



Forest Service

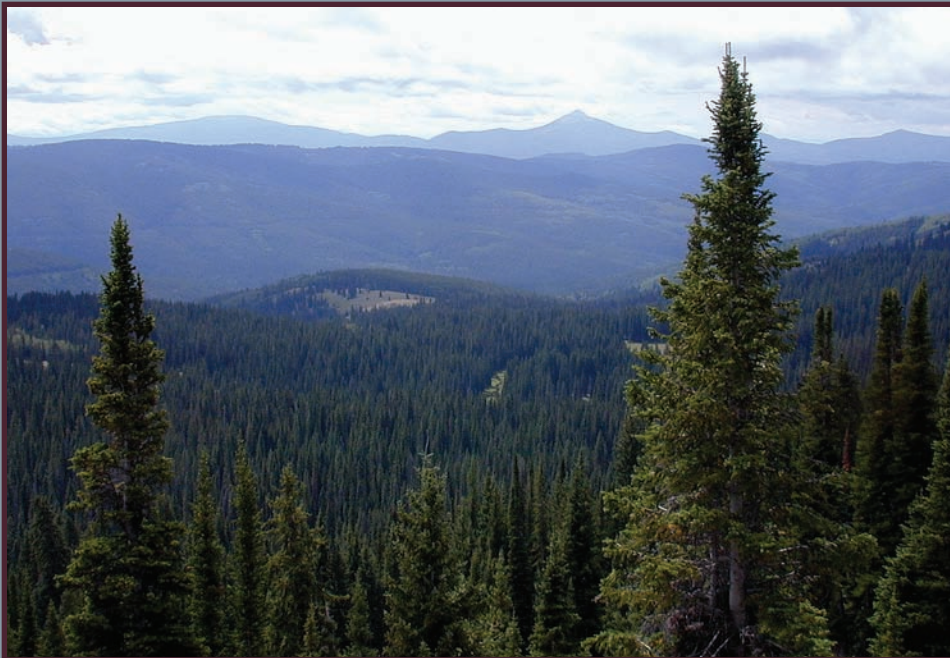
Rocky Mountain
Research Station

September 2008



Forest Resources of the Medicine Bow National Forest

Jim Steed



About the author

Jim Steed is an ecologist with the Interior West Forest Inventory and Analysis Program, Rocky Mountain Research Station in Ogden, Utah.

Contents

	Page
Description of the Medicine Bow National Forest	1
Forest land highlights of the Medicine Bow National Forest	2
Nonreserved timberland highlights of the Medicine Bow National Forest	9
The inventory methods.....	11
Documentation.....	13
For further information.....	13

Forest Resources of the Medicine Bow National Forest

Jim Steed

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 Medicine Bow National Forest using a nationally standardized mapped-plot design (for more details see “Inventory methods” section page 11). This report presents the highlights of this 2001 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 Medicine Bow 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 Medicine Bow National Forest

The Medicine Bow National Forest and Thunder Basin National Grassland in southern and eastern Wyoming and the adjacent Routt National Forest in northern Colorado were consolidated in 1995 under joint administration. This report does not include summaries of forest resources on the Routt National Forest. In Wyoming, the Medicine Bow-Routt National Forests administer 1,644,534 acres, which include 1,095,384 acres on the Medicine Bow National Forest and 549,150 acres on the Thunder Basin National Grassland (USDA 2000; 2002). Although the Thunder Basin National Grassland contains 25,781 acres of forest land, 77 percent of which is ponderosa pine timberland and 23 percent is juniper woodland (see definitions below), this report describes only the characteristics of the forest land sampled on the Medicine Bow National Forest (960,360 acres of forest land). This forest land acreage comprises 88 percent of the Medicine Bow while the remaining 12 percent is nonforest or water (fig. 1). 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 lodgepole pine and Douglas-fir), and woodland, where most trees often

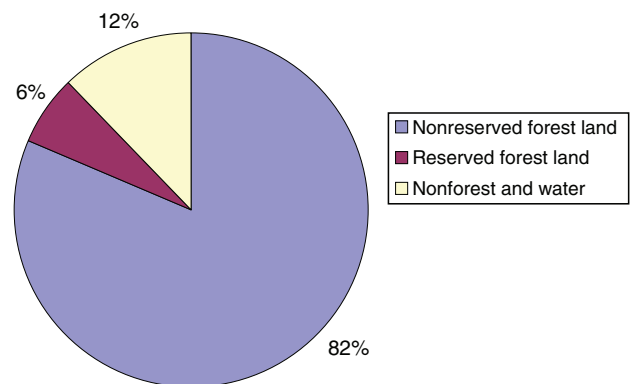


Figure 1—Percent area by land class and reserved status, Medicine Bow National Forest, 2001.

have a multi-stem growth form and are not typically used for industrial wood products (such as junipers). On the Medicine Bow, 98 percent of the total forest land is timberland while 2 percent is woodland.

Seven percent of the total area on the Medicine Bow National Forest is in reserved designation, meaning that it has been withdrawn from management for production of wood products. These reserved lands are located in the Encampment River, Huston Peak, Platte River, and Savage Run Wilderness areas. The first part of this report focuses on forest resources of all the forest land administered by the Medicine Bow National Forest, including reserved lands. A subsequent section will address nonreserved timberland and roadless areas.

