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Forest Resources of the Shoshone National Forest

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About the author

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The Interior West Forest Inventory and Analysis (IWFIA) Program of the USDA Forest Service, Rocky Mountain Research Station, as part of our National Forest System cooperative inventories, conducted a forest resource inventory on the Shoshone National Forest using a nationally standardized mapped-plot design (for more details see section "Inventory methods" page 11). This report presents the highlights of this 1999 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 IWFIA inventory sample (USDA 1999). Supplementary documentation and inventory terminology can be located in USDA (2002). Additional data collected by the Shoshone National Forest and used separately or in combination with IWFIA data may produce varying results. Changes since the inventory, such as the impact of recent disturbances on the Forest have not been incorporated into this report. Annual inventories will soon replace periodic inventories to help monitor these changes at shorter intervals.

Description of the Shoshone National Forest

The Shoshone National Forest administers 2,436,850 acres (USDA 2000; 2002) of which 61 percent is forest land, and 39 percent is nonforest or water (fig. 1). This report describes the characteristics of the forest land sampled on the Shoshone. Forest land is land that is at least 10 percent stocked (or formerly stocked) with live tally tree species and is greater than 1 acre in size and 120 feet wide. Based on tree species present, forest land is subdivided into timberland, where most trees are timber species commonly used for wood products (such as Douglas-fir and lodgepole pine), and woodland, where most trees often have a multi-stem growth form and are not typically used for industrial wood products (such as junipers). Although woodland species were measured on Shoshone FIA plots, they occurred as minor components of timberland types, so all of the forest land was classified as timberland. Fifty–seven percent of the total area on the Shoshone National Forest is in reserved designation in the Absaroka-Beartooth, North Absaroka, Washakie, Fitzpatrick, and Popo Agie Wilderness areas. The first part of this report focuses on forest resources of all the forest land administered by the Shoshone National Forest, including reserved lands. A subsequent section will address nonreserved timberland and roadless areas.

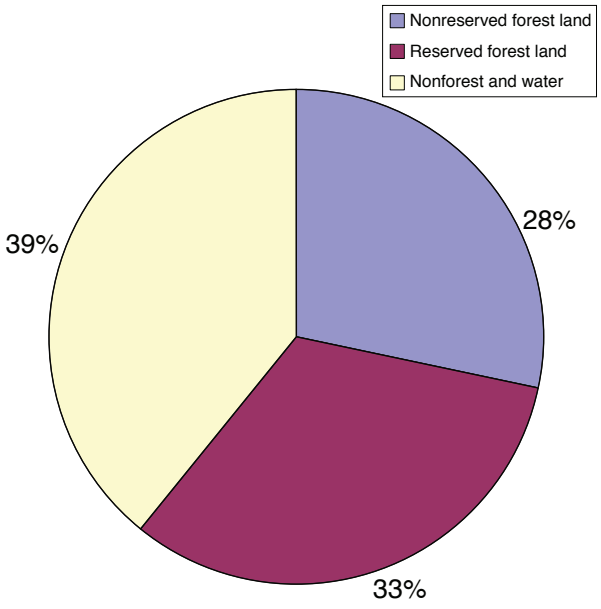


Figure 1— Percent area by land class and reserved status, Shoshone National Forest, 1999.

Forest land highlights of the Shoshone National Forest

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.

Forest types are dynamic and can change slowly through forest succession, or rapidly due to disturbances such as logging, fire, or insect and disease epidemics. Figure 2 presents the distribution of forest land area on the Shoshone National Forest by forest type. The Engelmann spruce forest type is the most common at 24 percent, followed in abundance by Douglas-fir at 22 percent. The lodgepole pine forest type comprises 19 percent of the forest land area; whitebark pine, 14 percent; spruce-fir, 12 percent; limber pine, 7 percent; and aspen, 2 percent.

Tree and stand size—The size distribution of trees is an indicator of structural diversity. Figure 3 displays the distribution of the 600 million live trees on the Shoshone National Forest by diameter class. Overall, this shows a typical diameter distribution with a higher number of small trees than large trees. Trees often reproduce prolifically, but thin out naturally over time due to competition for resources.

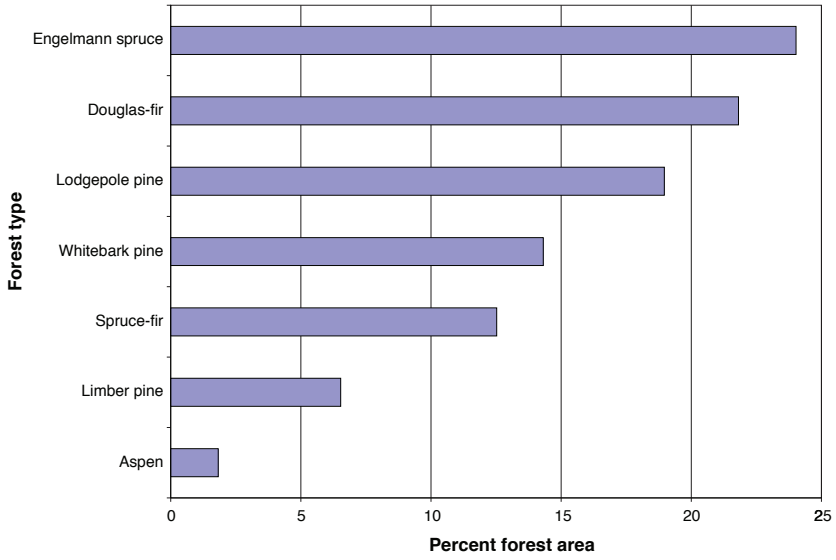


Figure 2—Percent of forest land area by forest type, Shoshone National Forest, 1999.

