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Forest Resources of the Lewis and Clark National Forest

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Cover photo by Frank Spirek, Computer Specialist,
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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 Lewis and Clark National Forest 1996 inventory, using commonly requested variables and summaries. The data could be summarized in other ways for different purposes (see "For further information" on the inside back cover). The information presented in this report is based solely on the IWRIME inventory sample (USDA 1996a). References are available for supplementary documentation and inventory terminology (USDA 2000). Additional data collected by the Lewis and Clark National Forest and used separately or in combination with IWRIME data may produce varying results.

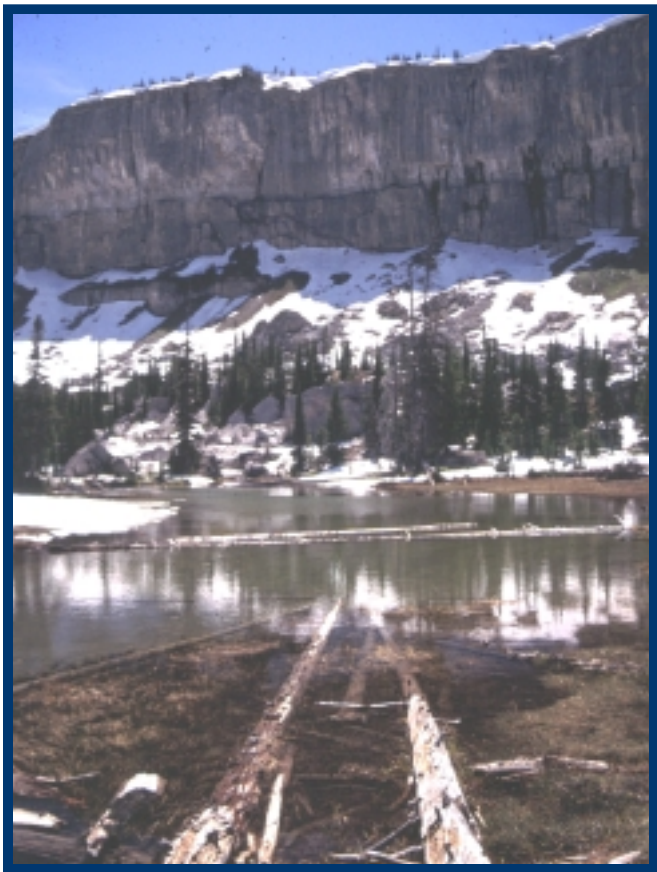

Photo by Frank Spirek

What forest resources are found on the Lewis and Clark National Forest?

The Lewis and Clark National Forest administers 1,862,291 acres (USDA 1996b; 2000) of which 89 percent is forest land and 11 percent is nonforest or water (fig. 1). Twenty-one percent of the total area of the Lewis and Clark is in a reserved designation in the Bob Marshall Wilderness and the Scapegoat Wilderness. The first part of this report will focus on forest resources of all the forest land on the Lewis and Clark, 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 the single predominant species concept used for classifying forest type applies to sites where Engelmann spruce and subalpine fir occur together within a stand, and in combination they compose the predominant live-tree stocking (USDA 2000).

Forest types are dynamic and can change slowly through forest succession, or rapidly due to disturbances such as timber harvest, fire, or insect and disease epidemics. On the Lewis and Clark, Douglas-fir at 29 percent is the most common forest type by percentage of total forest land area. Douglas-fir is followed in abundance by lodgepole pine at 28 percent, spruce-fir at 18 percent, Engelmann spruce at 8 percent, limber and whitebark pine at about

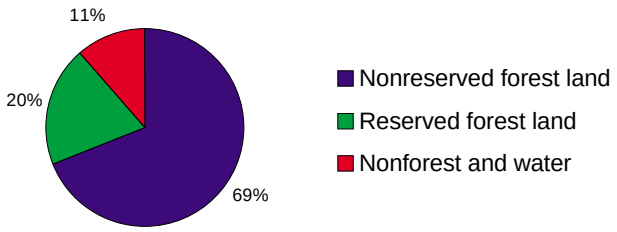

Figure 1—Percent area by land class and reserved status, Lewis and Clark National Forest.

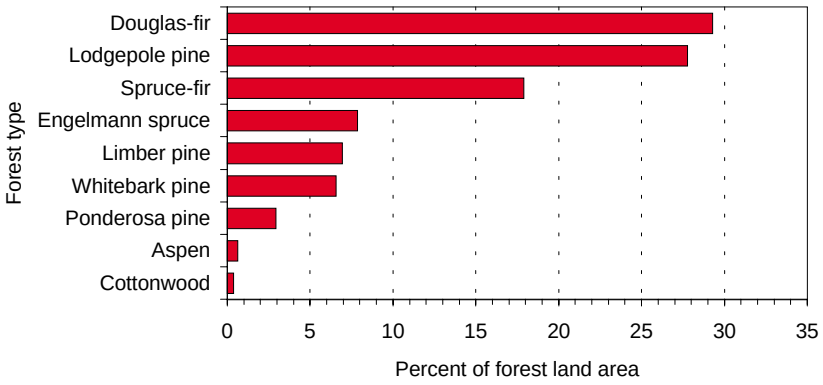

Figure 2—Percent of forest land area by forest type, Lewis and Clark National Forest.

