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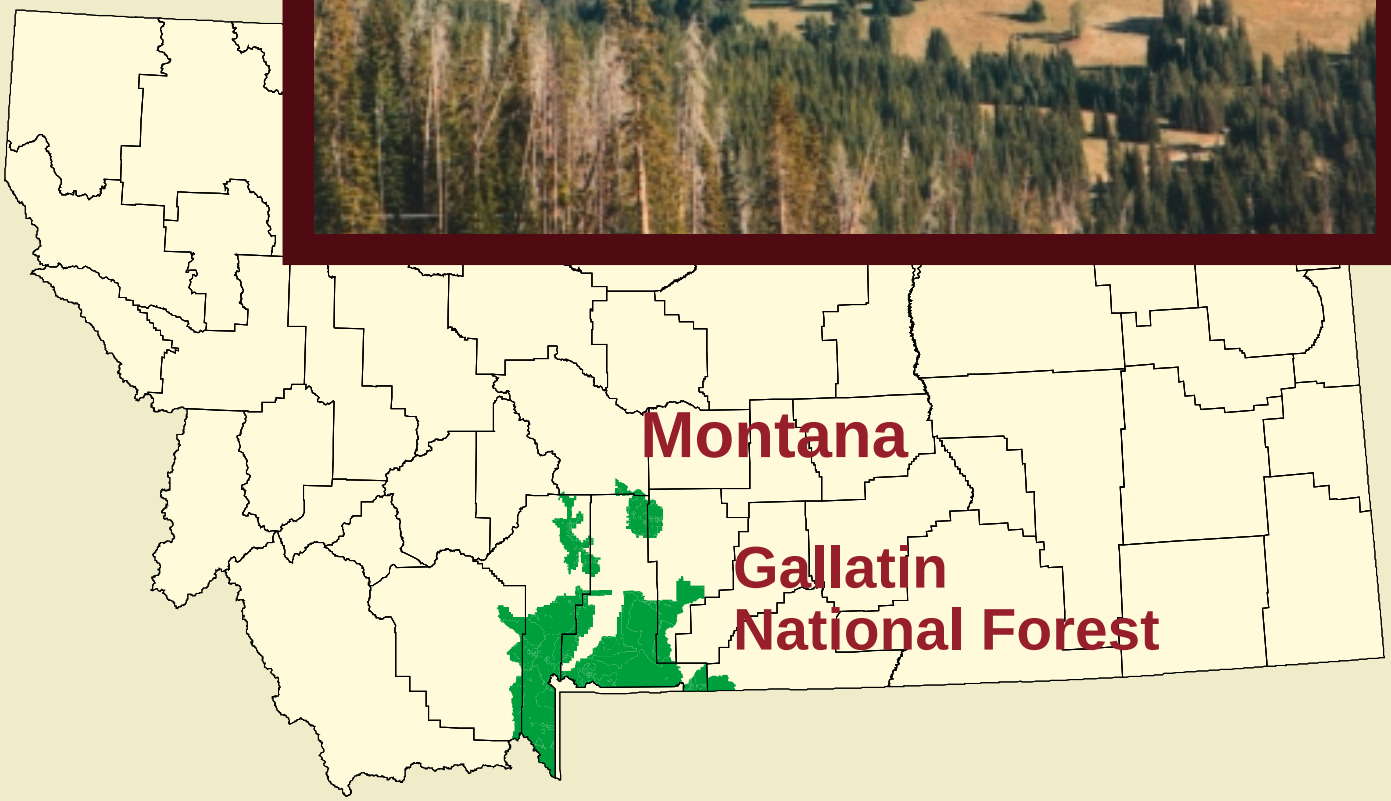
Forest Resources of the Gallatin National Forest

Larry T. DeBlander



About the author

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Cover photo by Rick Ellison, Civil Engineer Technician,
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Forest Resources of the Gallatin National Forest

Larry T. DeBlander

The Interior West Resource Inventory, Monitoring, and Evaluation (IWRIME) Program of the USDA Forest Service, Rocky Mountain Research Station (formerly the Intermountain Research Station), as part of its national Forest Inventory and Analysis (FIA) duties, entered into a cooperative agreement with the Northern Region (Region 1) for the inventory of its National Forests. This report presents the highlights of the Gallatin National Forest 1998 inventory, using commonly requested variables and summaries. The data could be summarized in other ways for different purposes (see the "For further information" on the inside back cover). The information presented in this report is based solely on the IWRIME inventory sample (USDA 1997). References are available for supplementary documentation and inventory terminology (USDA 2000). Additional data collected by the Gallatin National Forest and used separately or in combination with IWRIME data may produce varying results.

What forest resources are found on the Gallatin National Forest?

The Gallatin National Forest administers 1,800,626 acres (USDA 1998; USDA 2000) of which 81 percent is forest land and 19 percent is nonforest or water (fig. 1). Forty percent of the total area of the Gallatin is in a reserved designation in the Absaroka-Beartooth Wilderness and the Lee Metcalf Wilderness. The first part of this report will focus on forest resources of all the forest land on the Gallatin, including reserved lands. Lands not reserved from tree utilization, some of which would be considered suitable for timber production, will be addressed in a later section.

Forest type—Forest resources are often described using a forest type classification. Forest type refers to the predominant tree species in a stand, based on plurality of tree stocking. Stocking is an expression of the extent to which growing space is effectively utilized by live trees. One exception to this single predominant species concept is in stands where Engelmann spruce and subalpine fir occur together. If in combination they constitute the stocking plurality for a stand, forest type will be computed using the following criteria: for a stand to be classified as Engelmann spruce type, Engelmann spruce must be greater than or equal to 20 percent of the stocking, and subalpine fir must be less than 20 percent of the stocking. In other situations where subalpine fir and Engelmann spruce together have plurality the classification would be spruce-fir type (USDA 2000).

