide, ultimately sequestering carbon in trees and soils. For example, in 2019, U.S. forests were a net sink of greenhouse gases, meaning they sequestered more carbon from the atmosphere than they released.[18]
- **Animal Products.** Due to the animal species that make up, reside in, and rely on forests as part of their lifecycle, forests contribute to economically valuable animal products, such as subsistence wildlife species or commercial anadromous fish populations (e.g., salmon).

[17] This report does not detail all of the possible ways forests are used and valued.

[18] For more information, see CRS Report R46313, *U.S. Forest Carbon Data: In Brief*, by Katie Hoover and Anne A. Riddle.

- **Biodiversity.** For the purposes of this report, *biodiversity* refers to the mix of plant and animal species present in the forest.[19] These species—either as a mix or as individuals—may contribute to other resources and uses, such as recreational experiences (e.g., hunting, fishing, leaf peeping) or animal products. In addition, the biodiversity of plants and animals may, in and of itself, be valued.
- **Forest Products.** The economically valuable tissues of trees and plants are a prominent use of forests. Forests provide *timber* (unprocessed cut trees), a critical material for construction, paper products, and many other uses. Forests also produce fuelwood and non-timber forest products, such as food, fiber, medicines, decorative products, and others.
- **Recreational and Cultural Uses.** Forests may be used for recreational, educational, scientific, and spiritual purposes. Various forest resources—for example, plant and animal resources, water, and physical setting—may combine to determine each site's desirability for such uses.
- **Water.** Water cycles through forests, which influences its flow and quality. As such, forests play an important role in providing water, improving its quality, and mediating the risk of water-related disasters (e.g., floods, landslides). About 80% of the nation's fresh water originates from forests.[20]
- **Other Resources and Land Uses.** Additional uses for forests include grazing, energy and mineral development, and infrastructure and building siting.

Forests' various uses and values may inform forest owners' management choices or approaches.[21] Owners may find a number of resources or uses to be significant or may be required or constrained by law in how they treat certain forest resources or uses (or mixes of the two).

Forest Ecological Health

Forest health is not easily defined.[22] One definition of forest health relates to a forest's capacity to provide ecological and economic goods; another definition generally refers to ecological integrity and functioning, or a forest ecosystem's ability to respond to forest health stressors, or *disturbances* (e.g., wildfires, ice or wind storms, insect and disease infestations, timber harvests).[23] Forest ecosystems have inherent characteristics that enhance their capability to survive such events (*resistance*) or facilitate recovery after disturbance (*resilience*). Some tree species are adapted to specific disturbances occurring at regular intervals. Forest health stressors

[19] Biodiversity can also refer to biological variation at other scales, such as the genetic or ecosystem scales.

[20] James Sedell et al., *Water and the Forest Service*, FS-660, 2000.

[21] For purposes of this report, an *owner* of a public forest generally refers to the governmental agency charged with managing the forest resources.

[22] For a discussion of forest health concepts, see T. E. Kolb, M. R. Wagner, and W. W. Covington, *Forest Health from Different Perspectives*, FS, RMR-GTR-267, 1995, at https://www.fs.usda.gov/treesearch/pubs/23480; for a discussion of ecosystem health generally, see Robert Costanza, "Toward an Operational Definition of Ecosystem Health," in *Ecosystem Health: New Goals for Environmental Management*, eds. Robert Costanza, Bryan Norton, and Benjamin Haskell (Washington, DC: Island Press, 1992).

[23] *Disturbance* is defined as "any relatively discrete event in time that disrupts ecosystems, community, or population structure and changes resources, substrate availability, or the physical environment." Steward T. A. Pickett and P. S. White, *The Ecology of Natural Disturbance and Patch Dynamics* (Orlando: Academic Press, 1985). Disturbance events may be unplanned (e.g., precipitation events) or planned (e.g., harvest, prescribed fire).

may be biotic or abiotic, natural or anthropogenic, and may vary among biophysical regions and local environments.

Forest health is also difficult to measure.[24] Often, variables related to biophysical or ecological characteristics are used to indicate measures of forest health, such as tree damage or mortality. These indicator variables may be measured individually—or, more often, in combination—as a proxy for measuring ecosystem function. In some cases, ecosystem function is assessed by the degree of departure from a baseline or reference condition. For example, the FS uses watershed function as one method of evaluating the condition of national forests; to do so, the FS uses a combination of 12 different indicator variables to measure watershed function relative to a baseline condition.[25]

The following sections discuss tree mortality and describe three interrelated forest health issues: insect and disease infestations, adverse weather events, and wildfire-related issues.[26]

Tree Mortality

Some level of tree damage or mortality is expected in a forest, but high levels at large scales may indicate declining or degraded forest health. Degraded forest ecosystems, for example, may take longer to recover from or may be more susceptible to mortality in response to disturbances or other health stressors. Different disturbances also may interact and exacerbate the effects of other events in a feedback loop. For example, a prolonged drought may impair a tree's resistance to an insect or disease infestation or may make a tree more susceptible to damage during a wildfire. Some research indicates that climate variability is reshaping forest landscapes by altering the frequency, intensity, and timing of disturbance events in ways that may exceed many forests' resistance and resilience capacities.[27]

Nationwide, FS reported that about 10 billion cubic feet of tree mortality was observed in 2016.[28] In many cases, mortality can be attributed to multiple, sometimes interrelated, causes. This figure includes mortality related to disturbances such as insect and disease infestations, adverse weather events (e.g., drought; excessive moisture, wind, or ice), and wildfires. Each cause's relative contribution can be difficult to determine.

In the eastern United States (which most closely coincides with the North and South regions in this report), tree mortality is low relative to tree growth, meaning new tree growth can replace tree mortality relatively quickly.[29] In many parts of the western United States (which most closely coincides with the Rocky Mountain and Pacific Coast regions in this report), tree mortality can be

[24] See, for example, D. J. Rapport, R. Costanza, and A. J. McMichael, "Assessing Ecosystem Health," *Trends in Ecology and Evolution*, vol. 13, no. 10 (October 1998), pp. 397-402.

[25] For more information, see the FS, "Watershed Condition Framework," at https://www.fs.fed.us/naturalresources/watershed/condition_framework.shtml.

[26] Other issues affecting forest health (e.g., potential impacts from climate change) are beyond the scope of this report.

[27] James M. Vose, David L. Peterson, and Toral Patel-Weynard, *Effects of Climate Variability and Change on Forest Ecosystems: a Comprehensive Science Synthesis for the U.S.*, FS, PNW-GTR-870, 2012, at http://www.treesearch.fs.fed.us/pubs/42610.

[28] This figure reflects mortality as reported on U.S. timberlands. Oswalt et al., *FRUS 2017*, Appendix A, Table 33. For more on timberlands, see "Forest Ownership Overview and Data."

[29] Kevin M. Potter and Barbara L. Conkling, *Forest Health Monitoring: National Status, Trends, and Analysis 2020*, FS, GTR-SRS-261, July 2021, p. 27, at https://www.fs.usda.gov/treesearch/pubs/62839 (hereinafter cited as Potter and Conkling, *FHM 2020*). The regions in the *FHM 2020* report differ from the regions used in this report, which are derived from regions in the *FRUS*. For a map of the *FHM 2020* regions, see FS, "Forest Health Highlights," at https://www.fs.fed.us/foresthealth/protecting-forest/forest-health-monitoring/monitoring-forest-highlights.shtml.

very high as a percentage of live volume or growth. In 2019, regions in the West experienced the greatest extent of certain individual disturbances relative to the rest of the country, such as insect and disease infestations, particularly in the Interior West (i.e., the Rockies).

Insect and Disease Infestations

According to some forest scientists, insects and diseases "represent the most serious threats to the Nation's forests" and have the potential for widespread ecological and economic impacts.[30] Both native and non-native invasive species present these threats. Insect and disease infestations vary in their impact on forest ecosystems. Some insects are *defoliators* and damage trees by eating their leaves and needles, disrupting the photosynthesis process (e.g., western spruce budworm). Other insects, diseases, and pathogens damage trees internally (e.g., mountain pine beetles). Both defoliation and internal damage can lead to tree mortality, though tree species vary in their tolerance of different pests. For example, some hardwood species generally may be more resilient to short-term defoliation events than some coniferous species, because they can refoliate in the same year.

The FS's Forest Health Monitoring (FHM) program annually reports the status of and trends in forest insect and disease conditions nationally and regionally.[31] The FHM program primarily conducts these reports from a landscape perspective and not by ownership class, given the regional extent of many infestations. In 2019, the FHM report included a retrospective on forest health conditions from 1997 through 2016, by *FRUS* region.[32] Across the 20-year period, insect- and disease-related mortality was highest nationwide from 2002 to 2006 and highest in the Rockies, relative to the other regions. These data reflect the significant impacts of the mountain pine beetle in the Rockies, specifically from 2002 to 2011. Over the 20-year period, insects were more widespread agents of mortality than diseases, and bark beetles were consistently the most important mortality agent across regions and over time, especially in the West. During this period, the North saw a larger proportion of tree mortality attributed to non-native invasive species than the other regions. More recently, from 2012 to 2016, insect- and disease-related mortality was highest in the Pacific Coast region.

Adverse Weather Events

Certain weather events adversely affect forest health. These events include discrete weather events, such as hurricanes, and events that occur over longer periods, such as droughts. Hurricanes, for example, can result in excessive precipitation and soil moisture, which deprive tree roots of oxygen for a prolonged period. Hurricanes and other weather events also can include high winds that break or uproot individual trees or groups of trees, an occurrence sometimes referred to as *windthrow* or *blowdown*. Winter storms that result in large accumulations of ice on tree branches also can result in damage or mortality to individual trees or groups of trees.

Drought occurs when there is a deficiency of moisture.[33] Although a lack of precipitation is often central to drought, high temperatures, high winds, lack of clouds, and low humidity also can contribute. Droughts may be seasonal, multiyear, or multi-decadal in duration. Variable

[30] Potter and Conkling, *FHM 2020.*

[31] Potter and Conkling, *FHM 2020.*

[32] Kevin M. Potter et al., *Forest Health Monitoring: National Status, Trends, and Analysis 2019*, FS, GTR-SRS-250, 2020, pp. 125-150, at https://www.srs.fs.usda.gov/pubs/60380.

[33] Text in this paragraph is drawn from CRS Report R46911, *Drought in the United States: Science, Policy, and Selected Federal Authorities*, coordinated by Charles V. Stern and Eva Lipiec.

precipitation levels and rising temperatures are intensifying droughts, particularly in some regions. Further, drought may affect certain regions of the United States on a short- or longer-term basis, with varying intensity over time. For example, the North has rarely experienced extreme or exceptional drought levels since 2000;[34] in contrast, periods of extreme and exceptional drought have been relatively common in the West since 2000.[35]

Trees absorb water from precipitation through their leaves or from the soil through their roots, and they use that water to fuel growth and many other internal processes. Droughts can alter the pattern, frequency, and total amount of water available to trees, which can disrupt those processes. Drought-stressed trees are more susceptible to disease infections and insect invasions than comparable trees not affected by drought. Because droughts reduce the overall moisture in a tree, drought-stressed trees are also more susceptible to ignition during a wildfire event. In addition, drought-stressed trees may take longer to recover from adverse events, such as impacts from wildfires or insect infestations. Further, the detrimental impacts of drought may continue for many years after the adverse event has concluded.

Wildfires

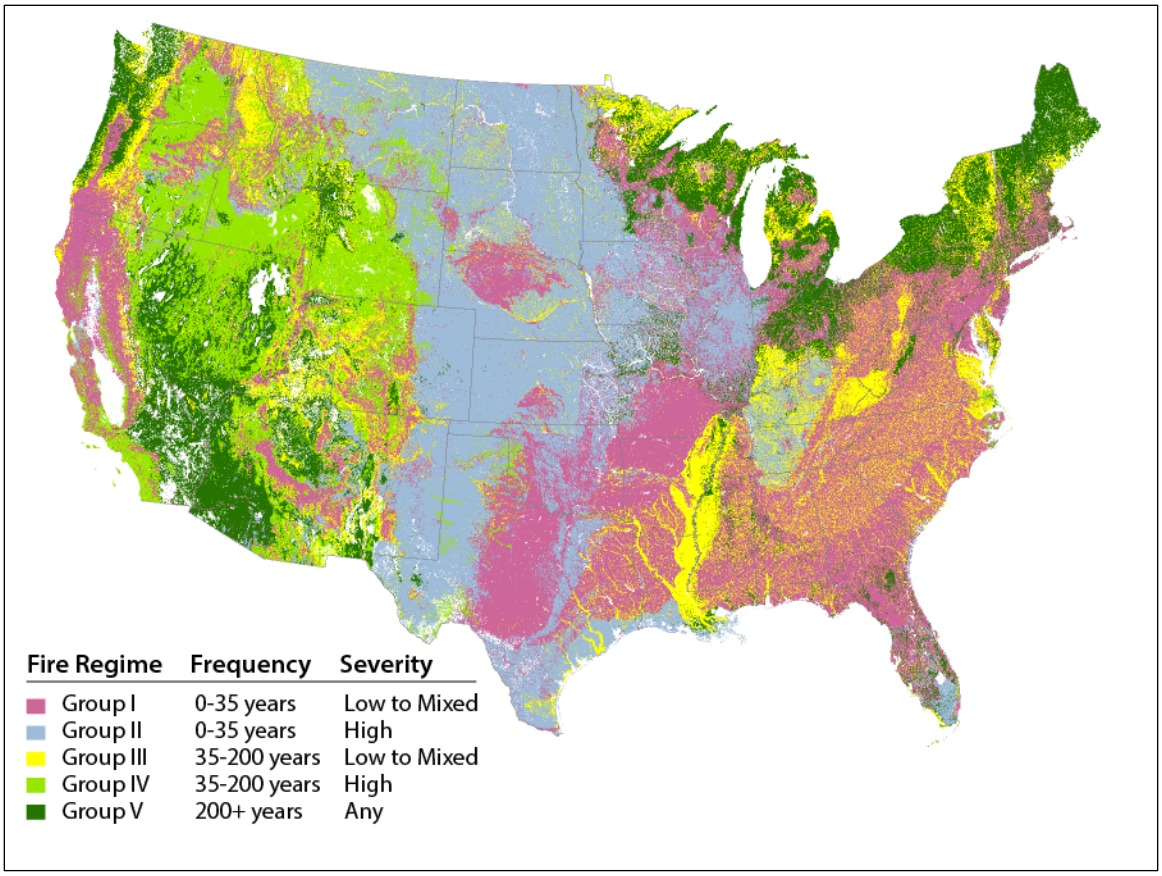
Wildfires are unplanned fires occurring in vegetated ecosystems. Wildfires are sometimes caused by lightning strikes but are more frequently caused by human activities (deliberate or accidental), such as sparks from equipment or campfires or loss of control over a prescribed burn. Weather conditions (e.g., heat, humidity, and wind) and fuel conditions (e.g., the moisture content and distribution of vegetation) affect wildfire spread and intensity. Wildfires can have some beneficial impacts on an ecosystem, but they often threaten homes, communities, and other valuable resources.

Different forest ecosystems have adapted to different wildfire frequencies and intensities, sometimes referred to as *fire regimes*. Some ecosystems are adapted to relatively frequent, low-intensity fires that burn the surface fuels (e.g., grasses, needles, leaves). Others are adapted to periodic, high-intensity fires that spread across the forest canopy and kill much of the vegetation, known as *stand-replacing fires*. Still other ecosystems are adapted to a mix of fire frequencies and severities. (See **Figure 3**.)