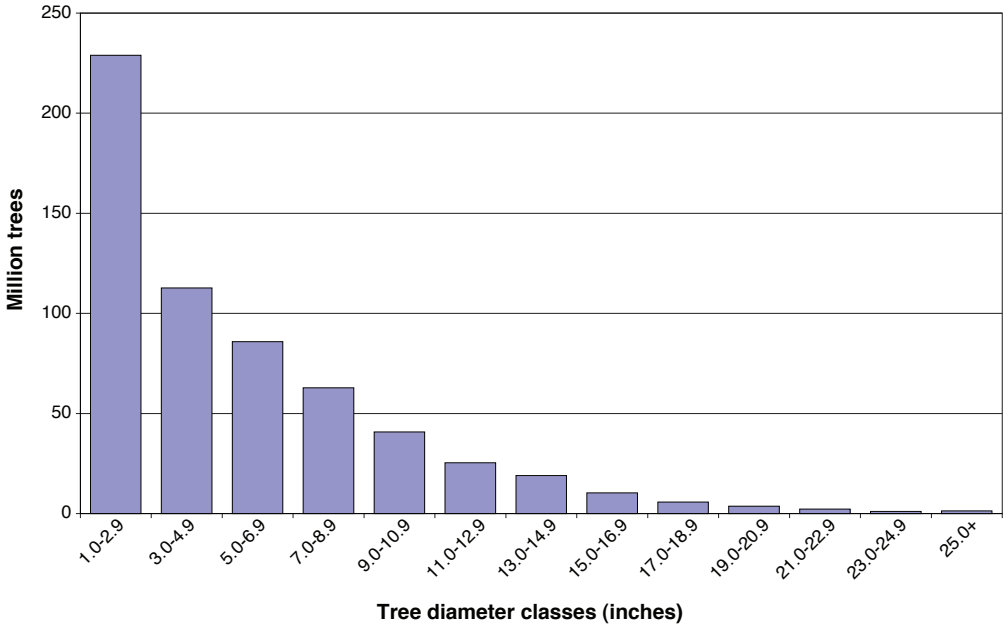


Figure 3—Number of live trees by 2-inch diameter class on forest land on the Shoshone National Forest, 1999.

Stand-size class is a classification of forest land based on the dominant diameter-size of live trees that contribute to stand stocking. Large trees are timber-type softwoods and all woodland tree species 9.0 inches diameter and greater, and timber-type hardwoods 11.0 inches diameter and greater; medium trees include timber-type softwoods and all woodland tree species 5.0 to 8.9 inches diameter, and timber-type hardwoods 5.0 to 10.9 inches diameter; and saplings/seedlings comprise all trees under 5.0 inches diameter. Nonstocked stands are typically those that have been recently disturbed by tree cutting, forest fire, or other large-scale change. For tree stocking, fewer large-diameter trees compared to small-diameter trees are required to fully stock a site. Figure 4 shows a breakdown of forest land on the Shoshone National Forest by area and stand-size class. Sixty-four percent of the stands have a majority of stocking from large trees, while 8 percent are nonstocked.

Figure 5 shows the area of forest land by forest type and stand-size class on the Shoshone National Forest. The two most common forest types in the large tree class are the Engelmann spruce and Douglas-fir forest types, which together make up 54 percent of the large tree stands. Forty-six percent of the stands in the medium tree class are the lodgepole pine forest type.

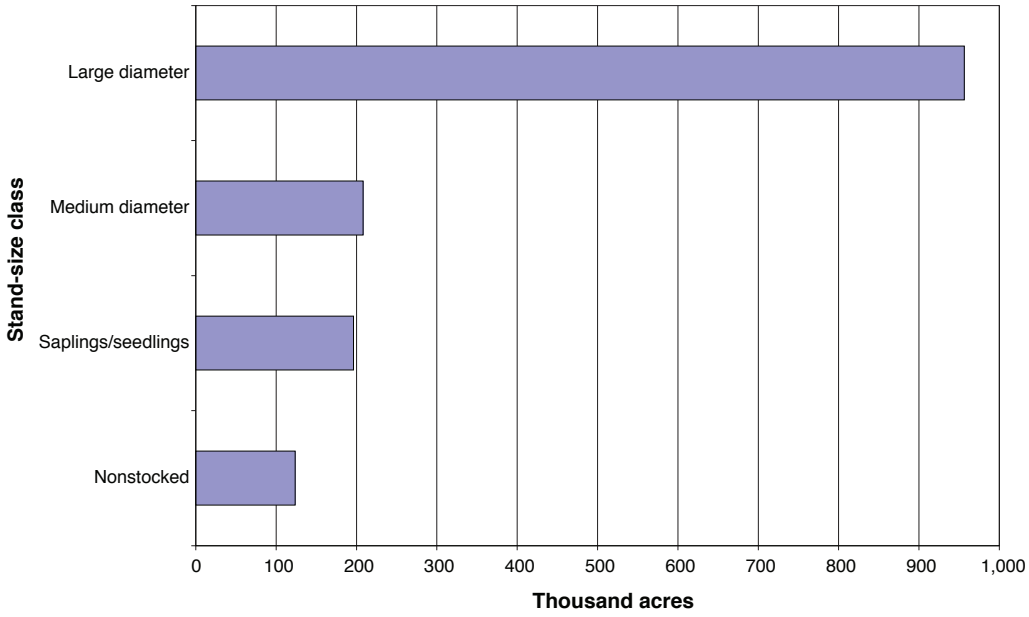


Figure 4—Area of forest land by stand-size class, Shoshone National Forest, 1999.

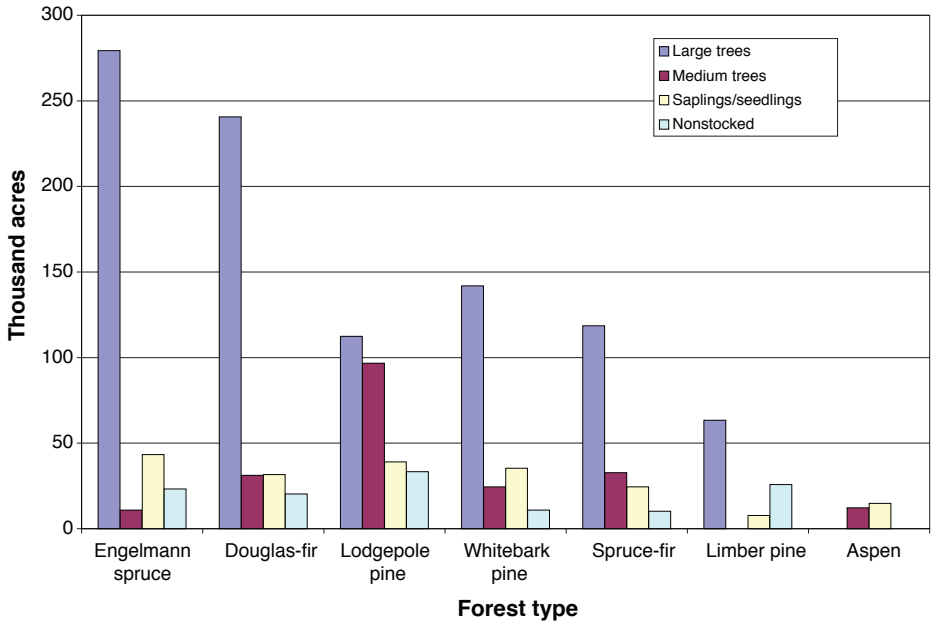


Figure 5—Area of forest land by forest type and stand-size class, Shoshone National Forest, 1999.