7 percent each, and ponderosa pine at 3 percent (fig. 2). Traces of aspen and cottonwood types also occur.

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 subregional 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 (USDA 1995; Jones 1997). These habitat type groups serve as integrators of the moisture availability and temperature gradients of the biophysical environment (Jones 1997).

The Lewis and Clark has more than 70 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 Lewis and Clark. The most common habitat type group is the warm and very dry group followed by the cool and moist group, occurring on 19 and 18 percent of the forest area, respectively. By using habitat type groups to summarize forest land area, the Lewis and Clark 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 three diameter-size classes. Sixty-five percent of all live trees on the Lewis and Clark are from 1.0 to 4.9 inches diameter, 24 percent are from 5.0 to 8.9 inches diameter, and 11 percent are 9.0 inches diameter and greater. Lodgepole pine makes up 33 percent of the total number of trees; subalpine fir and Douglas-fir, 21 percent each; Engelmann spruce, 12 percent; limber pine, 6 percent; whitebark pine, 4 percent; and ponderosa pine, 2 percent. Aspen, Rocky Mountain juniper, balsam poplar, black cottonwood, and plains cottonwood combined contribute about 1 percent. Species that are scarce may not be encountered with the extensive sampling strategy used for this inventory.

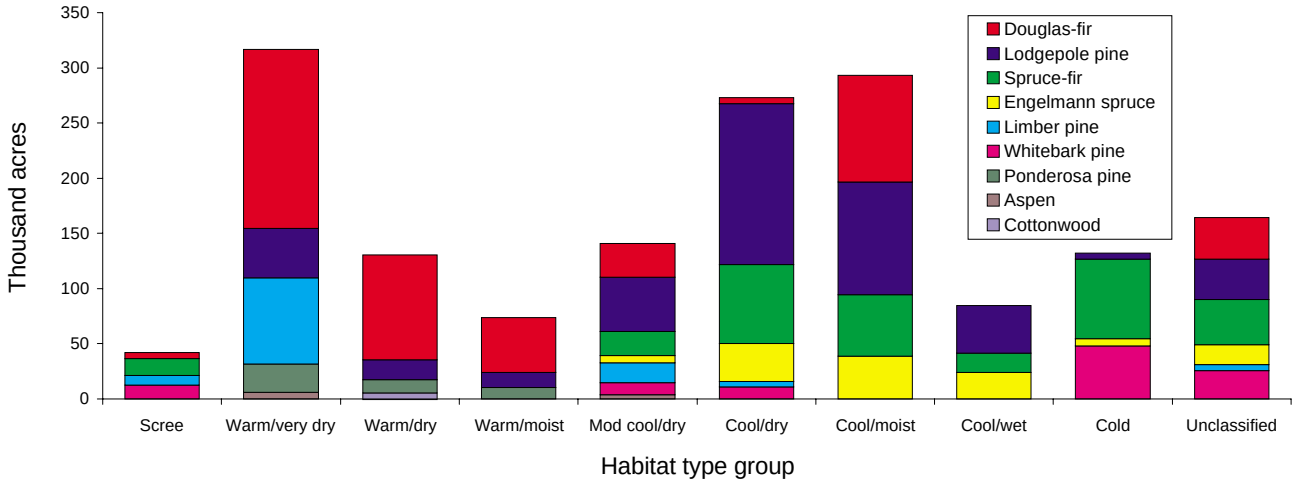

Figure 3—Area of forest land by forest type and habitat type group, Lewis and Clark National Forest.