[34] Drought conditions impacting broad-scale areas are classified as ranging from *abnormally dry* to *exceptionally dry*, according to a scale developed by the U.S. Drought Monitor, a federal and nonfederal partnership that researches, monitors, and reports drought conditions. For more information on drought, see U.S. Drought Monitor, "Current Map," at https://droughtmonitor.unl.edu/ and CRS Report R46911, *Drought in the United States: Science, Policy, and Selected Federal Authorities*, coordinated by Charles V. Stern and Eva Lipiec.

[35] For example, most of the western United States experienced widespread drought conditions in 2021, and California experienced severe droughts from 2012 to 2016.

Figure 3. U.S. Historical Fire Regime Groups



Sources: CRS, from FS and Department of the Interior, Landscape Fire and Resource Management Planning Tools (LANDFIRE) Program, "Fire Regime Group Dataset," at https://www.landfire.gov/frg.php, and FS, *Fire Effects Information System: Synthesis About Fire Ecology and Fire Regimes in the United States*, 2012, at https://www.feis-crs.org/feis/.

Notes: White areas on the map reflect lakes or rivers, landscapes with indeterminate fire regime characteristics, or landscapes classified as barren, snow/ice, or sparsely vegetated. Alaska contains a mix predominantly of Fire Regime Group IV, and Fire Regime Group V, with a few areas classified as Fire Regime Group III and other landscapes that are snow or ice or of indeterminate fire regime characteristics. Hawaii contains a mix of predominantly Fire Regime Group I and Fire Regime Group V, with a few areas classified as Fire Regime Group III and other landscapes that are barren or of indeterminate fire regime characteristics. Severity is characterized by the percentage of the forest overstory that is damaged or replaced. Low-severity fires replace less than 25% of the dominant overstory, mixed-severity fires replace up to 75% of the overstory, and high-severity fires replace more than than 75% of the overstory.

Fire patterns are driven, in part, by an ecosystem's biophysical characteristics. Southern ecosystems are adapted to relatively frequent wildfires, whereas northern ecosystems are adapted to relatively infrequent wildfires. Ecosystems in the Rocky Mountain and Pacific Coast region are adapted to a variety of fire patterns.

Other factors also influence fire behavior and patterns, including management (related in part to the accumulation or removal of biomass) and patterns of development near or within the ecosystem. The area where structures (usually homes) are intermingled with—or adjacent to—vegetated wildlands (e.g., forests or rangelands) is the *wildland-urban interface*.[36] The proximity

[36] V. C. Radeloff et al., "The Wildland-Urban Interface in the United States," *Ecological Applications*, vol. 15, no. 3 (2005), pp. 799-805.

to vegetated landscapes may put these areas at an increased risk of experiencing wildfires and associated damage (and may increase the complexity and cost of wildfire suppression efforts in and near the wildland-urban interface).

In many forest ecosystems in the United States, historic fire patterns have been disrupted, primarily by prevention and suppression efforts aimed at minimizing fire and undesirable fire impacts. The wide-scale exclusion of fire across many different ecosystems had unintended effects, such as an accumulation of vegetation.[37] The increased vegetation, or biomass, can serve as fuel that increases the intensity and spread of wildfires, making them more difficult to contain or suppress, or otherwise impacting the existing forest's resistance and resiliency. The increased biomass also can facilitate the transmission of insects and diseases into forests or may alter the species composition of a forest, potentially diminishing desirable species. Nearly all forest ecosystems in the United States have exhibited fire-exclusion impacts, though the effects may be most pronounced on forests historically adapted to frequent, low-severity fire regimes (e.g., Fire Regime Group I).

Mitigating Wildfire Risk

Wildfire is an ecological process, and wildfires will occur in forests regardless of their ecological conditions. Severe wildfires cannot be prevented or mitigated in certain ecosystems. For example, some ecosystems (e.g., lodgepole pines in the Rocky Mountain region) are adapted to high-severity, stand-replacing fires, and these fires are crucial to ecosystem functions (e.g., the high temperatures from fires release the seeds to facilitate propagation). In forests adapted to low-severity fires, however, a high-severity fire could have damaging ecological impacts. Degraded forest ecosystems may contribute to and benefit from fire, whereas some functioning ecosystems may be severely damaged by fires. Because of this, the overarching forest health concern related to wildfire is the extent to which the pattern of fire frequency and severity deviates from the historical fire regime. Therefore, a forest health objective of many forest managers and scientists is to reduce the risk of *uncharacteristic* fire rather than to reduce the risk of fire generally. Relatedly, another forest health objective is to facilitate the return of historic fire patterns specific to the forest type.

Measuring or assessing the effects of wildfire is complex. Most wildfire statistics—such as number of fires or acres impacted—are indicators of wildfire activity but do not convey a wildfire's ecological impact (or the degree of impacts to humans or communities). Acreage impacted is also an imperfect metric, as in many cases it is influenced by specific management decisions, most notably decisions regarding whether a fire is aggressively suppressed or allowed to burn without significant intervention.

Nonetheless, nationwide data indicate that the number of annual wildfires is variable but decreased slightly over the last 30 years. Data also show that the number of acres burned or impacted annually, while also variable, generally increased over the same period. More wildfires occur in the eastern United States (e.g., North and South regions), but wildfires are much larger in the western regions (e.g., Rocky Mountain and Pacific Coast regions). In 2020, nearly 59,000 wildfires affected 10.1 million acres nationwide, the second-most acreage impacted in any year since record keeping began.[38] In 2020, 93% of the acreage impacted was in the western regions of the country, but that accounted for only 43% of the fires.

[37] See for example, Robert E. Keane et al., *Cascading Effects of Fire Exclusion in Rocky Mountain Ecosystems: A Literature Review*, FS, RMRS-GTR-91, 2002; or Charles W. Lafon, *Fire History of the Appalachian Region: A Review and Synthesis*, FS, SRS-GTR-219, 2017.

[38] Historical fire statistics were first reported in 1960, but data collected prior to 1983 were reported using different methodologies and may not be considered official records. National Interagency Fire Center (NIFC), *Total Wildland Fires and Acres (1983-2020)*, at https://www.nifc.gov/fire-information/statistics/wildfires (hereinafter cited as NIFC, *Total Wildland Fires and Acres*). For more information, see CRS In Focus IF10244, *Wildfire Statistics*, by Katie Hoover and Laura A. Hanson.

Most wildfires are caused by human activities, but lightning-caused fires tend to be much larger than human-caused fires. For example, in 2020, lightning caused 9% of the fires but those fires accounted for 41% of the acreage impacted that year.

Forest Management

Forest management occurs for various reasons, which typically are chosen by the *manager*—the person or group of people with the authority to take action on the land (often, the owner). Forest management is characterized by the application of *silviculture*—the process of controlling the establishment, growth, composition, health, and quality of trees.[39] Because trees dominate forest ecosystems, silviculture is used to manage for many forest resources, including recreation, timber, water resources, and wildlife. This section focuses on silvicultural activities, because the practice of these activities is unique to forests. Some forest management practices may not involve manipulation of trees (e.g., activities related to roads, developed sites, or others) and are not described in depth here.

Individual forest management activities can serve a range of purposes, including multiple, simultaneous purposes. For example, thinning—or systematically removing part of—tree stands can reduce both the risk of insect and disease infestations and resource competition, meaning a manager may choose to thin tree stands to increase timber production, improve forest health, or both. Other activities may serve a single purpose; for example, fertilizer treatments are used almost exclusively to increase timber production. Some silvicultural treatments and their purposes include the following:

- **Prescribed fire**, the intentional use of fire, may reduce fuels, restore fire-adapted species, or otherwise promote desirable ecological conditions (particularly in areas where fire has been excluded).
- **Thinning** is the process of systematically removing part of a stand to improve the remaining trees' overall quality. Thinning can be *pre-commercial*, if the removed trees have no saleable value, or *commercial,* if the trees can be sold. Thinning differs from timber harvesting in that its main purposes are to reduce stand density and decrease resource competition for the trees remaining on-site.
- **Timber stand improvement** is a term that typically applies to managing a forest for timber production. It includes any activities not otherwise listed that improve stand quality and productivity, such as weeding; pruning; using chemical treatments, such as fertilizing or applying herbicides; and culling individual unwanted trees, such as those that are damaged, diseased, or poorly formed.
- **Timber harvesting** includes any practice where many trees are removed from a forest. Managers can perform tree harvesting with a range of intensity, from a so-called *clearcut* or *regeneration harvest* (removal of all trees) to *selective harvesting* (removal of trees of a specific size, age, species, or condition). Timber harvesting can include *salvage:* harvest of dead, diseased, fallen, or damaged trees. Timber harvesting differs from thinning in that regeneration—growth of new trees—is a primary goal.
- **Tree planting and site preparation** activities may increase productivity in various ways. Compared with forests that regenerate naturally, planting trees offers greater control over species and genetic mix, tree spacing, and other factors that increase productivity. Managers can conduct site preparation

[39] FS, "Silviculture," at https://www.fs.fed.us/forestmanagement/vegetation-management/silviculture/index.shtml.

activities that enhance productivity, such as control of other vegetation, in concert with planting. Planting is a relatively costly management activity and is most commonly performed to establish plantations for timber production purposes. However, managers may perform planting for other purposes, such as post-wildfire revegetation or reestablishment of desirable species.

This list is not exhaustive; in particular, it primarily relates to silvicultural management of forests that will remain forests and excludes non-silvicultural actions. In addition, forest management can involve intentionally *not* taking action. For example, some wildlife species rely on standing dead trees, so excluding harvesting or allowing certain pest and disease conditions may be part of managing for these species.

The management activities performed on U.S. forests vary widely, although trends exist within ownership classes. Management can range from no active management by the landowner to frequent management for one or more values in practically endless combinations of activities. As one example, to restore habitat for a fire-adapted songbird species, managers may apply prescribed fire repeatedly, harvest selected undesirable trees, plant trees and understory plants for food and cover, and reroute trails and roads.

Some forest management activities may focus on responding to health stressors to reduce risk to people or timber resources or to promote other forest values. The extent to which various forest management practices can prevent, treat, or facilitate recovery from disturbances varies by the specific disturbance agent. Further, the extent to which forest management practices can demonstrably improve forest health conditions is difficult to assess. Attributing forest health outcomes to any specific forest management activity is difficult, in part due to challenges in measuring such outcomes. It is likewise difficult to compare forest health conditions or outcomes across different forests. However, there is some debate regarding the extent to which certain forest management activities—particularly related to timber production—exacerbate or improve degraded forest health conditions (see "Timber Production and Forest Health," below).

Active and Intensive Management

The terms *active management* and *intensive management* are frequently used to describe forest management regimes with certain characteristics (although definitions and usage may vary). The descriptions below define the terms for the purposes of this report and illustrate some of the more common usages.

- **Active management** generally refers to management regimes consisting of planned activities to promote desired objectives. Active management can employ a wide variety of activities in pursuit of an equally wide variety of forest management goals. For example, a landowner could actively manage a forest for timber production, water quality, recreation, fish and wildlife habitat, scenery, or a combination of all of these resources and uses. Active management primarily contrasts with *passive* management—little to no planned intervention—rather than referring to specific objectives or actions.
- **Intensive Management** generally refers to management regimes consisting of many planned activities to optimize tree growth for timber production. For example, managers may plant genetically improved trees, use herbicides to exclude other vegetation, apply fertilizer, thin frequently, and clear-cut the forest at the desired age, while establishing and maintaining a road network for equipment access. Tree planting is often part of an intensive management regime and occurs primarily for growing important commercial softwood species. These sites are often managed as *plantations*, where the sites are intentionally planted in uniform rows of one selected, commercially valuable species.

Timber Production

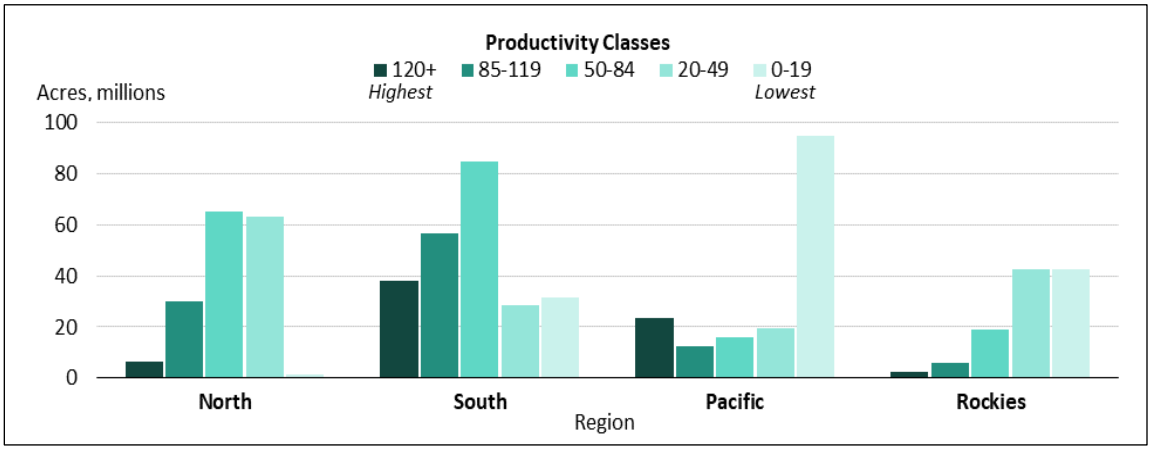
The United States is the world's largest producer and consumer of wood for industrial manufacturing.[40] Thus, production of *timber*—cut trees, the raw material from which wood products are made—from U.S. forests is often of interest to Congress. This section discusses how certain biophysical factors and forest management activities influence *timber productivity* (the amount of biomass that a forest produces over a given time) and decisions regarding timber harvesting. This section also discusses the relationship between timber production and forest health and notes broad-scale regional variations.

Biophysical Factors

The physical characteristics of forests drive their productivity potential. Regional and local physical factors appear to set upper limits on vegetation productivity.[41] The FS categorizes land's potential for growing trees through *productivity classes,* or ranges of potential volume growth per acre per year (see **Figure 4)**.

Figure 4. Forest Acres in Productivity Classes, 2017, by Region

(by potential cubic feet of growth per acre per year)



Source: Oswalt et al., *FRUS 2017,* Appendix A, Table 4.

Notes: *Productivity classes* are broad ranges of potential annual tree growth on a given parcel of land. Productivity classes are determined by physical factors, such as precipitation, temperature, and soils. Data are from 2017.

Trends in productivity classes generally are driven by common broad-scale factors within regions, such as similar temperature or moisture regimes. For example, the Rocky Mountain region, which is the most arid of the four regions, has the least land in the most productive classes. By contrast, the South has the most land in the most productive classes, perhaps due to the region's abundant precipitation and long growing seasons. Although the North receives abundant precipitation, its relatively shorter growing seasons and lower average temperatures may limit the amount of land in the highest productivity classes. The Pacific Coast region, which includes forests with very

[40] Consuelo Brandeis et al., "Status and Trends for the U.S. Forest Products Sector: A Technical Document Supporting the Forest Service 2020 RPA Assessment," FS, GTR- SRS-25855, 2021. Wood is also used for purposes other than industrial manufacturing, such as personal fuelwood use.

[41] Thomas Crow, Daniel Dey, and Don Reimenschneider, "Forest Productivity: Producing Goods and Services for People," FS, FS-GTR-NC246, 2006.

different temperature and moisture regimes, has both the most land in the lowest productivity classes and the second-most land in the highest productivity class.

A forest's productivity and desirability for timber production also depend on the tree species present—particularly, the mix of hardwoods and softwoods.[42] In broad terms, the commercial softwoods in the United States grow faster than the commercial hardwoods, making softwoods the prevailing species in U.S. timber markets. In 2017, the United States produced about 10.7 million cubic feet of softwood roundwood equivalents, compared with 5.3 million cubic feet of hardwoods.[43] Important U.S. timber producing regions, and the prevalence of certain management practices, often center on softwood silviculture.