Forest types are dynamic and can change slowly through forest succession, or rapidly due to disturbances such as fire, or insect and disease epidemics. On the Gallatin,

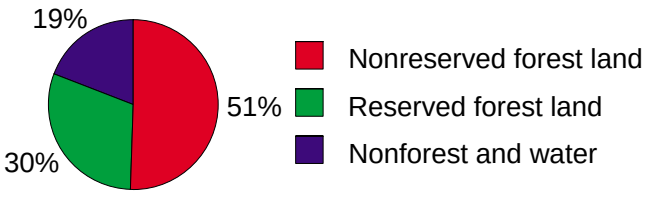

Figure 1—Percent area by land class, Gallatin National Forest.

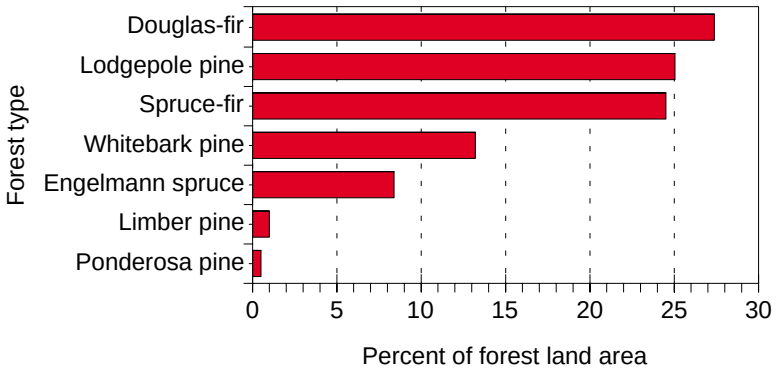

Figure 2—Percent of forest land area by forest type, Gallatin National Forest.

Douglas-fir at 27 percent is the most common forest type by percentage of total forest land area. Douglas-fir is followed in abundance by lodgepole pine and spruce-fir at 25 percent each, whitebark pine at 13 percent, Engelmann spruce at 8 percent, and limber pine and ponderosa pine at about 1 percent each (fig. 2).

Habitat type—Forest communities can be described using a habitat type classification. Habitat type is generally influenced by site characteristics such as slope, aspect, elevation, soils, and climate. Compared to forest types, which describe the species currently occupying the site, habitat types describe lands in terms of their potential to produce similar plant communities at successional climax. More than 100 forest habitat types and phases were described for Montana by Pfister and others (1977). To assist with sub-regional and landscape level assessments, habitat types from the Northern Region have subsequently been summarized into Westside and Eastside groups based on similarities in natural disturbance regimes, successional patterns, and structural characteristics of mature stands (Jones 1997; USDA 1995). These habitat type groups serve as integrators of the moisture availability and temperature gradients of the biophysical environment (Jones 1997).

The Gallatin has more than 60 unique forest habitat types that have been classified into Eastside habitat type groups. Figure 3 shows area by forest type and habitat type group on the Gallatin. The most common habitat type group is the cool and dry group followed by the cold group, occurring on 28 and 20 percent of the forest area, respectively. By using habitat type groups to summarize forest land area, the Gallatin can be categorized in a way that theoretically will not change with disturbance or advancing succession.

Number of live trees—Another way to assess forest diversity is by examining the composition of forest land by tree species. Figure 4 shows total number of live trees by species in four diameter-size classes. Fifty-three percent of all live trees on the Gallatin are from 1.0 to 3.9 inches diameter, 22 percent are from 4.0 to 6.9 inches diameter, 13 percent are from 7.0 to 9.9 inches diameter, and 12 percent are 10.0 inches diameter and greater. Subalpine fir makes up 35 percent of the total number of trees; lodgepole pine, 21 percent; Engelmann spruce, 15 percent; Douglas-fir, 14 percent; and whitebark pine, 12 percent. Rocky Mountain juniper, limber pine, ponderosa pine, western white pine, aspen, and Rocky Mountain maple combined contribute over 2 percent. Species that are scarce may not be encountered with the extensive sampling strategy used for this inventory.

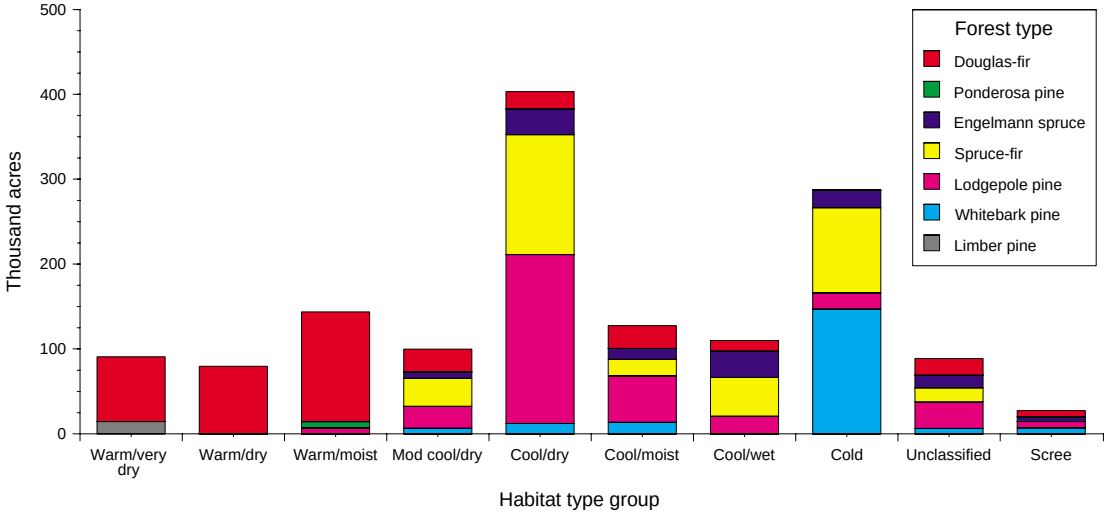

Figure 3—Area of forest land by forest type and habitat type group, Gallatin National Forest.