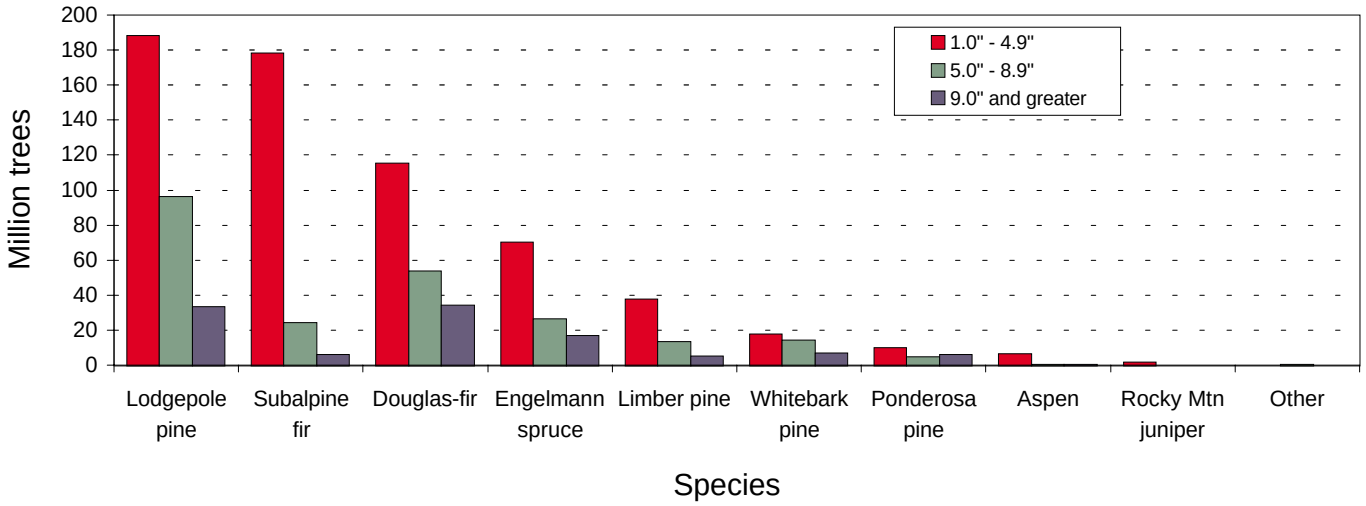

Figure 4—Number of live trees 1.0 inch diameter and greater by species and size class, Lewis and Clark National Forest.

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 Lewis and Clark, the predominantly competing species in order from most to least are Douglas-fir, lodgepole pine, Engelmann spruce and ponderosa pine at lower elevations, and lodgepole pine, Douglas-fir, Engelmann spruce, subalpine fir and whitebark pine at higher elevations.

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 67 million standing dead trees (snags) greater than 5.0 inches diameter on the Lewis and Clark National Forest. This number includes both hard and soft snags of all species. Many wildlife species are dependent upon snags. The species, size, and density of snags required vary according to the species of wildlife. Because large diameter snags are generally somewhat scarce relative to smaller snags, they tend to be the focus of more attention. Considering snags 11.0 inches diameter or larger, an estimated

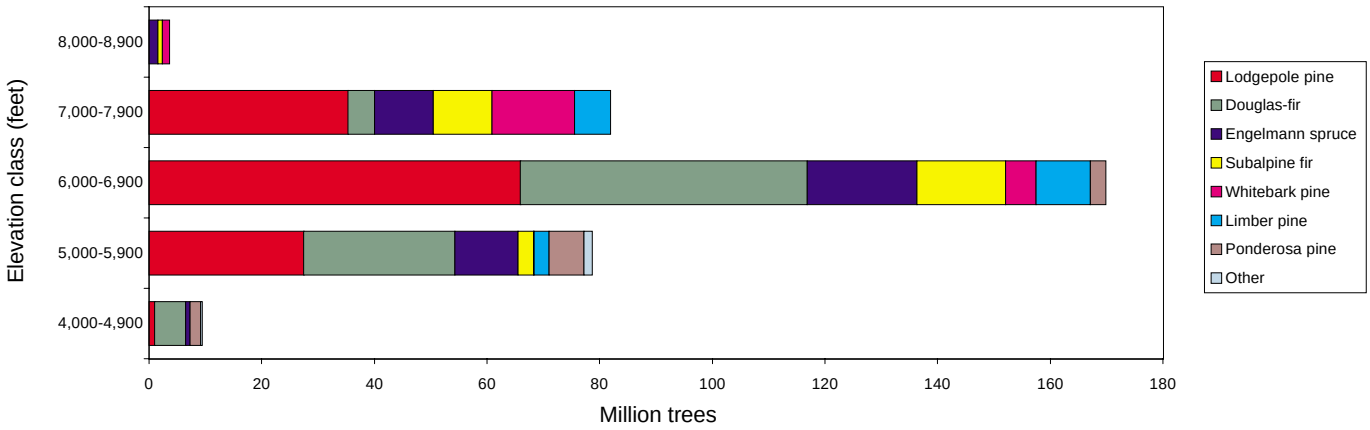

Figure 5—Number of live trees 5.0 inches diameter and greater by species and elevation class, Lewis and Clark National Forest. Sample site elevation determined to nearest 100 feet.

6.9 per acre occur on Lewis and Clark forest land. Of the very large snags (19.0 inches diameter or larger) there is an estimated 0.4 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 2.3 million tons of down dead trees on Lewis and Clark 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 six predominant types and all forest types combined. For all forest types combined the saplings/seedlings stand-size class has the highest weight at 2.1 tons per acre, followed by the large tree class at 1.4 tons per acre. For all stand-size classes combined the Engelmann spruce type has the highest weight at 3.8 tons per acre, followed by spruce-fir at 2.6 tons per acre, and lodgepole pine at 1.8 tons per acre. No down dead trees were sampled on ponderosa pine, aspen, or cottonwood forest types.

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 Lewis and Clark. Overall, there are a higher number of small trees 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. Large trees include softwoods 9.0 inches diameter and greater, and hardwoods 11.0 inches diameter and greater; medium trees include softwoods 5.0 to 8.9 inches diameter, and hardwoods 5.0 to 10.9 inches diameter. 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 Lewis and Clark by stand-size class. This figure shows that about 45 percent of the stands have a majority of stocking from large trees, and that a high percentage of stands occur in the saplings/seedlings stand-size class, such as stands that have been previously disturbed by fire and are regenerating.

Figure 9 shows stand-size classes for the six most predominant forest types accounting for the most acreage on the Lewis and Clark. Thirty-three percent of the total forest land area is classified in the Douglas-fir, lodgepole pine, or spruce-fir large tree category, 10 percent in the lodgepole pine medium tree category, and 8 percent in the spruce-fir saplings/seedlings category.