Number of live trees—Another way to assess forest diversity is by examining the composition of forest land by tree diameter and species. Figure 6 shows the 600 million live trees by species in three diameter-size classes. Fifty-seven percent of all live trees on the Shoshone National Forest are from 1.0 to 4.9 inches diameter, 25 percent are from 5.0 to 8.9 inches diameter, and 18 percent are 9.0 inches diameter and greater. Engelmann spruce makes up 23 percent of the total number of trees; subalpine fir, 21 percent; whitebark pine, 18 percent; lodgepole pine, 15 percent; Douglas-fir, 11 percent; limber pine, 6 percent; aspen, 5 percent; and the remaining species in figure 6 comprise the final 1 percent. Species that are scarce may not be encountered with the extensive sampling strategy used for this inventory.

Figure 7 shows the number of live trees by species and elevation class. Elevation is closely correlated with variations in

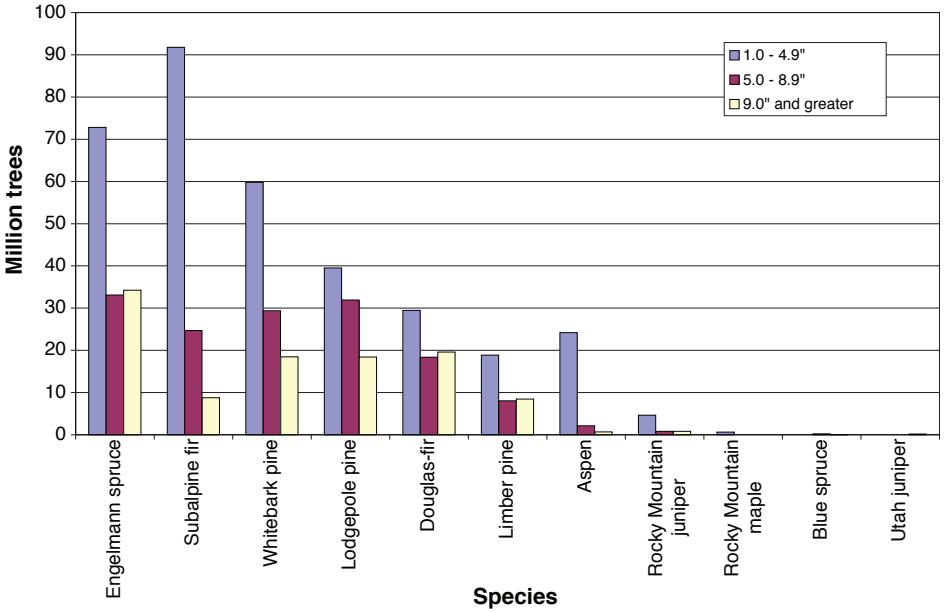


Figure 6—Number of live trees 1.0 inch in diameter and greater on forest land by species and diameter-size class, Shoshone National Forest, 1999.

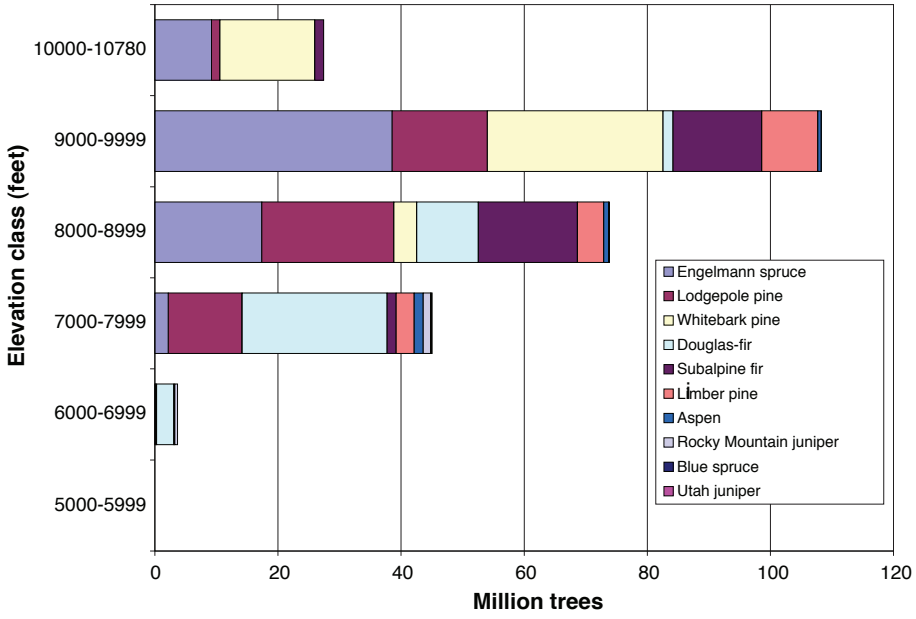
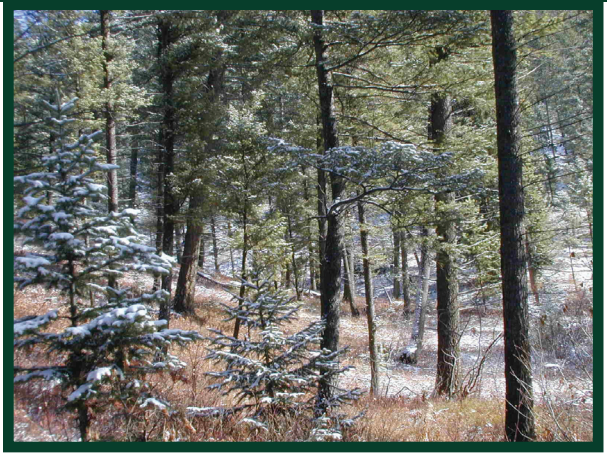


Figure 7—Number of live trees 5.0 inches diameter and greater on forest land by species and elevation class, Shoshone National Forest, 1999.

local climate. Precipitation generally increases with rising elevation, while temperature decreases. Aspect complicates this general rule; allowing relatively warmer- and dryer-site species to grow at higher elevations on south- and west-facing slopes. These factors have a profound effect on competition between tree species. The Shoshone National Forest displays some distinct elevation patterns in tree distribution: whitebark pine and Engelmann spruce do well at higher elevations, while Douglas-fir is a dominant species at lower elevations. Lodgepole pine and subalpine fir are most common at the middle elevations.