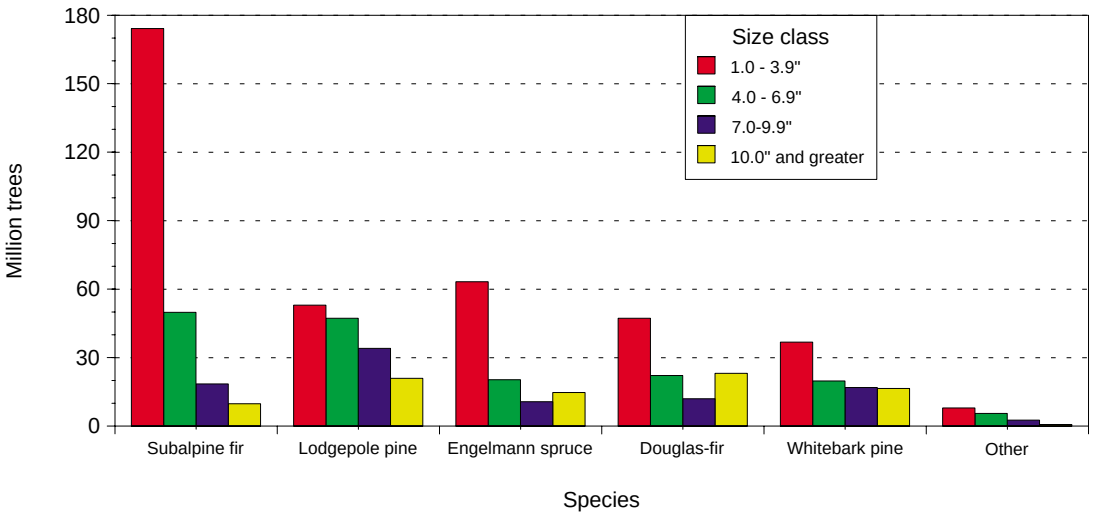

Figure 4—Number of live trees 1.0 inches diameter and greater, by species and size class, Gallatin National Forest.

Figure 5 shows the number of live trees by species and elevation class. Elevation, mentioned above as a site characteristic affecting habitat type, is associated with variations in local climate. For example, precipitation generally increases with rising elevation, while temperature decreases. These factors have a profound impact on a tree species' ability to compete with other species at various elevations. On the Gallatin, the predominantly competing species in order from most to least are Douglas-fir and lodgepole pine at lower elevations (less than 7,000 feet), and lodgepole pine, subalpine fir, Engelmann spruce, whitebark pine, and Douglas-fir at higher elevations (7,000 feet and greater).

Number and weight of dead trees—Standing and down dead trees are an important component of forest ecosystems, with many uses such as providing habitat for many species of wildlife and functioning as nutrient sinks. There are roughly 65 million standing dead trees (snags) greater than 5.0 inches diameter on the Gallatin National Forest. This number includes both hard and soft snags of all species. Many wildlife species are dependent upon snags, and this dependency may vary by the size, species, and number of snags present. Because large diameter snags are generally somewhat scarce relative to smaller snags, they tend to be the focus of more attention. Considering snags

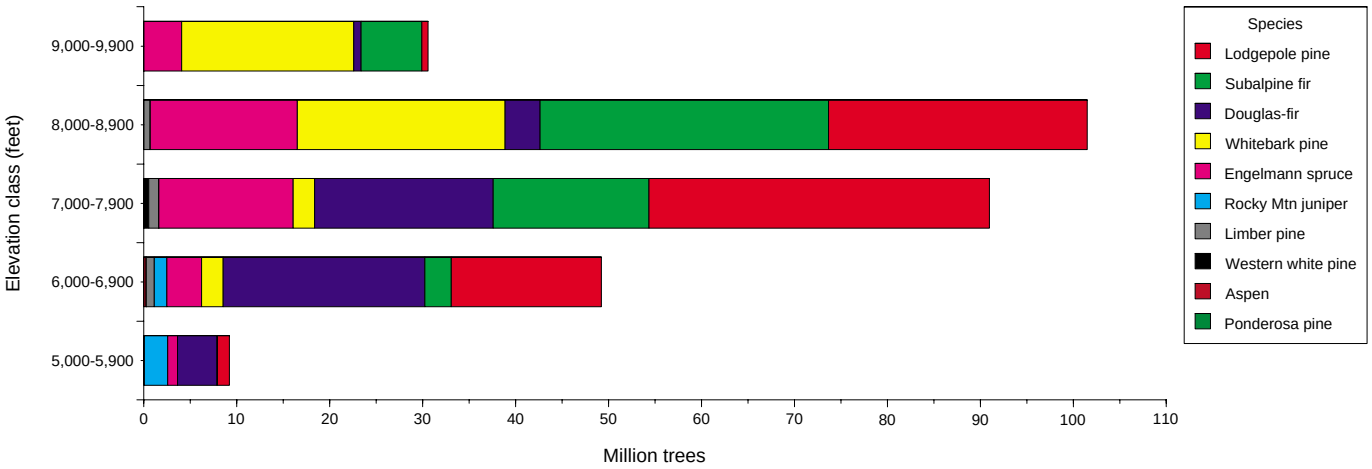

Figure 5—Number of live trees 5.0 inches diameter and greater by species and elevation class, Gallatin National Forest. Sample site elevation determined to nearest 100 feet.

11.0 inches diameter or larger, an estimated 11.6 per acre occur on Gallatin forest land. Of the very large snags (19.0 inches diameter or larger) there are 1.4 per acre. The most abundant species of snags in the 19-inch and larger category is Engelmann spruce, followed by Douglas-fir and whitebark pine.

The amount of down dead material can contribute significantly to forest fuel loads. There are more than 3.9 million tons of down dead trees on Gallatin forest land. This estimate includes the bole and bark of trees 5.0 inches diameter and greater. Figure 6 shows the weight per acre of down dead trees by stand-size class for the five predominant types and all forest types combined. For all stand-size classes combined the lodgepole pine type has the highest weight at 3.9 tons per acre, followed by spruce-fir at 3.1 tons per acre. For all forest types combined the sapling/seedling stand-size class has the highest weight at 3.2 tons per acre, followed by the large tree class at 2.8 tons per acre.