Wood volume, biomass, and basal area 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, biomass, and basal area summaries that contain estimates of more tree resources such as total wood fiber. Volume and basal area summaries include 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. The net volume of wood in live trees on the Lewis and Clark is estimated to be in excess of 2.7 billion cubic feet. Total biomass of wood in live trees on the Lewis and Clark is estimated at over 58 million tons. Biomass estimates include boles, bark, and branches of all live trees

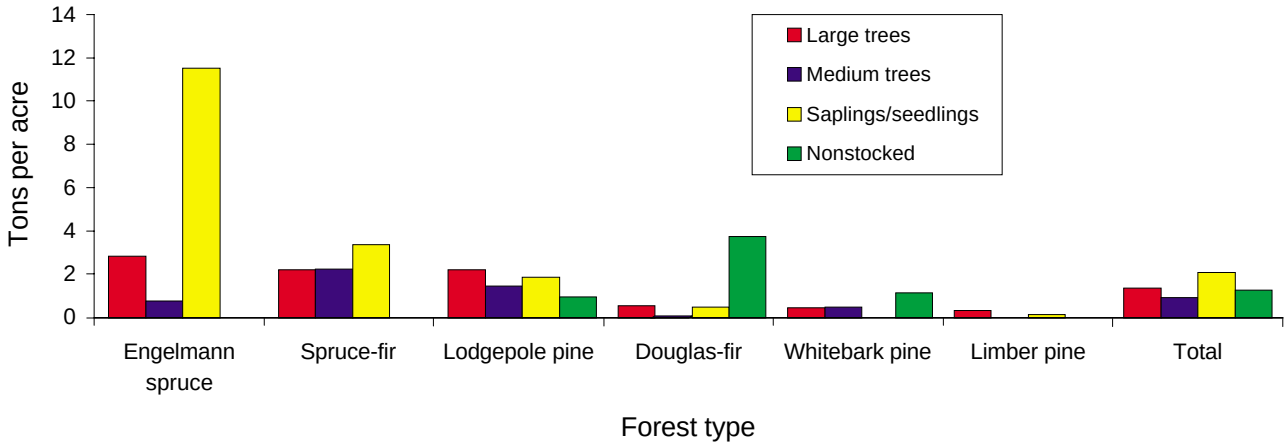

Figure 6—Weight of down dead trees 5.0 inches diameter and greater on forest land by forest type and stand-size class, Lewis and Clark National Forest.

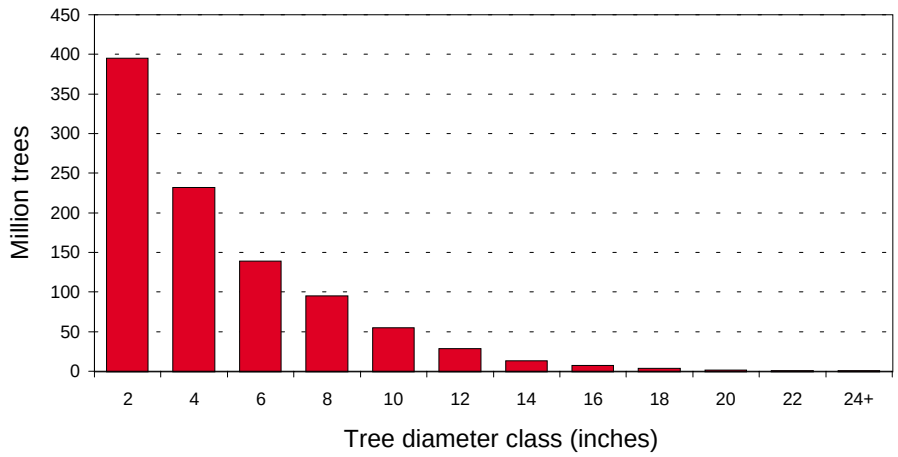

Figure 7—Number of live trees by diameter class, Lewis and Clark National Forest.

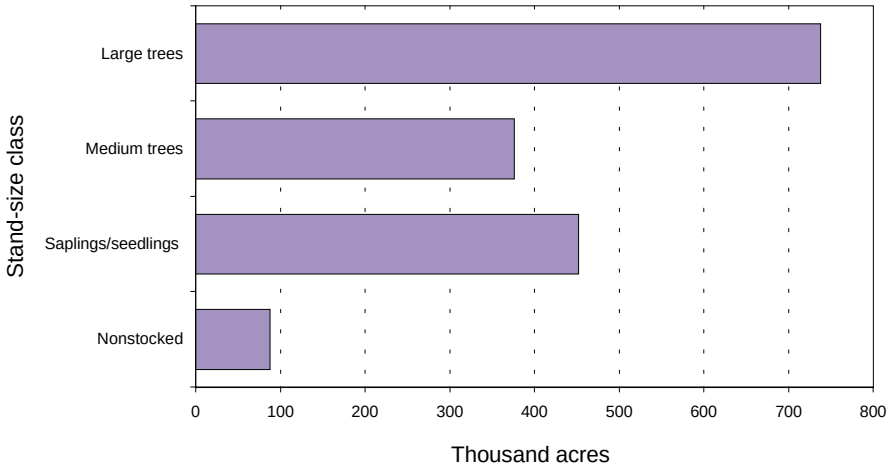

Figure 8—Forest land area by stand-size class, Lewis and Clark National Forest.