Forest land highlights of the Medicine Bow 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.

When Engelmann spruce and subalpine fir occur together in a stand, and in combination they constitute the predominant live-tree stocking, forest type is classified as an Engelmann spruce type if Engelmann spruce individually is greater than or equal to 20 percent relative stocking, and subalpine fir is less than 20 percent relative stocking. For all other stands where Engelmann spruce and subalpine fir have plurality, the stand is classified as the spruce-fir type.

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

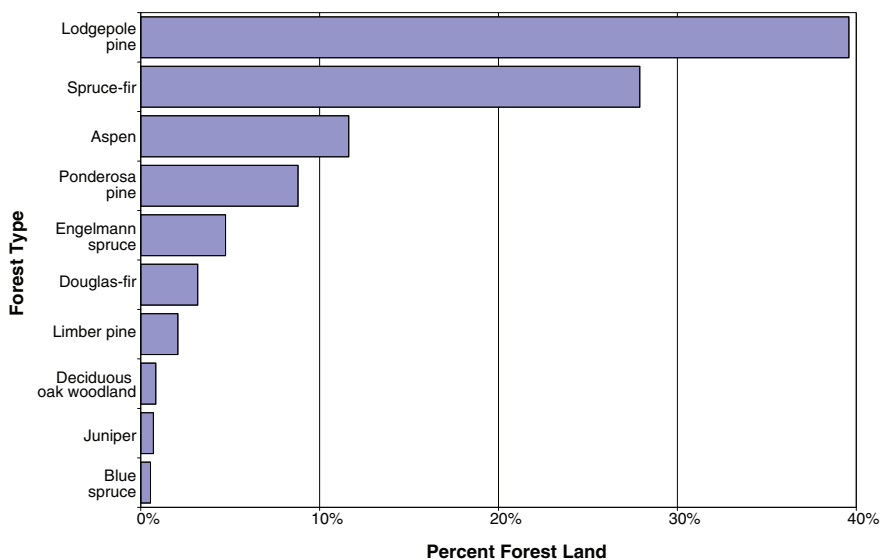


Figure 2—Percent of total forest land area by forest type, Medicine Bow National Forest, 2001.

presents the distribution of forest land area on the Medicine Bow National Forest by forest type. The lodgepole pine forest type is the most common at 40 percent, followed in abundance by spruce-fir at 28 percent. The aspen forest type comprises 12 percent of the forest land area, ponderosa pine 9 percent, Engelmann spruce 5 percent, Douglas-fir 3 percent, and limber pine 2 percent. Juniper, deciduous (Gambel) oak woodland, and blue spruce forest types each comprise 1 percent.

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

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 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; and saplings/seedlings comprise all trees under 5.0 inches diameter. Nonstocked stands 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 Medicine Bow National Forest by area and stand-size class. Forty-nine percent of the stands have a majority of stocking from large trees, while 3 percent are nonstocked.

Figure 5 shows the area of forest land by forest type and stand-size class on the Medicine Bow National Forest. The two most common forest types in the large tree class are the lodgepole pine and spruce-fir forest types, which together make up 62 percent of the large tree stands.

These forest types also make up 77 percent of the stands in the medium tree class. Some class breakdowns such as for the blue spruce, juniper, and deciduous oak woodland forest types may not be representative due to small sample sizes (two or fewer sampled conditions).

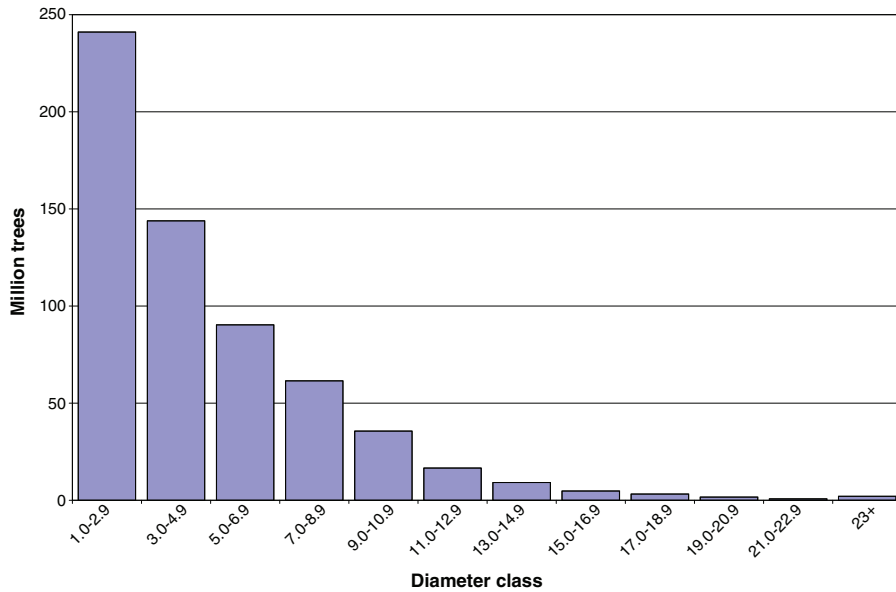


Figure 3—Number of live trees on forest land by 2-inch diameter class, Medicine Bow National Forest, 2001.