Size—The size distribution of trees in a stand is an indicator for structural diversity. Figure 7 displays the tree size distribution by diameter class on the Gallatin. Overall, there are many more small than large trees.

Stand-size class is a classification of forest land based on the predominant diameter size of live trees that contribute to the majority of stocking. In terms of stocking, fewer large-diameter trees compared to small-diameter trees are required to fully utilize a site. Figure 8 displays a breakdown of forest land on the Gallatin by stand-size class. This figure shows that most stands have a majority of stocking from large trees and that relatively few stands are considered to be nonstocked, such as stands that have been recently harvested or burned.

Figure 9 shows stand-size classes for the five most predominant forest types accounting for the most acreage on the Gallatin. Over 53 percent of the total forest land area is classified in the Douglas-fir, spruce-fir, or lodgepole pine large tree category.

Wood volume and biomass of live trees—Conventional volume analysis focused on commercial timber species that met certain quality standards (in other words, growing-stock trees). This section emphasizes volume and biomass summaries that include estimates of more tree resources such as total wood fiber. The net volume of wood in live trees on the Gallatin is estimated to be in excess of 3.2 billion cubic feet. This includes trees 5.0 inches diameter breast height (d.b.h.) and larger for timber species, and 3.0 inches diameter at root collar (d.r.c.) and larger for tree species such as Rocky Mountain maple or Rocky Mountain juniper, often referred to as woodland species. Total biomass of wood in live trees on the Gallatin National Forest is estimated at over 61 million tons. Biomass estimates include boles, bark, and branches of all live trees including saplings. The following is a breakdown of net cubic-foot volume and tons of biomass by species:

Species	Volume (Million cubic feet)	Biomass (Million tons)
Lodgepole pine	963.1	16.7
Douglas-fir	706.4	15.7
Engelmann spruce	680.8	11.4
Whitebark pine	446.8	8.7
Subalpine fir	416.3	8.5
Limber pine	12.7	.3
Rocky Mountain juniper	3.9	.1
Western white pine	3.5	T
Ponderosa pine	3.5	T
Aspen	2.0	T
Rocky Mountain maple	—	T
Total	3,239.1	61.7

T – Less than 100,000

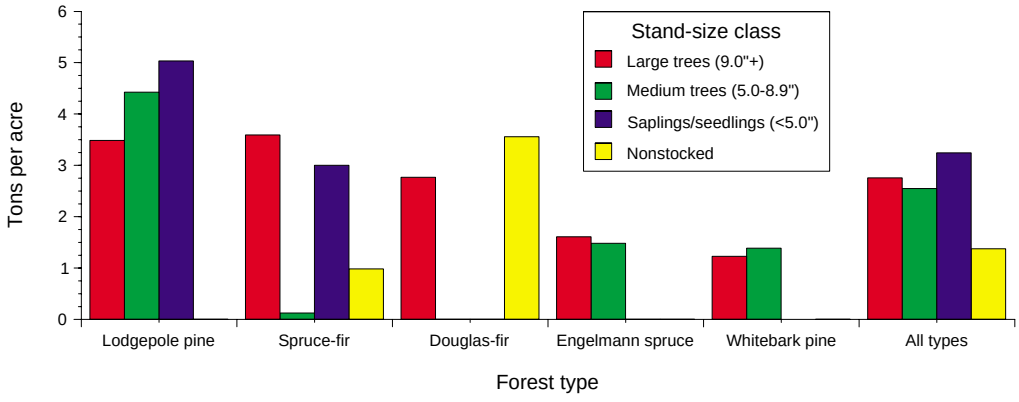

Figure 6—Weight of down dead trees 5.0 inches diameter and greater on forest land by forest type and stand-size class, Gallatin National Forest.

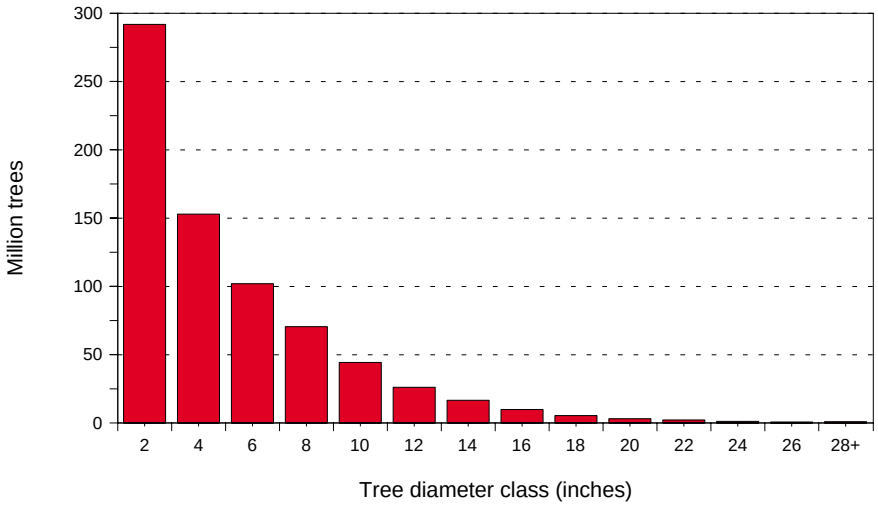

Figure 7—Number of live trees by diameter class, Gallatin National Forest.

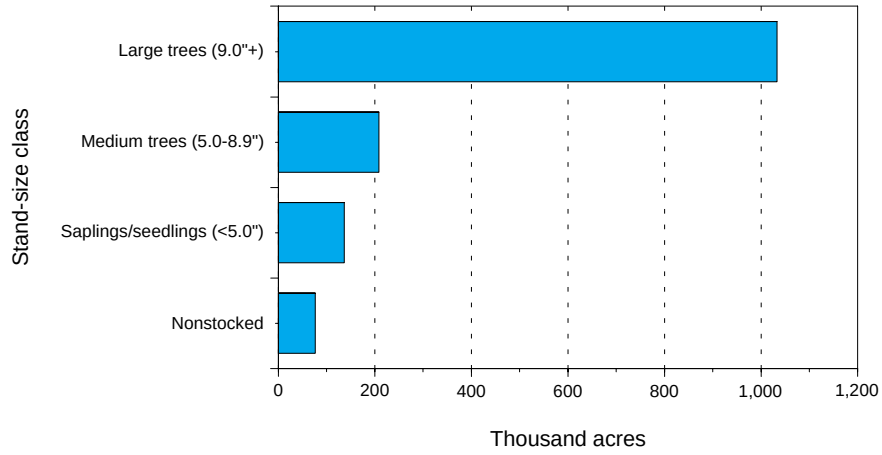

Figure 8—Forest land area by stand-size class, Gallatin National Forest.