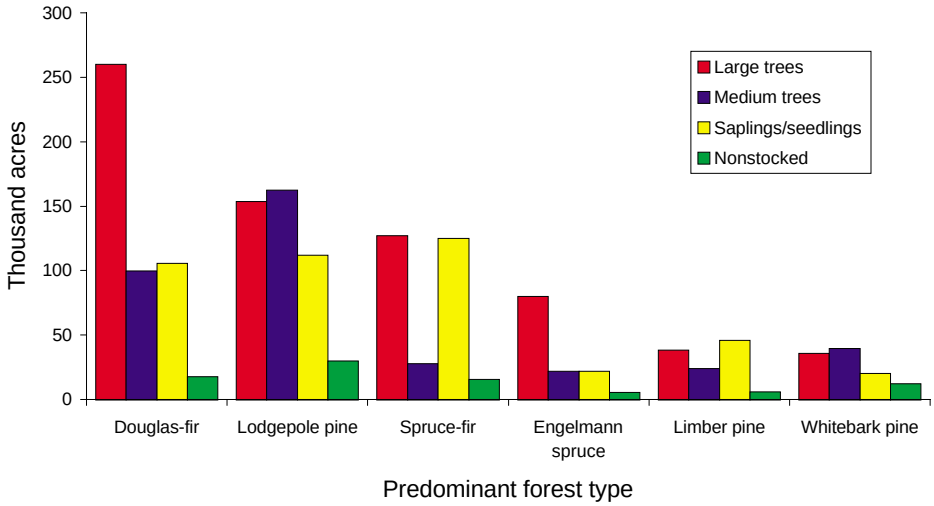

Figure 9—Area of forest land by predominant forest type and stand-size class, Lewis and Clark National Forest.

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	1,037.4	19.9
Douglas-fir	711.3	17.1
Engelmann spruce	504.0	9.0
Subalpine fir	192.8	4.9
Whitebark pine	146.8	3.0
Ponderosa pine	93.3	2.0
Limber pine	87.8	2.2
Aspen	5.5	.1
Plains cottonwood	1.3	T
Black cottonwood	1.1	T
Balsam poplar	1.0	T
Rocky Mountain juniper	0.5	T
Total	2,782.9	58.2

T – Less than 100,000

Figure 10 displays the percent net cubic-foot volume of live trees by diameter class. A breakdown by species shows approximately 82 percent of ponderosa pine, 79 percent of Engelmann spruce, and 76 percent of Douglas-fir volume is in trees 9.0 inches and greater d.b.h. About 57 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 estimates per acre can be computed along with basal area (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 Lewis and Clark is in the Engelmann spruce forest type. The highest basal area per acre is in the ponderosa pine forest type. Volume and basal area per acre for some forest types on the Lewis and Clark may be relatively low due to the high occurrence of stands in the saplings/seedlings stand-size class. Aspen and cottonwood volume and basal area per acre may not be representative due to small sample sizes.

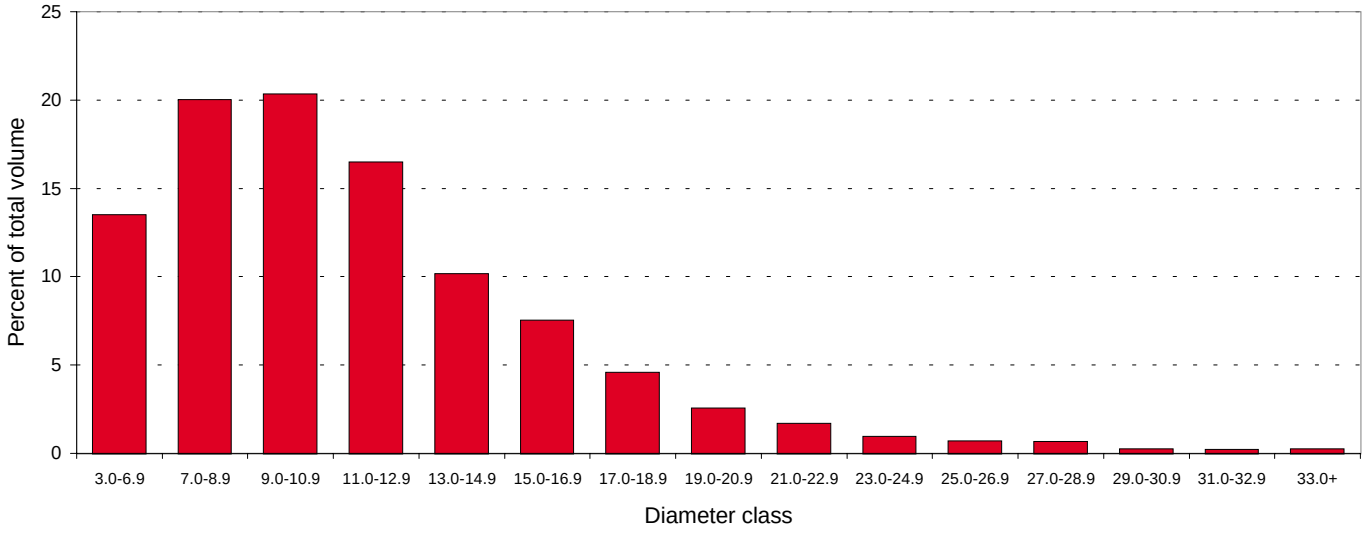

Figure 10—Percent net cubic-foot volume of live trees by diameter class, Lewis and Clark National Forest.