Examples of Productivity Differences in Commercial Tree Species

Selected examples illustrate the broad differences between some significant commercial softwood and hardwood species. For example, forestry researchers in Georgia specify that the softwood loblolly pine, one of the most commercially important species of the South, is generally harvested before 35 years of age. In the specific case of harvest at the age of 33, loblolly pine may yield up to 55 tons of sawtimber per acre. Conversely, at 30 years of age, mixed upland hardwoods in Georgia are not expected to yield *any* merchantable sawtimber; these trees only have yields of 40 tons per acre or more beginning in year 50. In other states, foresters suggest rotation ages that may exceed 100 years for certain hardwoods. By contrast, the most commercially important timber species in the Pacific Coast region, Douglas fir, may be grown in periods of approximately 30-50 years.

Sources: Dickens et al., "Natural and Artificial Loblolly Pine Regeneration and Upland Mixed Hardwoods Natural Regeneration Economic Comparisons Using Three Stumpage Price Sets," Warnell School of Forestry, University of Georgia, 2014; Eini Lowell et al., "Effect of Rotation Age and Thinning Regime on Visual and Structural Grades of Douglas Fir Logs," *Forests*, vol. 9 (2018), pp. 576-593; Wisconsin Department of Natural Resources, "Chapter 52: Central Hardwood Cover Type," in *Silviculture Handbook,* 2009.

Management and Productivity

Over regional scales, the combination of biophysical factors and management trends determines forest productivity. Biophysical factors, such as a site's productivity class, form the underlying basis for forest productivity. The choice of forest management further influences productivity by impacting species mix, growth rate, and other factors.

Management is often regionally distributed and may significantly influence productivity. For example, in 2017, most plantations existed in five states in the South and two states in the Pacific Coast regions.[44] In the South, plantations accounted for nearly half of all softwood volume, two-thirds of annual softwood growth, and four-fifths of annual softwood removals but less than one-fifth of overall forest area, suggesting significant impacts of management on productivity.[45]

Forest productivity can be measured by the net volume of trees on the landscape at a given point in time (in **Figure 5,** the amount of timber on timberland) in conjunction with the *annual growth,*

[42] Despite this nomenclature, there is significant variation in growth and wood characteristics between and within these classes—in particular, wood from hardwoods is not necessarily harder than wood from softwoods.

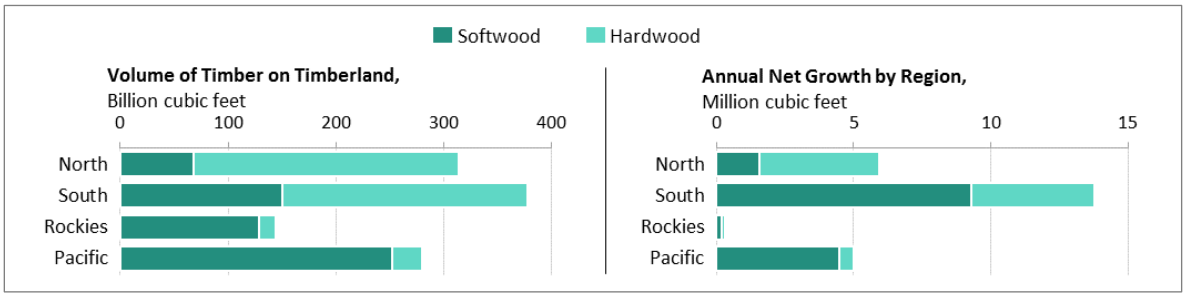
[43] James Howard and Shaobo Liang, "U.S. Timber Production, Trade, Consumption, and Price Statistics, 1965-2017," FS, FPL-RP-701, 2019. *Roundwood* refers to the main stem of the tree. Timber can be measured by volume (e.g., cubic feet or *board feet*, a measure of 12 inches by 12 inches by 1 inch) or weight (e.g., tons). Timber measurement units are a matter of choice and cannot be directly converted between one another. The *FRUS* primarily uses cubic feet to measure timber, and as such, most measures in this report also use cubic feet. However, other sources may use board feet or measures of weight.

[44] Oswalt et al., *FRUS 2017*, p. 41. The southern states are Alabama, Florida, Georgia, Louisiana, and Mississippi. In these states, 71% of planted acres are commercially important loblolly-shortleaf pine forests. The Pacific Coast states are Oregon and Washington, where the majority of planted acres are Douglas fir.

[45] Oswalt et al., *FRUS 2017*, p. 42.

or the overall amount of tree biomass that forestland accrues in a year. Together, these measures account for both management and biophysical factors in the amount of available timber and how quickly additional timber is added.

Figure 5. Measures of Timber Productivity, 2017



Source: Oswalt et al., *FRUS 2017*, Appendix A, Tables 17, 36, 39.

Common broad-scale biophysical factors and management trends within each region generally drive standing volume and net annual growth across forests in that region. For example, in 2017, the Rocky Mountain region had the lowest net annual growth of the four regions, which may reflect the generally low productivity of forestlands (see **Figure 4**) and high rates of mortality in the region. The South, with its generally high productivity and many intensely managed acres, had the highest rate of net annual growth. The North had the second-most-abundant standing timber volume but less land in high-productivity classes than the South or Pacific Coast regions (see **Figure 4**). Intensive management is also less common in the North than in other regions, which may have resulted in relatively lower net annual growth. The Pacific Coast region had less abundant standing timber volume and lower net annual growth than the North and South regions. The Pacific Coast region was relatively similar to the North region in annual net growth, however, perhaps due to the relatively high proportion of Pacific Coast land in the highest productivity class and the use of intensive forestry practices.

Harvest

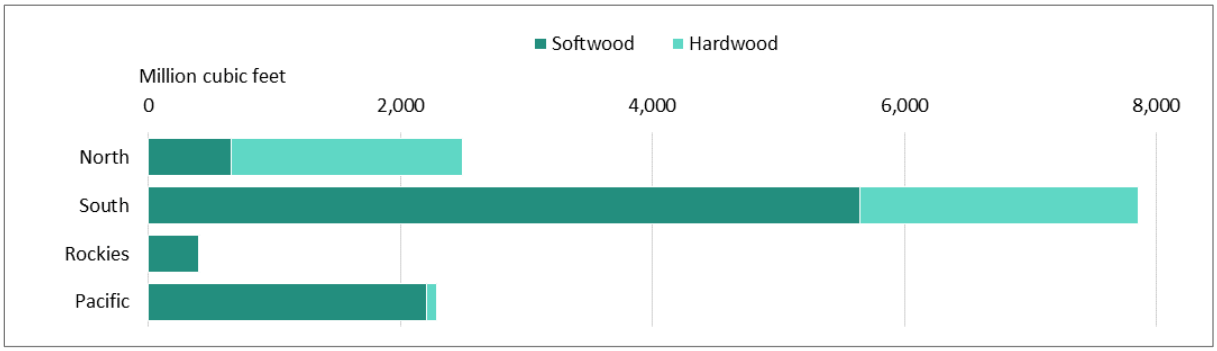
As described above, the amount of timber a forest ultimately produces depends on if, when, and how the forest is harvested. Depending on a manager's goals, resources, and constraints, a forest may never be harvested, regardless of productivity. Some forests may be harvested infrequently or not at all, such as those for which the manager has non-harvest-related goals (e.g., privacy, scenic beauty, recreational use); those that are costly to harvest (e.g., remote forests, forests in rugged terrain; or those that are unlikely to be profitable due to species, wood quality, or processing and transporting costs).

Ultimately, regional biophysical and management trends influence the likelihood of forests being harvested. Forests grown for the primary purpose of timber production are more likely to be intensively managed than forests grown for multiple purposes or for primary purposes other than timber production (though management actions, and timber harvesting, still may occur in these forests).

Figure 6 provides statistics on timber harvesting in the United States. As with trends in productivity, regional trends in timber harvesting are driven by common broad-scale factors. For example, the Rocky Mountain region, with its relatively low-productivity land, low growth rates, and high mortality (see **Figure 4** and **Figure 5)**, had the least timber harvest in 2017. The South, with its generally high productivity, high annual growth rates, and large timber stocks, had the most timber harvest overall. The North, with its abundant standing timber volume and relatively

higher annual growth of hardwoods, had the second-most hardwood harvest. Similarly, although the Pacific Coast region had less abundant standing timber volume than some regions, its relatively high annual growth rate and abundant standing volume of softwoods made it the second-most-significant softwood region.

Figure 6. Annual Roundwood Timber Harvest, by Region and Type, 2017



Source: Oswalt et al., *FRUS 2017*, Appendix A, Tables 17, 36, 39.

Notes: *Roundwood* refers to the main stem of the tree. Other materials created in harvesting trees are not included, particularly *logging residues,* the unused portions of harvested trees left at the harvest site. Annual hardwood roundwood harvest in the Rocky Mountain region is less than 1%.

Timber Production and Forest Health

Timber production and forest health are interrelated. Managers' timber production choices and other forest uses and conditions mutually influence one another (i.e., timber production can affect forest health, and forest health conditions can affect timber production). In broad terms, timber harvesting activities and any management actions intended to promote tree growth (e.g., plantation forestry, pesticide and fertilizer application) affect aspects of forest health. At the same time, forest health affects timber production by influencing harvest choices. For example, a land manager may harvest timber that otherwise would not have been harvested to forestall a disease outbreak, or a manager may not be able to profitably harvest timber due to insect damage. This mutual influence complicates any conclusion that timber harvests drive forest health *outcomes*; rather, at times, forest health conditions may drive harvest decisions, because forest health and timber production exist in a dynamic, interrelated system.

As described above, forest health is difficult to define and measure (see "Forest Ecological Health"), and no single comprehensive measure of forest health exists. For these reasons, it is difficult to draw broad conclusions about timber harvesting's impact on forest health. However, there are some known links between timber production and individual forest uses, resources, or functions. These links may relate to certain kinds of timber harvesting or to activities commonly undertaken to support timber production (e.g., the use of plantation forestry or pesticides). Similarly, there are some known links between forest health and timber production decisions.

Some timber production-related activities may negatively affect aspects of forest health, whereas others may positively impact aspects of forest health. For example, forests' resistance and resilience depend on biodiversity at multiple scales, and *natural forests*—as opposed to plantations—are usually more suitable as habitat for a wider range of native forest species.[46]

[46] United Nations Environment Programme, Convention on Biological Diversity, *Forest Resilience, Biodiversity, and Climate Change,* CBD Technical Series No. 43, 2009; and Eckehard Brockerhoff et al., "Plantation Forests and

Certain forest management practices, such as timber harvesting or fertilizer application, can negatively affect water quality and temperature.[47] Some silvicultural activities disturb or compact soils.[48] The degree of many of these impacts depends on the specific timber production practices. Specific management actions may mitigate negative effects; for example, use of certain practices can allow plantation forests to provide habitat, and can lessen the water quality impacts of timber harvesting or can reduce impacts to soils (though it is unclear if such effects can be completely eliminated).[49]

In some cases, the relationship between timber production activities and forest health is less clear-cut. For example, mortality from pests, diseases, and abiotic disturbances tends to be lower in intensively managed, planted forests than in natural forests, but practices used to control these disturbances may lead to other concerns.[50] Similarly, it is unclear how tree planting or past timber harvest influences the likelihood of some wildfire activity.[51]

Aspects of forest health, such as disturbances, also can drive timber-harvesting decisions. Managers may choose to preemptively harvest to forestall future disturbances, or they may salvage trees killed or damaged by disturbances. Some harvesting activities, such as thinning, can mitigate current disturbances or reduce the likelihood of future disturbances.[52] However, a harvest's effectiveness in addressing disturbance depends on the harvesting practices used and is not always understood. For example, some forms of thinning can worsen infestations of some pests and diseases, while controlling others.[53] Some experts argue that timber harvests in response to future or past disturbances can have worse ecosystem impacts than the disturbances themselves.[54] As with any timber harvesting activity, impacts likely depend on the harvest's scale, scope, and methods.

Forest Ownership Overview and Data

As of 2017, there were 765 million acres of forestland in the United States, the majority of which (58%) were privately owned (see **Figure 7, Figure 8,** and **Table 1)**.[55] The distribution of

Biodiversity: Oxymoron or Opportunity?," *Biodiversity and Conservation,* vol. 17, no. 5 (2008), pp. 925-951.

[47] Dan Binkley, Heather Burnham, and H. Lee Allen, "Water Quality Impacts of Forest Fertilization with Nitrogen and Phosphorus," *Forest Ecology and Management,* vol. 121, no. 3 (1999), pp. 191-213.

[48] Leslee Crawford et al., *Soil Sustainability and Harvest Operations: A Review,* FS, GTR-RMRS-421, 2021.

[49] Mitschka Hartley, "Rationale and Methods for Conserving Biodiversity in Plantation Forests," *Forest Ecology and Management,* vol. 155, no. 1-3 (2002), pp. 81-95; and Richard Cristan et al., "Effectiveness of Forestry Best Management Practices in the United States: A Literature Review," *Forest Ecology and Management,* vol. 360 (2016), pp. 133-151.

[50] Peter Gadgil and John Bain, "Vulnerability of Planted Forests to Biotic and Abiotic Disturbances," *New Forests,* vol. 17, no. 1-3 (1999), pp. 227-238.

[51] Jonathan Thompson, Thomas Spies, and Lisa Ganio, "Reburn Severity in Managed and Unmanaged Vegetation in a Large Wildfire," *Proceedings of the National Academy of Sciences,* vol. 104, no. 25 (2007), pp. 10743-10748.

[52] Christopher Fettig et al., "Cultural Practices for Prevention and Mitigation of Mountain Pine Beetle Infestations," *Forest Science,* vol. 60, no. 3 (2014), pp. 450-463 (hereinafter cited as Fettig et al., "Mountain Pine Beetle Infestations"); John Nowak et al., "Southern Pine Beetle Infestations in Relation to Forest Stand Conditions, Previous Thinning, and Prescribed Burning: Evaluation of the Southern Pine Beetle Prevention Program," *Journal of Forestry,* vol. 113, no. 5 (2015), pp. 454-462; and Scott Stephens et al., "The Effect of Forest Fuel-Reduction Treatments in the United States," *BioScience,* vol. 62, no. 6 (2012), pp. 549-560.