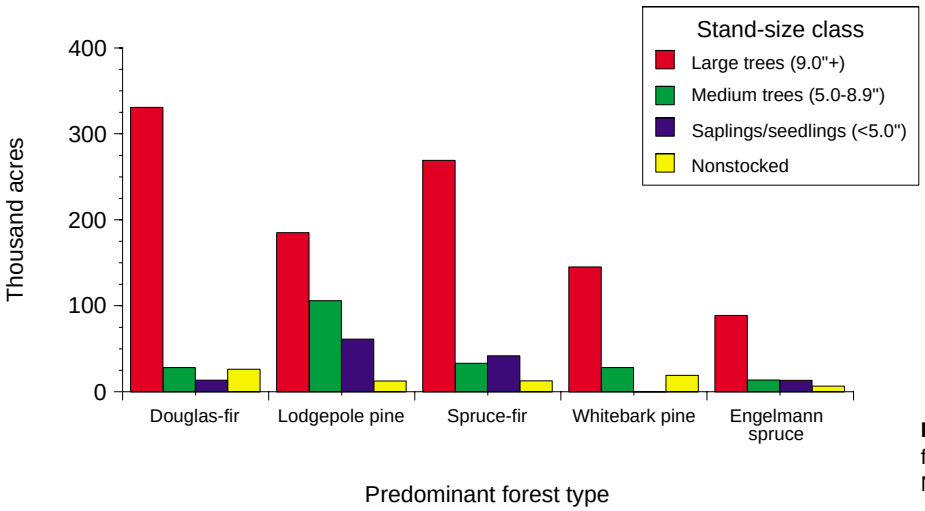

Figure 9—Area of forest land by predominant forest type and stand-size class, Gallatin National Forest.

Figure 10 displays the percent net cubic-foot volume of live trees by diameter class. A breakdown by species shows approximately 89 percent of Douglas-fir, 86 percent of Engelmann spruce, and 69 percent of lodgepole pine volume is in trees 9.0 inches and greater d.b.h. About 51 percent of subalpine fir volume is in trees less than 9.0 inches d.b.h.

Another way to look at wood volume is by forest type, for which net volume per acre can be computed (presented in the following table). These numbers include the many different species that can occur together within each forest type. The highest volume per acre on the Gallatin is in the Engelmann spruce forest type and the lowest is in limber pine. Volume per acre in limber pine and ponderosa pine may not be representative due to small sample sizes.

Forest type	Net cubic foot volume per acre	Number of plots
Engelmann spruce	2,927	19
Lodgepole pine	2,602	55
Spruce-fir	2,256	57
Whitebark pine	2,101	30
Douglas-fir	1,789	59
Ponderosa pine	893	1
Limber pine	544	2
Total		223

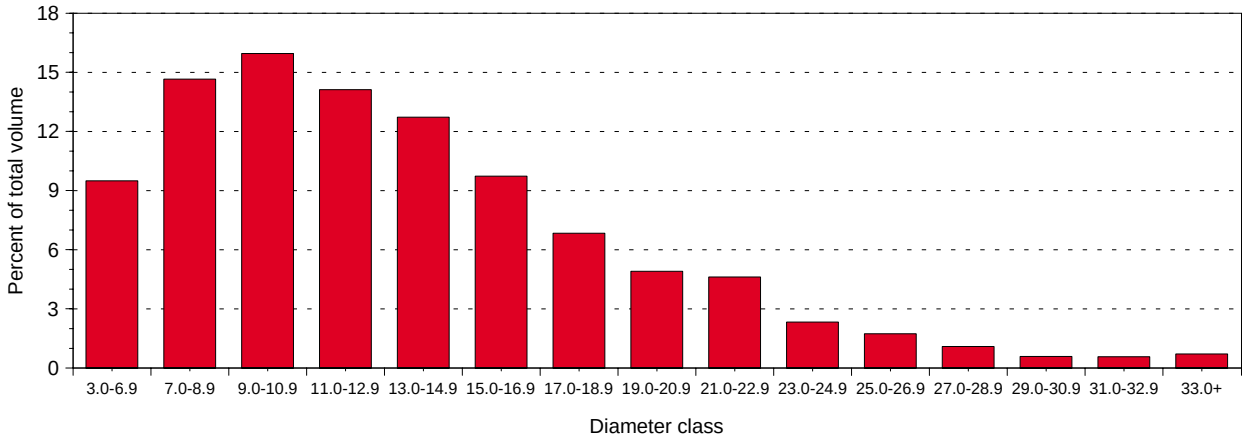

Figure 10—Percent net cubic foot volume of live trees by diameter class, Gallatin National Forest.

How does the forest change?

Stocking category—Many factors influence the rate at which trees grow and thrive, or die. As tree size and density increase, competition for available resources also increases. As was mentioned earlier, stocking is an expression of the extent to which growing space on a site is effectively utilized by live trees. Information about stocking can apply to many issues, such as timber production and management, wildlife habitat suitability, and risk of attack by insects or disease. For this analysis, stocking of all live trees is presented in three classes. High stocking sites are those that are 60 or more percent stocked with live trees. Medium stocking sites are those 35 to 60 percent stocked with live trees. Low stocking sites are those that are less than 35 percent stocked with live trees.