Forest type	Net cubic-foot volume per acre	Basal area sq. ft. per acre	Number of plots
Engelmann spruce	2,167	102	22
Lodgepole pine	1,951	89	74
Ponderosa pine	1,781	114	8
Spruce-fir	1,666	74	49
Douglas-fir	1,625	102	77
Whitebark pine	1,543	100	16
Aspen	664	50	2
Limber pine	641	54	18
Cottonwood*	0	0	1
Total			267

*All trees sampled in the cottonwood type were seedlings

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 stocking category and forest type is shown in figure 11. High stocking indicates conditions

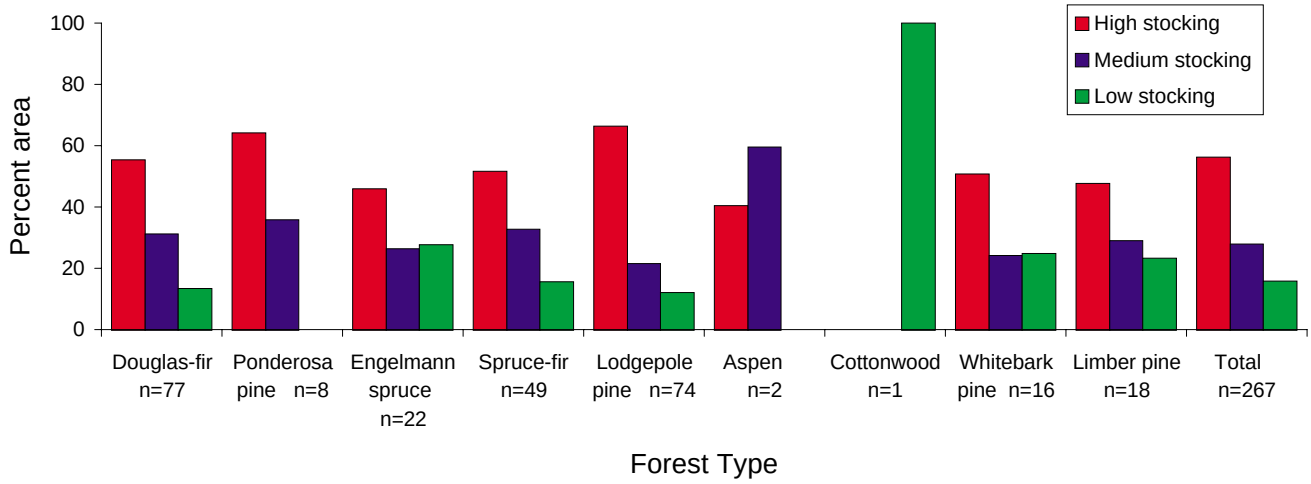

Figure 11—Percent area of live tree stocking category by forest type, Lewis and Clark National Forest. Includes number of plots by type.

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 56 percent of all forest land on the Lewis and Clark is estimated to be in the high stocking category. This includes about 66 percent of the lodgepole pine, 64 percent of the ponderosa pine, and 55 percent of the Douglas-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 Lewis and Clark is estimated to be 59.4 million cubic feet, and net annual growth is 50.6 million cubic feet. Gross annual growth is compared to mortality for six high-volume species in figure 12. Mortality on all forest land of the Lewis and Clark is about 15 percent of gross annual growth, with the largest mortality-to-growth ratio for the six high-volume species occurring in subalpine fir.

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 1995, 8.9 million cubic feet of wood from growing-stock trees (5.0 inches d.b.h. and greater) died on the Lewis and Clark. About 46 percent of the mortality was caused by disease, 21 percent by insects, and 9 percent by fire. Sixty-nine percent of the mortality occurred in just two species: lodgepole pine and Engelmann spruce.

Photo by Frank Spirek

Other information about the forest land of the Lewis and Clark

Accessibility—All forested plots visited by field crews were assigned a "distance to road" category. Based on this information, it is estimated that 18 percent of the forested area of the Lewis and Clark National Forest is less than a half mile from an improved road; 11 percent is between a half and 1 mile; 24 percent is between 1 and 3 miles; 19 percent is between 3 and 5 miles; and 28 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 31 percent of the forested area on the Lewis and Clark had no visible signs of disturbance; 22 percent each had disease or fire for its predominant disturbance; 8 percent had evidence of wind damage; 5 percent each had evidence of weather damage or tree cutting; 4 percent had evidence of other disturbance; and 3 percent had evidence of insect or animal damage.