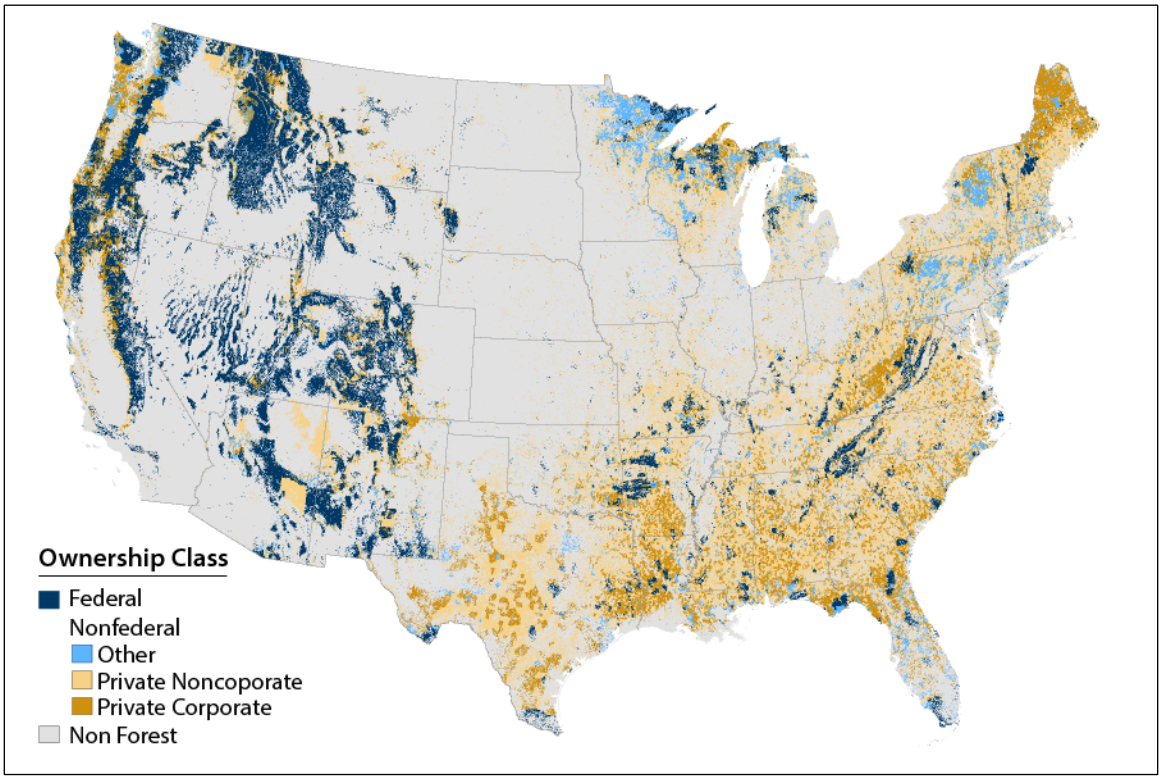
[53] Fettig et al., "Mountain Pine Beetle Infestations."

[54] David Foster and David Orwig, "Preemptive and Salvage Harvesting of New England Forests: When Doing Nothing Is a Viable Alternative," *Conservation Biology,* vol. 20, no. 4 (2006), pp. 959-970.

[55] Oswalt et al., *FRUS 2017,* Appendix A, Table 2.

ownership classes varied across the four major regions of the United States, with significant differences between the eastern regions (i.e., North, South) and the western regions (i.e., Rocky Mountain, Pacific Coast) (see **Figure 8**). Most forests in the eastern regions were private, whereas most forests in the western regions were public.

Figure 7. Forest Ownership in the Conterminous United States Circa 2014

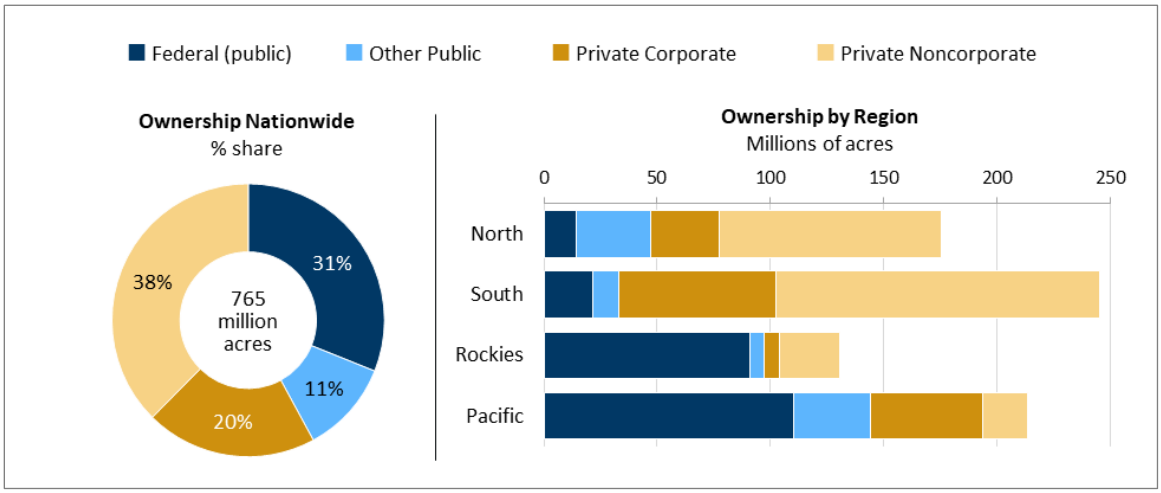


Source: CRS analysis of data from Jaketon H. Hewes, Brett J. Butler, and Greg C. Liknes, *Forest Ownership in the Conterminous United States Circa 2014: Geospatial Data Set*, FS Research Data Archive, 2017, at https://doi.org/10.2737/RDS-2017-0007.

Notes: Data are not available for Alaska, Hawaii, or the U.S. territories.

Privately owned forests are further classified as *corporate* and *noncorporate*, with additional classifications within the noncorporate ownership category. Public forests are classified as either *federal* or *other public*, a category that includes state, county, and municipal forests. Nonfederal forests include the private and other public *FRUS* ownership classes. For more detail on the private and public ownership classes, see "Federal Forests" and "Nonfederal Forests," below.

Figure 8. U.S. Forest Ownership, 2017



Source: Oswalt et al., *FRUS 2017*, Appendix A, Table 2.

Notes: The regions correspond to the regions in the *FRUS;* see Figure 1.

In 2017, two-thirds (514 million acres) of U.S. forests were classified as *timberlands*.[56] Timberlands are a subset of forestland, consisting of forests producing or capable of producing crops of industrial wood that are not withdrawn from timber use by statute or regulation. Forests classified as timberlands include areas that may not be logistically or financially available for timber production.[57]

The distribution of timberland by ownership varies from that of forest ownership generally (see **Table 1)**. Notably, in 2017, timberlands were more common in privately owned forests than in publicly owned forests. Specifically, whereas 58% of all U.S. forests were privately owned, 70% of U.S. timberlands were privately owned.[58] This pattern is most pronounced in the Pacific, where a larger portion of timberlands was privately owned relative to the portion of private forests in the region.

Table 1. Extent and Distribution of U.S. Forests and Timberlands Ownership, 2017, by Region

(in millions of acres)

	North	South	Rocky Mountain	Pacific Coast	Total
Land Acreage	**414**	**552**	**759**	**575**	**2,300**
Forest Acreage	**176**	**246**	**131**	**214**	**765**
Private Forests	129 (73% of forest acreage)	212 (86% of forest acreage)	33 (25% of forest acreage)	69 (32% of forest acreage)	444 (58% of forest acreage)
Corporate	*30 (17%)*	*69 (28%)*	*7 (5%)*	*49 (23%)*	*156 (20%)*
Noncorporate	*98 (56%)*	*143 (58%)*	*26 (20%)*	*20 (9%)*	*288 (38%)*

[56] Oswalt et al., *FRUS 2017*, Appendix A, Table 10.

[57] For example, some timberlands may be at high elevation or otherwise inaccessible, or they may be located too far away from timber processors to financially justify the expense of harvesting and hauling timber.

[58] Oswalt et al., *FRUS 2017*, Appendix A, Table 10.

	North	South	Rocky Mountain	Pacific Coast	Total
Public Forests	47 (27%)	33 (14%)	97 (75%)	144 (68%)	322 (42%)
Federal	*15 (8%)*	*22 (9%)*	*91 (70%)*	*110 (52%)*	*238 (31%)*
Other Public	*32 (18%)*	*11 (5%)*	*6 (5%)*	*34 (16%)*	*84 (11%)*
Timberland Acreage	**165 *(94% of forests)***	**208 *(85% of forests)***	**70 *(53% of forests)***	**72 *(34% of forests)***	**514 (67% of forests)**
Private Timberlands	128 (78% of timberland acreage)	182 (88% of timberland acreage)	19 (28% of timberland acreage)	30 (41% of timberland acreage)	359 (70% of timberland acreage)
Corporate	*30 (18%)*	*64 (31%)*	*5 (7%)*	*18 (26%)*	*117 (23%)*
Noncorporate	*98 (59%)*	*119 (57%)*	*14 (20%)*	*11 (16%)*	*242 (47%)*
Public Timberlands	37 (22%)	26 (12%)	50 (72%)	42 (59%)	155 (30%)
Federal	*11 (7%)*	*16 (8%)*	*47 (68%)*	*33 (46%)*	*108 (21%)*
Other Public	*26 (16%)*	*10 (5%)*	*3 (5%)*	*9 (12%)*	*48 (9%)*

Source: Oswalt et al., *FRUS 2017*, Appendix A, Tables 2 and 10.

Notes: Totals may not add precisely due to rounding.

The first two sections below describe the extent, distribution, management, and uses of federal and nonfederal forests across the United States. The nonfederal forests section includes discussion of those attributes by private (corporate and noncorporate and, within noncorporate, family and tribal/other) ownership and other public ownership. The following sections summarize forest health and timber production trends by ownership class; this information is available at different scales (e.g., public and private, federal and nonfederal), as noted.

The significant variation between and across federal and nonfederal forest owners affects the availability of information on different forest attributes and management activities and makes comparing and contrasting forest uses and management difficult. Information about federal forest management is readily available, because federal forests are ultimately managed by one entity (the federal government). By contrast, at least 98 different entities own and manage other public forests and around 11 million entities own and manage private forests.[59] Information about the management of forests in these categories is summarized to the extent possible from available data.

In many cases, data regarding private forest management objectives, activities, and plans are based on self-reported surveys. Accordingly, the private forest discussion below summarizes information about reported management objectives and activities. The section also provides information regarding the extent to which private forests are under management plans, generally as a proxy for active landowner participation in management and to facilitate comparison across ownerships.

[59] Oswalt et al., *FRUS 2017*, pp. 7-8. The estimate of 98 entities managing state and local forests reflects (1) state-owned forestland in each of the 50 states and (2) locally owned forestlands, which are in 48 states. Some state forestland may be managed by different entities within the same state, and there is not an estimate of the total number of locally owned forests. The estimate of 98 different entities likely understates the actual total.

Similarly, the "Nonfederal Public Forests: State and Local" discussion summarizes information about the uses and management objectives across the state and local forests. The federal forests section, in contrast, provides an overview of the statutory missions, uses, and management framework for federal forests.

Historic Land Settlement Patterns

The regional variation in public and private forest and timberland ownership is in large part due to the pattern of land settlement in the United States. The 13 original states ceded lands—generally between the Appalachian Mountains and the Mississippi River—to the federal government shortly after the establishment of the United States. The federal government also retained a portion of the lands in each new state upon granting statehood. Congress disposed of many of these *public domain* lands to raise money, pay off debts, and encourage westward settlement and development, among other reasons. Congress also reserved some of these lands for public purposes, such as the establishment of national parks, or authorized the President to reserve some of these lands, such as for the establishment of national forests. Later, Congress authorized the acquisition of land for establishing national forests in the East. Thus, nearly all of the federal forests in the original eastern states were acquired opportunistically through purchase and nearly all of the federal forests in the rest of the United States were established from relatively large and contiguous swaths of available public domain lands.

Congress authorized the acquisition of lands to establish national forests in the East in part due to concerns about 19th century logging practices and related impacts to watersheds, municipal water supplies, and timber supplies. Many logging companies during that time would harvest all the trees on a site and then abandon the land, for various reasons. For the most part, however, timber companies retained the most productive timberlands in private ownership, while many of the less productive areas became available for federal acquisition. These patterns explain why more timberland is in private ownership relative to public forest ownership, particularly in the East.

In the West, there are several potential explanations for the discrepancy between public forest and timberland ownership. One potential explanation is that because one original purpose of the national forests was to protect water supplies, many federal forests are in high-elevation headwaters regions. These areas generally contain less productive lands than mid- or lower-elevation areas. Another potential explanation is that some of the most productive timberlands were conveyed out of federal ownership, through land exchanges, for example, or because timber was one of the purposes for which private companies and individuals could settle and claim public domain land out of federal ownership.

For more background on the establishment of federal lands, see CRS Report R42346, *Federal Land Ownership: Overview and Data*, by Carol Hardy Vincent and Laura A. Hanson; or Department of the Interior, Bureau of Land Management, *Public Land Statistics, 2020,* Part 1, pp. 1-6, at https://www.blm.gov/about/data/public-land-statistics.

Sources: Con H. Schallau and Richard M. Alston, "The Commitment to Community Stability: A Policy or Shibboleth?," *Environmental Law*, vol. 17, no. 3 (1987), pp. 429-481, at https://www.jstor.org/stable/43265802; William E. Shands, "The Lands Nobody Wanted: The Legacy of the Eastern National Forests," in *Origins of the National Forests: A Centennial Symposium,* ed. Harold K. Steen (Durham, NC: Forest History Society), p. 1992; Jon A. Souder and Sally K. Fairfax, *State Trust Lands: History, Management, and Sustainable Use* (Kansas: University Press of Kansas, 1996), pp. 336-337.

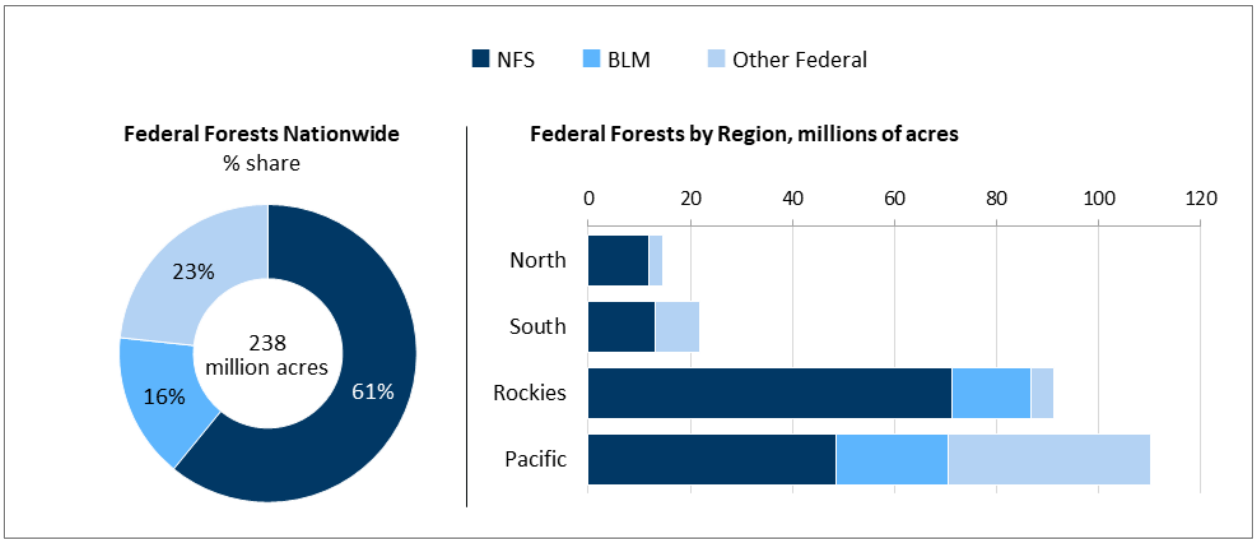
Federal Forests[60]

As of 2017, there were 238 million acres of federally owned forests in the United States. Two federal agencies, the FS and the Bureau of Land Management (BLM, within the Department of the Interior [DOI]), managed the majority of these forests. Most of the federal acreage (61%) is located within the National Forest System (NFS), managed by the FS, and 16% of federal forests were managed by the BLM. The *FRUS* does not further classify the ownership of the remaining 23% of federal forests, which are managed by agencies such as the National Park Service, Fish and Wildlife Service, and Bureau of Reclamation (all in DOI), and the Department of the Defense, among others. Less than half of the federal forests contained timberlands (108 million acres), and the distribution of federal timberlands varies from that of federal forests. The FS

[60] Unless otherwise noted, data in the "Federal Forests" section are from Oswalt et al., *FRUS 2017*, Appendix A, Tables 2 and 10.

managed the largest proportion of U.S. timberlands (89%); BLM managed 6% of federal timberlands, and the other federal agencies combined managed 5% of the timberland area.