The percent area by forest type and stocking category is shown in figure 11. High stocking indicates conditions where tree growth begins to slow and tree vigor starts to decrease, which can make trees more susceptible to attack by insect and disease. By this definition, about 48 percent of all forest land on the Gallatin is estimated to be in the high stocking category. This includes about 66 percent of the lodgepole pine, 51 percent of the whitebark pine, and 48 percent of the spruce-fir forest types on the Forest.

Growth—Another measure of forest vigor is net annual growth. Net annual growth is the difference between gross annual growth and losses due to mortality. Gross annual growth of growing-stock trees (5.0 inches d.b.h and greater) on all forest land of the Gallatin is estimated to be 61.3 million cubic feet, and net annual growth is 39.1 million cubic feet. Gross annual growth is compared to mortality for five

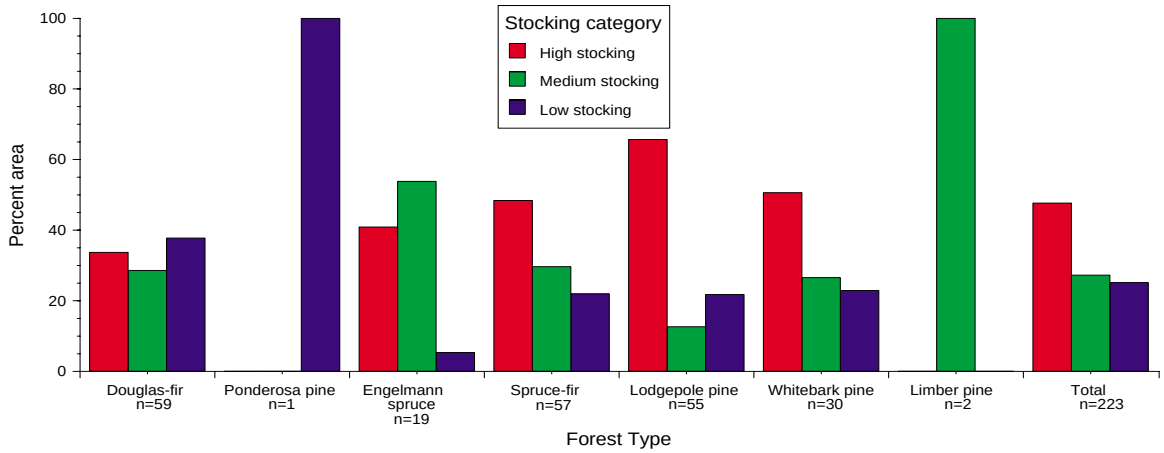

Figure 11--Percent area of live tree stocking category by forest type, Gallatin National Forest. Includes number of plots in each type.

Figure 11—Percent area of live tree stocking category by forest type, Gallatin National Forest. Includes number of plots in each type.

high volume species in figure 12. Mortality on the Gallatin is about 36 percent of gross annual growth on all forest land with the largest mortality-to-growth ratio for the five high volume species (70 percent) occurring in lodgepole pine.

Mortality—Field crews assess which trees have died in the past 5 years; these trees are used to estimate the average annual mortality. Based on this estimate, in 1997, 22.2 million cubic feet of wood from growing-stock trees (5.0 inches d.b.h. and greater) died on the Gallatin. About 27 percent of the mortality was estimated to be caused by disease, 26 percent by fire, and 15 percent by insects. Seventy-two percent of the mortality occurred in just two species: lodgepole pine and subalpine fir.

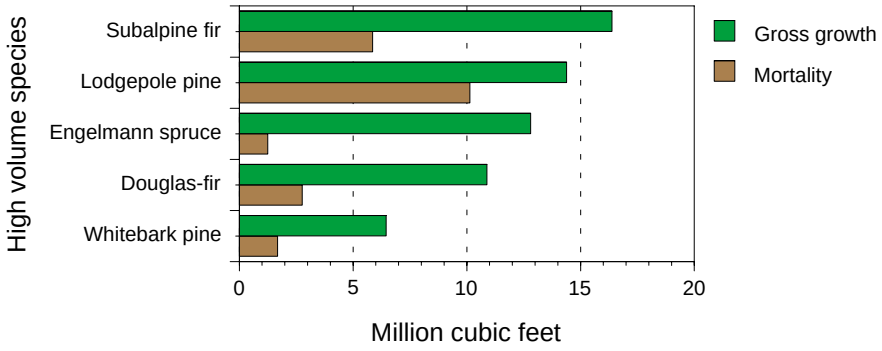

Figure 12—Gross annual growth of growing stock compared to mortality for five high volume species on all forest land, Gallatin National Forest.

Other information about the forest land of the Gallatin

Accessibility—All forested plots visited by field crews were assigned a "distance to road" category. Based on this information, it is estimated that 17 percent of the forested area of the Gallatin National Forest is less than a half mile from an improved road; 11 percent is between a half and 1 mile; 30 percent is between 1 and 3 miles; 17 percent is between 3 and 5 miles; and 25 percent is greater than 5 miles from an improved road.

Location history—Field crews also make a field observation on each forested plot of the predominant human or natural disturbance that affects the stand. From this it was estimated that 29 percent of the forested area on the Gallatin had no visible signs of disturbance; 26 percent had disease damage for its predominant disturbance, 14 percent had evidence of fire, 10 percent had evidence of weather damage, 9 percent had evidence of tree cutting, and 4 percent each had evidence of wind or animal damage. The remaining 4 percent had evidence of insect damage, road building, land clearing, or other disturbance.

Understory vegetation—Understory vegetation provides forage and cover for wildlife, contributes to forest fuel load, and can be an indication of the successional stage of the forest community. Field crews visually estimated crown canopy coverage and assigned a percent cover class for three different height classes (layers) of tree seedlings, shrubs, forbs, and graminoids (See USDA 1997 for details). Figure 13 shows the average percent cover of shrubs on forest land by height class (feet) and forest type.

How much forest land is suitable for timber production?

Wood production is one of many important uses of nonreserved forest land on the Gallatin. Nonreserved means the land has not been withdrawn from timber utilization through statute or administrative designation. The area of nonreserved forest land is 908,012 acres, or 62 percent of the total forest land area of the Gallatin. The net volume of growing-stock trees (5.0 inches d.b.h. and greater) on nonreserved forest land is over 1.9 billion cubic feet.