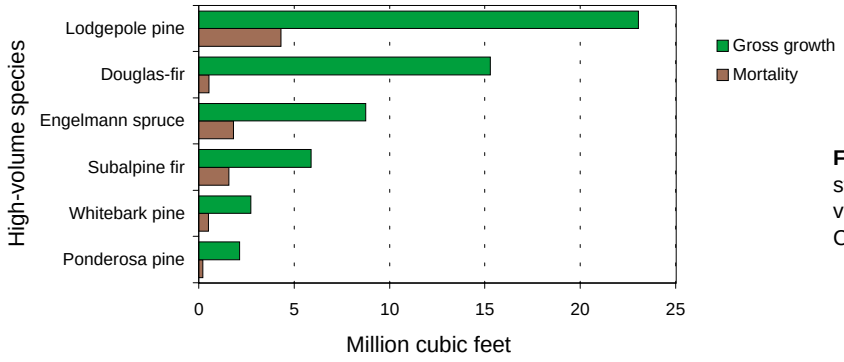

Figure 12—Gross annual growth of growing stock compared to mortality for six high-volume species on all forest land, Lewis and Clark National Forest.

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 1996a 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 Lewis and Clark. Nonreserved means the land has not been withdrawn from timber utilization through statute or administrative designation. The area of nonreserved forest land is 1,282,019 acres, or 78 percent of the total forest land area of the Lewis and Clark. The net volume of growing-stock trees (5.0 inches d.b.h. and greater) on nonreserved forest land is over 2.1 billion cubic feet.

About 33 percent of the nonreserved forest land is actually considered to be suitable for timber production (USDA 1986). 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.

Forest type and stand size—In terms of forest type, the composition of suitable forest land is different from that of all forest land. The largest differences are in the lodgepole pine and spruce-fir types. The lodgepole pine type makes up 38 percent of the suitable forest area, but only 28 percent of the total forest area. Conversely, spruce-fir comprises less than 9 percent of the suitable forest area, but makes up 18 percent of the total forest area. No aspen or cottonwood types were sampled on suitable lands.

Stand-size class distribution on suitable lands is different from that of all forest land. The largest differences are in the large tree and the saplings/seedlings stand-size classes. The large tree class makes up 54 percent of the suitable forest area, but only 45 percent of the total forest area. Conversely, the saplings/seedlings class comprises 17 percent of the suitable forest area, but makes up 27 percent of the total forest area.

Volume—The net volume of growing-stock trees (5.0 inches d.b.h. and greater) on suitable lands is estimated to be over 939.3 million cubic feet, which is about 43 percent of the net volume on nonreserved forest land. The net volume of sawtimber trees (sawtimber volume) on

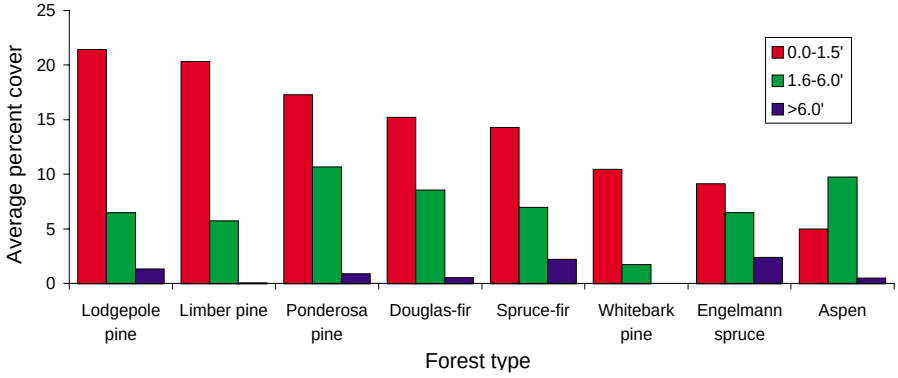

Figure 13—Average percent cover of shrubs on forest land by height class and forest type, Lewis and Clark National Forest.

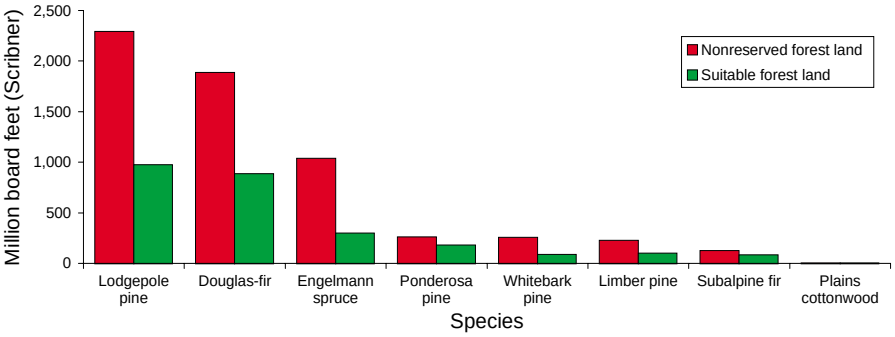

Figure 14—Sawtimber volume on nonreserved forest land compared to sawtimber volume on suitable forest land by species, Lewis and Clark National Forest.