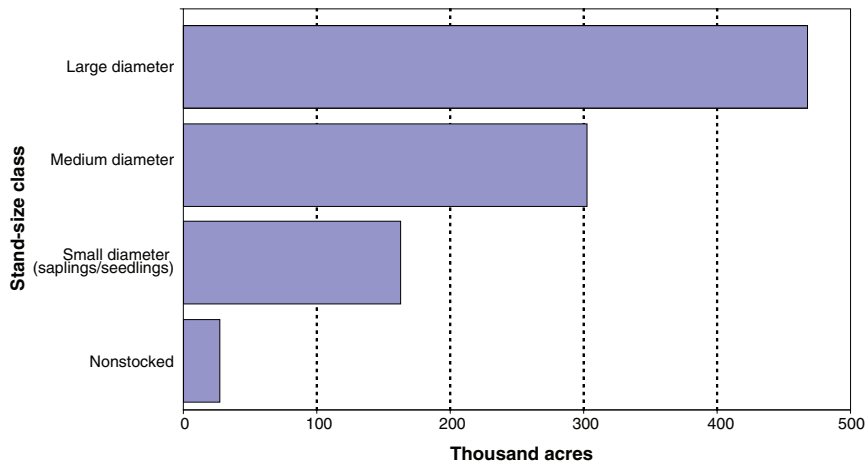


Figure 4—Forest land area by stand-size class, Medicine Bow National Forest, 2001. Large diameter includes softwoods 9.0" + and hardwoods 11.0" +; medium diameter includes softwoods 5.0-8.9" and hardwoods 5.0-10.9"; small diameter includes trees < 5.0".

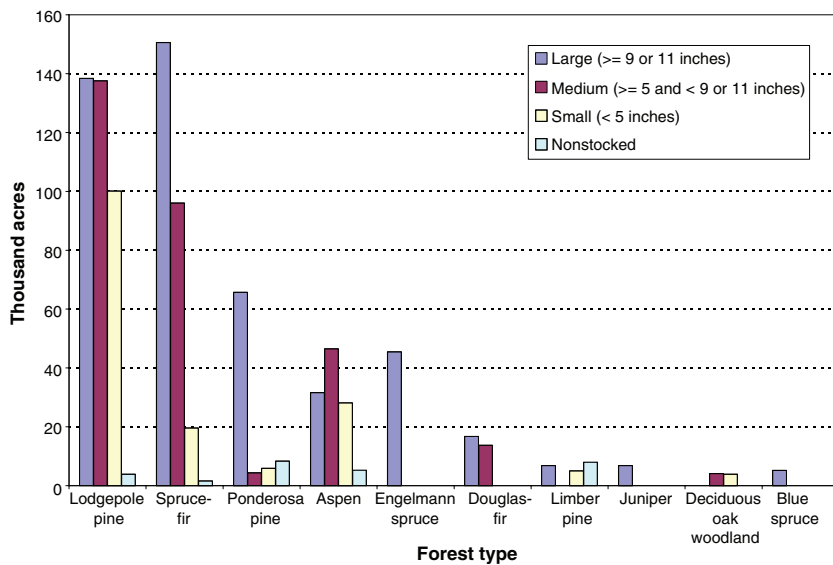


Figure 5—Area of forest land by forest type and stand-size class, Medicine Bow National Forest, 2001.

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 total number of live trees by species in three diameter-size classes. Sixty-three percent of all live trees on the Medicine Bow National Forest are from 1.0 to 4.9 inches diameter, 25 percent are from 5.0 to 8.9 inches diameter, and 12 percent are 9.0 inches diameter and greater. Lodgepole pine makes up 43 percent of the total number of trees; subalpine fir, 29 percent; Engelmann spruce and aspen 10 percent each; ponderosa pine, Douglas-fir, Gambel oak, and limber pine 2 percent each; 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 local climate. Precipitation generally increases with rising elevation, while temperature decreases. Aspect complicates this general rule; allowing relatively warmer- and

drier-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 Medicine Bow National Forest displays some distinct elevation patterns in tree distribution: Engelmann spruce and subalpine fir do well at higher elevations, while ponderosa pine, Gambel oak, Rocky Mountain juniper, and limber pine are most common at lower elevations. Lodgepole pine, Douglas-fir, and aspen are most common at the middle elevations.

Number and weight of dead trees—Standing and down dead trees are important to forest ecosystems because they provide wildlife habitat, function as nutrient sinks, protect the soil from erosion, and play an important role in fire ecology. Approximately 23 million standing dead trees (snags) and 34 million down dead trees 5.0 inches diameter and greater are on forest land on the Medicine Bow National Forest. If trees 1.0 inch diameter and greater are included there are 84 and 102 million, respectively. No standing or down dead trees were recorded in the blue spruce and juniper forest types.