About 41 percent of the nonreserved forest land is actually considered to be suitable for timber production (USDA 1987).). Suitable lands are designated through National Forest planning to have a management emphasis on timber production while maintaining other resource values (USDA 2000). Field plots that fell within the suitable forest area were identified, and attributes associated with those plots were then summarized to characterize the forest resources of the suitable lands.

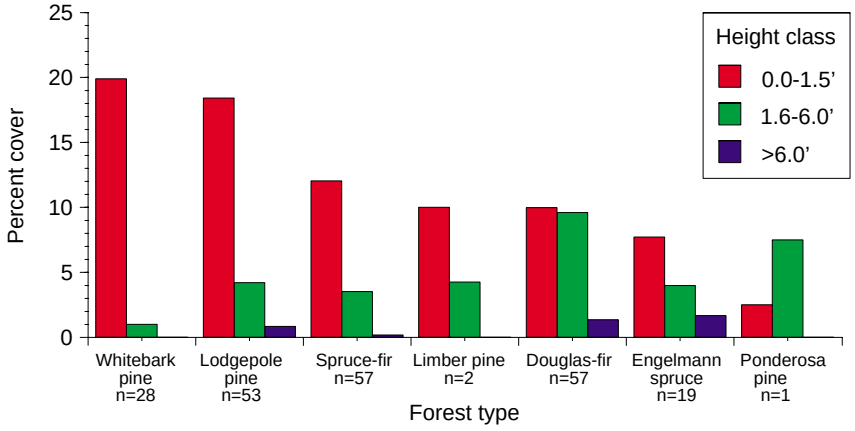

Figure 13—Average percent cover of shrubs on forest land by height class and forest type, Gallatin National Forest. Includes number of plots in each type.

Forest type and stand size—In terms of forest type, the composition of suitable forest land is different from that of the Forest as a whole. The largest differences are in the lodgepole pine, spruce-fir, and whitebark pine types. The lodgepole pine type makes up 48 percent of the suitable forest area, but only 25 percent of the total forest area. Conversely, spruce-fir and whitebark pine comprise only 11 and 2 percent, respectively, of the suitable forest area, but make up 25 and 13 percent of the total forest area. Stand-size class distribution on the suitable area is similar to that of the Forest as a whole. One exception is with the nonstocked class, which had no samples on suitable lands.

Volume—The net volume of growing-stock trees (5.0 inches d.b.h. and greater) on suitable lands is estimated to be over 817 million cubic feet, which is about 42 percent of the net volume on nonreserved forest land. The net volume of sawtimber trees (sawtimber volume) on suitable lands is estimated to be over 2.7 billion board feet (Scribner rule). Figure 14 shows the distribution of sawtimber volume on nonreserved forest land by species, compared to that on suitable lands. Douglas-fir, lodgepole pine, and Engelmann spruce together account for about 92 percent of the total sawtimber volume on suitable lands. Compared to nonreserved forest land only 22 percent of subalpine fir, 13 percent of whitebark pine, and 8 percent of limber pine sawtimber volume occur on suitable forest land. In contrast, 56 percent of the lodgepole pine sawtimber volume on the Gallatin occurs on suitable forest land.

Growth and mortality—Gross annual growth of growing-stock trees (5.0 inches d.b.h. and greater) on nonreserved forest land is estimated to be about 39.4 million cubic feet , and net annual growth is over 24.2 million cubic feet. Annual mortality is over 15.2 million cubic feet, or about 39 percent of gross annual growth on nonreserved forest land. By comparison, gross annual growth on suitable lands is estimated to be over 16.4 million cubic feet, and net annual growth is estimated to be over 6.5 million cubic feet. Annual mortality is about 9.9 million cubic feet or about 60 percent of gross annual growth on suitable forest land.

Gross annual growth of growing-stock trees (5.0 inches d.b.h. and greater) for five high volume species is compared to mortality on nonreserved and suitable lands, in figures 15 and 16, respectively. Subalpine fir has the largest ratio of mortality to gross annual growth on suitable forest land at 146 percent, compared to a ratio of 59 percent for nonreserved forest land. Douglas-fir has a ratio of 58 percent for suitable land and 26 percent for nonreserved land. No whitebark pine trees were sampled for mortality on suitable lands.

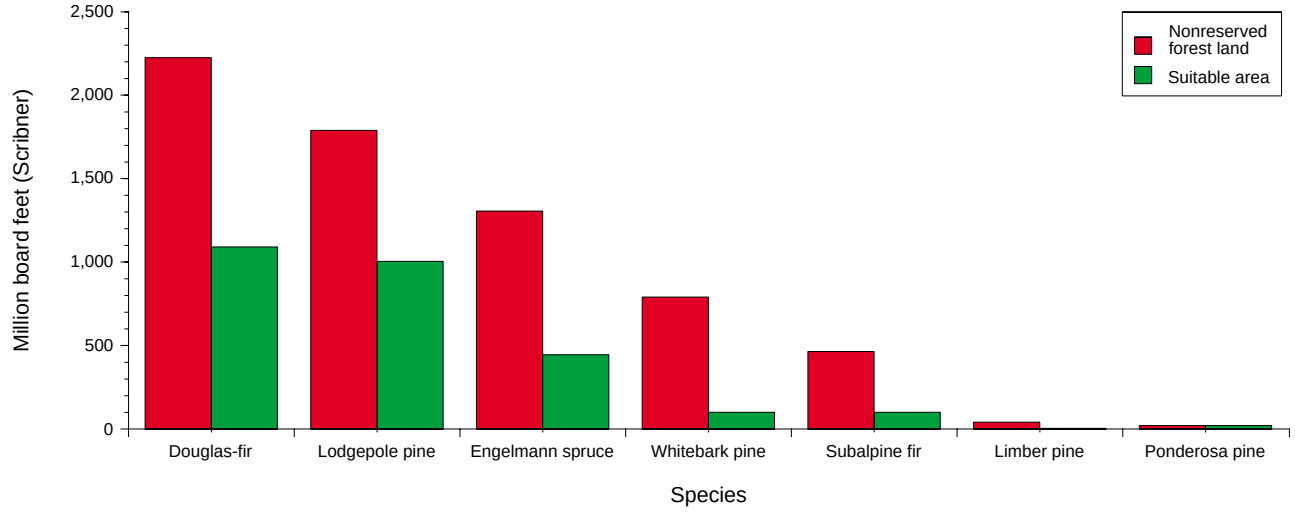

Figure 14—Sawtimber volume on nonreserved forest land compared to sawtimber volume on suitable lands, Gallatin National Forest.