Number and weight of dead trees—Standing and down dead trees are important for wildlife and in fire ecology, as well as acting as nutrient sinks and erosion controls. Approximately 72 million standing dead trees (snags) and 52 million down dead trees 5.0 inches diameter and greater are on forest land on the Shoshone National Forest. If trees 1.0 inch diameter and greater are included there are 150 million standing dead trees and 98 million down dead trees.

Many animals are dependent upon standing dead trees, but the species, size, and density of these trees required for quality habitat vary depending on wildlife species. Large diameter dead trees are generally scarce relative to smaller trees. Considering standing dead trees 11.0 inches diameter or larger, an estimated 11.9 per acre occur on forest land. Of the very large dead trees (19.0 inches diameter or larger) there is an estimated 1.5 per acre. Engelmann spruce was the most common species sampled with snags in the 19-inch and larger category.

The amount of dead material is a component of forest fuel loads. On the Shoshone, about 11.8 million tons of standing dead trees and 7.8 million tons of down dead trees are on forest land. This estimate includes the merchantable bole and bark of trees 5.0 inches diameter and greater. Figure 8 shows the weight per acre of down dead trees by stand-size class for each of the forest types and all forest types combined. For all forest types combined, the large tree stand-size class has the highest weight at 6.3 tons per acre, followed by the saplings/seedlings class at 4.0 tons per acre. For all stand-size classes combined, the spruce-fir type has the highest weight at 10.4 tons per acre, followed by Engelmann spruce and lodgepole pine at 6.9 and 6.4 tons per acre, respectively. Some class breakdowns such as the spruce-fir nonstocked class may not be representative due to small sample size.

Stand age—Stand age for this report is estimated from core samples of live trees. The estimate is limited to trees with diameters that fall in a stand's designated stand-size class. Many other factors affect the number of sample trees available for determining stand age. In general, stand age for dense stands that contain more core sample trees is more representative than stand age for sparse stands that contain fewer.

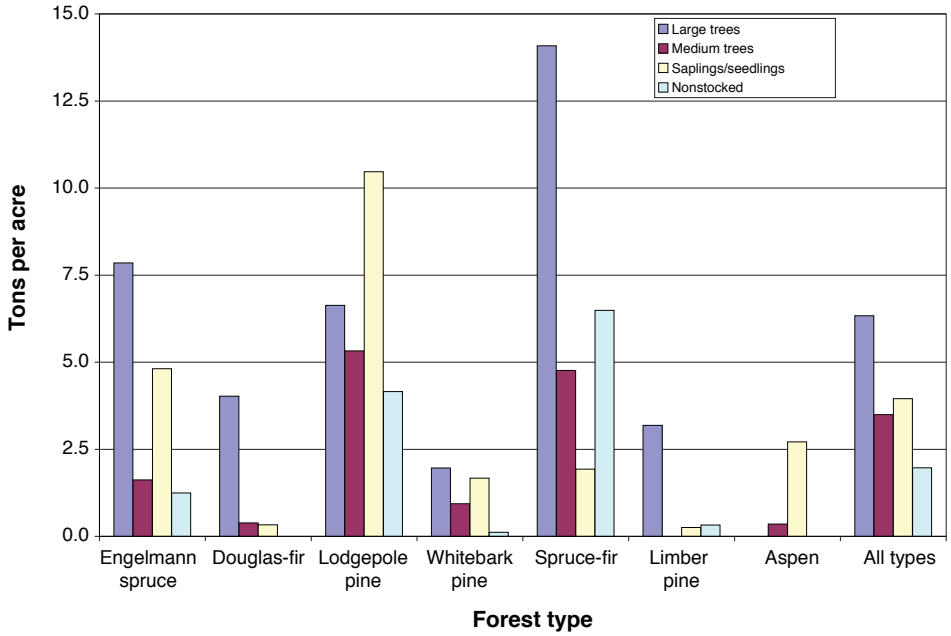


Figure 8—Weight of down dead trees 5.0 inches diameter and greater on forest land by forest type and stand-size class, Shoshone National Forest, 1999.

Figure 9 displays the percent of forest land area by forest type and stand-age class on the Shoshone National Forest. Stand age can indicate the duration since the last extensive disturbance of the forest overstory. This figure shows the 161- to 180-year class as the most common on the Forest, followed by the 141- to 160-year and 181- to 200-year age classes.

Wood volume, biomass, and basal area of live trees—Estimates of cubic-foot volume and basal area include all live trees 5.0 inches diameter and greater. Basal area is the cross-sectional area of a tree stem/bole (includes bark) at the point of diameter measurement. Biomass estimates include boles, bark, and branches of all live trees 1.0 inches diameter and greater. The net volume of wood on the Shoshone National Forest is estimated to be in excess of 3.2 billion cubic feet. Total biomass of wood is estimated at just over 57 million tons, and the total basal area is estimated to be about 147.4 million square feet. Table 1 is a breakdown of volume, biomass, and basal area by species.

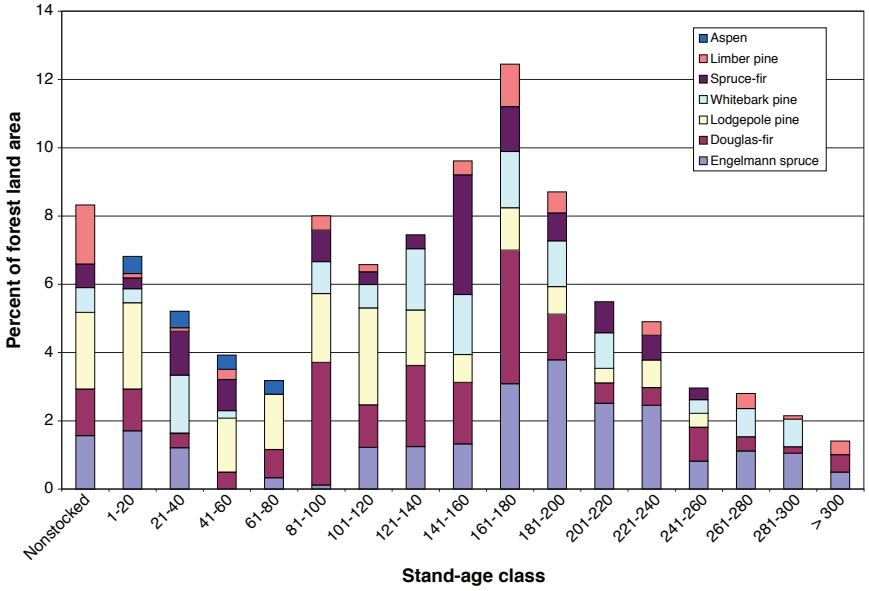


Figure 9—Percent of forest land area by forest type and stand-age class, Shoshone National Forest, 1999.