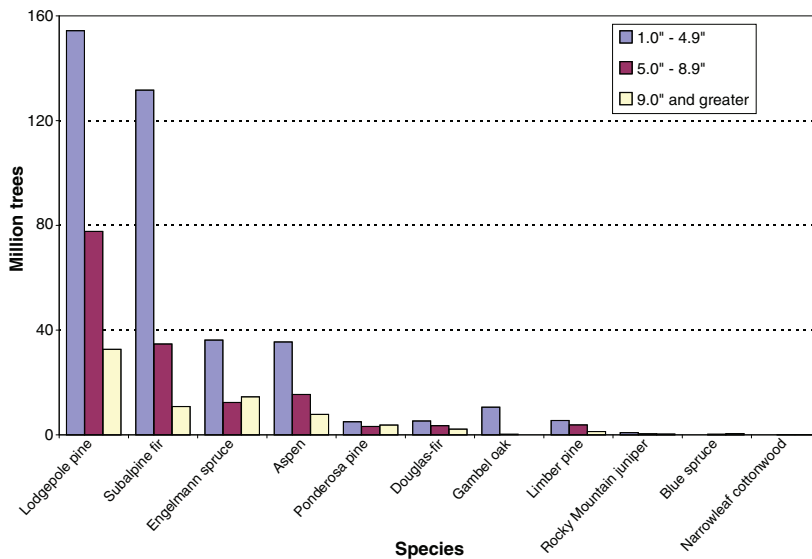


Figure 6—Number of live trees 1.0 inch diameter and greater on forest land by species and diameter class, Medicine Bow National Forest, 2001.

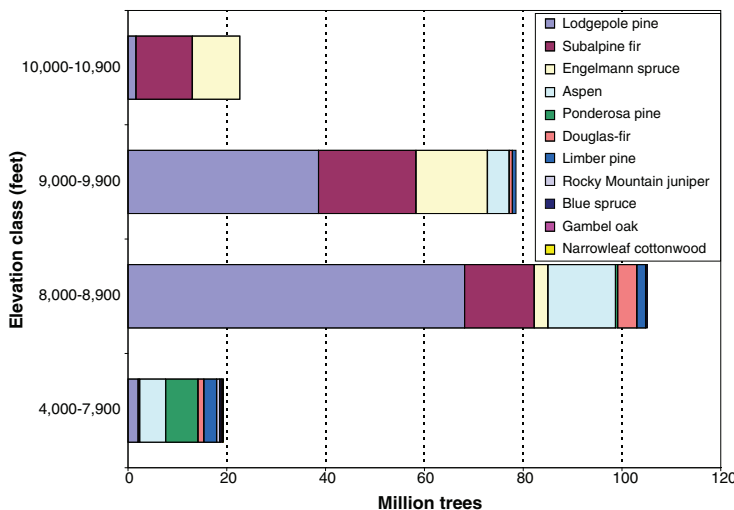


Figure 7—Number of live trees 5.0 inches diameter and greater on forest land by species and elevation class, Medicine Bow National Forest, 2001. Sample site elevation determined to the nearest 100 feet.

Many animals are dependent upon snags, but the species, size, and density of these trees required for quality habitat vary depending on wildlife species. Figure 8 shows the number of snags by forest type for three diameter classes. Of the total numbers of snags, 72 percent are between 1 inch and 4.9 inches diameter, with 62.9 snags per acre in this diameter range; and 23 percent are between 5 and 10.9 inches diameter, with 20.0 snags per acre. Snags 11 inches diameter or larger make up 5 percent of the total, with 4.4 snags per acre. Most of these large snags are found on spruce-fir (47 percent; 7.3 snags per acre), lodgepole pine (22 percent; 2.5 snags per acre), aspen (13 percent; 4.9 snags per acre), and ponderosa pine (8 percent; 4.2 snags per acre) forest types.

The amount of dead material is a component of forest fuel loads. On the Medicine Bow, about 3.0 million tons of standing dead trees and 4.7 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 9 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 medium tree stand-size class has the highest weight at 6.0 tons per acre, followed by the large tree stand-size class at 5.0 tons per acre, and the seedling/sapling stand-size class at 3.2 tons per acre. For all stand-size classes combined, the spruce-fir type has the highest weight at 9.2 tons per acre, followed by ponderosa pine at 5.5 tons per acre, and Engelmann spruce at 4.4 tons per acre. Several of the class breakdowns displayed in figure 9 may not be representative due to small sample sizes.

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.

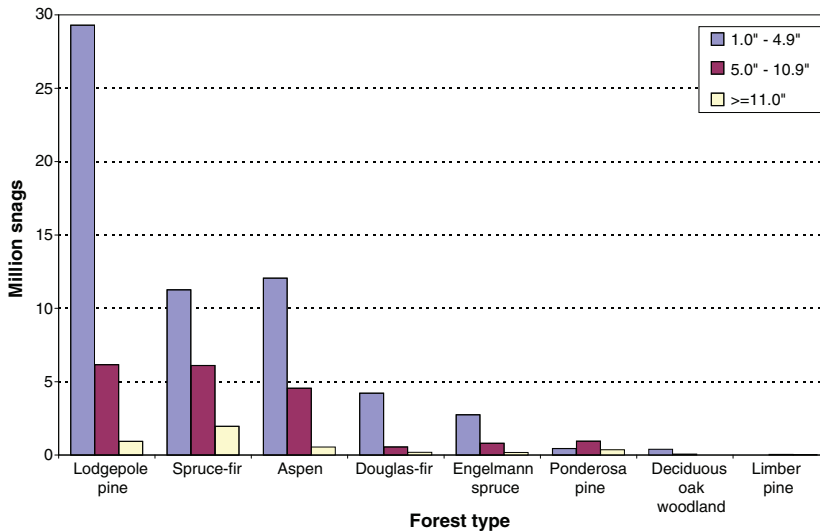


Figure 8—Number of standing dead trees 1.0 inch diameter and greater on forest land by forest type and diameter-size class, Medicine Bow National Forest, 2001.