Figure 9. Management and Distribution of U.S. Federal Forests, 2017



Source: Oswalt et al., *FRUS 2017*, Appendix A, Table 2.

Notes: BLM = Bureau of Land Management, in the Department of the Interior (DOI); NFS = National Forest System, managed by the Forest Service (in the U.S. Department of Agriculture); "Other Federal" primarily reflects lands managed by other bureaus within DOI or the Department of Defense.

This section focuses on forests managed by the FS and the BLM for several reasons. As noted above, the *FRUS* does not classify data for other federal forests further and, in some cases, does not report data on those forests. In addition, the FS and the BLM are managed under similar statutory provisions for *multiple use* and *sustained yield* (see "Management Missions for FS and BLM Forests"), under which timber harvesting is an authorized use. With some exceptions, the other agencies' management missions generally do not include timber harvesting. In practice, almost all harvesting of federal timber occurs on FS and BLM lands.

- The NFS (managed by the FS) comprises nearly 193 million acres and includes national forests; national grasslands; and other units, such as research and experimental areas.[61] National forests make up 98% of the NFS (188 million acres). Not all of the NFS is forested; the system contains 145 million acres of forest and woodland, of which 96 million acres (66%) are timberland.[62]
- The BLM manages about 246 million surface acres of federal lands, almost entirely located in the western regions of the United States.[63] About 15% (38 million acres) of BLM lands are forest; of that, 6 million acres (16%) are timberland. A significant portion of BLM forest and timberland areas are located

[61] The National Forest System (NFS) is defined at 16 U.S.C. §1609(a). See FS, *Land Areas Report (LAR)—as of September 30, 2020*, Table 1, at https://www.fs.fed.us/land/staff/lar-index.shtml.

[62] For more information, see CRS Report R43872, *National Forest System Management: Overview, Appropriations, and Issues for Congress*, by Katie Hoover and Anne A. Riddle.

[63] The Bureau of Land Management (BLM) lands are officially named *public lands* (43 U.S.C. §1702(e)) but are referred to as *BLM lands* in this report to avoid confusion. The BLM also administers the federal subsurface estate, which is not discussed in this report.

in one state—Oregon—and are known as the Oregon and California Railroad Grant (O&C) Lands.[64] Congress revested these lands to the federal government following a violation of grant terms and established a separate statutory mission for these lands.

Management Missions for FS and BLM Forests

The FS and the BLM manage most of the lands under their jurisdictions under similar statutory missions: both manage for a balance of *multiple uses* and a *sustained yield*.[65]

- **Multiple use** management means considering the relative values of the various resources and the combination of uses that best meets the needs of the American people. It does not necessarily mean maximizing dollar returns or outputs, nor does it necessarily require that any one area be managed for all or even most uses. The multiple uses to balance include livestock grazing; energy and mineral development; recreation; timber production; watershed protection; wildlife and fish habitat; and natural scenic, scientific and historical values.[66] Congress did not specify that managers should prioritize one use over any other use; reportedly, Congress specifically listed the uses in alphabetical order to avoid conferring any implied prioritization for management of the NFS.[67]
- Managing for a **sustained yield** means ensuring a high level of resource outputs are maintained in perpetuity without impairing the land's productivity.

Many have interpreted the management direction provided in the O&C statutes as establishing a separate management mission, termed a *dominant use* mission. The O&C lands are to be managed for a sustained yield of permanent forest production, watershed protection, recreation, and contribution to the economic stability of local communities and industries.[68] Although some would interpret this statutory direction as managing for multiple uses, others contend it requires management for timber production over the other uses—that is, timber production is the dominant use. The dominant use interpretation has been controversial at times and requires equating *timber production* to *forest production*. BLM has adopted the interpretation and the courts have affirmed it at various times.[69]

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[64] The FS manages a small portion of the Oregon and California (O&C) lands. Although separate, the O&C lands also commonly include the Coos Bay Wagon Road lands, which consist of lands in two counties in Oregon that also were returned to the federal government. For more information on the O&C Grant Lands, see CRS Report R42951, *The Oregon and California Railroad Lands (O&C Lands): Issues for Congress*, by Katie Hoover.

[65] The management mission for the national forests was established pursuant to the Multiple-Use Sustained Yield Act of 1960 (MUSY; Act of June 12, 1960; P.L. 86-517, 16 U.S.C. §§528-531). Other laws govern the management of some other NFS units. The management mission for BLM public lands was established pursuant to the Federal Land Policy and Management Act of 1976 (FLPMA; P.L. 94-579, 43 U.S.C. §§1701 et seq.).

[66] The uses listed include those specified for the BLM through FLPMA (43 USC §1702(c)). The uses specified for the NFS in MUSY (16 U.S.C. §528) are more limited and do not specifically include energy and mineral or natural scenic, scientific, or historical values, though other statutes authorized those uses for the NFS.

[67] MUSY listed the multiple uses as "outdoor recreation, range, timber, watershed, and wildlife and fish purposes" (16 USC U.S.C. §528,). Con H. Schallau and Richard M. Alston, "The Commitment to Community Stability: A Policy or Shibboleth?," *Environmental Law*, vol. 17, no. 3 (1987), p. 469, at https://www.jstor.org/stable/43265802.

[68] 50 Stat. 874; 43 U.S.C. §2601.

[69] For more discussion on the dominant use framing, see, for example, Deborah Scott and Susan Jane M. Brown, "The Oregon and California Lands Act: Revisiting the Concept of 'Dominant Use,'" *Journal of Environmental Law and Litigation*, vol. 21 (2007), pp. 259-316; and Michael C. Blumm and Tim Wigington, "The Oregon & California Railroad Grant Lands' Sordid Past, Contentious Present, and Uncertain Future: A Century of Conflict," *Boston College*

Management Framework for FS and BLM Forests

Both the FS and the BLM are required to engage in long-term forestland use and resource management planning to inform and guide their decisionmaking processes for balancing multiple uses and ensuring a sustained yield of resources.[70] (For the BLM, these requirements apply to all lands within the agency's jurisdiction, including the O&C lands.) The specific processes and procedures vary between the FS and the BLM, but generally the land and resource management plans (sometimes referred to as *forest plans*, particularly for the FS) are developed through an interdisciplinary process, with opportunities for public involvement. The plans guide management of the plan area by identifying desired resource conditions; determining the land's suitability for various uses; and specifying the objectives, standards, and guidelines for activities and uses in the area. The plans provide management direction and establish a framework to guide future decisionmaking regarding specific on-the-ground actions and resource allocation decisions, but they do not authorize or commit the agencies to take any specific actions. The plans may constrain future projects or activities in specific areas.[71]

Projects are the specific on-the-ground actions that implement the forest plan prepared for a particular site.[72] Projects may include timber harvests, trail maintenance, or issuance of special-use authorizations for rights-of-ways across agency lands, among many other activities. Projects also require an interdisciplinary planning and review process with opportunities for public involvement, but the specific requirements vary based on the project type and other characteristics.

The development of plans and projects must comply with any laws of general applicability that govern federal action and generally is subject to various administrative and judicial review procedures. Each agency has developed procedures to comply with applicable statutory requirements, such as those imposed by the Endangered Species Act, National Environmental Policy Act, and National Historic Preservation Act.[73]

Federal Forest Management: Financial Considerations

Management decisions for federal forests are not based on financial optimization for the federal government. In the 1960s, Congress debated adding profitability as a goal for national forest management but ultimately defined *multiple use* to mean considering "the relative values of the various resources, [but] not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output" (16 U.S.C. §531(a)). Although the FS considers management costs and efficiencies during the development of forest plans and projects, it considers these financial factors relative to other ecological and social factors. More specifically, FS regulations stipulate that forest plans "guide management of [National Forest System] lands so that they are ecologically sustainable and contribute to social and economic sustainability ... and have the capacity to provide people and communities ... a range of social, economic, and ecological benefits for the present and into the future" (36 C.F.R. 217.1(c)).

of Environmental Affairs Law Review, vol. 40, no. 1 (2013).

[70] The planning requirements for the FS were established pursuant to the National Forest Management Act of 1976 (P.L. 94-588, 16 U.S.C. §§1601 et seq.). The FS planning regulations are promulgated at 36 C.F.R. Part 219. The planning requirements for the BLM were established pursuant to FLPMA; the BLM planning regulations are promulgated at 43 C.F.R. Part 1600.

[71] 36 C.F.R. 219.15.

[72] 36 C.F.R. 219.19.

[73] Endangered Species Act of 1973 (P.L. 93-205, 16 U.S.C. §§1531 et seq.); National Environmental Policy Act of 1969 (P.L. 91-190, 42 U.S.C. §§4321–47); National Historic Preservation Act (P.L. 89-665, 54 U.S.C. §§300101 et seq.). Another relevant law of general applicability is the Administrative Procedure Act (P.L.79-404, 5 U.S.C. §§500 et seq.).

Further, contributing to economic sustainability or providing economic benefits generally means conferring those benefits to communities surrounding the national forests, not necessarily to the federal government. At various times, goals of contributing to community stability or otherwise supporting timber-dependent communities have shaped FS policies and decisions. At times, these considerations have led the FS to make decisions that would not be financially optimal for the federal government, such as below-cost timber sales. This decisionmaking model can appear inefficient in comparison to the models of some private actors, especially those that manage their lands to optimize timber production or financial returns.

Sources: Con H. Schallau and Richard M. Alston, "The Commitment to Community Stability: A Policy or Shibboleth?," *Environmental Law*, vol. 17, no. 3 (1987), pp. 429-481, at https://www.jstor.org/stable/43265802; David Wear, "Chapter 12: Public Timber Supply Under Multiple-Use Management," in *Forests in a Market Economy*, eds. Erin Sills and Karen Abt (Boston: Kluwer Academic Publishers, 2003), pp. 203-220; Robert W. Wolf, "National Forest Timber Sales and the Legacy of Gifford Pinchot: Managing a Forest and Making it Pay," *University of Colorado Law Review,* vol. 60, no. 4 (1989), pp. 1063-1064.

Uses of FS and BLM Forests

As noted above, the FS and the BLM administer the federal forests they manage for sustained yields of multiple uses. According to the agencies' respective statutory missions, the multiple uses to be balanced include fish and wildlife purposes, outdoor recreation, mineral and energy development, range (livestock grazing), timber, and watershed management (other forests also provide many such uses, but not necessarily in the same way or to the same degree). These uses are briefly summarized below, to the extent the provision of resources on FS and BLM lands differs from on other forestland, particularly private forests.[74]

- Like private forests, BLM and FS forests contain **fish and wildlife habitats**, including those for commercially significant species and botanically significant resources. As in private forests, these resources contribute to other uses and benefits, such as recreational and economic use. Federal forests also have specific statutory requirements for conserving threatened and endangered species.[75] In addition, as part of their **range management** responsibilities, the FS and BLM must manage and protect populations of wild horses and burros.[76]
- Unlike private forests, most FS and BLM forests are broadly open to the public for **recreation purposes**, such as camping, fishing, hiking, horseback riding, hunting, skiing, snowboarding, wildlife viewing, and more.[77]
- **Timber production** was an original purpose of many federal forests, such as the national forests.[78] Timber harvesting occurs in FS and BLM forests for a variety of purposes, such as to produce commercial timber or promote certain forest conditions. A relatively small amount of U.S. timber is harvested from federal forests (see **Figure 13**).[79]

[74] The ways in which the FS and the BLM determine how to balance the multiple uses is discussed in "Management Framework for FS and BLM Forests."

[75] Endangered Species Act of 1973. For more information, see CRS Report R46677, *The Endangered Species Act: Overview and Implementation*, by Pervaze A. Sheikh, Erin H. Ward, and R. Eliot Crafton.

[76] 16 U.S.C. §§1331 et seq. For more information on wild horses and burros, see CRS In Focus IF11060, *Wild Horse and Burro Management: Overview of Costs*, by Carol Hardy Vincent.

[77] See, for example, CRS Report R45103, *Hunting and Fishing on Federal Lands and Waters: Overview and Issues for Congress*, by R. Eliot Crafton.

[78] 16 U.S.C. §475, 43 U.S.C. §2601.

[79] For more information, see CRS Report R45688, *Timber Harvesting on Federal Lands*, by Anne A. Riddle.

- Most BLM lands and many NFS lands are open to public **mineral and energy resource exploration and development**.[80]
- Protecting **watershed health** was among the original purposes of the national forests.[81] It includes the management of surface and groundwater resources as well as water uses and rights on NFS and BLM lands. As on private lands, watersheds on federal forests support ecological services, such as flood control and water quality. Nearly one-fifth of the nation's water originates on NFS lands.[82]
- Congress has provided management direction within BLM and FS lands by creating **special designations** for certain areas, which may aim to preserve certain conditions or resources of the land, provide for particular public uses, or fulfill other purposes in perpetuity. Resource development and use is generally more restricted in these specially designated areas than on general BLM or NFS lands, and Congress typically provides specific guidance with each designation. Examples of these designations include wilderness, national recreation areas, and national monuments.[83] Such areas generally do not have publicly accessible analogues on private lands.[84]

BLM and NFS lands also are used for other purposes and services that support national policies and federal land laws. Various authorities may permit these uses or activities on applicable lands, allowing uses of BLM and NFS lands for purposes ranging from commercial filming to ski resort operation to various types of water, communication, and energy infrastructure and rights-of-ways, among others.

Nonfederal Forests

As of 2017, the majority of the 765 million acres of forests in the United States were nonfederal. Nonfederal forests may be privately owned or publicly owned (i.e., by states, counties, or localities). Most nonfederal forests were classified as privately owned (443 million acres, or 58%); an additional 84 million acres (11%) were classified as nonfederal public forests.

Private Forests

In the *FRUS,* the FS defines ownership of private forestlands as falling into two categories: *private corporate* and *private noncorporate,* defined in **Table 2.** The FRUS, and other FS resources, also refers to three additional categories of land: *family, tribal,* and *other private.* The

[80] 30 U.S.C. §§181 et seq. The BLM manages the subsurface rights to virtually all federal lands, including NFS lands.

[81] 16 U.S.C. §475.

[82] FS, "Watershed, Fish, Wildlife, Air and Rare Plants," at http://www.fs.fed.us/biology/watershed/#focus.

[83] For more information, see CRS Report R45340, *Federal Land Designations: A Brief Guide*, coordinated by Laura B. Comay.

[84] Certain mechanisms exist for creating legally binding protections on private lands. However, these mechanisms exist at smaller scales than for federally protected lands and vary substantially in their provisions, meaning the two are not directly comparable. For example, a *conservation easement* is a binding, voluntary agreement between a private landowner and an outside party (generally, a nonprofit organization or government) that permanently constrains the uses of a given land parcel, generally to achieve certain conservation purposes. Conservation easements generally are applicable to present and future owners of the land. Conservation easements' purposes and provisions vary and may contain provisions similar to the protections afforded certain federal lands (such as restrictions on development). In particular, most conservation easements are not open to the public. See Katherine Lieberknecht, "Public Access to U.S. Conservation Land Trust Properties: Results from a National Survey," *Journal of the American Planning Association*, vol. 75, no. 4 (2009), pp. 479-491.

correspondence between these categories and the *FRUS* category of private noncorporate is difficult to determine, as the *FRUS* does not describe their relationship and the term *private noncorporate* is not widely used in other FS analysis.

Table 2. Private Forest Ownership Categories

Category	Definition
Private Corporate	Owners that are formally incorporated, including corporations, timber investment management organizations, real estate investment trusts, Alaska Native corporations, and private universities that own forest or woodland.
Private Noncorporate	Ownership by noncorporate interests, including Native American lands, unincorporated partnerships, clubs, and lands leased by corporate interests.
Family	Ownership by families, individuals, trusts, estates, and family partnerships.
Tribal	Ownership by Native American tribes or individuals within reservation boundaries.
Other Private	Ownership by nongovernmental organizations, associations, clubs, and other unincorporated organizations.