Table 1—Net volume, biomass, and basal area on forest land by species, Shoshone National Forest, 1999.

Species	Volume (≥5.0" dia.) (Million cubic feet)	Biomass (≥1.0" dia.) (Million tons)	Basal area (≥5.0" dia.) (Million square feet)
Engelmann spruce	1,189.6	18.6	47.9
Lodgepole pine	578.8	9.8	23.9
Douglas–fir	522.6	10.8	24.9
Whitebark pine	475.8	9.0	25.7
Subalpine fir	257.2	5.0	12.5
Limber pine	183.5	3.5	10.3
Aspen	13.8	0.3	1.0
Rocky Mountain juniper	3.4	†	0.9
Blue spruce	1.4	†	†
Utah juniper	0.8	†	0.2
Rocky Mountain maple[a]	—	†	—
Total (not exact due to rounding)	**3,227.0**	**57.1**	**147.4**

† – Less than 100,000
[a] No Rocky Mountain maples over 5.0 inches diameter were measured

Figure 10 displays the percent net cubic-foot volume of live trees by diameter class. Eighty-four percent of this volume is in the 9.0- to 10.9-inch and greater diameter class. By species, 90 percent of Engelmann spruce and 88 percent each of Douglas-fir and limber pine volume is in trees 9.0 inches diameter and greater. Common species with low percentages of volume in trees 9.0 inches diameter and larger include lodgepole pine and aspen at 73 percent each and subalpine fir at 67 percent.

Another way to look at wood volume is by forest type, for which estimates per acre can be computed along with basal area (table 2). These numbers include the many different species that can occur together in each forest type. The highest volume and basal area per acre on the Shoshone National Forest is in the Engelmann spruce forest type. Volume and basal area per acre for aspen may not be representative due to the small sample size. One characteristic of the mapped-plot design is that a plot may sample more than one condition (last two columns of table 2). A forest condition is generally defined as an area of relatively homogeneous vegetative cover that meets the criteria for forest land. Forest type is one of several attributes that define and separate conditions identified on the plot.

Stand density index—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.

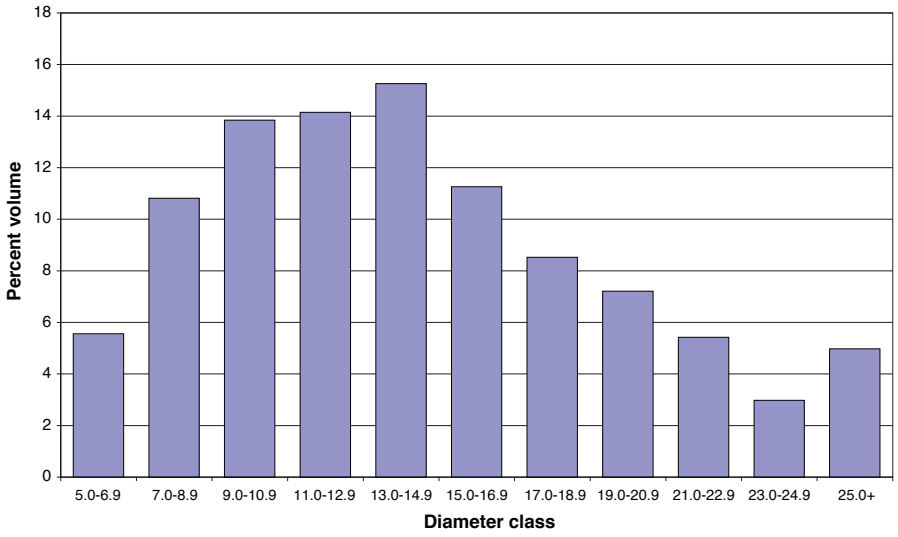


Figure 10—Percent of total net cubic-foot volume of live trees by diameter class, Shoshone National Forest, 1999.

Table 2—Net volume per acre, basal area per acre, number of conditions, and condition proportions on forest land by forest type, Shoshone National Forest, 1999.

Forest type	Net cubic-foot volume per acre	Basal area sq. ft. per acre	Number of conditions[a]	Condition proportions[b]
Engelmann spruce	3,175	131	67	55.7
Spruce–fir	2,633	108	34	29.5
Whitebark pine	1,947	108	41	33.8
Lodgepole pine	1,744	77	52	42.9
Limber pine	1,647	90	21	14.9
Douglas–fir	1,643	81	56	49.6
Aspen	298	21	5	4.2
Total			**276**	**230.6**

[a]Number of conditions by forest type that were sampled. These numbers are often greater than the total number of forested plots by forest type because a plot may sample more than one forest condition.
[b]Sum of the condition proportions of plots by forest type that were sampled. These numbers are often less than the total number of plots by forest type because of nonforest condition proportions (from plots containing both forest and nonforest conditions) that are not included here.

Stand density index (SDI), as developed by Reineke (1933), is a relative measure of quantifying the relationship between trees per acre and average stand diameter. The concept was developed for even-aged stands dominated by one or two related size classes (based on diameter and/or height), but can also be applied to uneven-aged stands composed of three or more size classes (Long and Daniel 1990; Shaw 2000). SDI is usually presented as a percentage of the maximum SDI for each forest type (Van Dyck 2002). Maximum SDI values for the forest types on the Shoshone National Forest were estimated using FIA plot data, and formulated specifically to match the procedure used by FIA to calculate SDI (Shaw 2000). Resulting percentages were grouped into four classes (fig. 11), whose thresholds have ecological and management significance. A site is considered to be fully occupied at 35 percent of SDI maximum, which marks the onset of competition-related stresses and slowed growth rates (Long 1985). Based on FIA sample data, 53 percent of all forest stands on the Shoshone National Forest are considered to be fully occupied.