suitable lands is estimated to be over 2.6 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. Lodgepole pine, Douglas-fir, and Engelmann spruce together account for about 83 percent of the total sawtimber volume on suitable lands. Compared to nonreserved forest land 34 percent of whitebark pine and 29 percent of Engelmann spruce sawtimber volume occur on suitable forest land. In contrast, 69 percent of the ponderosa pine sawtimber volume on the Lewis and Clark 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 47.1 million cubic feet, and net annual growth is about 41.3 million cubic feet. Annual mortality is over 5.7 million cubic feet, or about 12 percent of gross annual growth on nonreserved forest land. By comparison, gross annual growth on suitable lands is estimated to be over 18.6 million cubic feet, and net annual growth is estimated to be over 16.6 million cubic feet. Annual mortality is about 2.0 million cubic feet or about 11 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 six high-volume species is compared to mortality on nonreserved and suitable lands in figures 15 and 16, respectively. Engelmann spruce has the

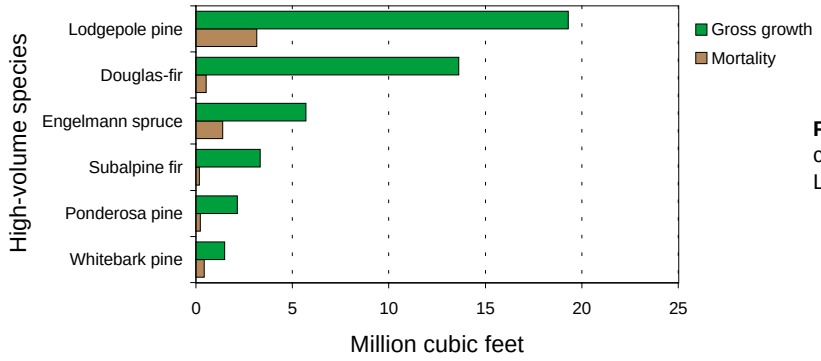

Figure 15—Gross annual growth of growing stock compared to mortality for nonreserved forest land, Lewis and Clark National Forest.

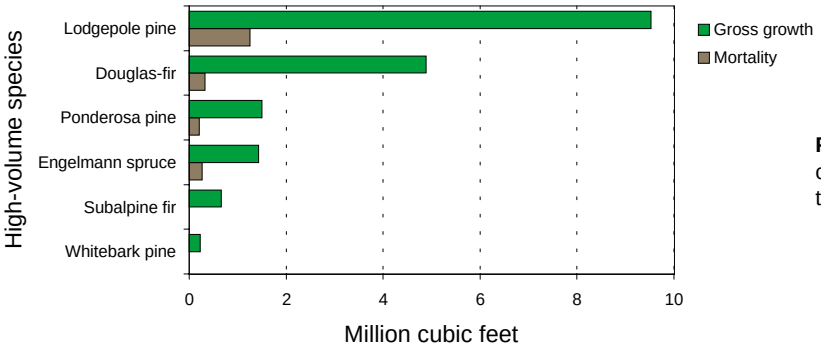

Figure 16—Gross annual growth of growing stock compared to mortality for forest land suitable for timber harvest, Lewis and Clark National Forest.

largest ratio of mortality to gross annual growth on suitable forest land, and whitebark pine has the largest ratio of mortality to gross annual growth for nonreserved forest land. No whitebark pine or subalpine fir trees were sampled for mortality on suitable lands.

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 299 field plots on the Lewis and Clark using the standard IWRIME grid, of which 2 were inaccessible. Of the plots field sampled, 267 were forested.

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 “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, Lewis and Clark National Forest.

Land class	Attribute	Growing-stock volume	Percent standard error
		Cubic feet	
Total forest land	Volume	2,770,789,569	5.3
	Growth	50,562,937	8.0
	Mortality	8,854,902	18.4
Nonreserved forest land	Volume	2,185,267,048	5.9
	Growth	41,316,725	8.6
	Mortality	5,784,147	21.7
Land suitable for timber production	Volume	939,355,659	11.8
	Growth	16,613,023	15.7
	Mortality	2,018,538	35.2

Photo by Frank Spirek

Documentation

Jones, J. L. 1997. Classification of regional habitat type groups—an integration of eastside and westside forest classifications. Unpublished report on file at: Flathead National Forest, Kalispell, MT.

Pfister, Robert D.; Kovalchik, Bernard L.; Arno, Stephen F.; Presby, Richard C. 1977. Forest habitat types of Montana. Gen. Tech. Rep. INT-34. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 174 p.

U.S. Department of Agriculture, Forest Service. 1986. Lewis and Clark National Forest Plan. Great Falls, MT: U.S. Department of Agriculture, Forest Service, Northern Region.

U.S. Department of Agriculture, Forest Service. 1995. Biophysical classification—habitat groups and descriptions. Report on file at: U.S. Department of Agriculture, Forest Service, Northern Region, Kalispell, MT.

U.S. Department of Agriculture, Forest Service. 1996a. Interior West forest land resource inventory field procedures, 1996–1997. Ogden, UT: USDA Forest Service, Intermountain Research Station.

U.S. Department of Agriculture, Forest Service. 1996b. Land Areas of the National Forest System. FS-383. As of September 1996.

U.S. Department of Agriculture, Forest Service. 2000. IWRIME reference documents for Region 1 Montana National Forests (1993 to 1998). [Online]. Available: http://www.fs.fed.us/rm/ogden/state_reports/montana/mt_nfs.html (also available on file at: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT).

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Selected data for this forest are 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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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.