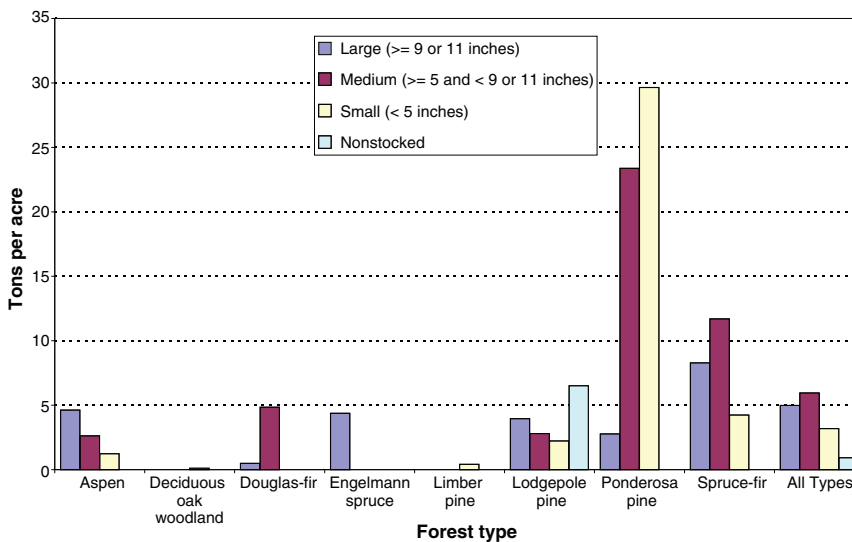


Figure 9—Weight of down dead trees 5.0 inches diameter and greater on forest land by forest type and stand-size class, Medicine Bow National Forest, 2001.

Figure 10 displays the percent of forest land area by forest type and stand-age class on the Medicine Bow National Forest. Stand age can indicate the duration since the last extensive disturbance of the forest overstory. This figure shows the 81- to 100-year class is the most common on the Forest, followed by the 101- to 120-year and 1- to 20-year age classes.

Wood volume, biomass, and basal area of live trees—
In general, estimates of volume, biomass, and basal area describe the amount of wood fiber in the forest. Each estimate summarizes different portions of a tree and is therefore more appropriate for various forest resource applications. For example, volume relates closely to wood as a product, biomass to forest or tree productivity, and basal area to forest or tree density. In table 1, volume represents

the amount of wood fiber in the merchantable bole of a tree, while biomass represents the amount of wood fiber in terms of oven-dry weight including bole, bark, and branches of a tree. Basal area estimates include the cross-sectional area of a tree stem/bole at the point where diameter is measured. Table 1 shows a breakdown by species of net volume and basal area for live trees 5 inches diameter and larger and biomass for live trees 1 inch diameter and larger on the Medicine Bow. Lodgepole pine makes up 43 percent of the volume, 44 percent of biomass, and 41 percent of basal area. Although substantially less abundant in numbers than subalpine fir (see fig. 6), Engelmann spruce accounts for a higher percentage of volume (27 versus 15 percent), biomass (24 versus 16 percent), and basal area (23 versus 17 percent) because it has more stems in the larger diameter classes.

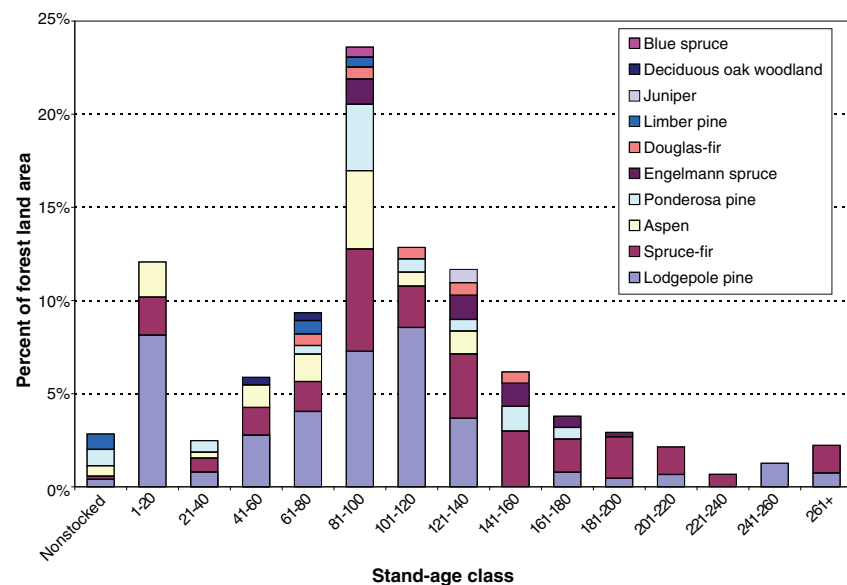


Figure 11 displays the percent net cubic-foot volume of live trees by diameter class. Seventy-three percent of this volume is in trees 9.0 inches and greater. By species, 96 percent of blue spruce, 93 percent of Engelmann spruce, and 89 percent of ponderosa pine volume is in trees 9.0 inches diameter and greater. Common species with the lowest percent volume in trees 9.0 inches diameter and larger include lodgepole pine and limber pine at 63 percent each and subalpine fir at 65 percent.