Sources: Private corporate and private noncorporate: Oswalt et al., *FRUS 2017*, Glossary and pp. 7-8. Family, tribal, and other private: Brett Butler et al., *Family Forest Ownerships of the United States, 2018: Results from the USDA Forest Service National Woodland Owners Survey*, FS, GTR-NRS-199, February 2021 (hereinafter cited as Butler et al., *Family Forest Ownerships*). *Tribes* includes Native American and Alaska Native tribal governments and individuals within reservation boundaries

In general, various sources agree that most U.S. forestland is privately owned, the great majority by family and corporate owners. Due to imprecision in definitions, it is sometimes unclear how data referring to private forest ownership can be reconciled across sources. In addition, the data in the *FRUS* do not appear to be internally consistent: The *FRUS* specifies that family forest ownership accounts for 38% of U.S. forests, making it the single largest U.S. forest ownership class.[85] The *FRUS* also estimates that other private owners and tribes—defined as forests and woodlands owned by Native American and Alaska Native tribal governments and by individuals within reservation boundaries—each control an estimated 2% of U.S. forests.[86] These totals do not add to the overall *FRUS* estimate of private noncorporate ownership (38%). The *FRUS* estimates that 20% of forests are in corporate ownership. The *FRUS* figures for each individual ownership class—family, corporate, other private, and tribal—are similar or identical to estimates given elsewhere.[87]

Private forest ownership varies regionally throughout the United States. In 2017, most of the private forests were located in the North and South regions (see **Figure 8** and **Table 1**); noncorporate ownership comprised more than half of the total private forests in these regions. Corporate ownership accounted for a smaller portion of overall forest ownership in the North and South regions. In the western regions, private forests made up a minority of land ownership. In the Pacific Coast region, one-third of forests were privately owned, primarily by corporations. In contrast, one-quarter of the forests in the Rocky Mountain region were privately owned, mostly

[85] Oswalt et al., *FRUS 2017*, p. 8.

[86] Oswalt et al., *FRUS 2017*, p. 8.

[87] See for example, Brett Butler et al., *Family Forest Ownerships of the United States, 2018: Results from the USDA Forest Service National Woodland Owners Survey*, FS, GTR-NRS-199, February 2021 (hereinafter cited as Butler et al., *Family Forest Ownerships*), which estimated that 39% of forestland is in private family ownership, 19% is in corporate ownership, 2% is in tribal ownership, and 2% is in other private ownership.

by noncorporate owners. Family owners dominate private noncorporate ownership throughout the United States.

As of 2017, most U.S. timberlands (70%) nationwide were privately owned, primarily by noncorporate owners. In addition, private owners controlled more timberlands relative to their forest ownership. For example, corporate owners controlled about one-quarter of U.S. timberlands and owned one-fifth of forests. Noncorporate owners controlled 47% of U.S. timberlands and owned 38% of forests. Of the timber removed from timberlands annually in the United States, 89% came from private lands.[88] CRS was unable to locate more precise measures of nationwide timber harvest or removals by specific private ownership groups (e.g., family, corporate).

Private forest owners generally manage their land according to their values and objectives. Forest owners generally may pursue their goals for the land, including by managing to maximize any values they wish or by not actively managing the land at all, subject to the constraints of knowledge, financial resources, time, or wherewithal. Private forest owners generally are not required to analyze the conditions of their forests or plan forest activities in advance, meaning their actions may be as ad hoc or as systematic as the owners wish. The only constraints on private forest owners are applicable state or local laws regarding forestry, which vary throughout the United States.[89] Although private forest management is sometimes controversial, there are limited avenues for public comment or interference. In contrast to public forest owners, private forest owners are free to exclude public use or access to their land, such as for recreational purposes.

The following sections describe the management classes of private forests to the extent possible. The heterogeneity of private forests makes it difficult to generalize or draw conclusions about the management of private forests as a single ownership class. Because corporate and family forests make up the majority of private U.S. forests, these forests are discussed under individual headings below. Tribal and other noncorporate private ownerships are grouped into a third section.

Private Corporate Ownership

As of 2017, there were 156 million acres of forests in corporate ownership nationwide, comprising 35% of privately owned forest area.[90] Just under one-quarter of U.S. timberlands and one-third of privately owned timberlands were in corporate ownership.[91] The corporate ownership class contains two important organizational types, which may affect the management of lands within this class:

- *Industrial*: Vertically integrated companies that own both timberland and processing facilities.
- *Institutional:* Companies that manage or own timberland but do not own processing infrastructure, generally considered to include timberland investment management organizations (TIMOs) and real estate investment trusts (REITs). TIMOs are organizations that acquire, manage, and sell timberland for

[88] Oswalt et al., *FRUS 2017*, p. 9.

[89] CRS is generally unable to analyze nonfederal laws. However, nonfederal laws affecting private forestlands vary throughout the United States, and CRS located some evidence suggesting these laws can influence private landowner behavior. CRS is unable to comment on whether such instances are common or representative of all states.

[90] Oswalt et al., *FRUS 2017*, Appendix A, Table 2.

[91] Oswalt et al., *FRUS 2017*, Appendix A, Table 11.

institutional investors, such as pension funds, foundations, or endowments. REITs are organizations that own income-producing land and are required to distribute a specified share of revenues to investors.

Industrial owners were historically the most common form of corporate ownership. However, since the 1990s, ownership within this class has increasingly shifted toward institutional ownership as industrial owners have divested of their timberlands.[92] According to some estimates, most of the corporate forest acreage remains industrial; as of 2017, just under one-third was institutional.[93]

Corporate forest owners are generally profit maximizing or investment oriented. Within this ownership class, land management generally focuses on intensive silvicultural techniques to maximize timber production.[94] Corporate forest owners generally employ professional staff to manage forests and have formal forest management plans for their lands.[95] As of 2017, about 51% of planted forests—a hallmark of intensive forestry—were on corporate lands, although corporate forests accounted for 20% of overall forest ownership; the proportion of planted forests on corporate lands was even higher in the South and Pacific Coast regions.[96] On FS surveys, corporate owners reported frequently engaging in management activities related to timber harvesting, such as applying herbicides and fertilizers; conducting road work; and reducing insects, diseases, and invasive species.[97]

Among corporate owners, forest management activities related to other objectives also are common. On FS surveys, many corporate owners report collecting money from practices other than timber harvesting, such as hunting; mineral, oil, and gas extraction; and recreational activities.[98] CRS was unable to locate information on what proportion of corporate forests are open or closed to the public. One study noted that institutional owners in the South had policies of closing land to public access or charging for certain activities (e.g., hunting), often in contrast to open-access policies of previous industrial owners.[99] Many corporate owners reported that goals of protecting wildlife, water, and nature, and wildlife habitat improvement activities are common.[100] This approach may reflect the aim of complying with *best management practices*

[92] John Bliss et al., "Disintegration of the U. S. Industrial Forest Estate: Dynamics, Trajectories, and Questions," *Small-Scale Forestry*, vol. 9, no. 1 (December 2009), pp. 53-66.

[93] Emma Sass et al., "Dynamics of Large Corporate Forestland Ownerships of the United States," *Journal of Forestry*, vol. 119, no. 4 (2021). Hereinafter cited as Sass et al., "Dynamics of Large Corporate Forestland Ownerships."

[94] Andrew Gunnoe, Conner Bailey, and Lord Kwayke Ameyaw, "Millions of Acres, Billions of Trees: Socioecological Impacts of Shifting Timberland Ownership," *Rural Sociology*, vol. 83, no. 3 (2018), pp. 799-822. Hereinafter cited as Gunnoe et al., "Millions of Acres."

[95] According to Sass et al., "Dynamics of Large Corporate Forestland Ownerships," 77% of large corporate forest owners report having management plans that cover all of their land and 92% report having management plans that cover at least half of their land.

[96] Oswalt et al., *FRUS 2017*, p. 9 and Appendix Table 8.

[97] According to Sass et al., "Dynamics of Large Corporate Forestland Ownerships," all large corporate respondents reported engaging in timber harvesting and roadwork within the last five years and more than 75% reported using herbicides and reducing invasive plants. Over 50% reported reducing insects and diseases, and over 25% reported applying fertilizers. These figures vary between corporate ownerships, sometimes substantially; for example, over 75% of timber investment management organizations and real estate investment trusts reported applying fertilizers in the last five years, compared with approximately 25% of industry respondents.

[98] For example, over half of corporate forest owners report collecting revenue from recreation-based leasing. See Sass et al., "Dynamics of Large Corporate Forestland Ownerships."

[99] Gunnoe et al., "Millions of Acres."

[100] According to Sass et al., "Dynamics of Large Corporate Forestland Ownerships," over 75% of respondents reported improving wildlife habitat in the last five years. Survey respondents reported that protecting wildlife habitat, water, and

(practices aimed at protecting natural resources during forest management activities), operating hunting or recreation facilities, or certification standards. About 75% of corporate owners reported certifying some of their land through a private certification organization, such as the Forest Stewardship Council or the Sustainable Forestry Initiative, and two-thirds reported certifying all of their land.[101]

CRS was unable to locate nationwide estimates of the amount of timber harvested from corporate forests.[102] However, various sources indicate that measures of timber productivity from corporate forests may be higher than from other private forests. For example, although corporate owners accounted for less than one-quarter of the timberlands nationwide in 2017, corporate owners accounted for a much higher proportion of the net volume of growing stock.[103] Plantations in the South—55% of which were in corporate ownership—contain less than half of the region's softwood volume but had two-thirds of the region's annual softwood growth and an even higher percentage of the region's annual softwood removals.[104] One study of forests in the northeast found that corporate forests were twice as likely to be harvested in any given year than public forests of any kind and 25% more likely to be harvested than other private forests (e.g., family forests).[105]

Private Noncorporate Forest Ownership: Family Ownership

In 2017, nearly 272 million acres (38%) of U.S. forests were in family ownership, and family forests were the single largest ownership category for U.S. forests.[106] Just under half of the timberlands in the United States and two-thirds of privately owned timberlands were in family ownership.

Family forest ownership is characterized by many relatively small parcels with many *owners* (the individual or group with title to the land, which may be more than one individual person—that is, a family would be considered one owner). The FS estimates there were over 10.6 million family forest owners in the United States in 2017.[107] There is considerable variation among those owners and the types of forests they control. For example, data from 2018 showed that the majority of family owners controlled forests 9 acres or less in size, and 89% of family owners controlled forests of 49 acres or less (see **Figure 9)**.[108] However, this large number of owners controlled a minority of the family forest acreage (27%); the majority of family forest acreage (73%) was

nature are the third-, fourth-, and fifth-most common objectives of corporate forest landowners, respectively (after timber harvesting and land investment).

[101] Sass et al., "Dynamics of Large Corporate Forestland Ownerships."

[102] CRS was unable to identify a comprehensive source of nationwide data for timber harvesting on private forests. Some private timber harvesting data are available by certain regions or states for some years, but the data are not comprehensive or comparable across regions or states. See, for example, the forestry research products produced by the Bureau of Business and Economic Research at the University of Montana (https://www.bber.umt.edu/FIR), which reports timber harvesting data for many western states but not consistently across all time periods or ownerships. CRS was unable to locate similar resources for other regions.

[103] Oswalt et al., *FRUS 2017*, Appendix A, Table 32.

[104] Oswalt et al., *FRUS 2017*, p. 41.

[105] Jonathan Thompson et al., "Social and Biophysical Variation in Regional Timber Harvest Regimes," *Ecological Applications*, vol. 27, no. 3 (2017), pp. 942-955.

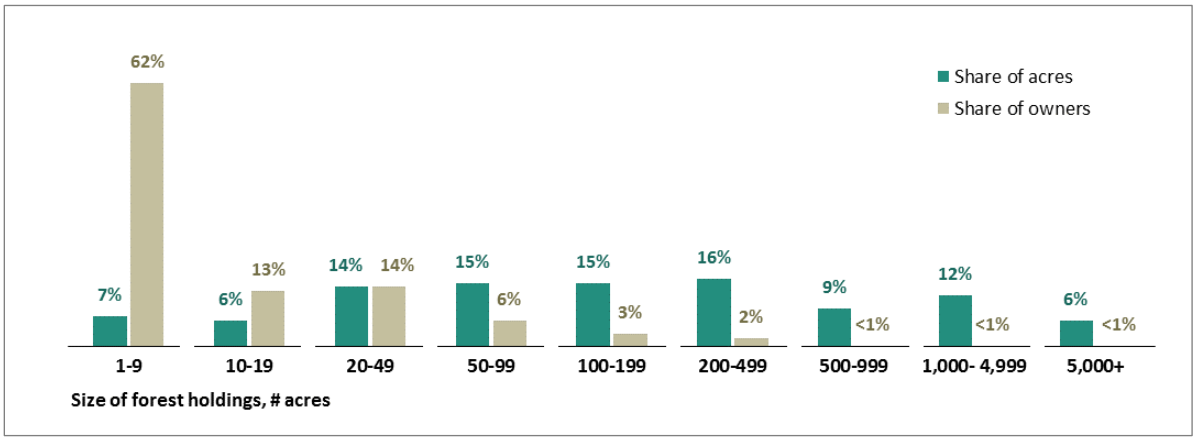
[106] The exact figures for family forest ownership vary across different FS sources but are relatively similar. Oswalt et al., *FRUS 2017*, p. 8, estimates 38%, and Butler et al., *Family Forest Ownerships*, Appendix 1, Table US-1, estimates 39%.

[107] Oswalt et al., *FRUS 2017*, p. 7.

[108] Butler et al., *Family Forest Ownerships*, Appendix 1, Table US-12.

controlled by the remaining 11% of owners. In other words, most family forest *owners* had small parcels, but the majority of family forest *acres* were controlled by relatively few owners with large parcels.

Figure 10. Percentage of Family Forest Acres and Owners, 2018, by Size Class



Source: Table US-12 (Appendix 1) in Butler et al., *Family Forest Ownerships*.

Notes: *Owners* means the individual or group with title to the forestland holding, which may be more than one individual person (i.e., a family would be considered one owner).

Within the family forest ownership category, reasons for owning forestland and forest management objectives vary and may include single or multiple objectives. The intensity and frequency of management activities also vary, from little to no management to active management for one or more values. According to one study, "one of the most important attributes is size of forest holdings ... because it directly influences many activities and is correlated with numerous other characteristics."[109] For example, there is some evidence from 2018 that those who owned more land may have been more likely to have a management plan or seek professional management advice;[110] overall, less than one-quarter of family forest acres were managed under written management plans, about one-third of acres are associated with formal management advice,[111] and forest certification through private programs is rare.[112] Similarly, some evidence suggested those who own more land harvest greater amounts of commercial timber.[113] CRS was unable to locate nationwide estimates of the amount of timber harvested from family forests. As of 2017, about 34% of family forestland was planted; the remainder was naturally regenerated.[114]

According to the FS's findings from the 2018 National Woodland Owners Survey, the most common reasons cited by family forest owners for owning forestland were beauty or scenery, privacy, nature protection, wildlife protection, and water protection.[115] In general, family forest

[109] Brett Butler et al., "One Size Does Not Fit All: Relationships Between Size of Family Forest Holdings and Owner Attitudes and Behaviors," *Journal of Forestry*, vol. 119, no. 1 (2021).

[110] Butler et al., *Family Forest Ownerships*, Figure 21.

[111] Butler et al., *Family Forest Ownerships*, Appendix 1, Tables US-11 and US-24.

[112] Butler et al., *Family Forest Ownerships*, Figure 18, Appendix 1, Table US-16.

[113] Butler et al., *Family Forest Ownerships*, Appendix 1, Table US-12.