Components of change: 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 live trees (5.0 inches diameter and greater) on all forest land on the Shoshone National Forest is estimated to be 40 million cubic feet, and net annual growth is 3.4 million cubic feet. Gross annual growth is compared to mortality for six high volume species in figure 12. Mortality on all forest land on the Shoshone National Forest is about 92 percent of gross annual growth. Douglas–fir has 83 percent more mortality than growth, while subalpine fir mortality exceeds growth by 17 percent. The leading causes of mortality in these two species were root diseases (58 percent of Douglas-fir mortality and 27 percent of subalpine fir mortality) and bark beetles (20 percent of Douglas-fir mortality and 28 percent of subalpine fir mortality).

Components of change: mortality—Field crews assess which trees have died in the past 5 years; these trees are

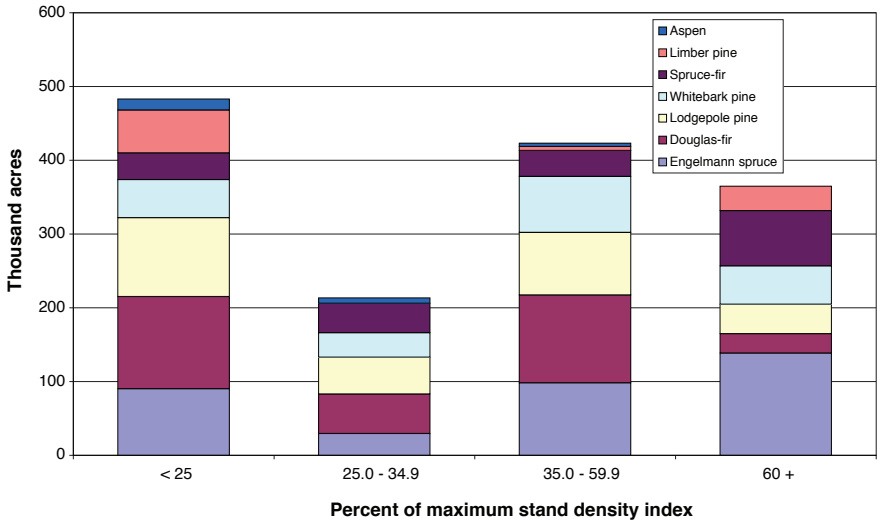


Figure 11—Area of forest land by forest type and percent stand density index, Shoshone National Forest,1999.

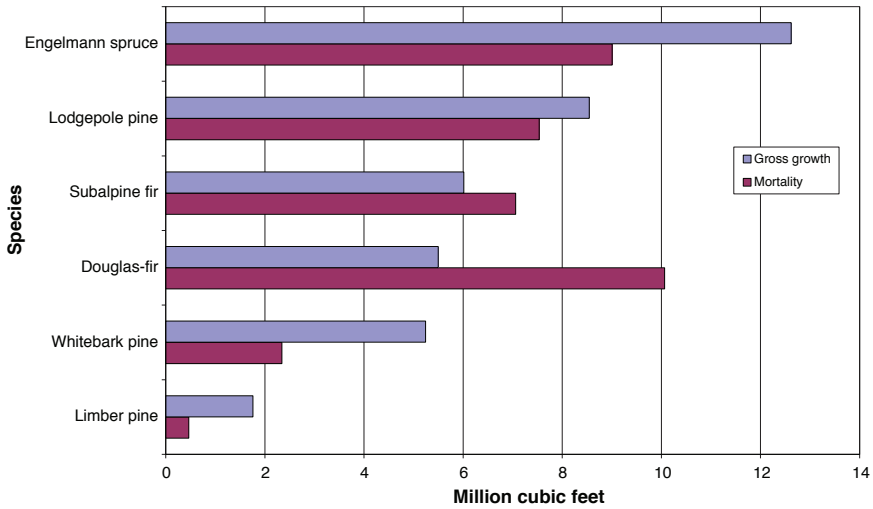


Figure 12—Gross annual growth of all live trees 5.0 inches diameter and greater compared to mortality for six high volume species on all forest land, Shoshone National Forest, 1998.

used to estimate an average annual mortality. Based on this estimate, in 1998, 36.6 million cubic feet of wood from live trees (5.0 inches diameter and greater) died on the Shoshone National Forest. About 49 percent of the mortality was caused by disease, 33 percent by insects, and 14 percent by weather. Less than 1 percent of the total mortality was fire–related. The following are the top five mortality species accounting for 98 percent of overall mortality: Douglas-fir (27 percent), Engelmann spruce (25 percent), lodgepole pine (21 percent), subalpine fir (19 percent), and whitebark pine (6 percent).

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. On each plot, field crews visually estimated crown canopy coverage for four plant groups – tree seedlings/saplings, shrubs, forbs, and graminoids (See USDA 1999 for details). Figure 13 shows the average percent cover of plant groups on forest land by forest type. Forest wide, subalpine fir is the most abundant understory seedling/sapling species, followed by Engelmann spruce. The most abundant understory shrubs are grouse whortleberry, common juniper, and big sagebrush. Aster species, heartleaf arnica, and Virginia strawberry are the most abundant forbs; and Idaho fescue, various sedge species, and Kentucky bluegrass are the most abundant understory graminoids on the forest.

Nonreserved timberland highlights of the Shoshone National Forest

Reserved lands are those that have been withdrawn from management for production of wood products, such as wilderness areas and National Parks. The nonreserved portion of the Shoshone contains nearly 47 percent of the forest land on the National Forest, all of which is designated as timberland. The nonreserved portion of the Shoshone is further divided by roadless designation. Currently, approximately 465,415 acres of nonreserved timberland, or 67 percent, is designated as roadless area, which limits management for wood products. There are 230 million live growing-stock trees on nonreserved timberland, 88 million in roaded portions and 142 million in roadless areas.

Forest type—Lodgepole pine is the most common forest type on nonreserved timberland on the Shoshone at 27 percent of nonreserved timberland, followed by Douglas-fir (23 percent) and Engelmann spruce (18 percent). On the roadless portion, Douglas-fir is the most common at 26 percent, followed by Engelmann spruce (22 percent) and lodgepole pine (20 percent). The lodgepole pine forest type is by far the most abundant on the roaded portion of the nonreserved timberland at 41 percent, followed by spruce-fir (18 percent) and Douglas-fir (17 percent).