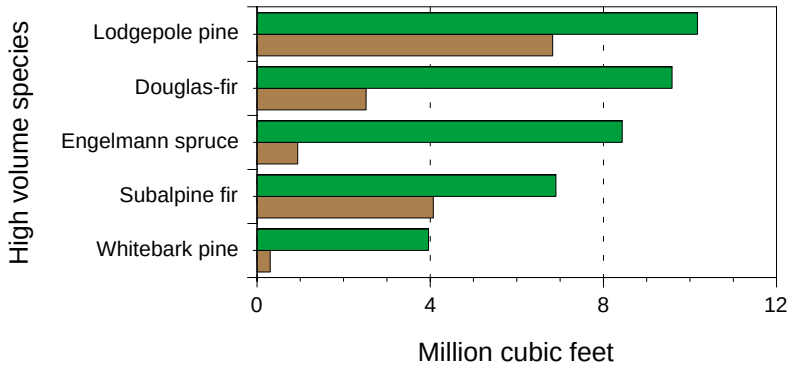

Figure 15—Gross annual growth of growing stock compared to mortality for nonreserved forest land, Gallatin National Forest.

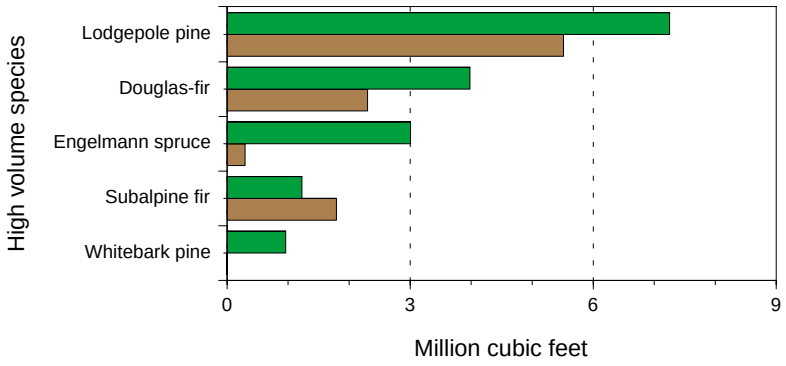

Figure 16—Gross annual growth of growing stock compared to mortality for forest land suitable for timber harvest, Gallatin National Forest.

How was the inventory conducted?

FIA inventories provide a statistical-based sample of forest resources across all ownerships that can be used for planning and analyses at local, State, regional, and national levels. IWRIME has not traditionally conducted inventories on National Forest lands in the West, but in Montana, a cooperative agreement with funding and personnel from the Inventory Service Center of the Forest Service Northern Region, made possible an inventory of National Forest System lands, using IWRIME procedures.

IWRIME uses a two-phase sampling procedure for all inventories. Phase one of the inventory is based on a grid of sample points systematically located every 1,000 meters across all lands in the State. Phase one points are assigned ownership and vegetative cover attributes using maps and remotely sensed imagery. Field crews conduct phase two of the inventory on a subsample of the phase one points that occur on forest land. The sampling intensity is one field plot every 5,000 meters, or about every 3 miles. Phase two plots are stratified based on phase one ownership and vegetation information, and weights are assigned to each stratum based on the proportion of phase one points in that stratum. There were 283 field plots on the Gallatin using the standard IWRIME grid, of which eight were inaccessible or sample missed. Of the plots field sampled, 223 were forested.

Photo by Rick Ellison

The sample was designed to meet national standards for precision in State and regional estimates of forest attributes. Standard errors, which denote the precision of an estimate, are usually higher for smaller subsets of the data. Percent standard errors for net volume, net annual growth, and annual mortality estimates of growing stock on total forest land, nonreserved forest land, and forest lands suitable for timber production are presented in table 1. Standard errors for other estimates are available upon request (see the "For further information" section on the inside back cover).

Table 1—Percent standard errors for net volume, net annual growth, and annual mortality of growing-stock trees (5.0 inches d.b.h. and greater) on total forest land, nonreserved forest land, and land suitable for timber production, Gallatin National Forest.

Land class	Attribute	Growing-stock volume	Percent standard error
		Cubic feet	
Total forest land	Volume	3,239,079,797	6.2
	Growth	39,109,103	21.6
	Mortality	22,234,419	30.1
Nonreserved forest land	Volume	1,955,450,331	7.5
	Growth	24,203,342	30.5
	Mortality	15,210,868	42.8
Land suitable for timber production	Volume	817,905,982	15.0
	Growth	6,583,900	102.1
	Mortality	9,904,906	65.0

Documentation

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For further information

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Some of the information presented here is just a small part of a national data base that houses information for much of the forest land in the United States. This data base can be accessed on the Internet at the following web site:

http://www.srsfia.usfs.msstate.edu/scripts/ew.htm

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Photo by Rick Ellison

The Rocky Mountain Research Station develops scientific information and technology to improve management, protection, and use of the forests and rangelands. Research is designed to meet the needs of National Forest managers, Federal and State agencies, public and private organizations, academic institutions, industry, and individuals.

Studies accelerate solutions to problems involving ecosystems, range, forests, water, recreation, fire, resource inventory, land reclamation, community sustainability, forest engineering technology, multiple use economics, wildlife and fish habitat, and forest insects and diseases. Studies are conducted cooperatively, and applications may be found worldwide.