Figure 10—Percent of forest land area by forest type and stand-age class, Medicine Bow National Forest, 2001.

Table 1—Net volume, biomass, and basal area on forest land by species, Medicine Bow National Forest, 2001.

Species	Volume ≥ 5" dia. (Million cubic ft.)	Biomass ≥ 1" dia. (Million tons)	Basal area ≥ 5" dia. (Million square ft.)
Lodgepole pine	1,019.6	18.4	43.3
Engelmann spruce	645.1	9.9	24.1
Subalpine fir	345.7	6.9	17.7
Aspen	178.4	3.2	9.6
Ponderosa pine	76.3	1.6	4.7
Douglas-fir	48.6	1.1	2.8
Limber pine	24.8	0.6	1.9
Blue Spruce	19.0	0.3	0.7
Rocky Mountain juniper	2.0	†	0.4
Gambel oak	0.4	†	0.1
Narrowleaf cottonwood	0.2	†	†
Total (not exact due to rounding)	2,360.0	42.1	105.2

† – Less than 100,000

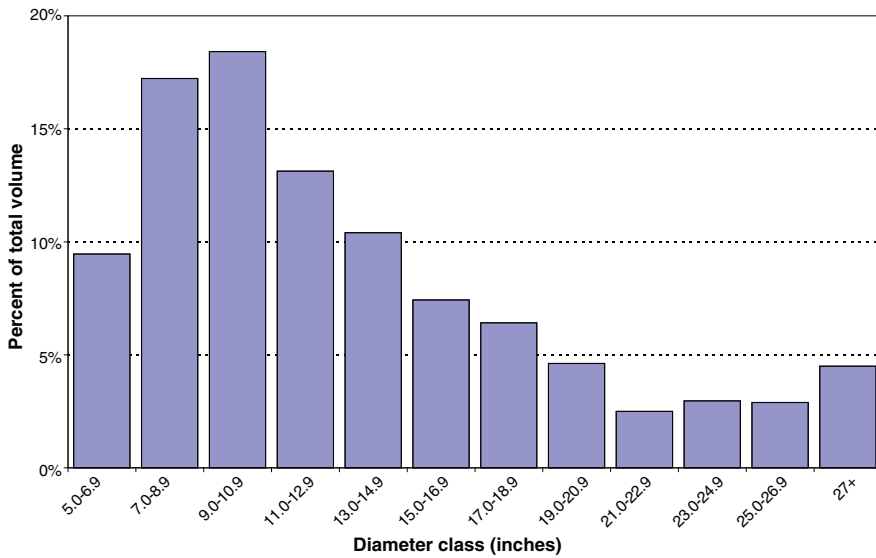


Figure 11—Percent net cubic foot volume of live trees on forest land by diameter class, Medicine Bow National Forest, 2001.

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, biomass, and basal area per acre on the Medicine Bow National Forest is in the Engelmann spruce forest type, followed by spruce-fir and blue spruce. Several of the type summaries listed in table 2 may not be representative due to small sample sizes. 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 (stand) is generally defined as an area of relatively homogeneous vegetative cover that meets the criteria for forest land. Forest type, along with other attributes such as stand size, origin, and density, defines and separates 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. Stand density index (SDI), as developed by Reineke (1933), is a relative measure of quantifying the relationship between number of 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 Medicine Bow National Forest were estimated using FIA plot data, and formulated specifically to match the procedure used by FIA to calculate SDI (Shaw 2000).

Table 2—Net volume per acre, biomass per acre, basal area per acre, number of conditions, and condition proportions on forest land by forest type, Medicine Bow National Forest, 2001.

Forest type	Volume (cubic feet per acre)	Biomass (tons per acre)	Basal area (sq. ft. per acre)	Number of conditions ^a	Condition proportions ^b
Engelmann spruce	6,267	97.6	233	8	7.3
Spruce-fir	3,012	52.3	131	43	39.3
Blue spruce	2,690	39.8	101	1	1.0
Lodgepole pine	2,284	42.3	100	74	57.8
Aspen	2,127	37.7	105	28	17.3
Douglas-fir	1,834	39.7	113	7	5.0
Ponderosa pine	891	18.7	55	14	13.0
Limber pine	699	15.6	40	4	3.2
Juniper	274	5.0	40	1	1.0
Deciduous woodland oak	85	6.8	13	2	1.5
Total	2,457	43.9	110	182	*146.5

^a Number of conditions by forest type that were sampled. This sum of numbers is often greater than the total number of plots because a plot may sample more than one forest condition.

^b Sum of the condition proportions of plots by forest type that were sampled. The sum of these numbers is often less than the total number of plots because of nonforest condition proportions (from plots containing both forest and nonforest conditions) that are not included here.

*Number does not add to total due to rounding.