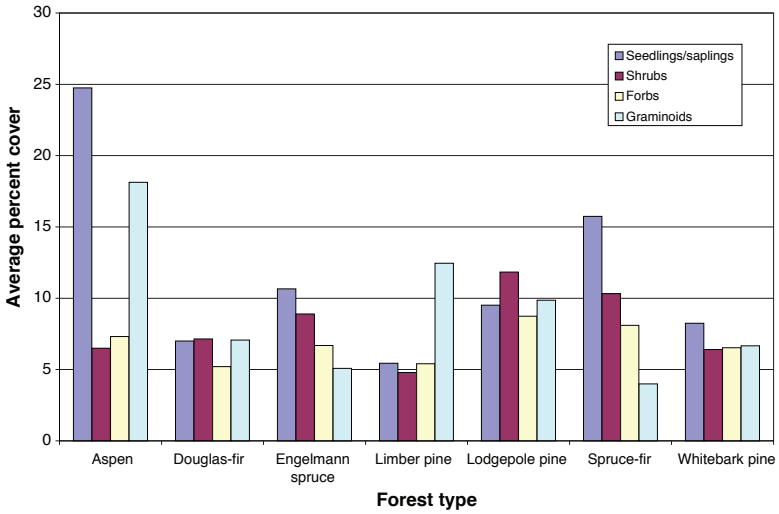


Figure 13—Average percent cover of trees (seedlings/saplings), shrubs, forbs, and graminoids on forest land by forest type, Shoshone National Forest, 1999.

Dead trees and fuels—There are approximately 33 million standing dead trees (snags) and 29 million down dead trees 5.0 inches diameter and greater on nonreserved timberland, with 8 million standing dead and 9 million down dead occurring on the roaded portion. Snags at least 11.0 inches diameter are found at densities of 11.0 per acre, with 8.5 per acre in the roaded portion of the forest. There are 0.8 snags per acre 19.0 inches diameter or greater, with 1.0 per acre in roaded areas. The merchantable bole and bark of all dead trees at least 5.0 inches in diameter on reserved timberland is equal to about 4.8 million tons in standing dead (1.2 million tons in the roaded portion) and 3.8 million tons in down dead (1.3 million tons in the roaded portion). The highest weights per acre of down dead trees on nonreserved timberland are similar for those on all forest land, both by stand-size class for all forest types combined (large tree class at 6.5 tons per acre and seedling/sapling class at 5.6 tons per acre) and by forest type for all size classes combined (spruce-fir type at 15.7 tons per acre, Engelmann spruce at 6.6 tons per acre, and lodgepole pine at 6.2 tons per acre).

Stand age—Stands are generally younger on nonreserved timberland than on all forest land, with the 81- to 100-year age class being the most common, followed by the 1- to 20-year age class. The 81- to 100-year age class is also the most common in the roadless areas, while the 141- to 160-year age class is the most common in the roaded portion. For several of the older age classes, no stands were encountered in the roaded portion of the forest, including the most common age class on all forest land (161- to 180-years).

Wood volume, biomass, and basal area of growing-stock trees—Table 3 displays a breakdown of net cubic volume, tons of wood biomass, and square foot basal area for growing-stock trees 5 inches diameter and greater by species on nonreserved timberland for the Shoshone. The total net cubic-foot volume is nearly 1.3 billion cubic feet, with 29 percent of the volume in the roaded areas. Engelmann spruce and lodgepole pine together account for 55 percent of the volume on nonreserved timberland. Total wood biomass is estimated at 21.2 million tons, 28 percent of it on the roaded portion of the forest. Fifty-one percent of the biomass on nonreserved timberland consists of Engelmann spruce and lodgepole pine. Total basal area is estimated at 58.9 million square feet, again 28 percent of it in roaded areas. Engelmann spruce and lodgepole pine comprise 51 percent of basal area on nonreserved timberland. About 25 percent each of the volume, biomass, and basal area of Engelmann spruce and about 38 percent of each for lodgepole pine are in roaded portions of the forest.

The net volume of sawtimber trees (sawtimber volume) on nonreserved timberland is estimated to be over 4.9 billion board feet (International ¼-inch rule). This includes all growing-stock trees 9.0 inches diameter and greater for softwoods, and 11.0 inches diameter and greater for hardwoods. Figure 14 illustrates the sawtimber volume on nonreserved timberland by diameter class and roadless designation. The 13.0 to 14.9-inch diameter class has the most volume at 18 percent, followed closely by the 11.0 to 12.9-inch class at 17 percent. Thirty-five percent of the total sawtimber volume on the Shoshone National Forest is from Engelmann spruce (8 percent in roaded areas), with 22 percent from lodgepole pine (8 percent in roaded areas), 17 percent from Douglas-fir (4 percent in roaded areas), and 10 percent from whitebark pine (3 percent in roaded areas). Overall, 27 percent of the sawtimber volume is on the roaded portion of the forest.

Stand density index—Forty-eight percent of the nonreserved timberland stands on the Shoshone National Forest are at 35 percent or more of SDI maximum, or considered to be fully occupied. Thirty-seven percent of lodgepole pine stands, 40 percent of Douglas-fir stands, and 63 percent of Engelmann spruce stands are fully occupied.

Components of change: growth and mortality—Gross annual growth of growing-stock trees on nonreserved timberland on the Shoshone is estimated at 18.0 million cubic feet, while mortality is an estimated 10.2 million cubic feet. Thirty-nine percent of the growth and 27 percent of the mortality occurred on the roaded portion of the nonreserved

Table 3—Net volume, biomass, and basal area of growing-stock trees 5 inches diameter and greater by species on nonreserved timberland, Shoshone National Forest, 1999.

Species	Volume (Million cubic feet)	Biomass (Million tons)	Basal area (Million square feet)
Engelmann spruce	366.2	5.5	15.7
Lodgepole pine	326.0	5.3	14.0
Douglas–fir	214.6	4.4	11.5
Whitebark pine	131.8	2.2	6.0
Limber pine	113.1	1.9	5.9
Subalpine fir	101.4	1.6	4.8
Aspen	13.3	0.2	0.8
Blue spruce	0.4	†	†
Total (not exact due to rounding)	**1,266.8**	**21.2**	**58.9**