[114] Oswalt et al., *FRUS 2017*, Appendix A, Table 8.

[115] Butler et al., *Family Forest Ownerships*, Figure 17.

owners reported a relatively low frequency of taking management actions on their land; about 25% of family forest owners reported taking no management action on their lands in the last five years. Further, although timber cutting for personal use was the most frequently reported management activity, no management action was the second-most-reported activity.[116] Family forest owners reported that the other most common management activities included managing for wildlife, reducing invasive plants, working on trails, and harvesting non-timber forest products.

Most family forestland was associated with some recreational use, primarily for the landowners, their families, or their friends. However, most family forestland was closed to use by the public.[117]

Private Noncorporate Forest Ownership: Tribal and Other

Other private noncorporate forests include two forest types: other private and tribal forests (see **Table 2**). Although the *FRUS* does not specify separate acreage statistics for these forests, other sources estimated there are 11 million acres of other private forests in the United States and 17 million acres of tribal forests.[118] In 2017, approximately 8 million acres of tribal forests were timberlands.[119] CRS was unable to locate estimates of the amount of timberland in other private forests.

These two categories of forests vary across nearly all measures, including their extent, biophysical characteristics, and the management objectives and actions of the owner (i.e., the tribal government, individual tribal member, nonprofit organization, or club). Because of this, it is not possible to generalize or draw conclusions about the management of these forests as ownership classes. In particular, little information on forest management by other private forest owners is available. Information on tribal forests is more accessible, but the heterogeneity of tribal forests makes it challenging to generalize about their management.

According to the *FRUS*, as of 2017, 313 federally recognized tribes managed forests.[120] Individual tribal forest holdings ranged in size from 1 acre to more than 5 million acres. Management of tribal forests was shaped by the forests' ownership (i.e., the tribal government or an individual) and by legal and regulatory structures related to the owner, such as treaty law. In many cases, tribes have retained rights under treaty law to access forests and forest resources outside of their ownership, for purposes such as harvesting forest products, hunting and fishing, conducting spiritual and religious ceremonies, and accessing sacred sites. Some tribal forests may be under a forest management plan developed in cooperation with the Bureau of Indian Affairs (BIA).[121] According to a 2013 BIA analysis, tribal forest management is centered on

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[116] Butler et al., *Family Forest Ownerships,* Figure 18.

[117] Butler et al., *Family Forest Ownerships,* Appendix 1, Tables US-22 and 23. The FS estimates that, in the five years prior to the survey response, 80% of family forest acres were associated with hunting, 57% with hiking or walking, 36% with off-road vehicle use, and 31% with fishing. About 67% of family forest acres had recreational use by the owner or their spouse, 60% by the owner's children, 56% by other family, and 61% by friends. Use by the public was rare (5% of acres or less), and about 72% of family forest acres were posted with some sort of closure, most commonly to trespassing (i.e., general access).

[118] Oswalt et al., *FRUS 2017,* Appendix A, Table 2.

[119] Butler et al., *Family Forest Ownerships,* Figure 18, Appendix 1, Table US-16.

[120] Oswalt et al., *FRUS 2017,* pp. 51-53. This figure does not include Alaska Native corporations or village corporations.

[121] Oswalt et al., *FRUS 2017*, p. 52. Bureau of Indian Affairs policy specifies that "Forest Management Plans ... are required for all Indian forest lands in federal trust status." It is unclear whether the definition of *tribal* used by the Forest Service in the *FRUS* refers only to tribal lands in federal trust status. Bureau of Indian Affairs, "Forest

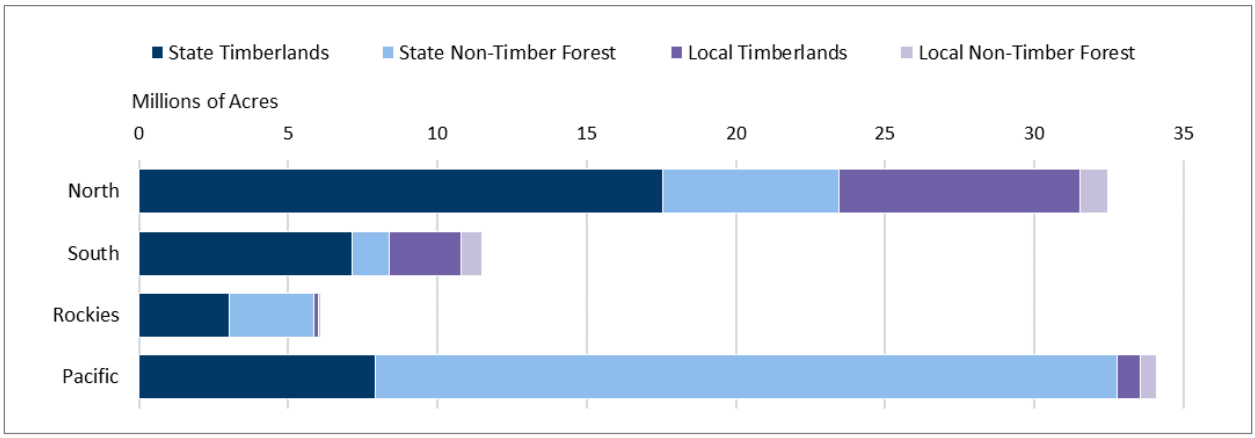
"sustainability and long-term stewardship," although the analysis specified that the degree to which tribes can implement these principles depends on numerous factors.

Nonfederal Public Forests: State and Local

In 2017, there were 70 million acres of state-owned public forests in the United States, and 14 million acres of county or municipally owned public forests (referred to as *local* forests throughout this report). Just over half of the state forests (51%) contained timberlands, and 84% of the local forests contained timberlands. Nearly half of the state forests (47%) were in the Pacific, and two-thirds (67%) of the local forests were in the North, primarily in Wisconsin, Minnesota, and Michigan. State and local forests vary across nearly all measures, including extent, biophysical characteristics, administering agency, and management purposes. As a result, it is not possible to generalize or draw conclusions about the management of state and local forests as a single ownership class.

Many—though not all—of the state forests are *state trust lands*, particularly in the states outside of the original 13 colonies.[122] As a condition of statehood, Congress granted specific parcels of land to states with the requirement that revenue generated from the sale or lease of the land benefit specific public purposes, primarily education.[123] State trust lands have an explicit fiduciary responsibility to generate revenue, though states vary in how they fulfill this responsibility. Not all state trust lands contain forest or timber resources. Many state trust lands are leased for grazing or other resource uses, and some state trusts lands have been sold.

Figure 11. Other Public Forests and Timberlands by Region, 2017



Source: Oswalt et al., *FRUS 2017*, Appendix A, Tables 2 and 10.

Management Planning," in *Indian Forest Management Handbook*, 53-IAM-2-H. For more information on tribal lands, see CRS Report R46647, *Tribal Land and Ownership Statuses: Overview and Selected Issues for Congress*, by Tana Fitzpatrick.

[122] The state forests in Michigan, Minnesota, and Wisconsin are not state trust lands but were established primarily through tax foreclosures. See Jon A. Souder and Sally K. Fairfax, *State Trust Lands: History, Management, and Sustainable Use* (Kansas: University Press of Kansas, 1996). Hereinafter cited as Souder and Fairfax, *State Trust Lands*. See also Mark Haggerty and Chelsea Liddell, *State Trust Lands in Transition: Understanding the Trust Model*, Headwaters Economics, 2019.

[123] Granting trust land to states was first established in the Land Ordinance of 1785, as adopted by the Continental Congress.

Uses of State Forests

Some states have multiple use mandates for their state forests—requirements to consider the balance of multiple uses of the forest, such as timber production, recreation, fish and wildlife, and others—a mandated shared by the federal forests (see "Federal Forests"). However, in many cases, the balance of the uses is based explicitly on revenue production; this is particularly the case for states with trust responsibilities and a multiple use mandate (e.g., Washington, Oregon).[124] For these multiple use trust forests in particular, fulfilling the trust obligation by providing financial returns is distinct from providing general public benefits. In these states, fulfilling the trust responsibility is prioritized and other uses are permitted to the extent they are compatible with—or do not interfere with—this obligation. Some states (e.g., Montana, Washington) also have explicit or implied sustained yield directives requiring owners to manage forests to provide a consistent supply of resources in perpetuity, similar to federal directives for federal forests.[125]

Forest Health by Forestland Ownership

Many forest health issues typically impact large areas simultaneously and do not necessarily vary by ownership class. For example, areas experiencing drought or a discrete adverse weather event will experience similar effects, regardless of ownership. As a result, comprehensive data and information regarding forest health conditions by ownership class are not readily available. Limited data are available, however, such as tree mortality observations by ownership. In addition, some studies have examined forest health outcomes across small areas (e.g., forest types, states). Some of this information is summarized below.

Observations on tree mortality suggest mortality is more prevalent on public timberlands than private timberlands.[126] More specifically, in 2017, public timberlands accounted for 30% of all timberlands nationwide but accounted for 50% of tree mortality nationwide in terms of volume. This trend was most pronounced in the Rocky Mountain and Pacific Coast regions: In the Rockies, public timberlands accounted for 72% of timberland area and 90% of mortality. In the Pacific, public timberlands accounted for 59% of timberland area and 72% of mortality.

Some perceive forest health to be a larger problem on federal forests relative to other forests. Although this perception may be true—particularly across some measures, such as mortality or biomass density—it also may be an example of information availability bias: more information is available on forest health measures across federal forests due to greater levels of public access, availability for research, and scrutiny. Some studies have identified examples where forest health outcomes appear to be better on federal forests relative to private forests, however, or on public forests (federal and other public) relative to private forests. For example, watersheds with higher concentrations of federal compared to private forests had improved watershed conditions,[127] and streams flowing through federal forests had higher water quality than streams flowing through nonfederal forests.[128] Other studies have found that public forests tend to be more structurally

[124] Souder and Fairfax, *State Trust Lands,* p. 166.

[125] Souder and Fairfax, *State Trust Lands,* p. 167.

[126] Oswalt et al., *FRUS 2017,* Appendix A, Table 33.

[127] Kirsten Gallo et al., *Northwest Forest Plan—the First 10 Years: Preliminary Assessment of the Condition of Watersheds*, FS, PNW-GTR-647, 2005, https://www.fs.fed.us/pnw/pubs/pnw_gtr647.pdf.

[128] Shannon Hubler, *High Level Indicators of Oregon's Forested Streams*, Oregon Department of Environmental Quality, DEQ09-LAB-0041-TR, 2009, https://www.oregon.gov/deq/FilterDocs/10-LAB-003.pdf.

complex than the more production-style forests on private lands; presumably, this complexity provides public forests with the interrelated benefits of biodiversity and resiliency.[129] However, more research on the influence of ownership trends on various forest management objectives is needed to draw definitive conclusions.

Wildfire Data by Ownership

Wildfire data and statistics are reported not by ownership class but by the governmental entity responsible for handling the wildfire response. The federal government is responsible for wildfires that begin on federal lands, and states generally are responsible for wildfires that begin on nonfederal (state, local, and private) lands.[130] Wildfires that spread across ownership boundaries remain categorized and reported by the entity providing wildfire response and protection, which creates challenges when reporting and interpreting wildfire data. Reported acreage, for example, may reflect a mix of land ownership. Nonetheless, wildfire data by protecting entity (e.g., federal, state) are a reasonable proxy for wildfire data by ownership (e.g., federal, nonfederal). Although outside the specific focus of this report, there is some evidence that the public responsibility for wildfire protection is a disincentive for private landowners to reduce wildfire risk in areas of mixed landownership and is an incentive for subsidizing wildland-urban interface development.[131]

Across all ownerships, an annual average of 61,400 wildfires burned an annual average of 7.8 million acres nationwide for the five-year period from 2016 through 2020.[132] Across that period, there were nearly 3.5 times more wildfires on nonfederal lands than on federal lands, on average, but the fires on federal lands were significantly larger. Those patterns are partly due to the geographic distribution of fires relative to forest ownership. More fires occur on nonfederal land in the eastern regions (i.e., North and South), where there is more nonfederal land, and larger fires occur in the western regions (i.e., Rocky Mountain and Pacific Coast), where there are larger parcels of contiguous, mostly federal land.

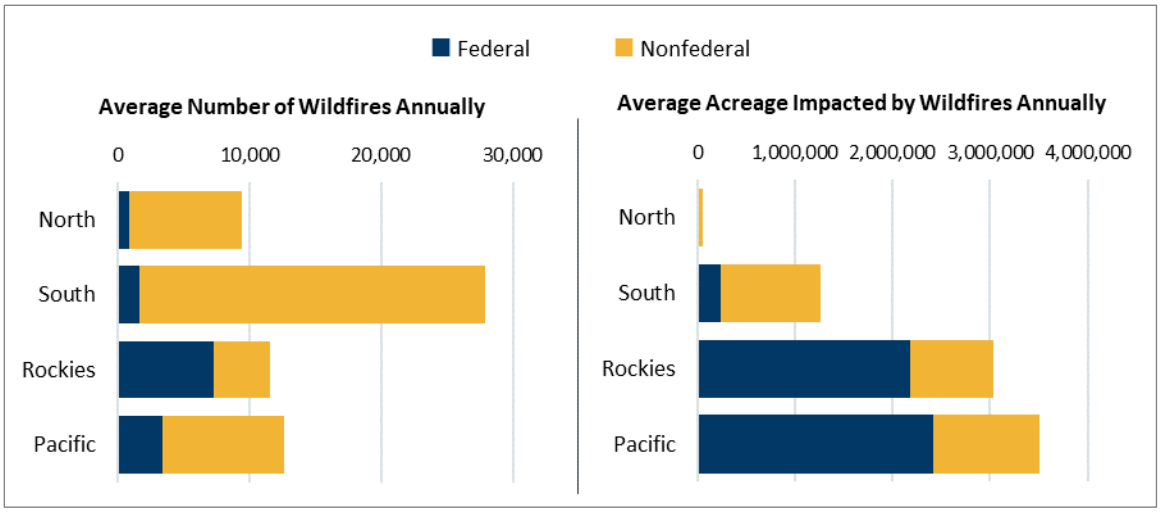
[129] Vivian Griffey et al., "Ownership Patterns Drive Multi-Scale Forest Structure Patterns across a Forested Region in Southern Coastal Oregon, USA," *Forests*, vol. 12, no. 1 (2021).

[130] Wildfire response may be managed jointly for comingled land ownership. The federal government may handle wildfire response on nonfederal lands pursuant to cooperative fire protection agreements.

[131] For more information, see Gwenlyn Busby and Heidi J. Albers, "Wildfire Risk Management on a Landscape with Public and Private Ownership: Who Pays for Protection?," *Environmental Management*, vol. 45 (2010), pp. 296-310.

[132] For more information, see CRS In Focus IF10244, *Wildfire Statistics*, by Katie Hoover and Laura A. Hanson.

Figure 12. Wildfires and Acreage Impacted, 2016-2020, by Entity Providing Protection



Source: CRS, from the Wildland Fire Summary annual reports published by the National Interagency Coordination Center, at https://www.nifc.gov/nicc/index.htm.