Resulting percentages were grouped into four classes (fig. 12), 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, 67 percent of all forest stands on the Medicine Bow 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 Medicine

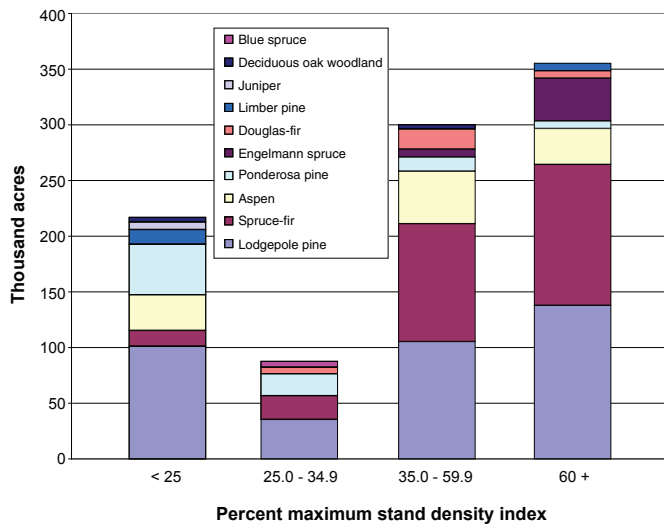


Figure 12—Area of forest land by forest type and percent stand density index, Medicine Bow National Forest, 2001.

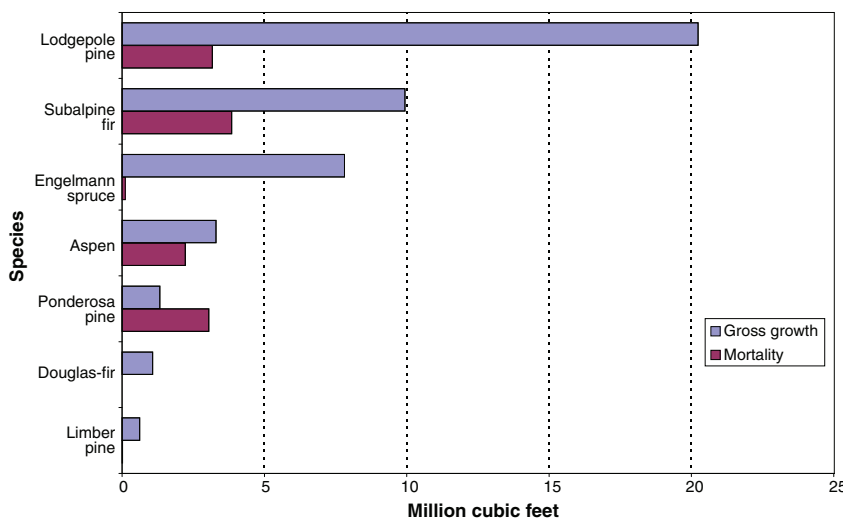


Figure 13—Gross annual growth of live trees 5.0 inches diameter and greater compared to mortality for seven high-volume species on all forest land, Medicine Bow National Forest, 2001.

Bow National Forest is estimated to be 45 million cubic feet, and net annual growth is 32 million cubic feet. Gross annual growth is compared to mortality in figure 13. Mortality of all forest land on the Medicine Bow National Forest is about 28 percent of gross annual growth. Mortality is only about 1.4 percent of gross annual growth for Engelmann spruce, 15.7 percent for lodgepole pine, and 38.8 percent and subalpine fir, while mortality exceeds growth by 130 percent for ponderosa pine. The leading causes of mortality in this species were insects (51 percent of mortality) and unknown causes (45 percent of mortality).

Components of change: mortality—Field crews assess which trees have died in the past 5 years; these trees are used to estimate an average annual mortality. Based on this estimate, in 2000, 12.4 million cubic feet of wood from live trees (5.0 inches diameter and greater) died on the Medicine Bow National Forest. About 37 percent of the mortality was caused by disease, 24 percent by insects, 11 percent by weather, and 26 percent by unknown causes. Sixty-three percent of disease mortality was due to root disease, while 97 percent of insect mortality was due to bark beetles. No fire-related mortality was recorded. The following are the top four mortality species accounting for about 99 percent of overall mortality: subalpine fir (31 percent), lodgepole pine (26 percent), ponderosa pine (25 percent), and aspen (18 percent).

Understory vegetation—Understory vegetation provides wildlife forage and cover, contributes to forest fuel load, and can be an indicator 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 14 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 lodgepole pine and aspen. The most abundant understory shrubs are grouse whortleberry, common juniper, and big sagebrush. Lupine species, aster species, and heartleaf arnica are the most abundant forbs; and Geyer’s sedge, pinegrass, Ross’ sedge, and other sedge species are the most abundant understory graminoids on the forest.

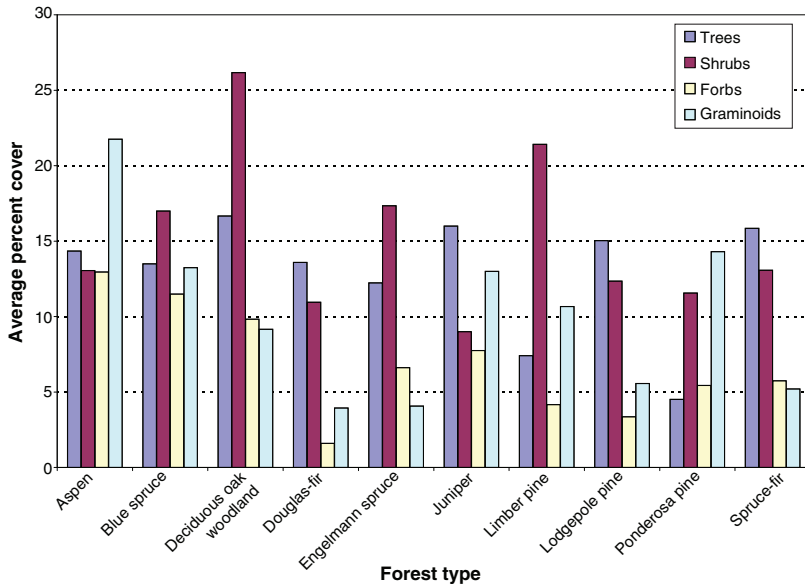


Figure 14—Average percent cover of trees (seedlings/saplings), shrubs, forbs, and graminoids on forest land by forest type, Medicine Bow National Forest, 2001.