† – Less than 100,000

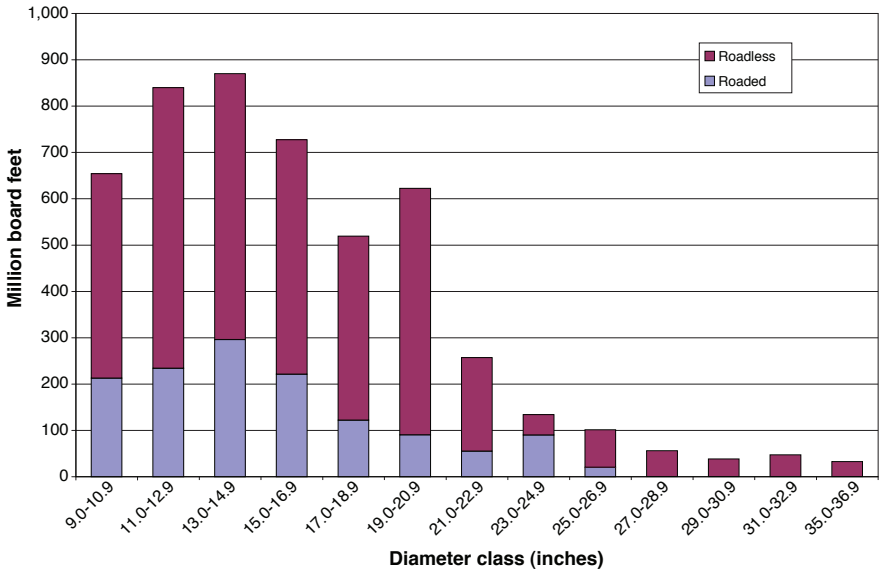


Figure 14—Sawtimber volume (International $^{1}/_{4}$-inch rule) on nonreserved timberland by diameter class and roadless designation, Shoshone National Forest, 1999.

timberland. Gross annual growth is compared to mortality of growing-stock trees for six high volume species in figure 15. Mortality is 57 percent of growth on nonreserved timberland, 68 percent on the roadless portion, and 39 percent on the roaded areas. Mortality volume was highest in lodgepole pine and subalpine fir, however mortality relative to growth for both species was higher in the roadless areas, resulting in negative net growth for both species in roadless areas. Both lodgepole pine and subalpine fir had positive net growth in roaded areas. The third highest mortality species, Douglas-fir, had no mortality in roaded areas. A major difference between growing-stock mortality in nonreserved timberland and live tree mortality in all forest land is the much lower mortality to growth on nonreserved timberland for the two highest mortality species on all forest land, Douglas-fir and Engelmann spruce.

The inventory methods

Forest Inventory and Analysis (FIA) provides a statistically-based sample of forest resources across all ownerships that can be used for planning and analyses at local, state, regional, and national levels. IWFIA uses a two-phase sampling procedure for all inventories. Phase one is based on a grid of sample points systematically located every 1,000 meters across all lands in a 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 the subsample of 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.

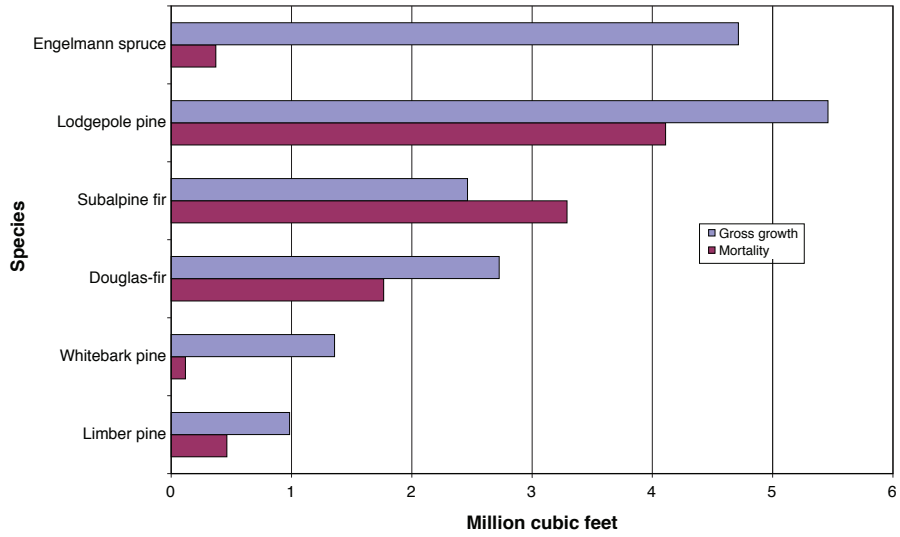


Figure 15 — Gross annual growth of growing-stock trees 5.0 inches diameter and greater compared to mortality for six high volume species on nonreserved timberland, Shoshone National Forest, 1998.

Phase two plots were sampled using the mapped-plot design (see next section). There were 391 field plots on the Shoshone National Forest, 14 of which were determined to be hazardous or inaccessible. A total of 209 field plots sampled only forest conditions, 34 sampled both forest and nonforest land conditions, 4 sampled both forest and water conditions (rivers, reservoirs, lakes, etc. at least 30 feet wide or 1 acre in area), 129 sampled only nonforest land conditions, and 1 sampled only water. A total of 276 forest conditions were sampled on 247 plots that contain 230.6 forest, 15.5 nonforest, and 0.9 water condition proportions.

About the mapped-plot design—The mapped-plot design was adopted by FIA nationwide by 1995. Its predetermined subplot layout uses boundary delineation, when necessary, to classify differing conditions. Most plots sample one forest condition, therefore delineating conditions is often not required.

Conditions were separated, or mapped, based on differences in any of five attributes: forest/nonforest, forest type, stand-size class, stand origin, and stand density. The condition proportion is the fraction of plot area sampled in each condition. The sum of all condition proportions for any given plot equals 1.00. Therefore, the number and relative size of plot conditions determines the weighted area used for sample expansion.

Standard errors—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. Forest-level estimates and percent standard errors by land class or type of trees for various attributes are presented in table 4. Standard errors for other estimates are available upon request (see "For further information" section on the inside back cover).

Table 4—Percent standard error for area estimates on total forest land and reserved timberland; and percent standard errors for estimates of net volume, net annual growth, and annual mortality for live trees on total forest land and growing-stock trees (5.0 inches d.b.h. and greater) on nonreserved timberland, Shoshone National Forest, 1999.

Land class or Type of trees	Attribute	Area or volume	Percent standard error
Total forest land (acres)	Area	1,484,703	±3.1
Total forest land (all trees cubic feet)	Volume	3,227,003,144	±6.0
	Growth	3,354,699	±234.9
	Mortality	36,630,258	±21.6
Nonreserved timberland (acres)	Area	692,815	±4.7
Nonreserved timberland (growing-stock trees cubic feet)	Volume	1,266,845,702	±9.1
	Growth	7,780,115	±34.7
	Mortality	10,181,130	±25.3

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For further information

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Selected data for this National Forest are part of a national database that houses information for much of the forest land in the United States. This database can be accessed on the Internet at the following web site:

http://fia.fs.fed.us/tools-data/

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.