As mentioned previously, the number of fires and acreage burned are indicators of the annual level of wildfire activity, but these statistics do not convey the degree of impacts to humans or communities. Acreage burned also does not indicate the wildfire's severity, the degree of impact upon forests or soils, or other ecological effects. In addition, acreage impacted is an imprecise indicator of wildfire activity and may be influenced by suppression strategies. Federal policy, for example, specifically allows wildfire response to range from aggressive suppression to monitoring while a fire burns, with no human intervention. This policy affects wildfire statistics: Wildfires impacted 10.1 million acres in 2015, the most in one year since official recordkeeping began.[133] Half the acreage impacted that year was in Alaska (5.1 million acres), and approximately 3.5 million of those acres were the result of a limited protection suppression response, meaning the fires were not actively suppressed and were allowed to burn and grow in size. State wildfire response strategies vary but often focus more on aggressive suppression than federal strategies.[134]

Timber Production by Forest Land Ownership

In 2017, approximately 89% of timber *removals from timberland* in the United States were from private timberlands (see **Figure 13**). Timber removal data reflect the volume of growing stock trees removed from the inventory of timberlands in a given year through timber harvesting, silvicultural treatments, or land clearing.[135]

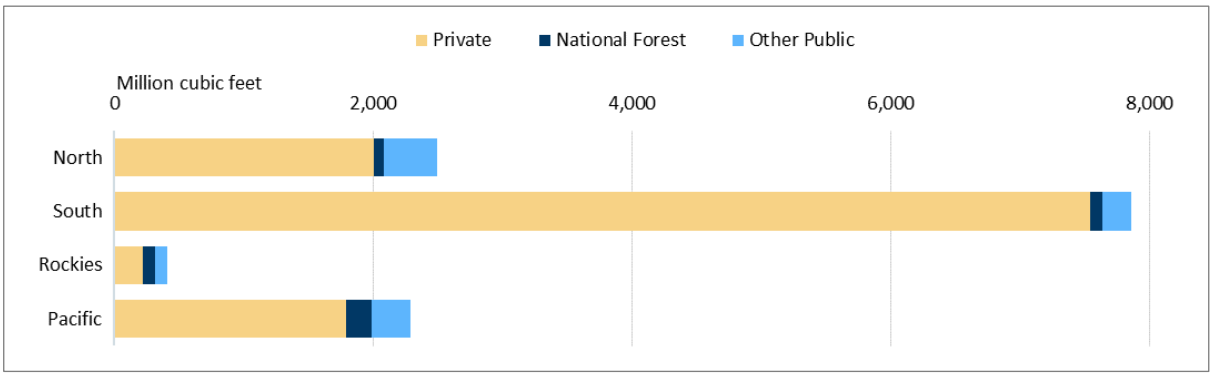
[133] Historical fire statistics were first reported in 1960, but data collected prior to 1983 were reported using different methodologies and may not be considered official records. NIFC, *Total Wildland Fires and Acres*.

[134] See, for example, Carlin Frances Starrs et al., "The Impact of Land Ownership, Firefighting, and Reserve Status on Fire Probability in California," *Environmental Research Letters*, vol. 13, no. 3 (2018).

[135] Removals data may approximate timber harvesting data, but the two are not precisely equivalent. For example, removals data may capture activities other than commercial harvests and would not capture timber harvests on non-timberland forest. CRS has identified discrepancies in timber harvesting data in regions with high amounts of non-timberland forest, such as the Rockies and the Pacific.

Figure 13. Timber Removals from Timberland, 2017, by Region

(in million cubic feet)



Source: Oswalt et al., *FRUS 2017*, Appendix A, Table 35.

Regional data show the proportion of timber removed from private timberlands is higher than the proportion of privately owned timberlands in most regions. This trend is most pronounced in the Rocky Mountain and Pacific Coast regions but also holds true in the South.[136] It is difficult to draw definitive conclusions about this discrepancy; it may relate to the overall greater likelihood of intensive management on private lands, particularly in the Pacific and the South. In 2017, private ownerships had 78% of the United States' planted timberland, and approximately 83% of net annual growth on timberland was on private lands in 2016. These figures suggest greater intensity of management on private lands than on public lands.[137] In the Rockies, where intensive forest management is less common, the discrepancy may relate to the relatively high proportion of rugged or inaccessible terrain in public forests. In addition, the available information may obscure some timber harvest dynamics, as the data exclude non-timberlands, which may be significant in the Rocky Mountain and Pacific regions.

Comparing Forests: Trends and Implications

As described above, the resources and biophysical conditions of forests in the United States are heterogeneous, as are the management objectives, constraints, and capabilities of different forest owners. The measurable outcomes for any given forest—such as timber production, forest health, and other metrics—result from the merging of these factors. Forest conditions may produce resources and outcomes in ways that specific management activities, regardless of ownership, cannot mitigate or overcome. Therefore, it is not possible to draw definitive conclusions regarding forest outcomes by ownership class.

However, some distinct trends exist regarding U.S. forests. The following sections synthesize data and concepts provided in the report to describe trends in the nationwide distribution of forest resources, trends across forest ownerships, and the interaction of these trends in the four *FRUS* regions. This section also discusses the implications of these trends, particularly regarding the challenges associated with comparing forest management outcomes generally and across forest ownerships specifically.

[136] In the Rockies, where about 28% of timberland is privately owned, about 54% of timber removals come from private timberlands. Similarly, in the Pacific Coast region, about 78% of timber removals come from private timberlands, although only 41% of timberland is privately owned.

[137] Oswalt et al., *FRUS 2017*, Appendix A, Table 34.

Forestland, Timber Resources, and Owners Are Unevenly Distributed

Forests distribution across the United States is uneven. Nearly one-third of U.S. forests are in the South region; the Pacific Coast and North regions each contain around one-quarter of the nation's forests, and the Rocky Mountain region contains 17% of U.S. forests. The variation in forestland distribution is driven in part by certain biophysical characteristics (e.g., climate, geography). These factors also contribute to differences regarding forest type (e.g., species mix) and ecological condition, or forest health, across and within the regions.

Likewise, timber resources are unevenly distributed across U.S. forests. Due to their biophysical characteristics, the South and Pacific Coast regions (specifically, the coastal regions of Oregon and Washington) contain the majority of forestland that is highly productive for timber; these areas also contain preeminent commercial timber species. Other regions, such as the Rockies and other parts of the Pacific Coast region (such as the eastern regions of Oregon and Washington), have limited potential for timber production. The North region has a medium potential for timber productivity. The Rocky Mountain and Pacific Coast regions also are more impacted by mortality than the other two regions. Thus, some regions of the United States—particularly the South and parts of the Pacific Coast—have greater endowments of timber resources than others do.

Patterns of land settlement and development influence the uneven distribution of forest ownership in the United States. In the North and South regions, most forests are privately owned, primarily by families. In the Rocky Mountain and Pacific Coast regions, most forests are publicly owned, primarily by the federal government. Corporate ownership is most common in the South and the Pacific. Thus, private ownership is more likely to overlap with high or medium productivity (in the South, North, and parts of the Pacific, such as coastal Oregon and Washington), whereas public ownership is more likely to overlap with low productivity (in the Rockies and other parts of the Pacific, such as eastern Oregon and Washington). Any comparison of forest outcomes—particularly related to timber production—across ownerships must account for these differences.

Forests Provide Multiple Benefits and Are Managed for Many Uses

Forests provide many benefits, including air and water resources, fish and wildlife, recreation and cultural use, timber resources, and more. In some cases, forests are the only or the primary source for these benefits. Across all ownerships, most forests are managed for multiple objectives. In many cases, however, an owner will manage a forest for a primary or dominant objective (e.g., timber production, recreation, fish and wildlife habitat).

Regardless of forest ownership, some forest benefits may accrue solely to the forest owner and others may not be exclusive to the owner. For example, timber production and grazing may benefit only the owner, whereas a forest's provision of fish and wildlife habitat, scenery, and water purification may benefit many people. For this reason, the public is often concerned with forest outcomes, regardless of forest ownership. Debate regarding forest management is often shaped by various stakeholders' interest in public goods (e.g., fish and wildlife habitat, scenery) compared with private goods (e.g., timber) and may be complicated by ownership of the forests in question.

Because forests are managed for different objectives, the extent to which forest management may be deemed "successful" varies. There is no universal method for setting forest management objectives or measuring forest management. Forest objectives are not shared across owners, meaning only certain outcomes are relevant for assessing management of individual forests. For example, the volume and value of timber harvested from a forest managed for timber production

is a measurable outcome but would not be an appropriate measure for evaluating the management of forests managed primarily for recreation, privacy, or other objectives. In addition, there is no universal standard for how forests "ought" to be managed against which to measure forest management objectives or outcomes, although stakeholder views about such issues are often strongly held. Due to the lack of objective measures, debate and analysis often center on the management requirements or constraints (or the lack thereof) in place for various owners.

Ownership Influences Management Objectives and Constraints

Forest management objectives vary across and within ownership classes. Among private forest owners, families—the largest ownership share of U.S. private forestland—commonly value scenery, privacy, wildlife, and recreation and often do not actively manage their land. However, family forest owners' values vary substantially, as do their management actions. Corporations generally manage their land to optimize financial returns, which is primarily (but not solely) achieved through timber production.

Private forest owners have nearly complete discretion over which forest management objectives to pursue and how to achieve those objectives; any restrictions are matters of state or local law. The extent to which private forest owners prioritize either public or private benefits depends primarily on the landowner. Although private forest management and use is contentious, public opportunity to comment or intervene in private forest management is rare. As such, private forest management may be more likely to reflect the values and constraints of the forest owner than any public concerns or wishes for the land.

Public forests generally are managed for multiple uses. Most federal forests must be managed in such a way that the multiple uses of forests are balanced, with little guidance on what *balance* means in this context. Federal law stipulates that most federal forestland be managed to provide a sustained yield of renewable resources. Certain timber management practices (e.g., plantation forestry) are uncommon on federal lands, perhaps due to the cost of such practices, their incompatibility with multiple use values, or for other reasons. Some state forests also have multiple use mandates, but many of these directives provide guidance on how to balance the uses (e.g., through maximizing or optimizing financial returns).

Because the management objectives for public forests are matters of federal, state, or local law, public forest owners have little discretion over which forest management objectives to pursue, particularly compared with private forest owners. Public forest owners also must implement forest management objectives according to the processes and procedures established by law. Management of public forests is contentious; in particular, the appropriate balance of public and private benefits from public forests is often a matter of debate. The extent that public forests supply private benefits (e.g., timber) relative to public benefits (e.g., recreation, habitat protection) is particularly controversial. For example, the appropriate role of federal timber in the private market has been debated since the establishment of the national forests. Government and industry stakeholders each have, at times, supported and opposed a more active contribution of federal timber. The public generally has the ability to comment or intervene in public forest management to assert these views. As such, public forest management may integrate public values, to the extent compatible with the forest management objectives stipulated in law.

Summary of Regional Trends

As described above, forest resources and ownership are distributed unevenly nationwide, and forest owners have broad management differences. In some cases, these factors interact, resulting in noticeable trends. These trends are summarized across the four *FRUS* regions below. The

following discussion is general in nature, and regional trends may mask site-specific differences or deviations from such trends.

Because timber outcomes are of general interest, the discussion below includes timber productivity. A particular trend is that certain timber management practices (e.g., plantation forestry) are most common in the South and Pacific Coast regions—the most productive timber regions—perhaps due to the underlying potential for productivity in those regions.

North Region

Forests in the North may be hardwood, softwood, or mixed types. In the North, most forests are privately owned, primarily by families, followed by corporations. States and localities manage most public forests, and there are few federal forests. Forests in the North are generally in a middle range of productivity and are less widely used for timber production than forests in other regions. Indicators of intensive timber management, such as plantation forestry, are rare in the North, and it has the second-least timber production of the four regions. Very little of that production originates on public forests, and any that does is generally from state- and locally owned land. Most forests in the North have patterns of infrequent fire, though fires on federal lands tend to be larger (as nationally), due primarily to differences in wildfire response. Because federal forests make up such a small share of forests in the North region, it is difficult to draw conclusions about relative forest management between federal and nonfederal forests—a common theme for both the North and the South regions.

South Region

Forests in the South may be hardwood, softwood, or mixed types. Almost all hardwood-dominated forests in the United States are in the North or the South. In the South, most forests are privately owned, primarily by families, followed by corporations. The South has the most corporate ownership in the nation. It also has the greatest amount of land in the highest productivity classes and includes several forest types that are highly valued for commercial timber production. The South has the most plantation forestry of any region, and intensive management for timber is relatively common, perhaps driven by the lands' productive capability. The South produces the most timber of any region, and little of that production originates from public forests. Most forests in the South have patterns of frequent, low severity fire, and prescribed fire is a commonly used forest management practice. As in the North, because federal forests make up such a small share of forests in the South, it is difficult to draw conclusions about forest management on federal and nonfederal forests.

Rocky Mountain Region

Softwoods dominate forests in the Rocky Mountain region. In the Rockies, most forests are publicly owned, primarily by the federal government. Most private ownership is by families. The Rockies have the least productive forestland in the nation and are subject to high degrees of mortality—so much so that mortality offsets a significant proportion of growth and may, in some cases, be greater than growth. Plantation forestry is relatively rare. The Rockies produce the least timber of any region in the nation. Although the available data show that most timber harvesting in the region occurs on private lands, other information suggests these data might be incomplete, due to how they are collected. However, the Rockies have the second-most federal timber harvesting of any region.

Pacific Coast Region

Softwoods also dominate forests in the Pacific Coast region. In the Pacific, most forests are publicly owned, primarily by the federal government. Most private ownership is by corporations. Forests vary considerably within the Pacific Coast region. Although some of the nation's least productive forestland is in this region, the Pacific also ranks second in total area of the most productive land. Its forests contain some highly valued commercial timber species. Plantation forestry by corporate owners in the region is common. The Pacific Coast region produces the second-most timber of any region in the nation, and most Pacific timber originates from private lands. However, the Pacific has the most federal timber harvesting of any region.

Issues for Congress

Because forests provide many public benefits, Congress may have multifold interests in the nation's forest resources. Across all ownerships, Congress may be interested in the ecological, economic, and social benefits that U.S. forests provide to the nation generally and to surrounding communities specifically. To promote these benefits, Congress may be interested in maintaining or improving the ecological health and functioning of the nation's forests, as well as in enhancing their capacity to survive and recover from disturbance events and adapt to changing climatic conditions. Similarly, Congress may be interested in preventing, treating, or facilitating recovery from various forest health stressors to reduce risk to people and timber resources or to promote other forest values. Congress also may be interested in improving or maintaining forests' economic and social benefits to communities and industries by enhancing certain forest resources or supporting certain forest uses.

To address these interests, one issue for Congress may be whether the baseline understanding of the nation's forest resources and conditions is sufficient. Congress may want to consider whether the level of federal investment in forest inventorying, monitoring, and research across U.S. forests is sufficient, too high, or too low; accordingly, Congress may choose to alter the amount or type of federal resources invested in those activities.

Another issue for Congress may be the federal government's role in addressing forest management and health concerns or mitigating forest risks. Congress may want to consider whether the level of federal investment in forest management generally is appropriate and may adjust federal resources accordingly. This could involve changes to the levels of federal funding, staffing, or other resources for either federal or nonfederal forest management, or both. Congress also may be interested in forest health or management issues by specific ownership class. For example, Congress may be specifically interested in issues related to management of federal forests. Congress also may be interested in federal authorities for assisting nonfederal forest owners, such as whether these authorities cover desired issues or account for desired ownership categories. These ownership-specific issues are discussed in more depth in other CRS products.[138]

Another issue for Congress may be whether and how to address forest risks that span multiple ownership boundaries. For example, Congress may want to consider expanding or facilitating cross-boundary forest management activities. This could be through authorizing and/or incentivizing a variety of federal and nonfederal partnerships and collaborations. In contrast,

[138] For more information on federal forests, see CRS Report R43872, *National Forest System Management: Overview, Appropriations, and Issues for Congress*, by Katie Hoover and Anne A. Riddle and CRS Report R45688, *Timber Harvesting on Federal Lands*, by Anne A. Riddle. For more information on nonfederal forests, see CRS Report R45219, *Forest Service Assistance Programs*, by Anne A. Riddle and Katie Hoover.

Congress may want to restrict those activities, for example, to target more specific concerns or areas.

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