timberland versus 3.2 tons per acre on all forest land, weights per acre of down dead trees on nonreserved timberland are generally similar for those on all forest land, both for all forest types combined (medium tree class at 6.1 tons per acre, and large tree class at 5.2 tons per acre) and for all size classes combined (spruce-fir type at 9.8 tons per acre, ponderosa pine at 5.5 tons per acre, and Engelmann spruce at 4.0 tons per acre).

Nonreserved timberland highlights of the Medicine Bow 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 Medicine Bow contains nearly 93 percent of the forest land on the National Forest, 98 percent of which is designated as timberland. The nonreserved portion of the Medicine Bow is further divided by roadless designation. Currently, approximately 288,806 acres of nonreserved timberland, or 33 percent, is designated as roadless area, which limits management for wood products.

Forest type—Lodgepole pine the most common forest type on nonreserved timberland on the Medicine Bow at 40 percent, followed by spruce-fir (28 percent) and aspen (12 percent). On the roadless portion, lodgepole pine is the most common at 39 percent, followed by spruce-fir (27 percent) and ponderosa pine (12 percent). The lodgepole pine forest type is the most abundant on the roaded portion of the nonreserved timberland at 41 percent, followed by spruce-fir (28 percent) and aspen (14 percent).

Dead trees and fuels—There are approximately 22 million standing dead trees and 32 million down dead trees 5.0 inches diameter and greater on nonreserved timberland, with 14 million standing dead and 22 million down dead occurring on the roaded portion. The merchantable bole and bark of these trees is equal to about 2.7 million tons in standing dead (1.8 million tons in the roaded portion) and 4.4 million tons in down dead (2.9 million tons in the roaded portion). With the exception of the small tree (seedling/sapling) class at 20.2 tons per acre on nonreserved

Stand age—Stand ages are generally similar on non-reserved timberland compared to all forest land, with the 81- to 100-year age class being the most common, followed by the 101- to 120-year age class, and the 1- to 20-year age class (figure 15). The 81- to 100-year age class is also the most common in both the roadless areas and roaded portion. However, the percentage of stands in the 1- to 20-year age class is substantially higher in the roaded portion compared to the roadless areas.



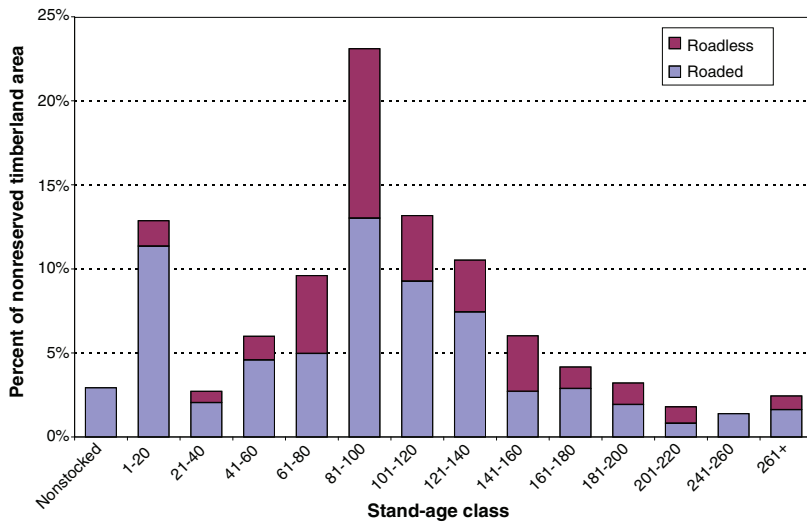


Figure 15—Percent of nonreserved timberland by roadless designation and stand-age class, Medicine Bow National Forest, 2001.

all growing-stock trees 9.0 inches diameter and greater for softwoods, and 11.0 inches diameter and greater for hardwoods. Figure 16 illustrates the sawtimber volume on non-reserved timberland by diameter class and roadless designation. The 9.0 to 10.9-inch diameter class has the most volume at 19 percent, followed closely by the 11.0 to 12.9-inch class at 18 percent. Thirty-seven percent of the total sawtimber volume on the Medicine Bow National Forest is from Engelmann spruce (15 percent in roaded areas), with 36 percent from lodgepole pine (23 percent in roaded areas), and 13 percent from subalpine fir (7 percent in roaded areas). Overall, 52 percent of the sawtimber volume is on the roaded portion of the forest.

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 Medicine Bow. The total net cubic-foot volume is nearly 2.1 billion cubic feet, with 57 percent of the volume in the roaded areas. Lodgepole pine and Engelmann spruce together account for 69 percent of the volume. Total wood biomass is estimated at 33.4 million tons, 58 percent of it on the roaded portion of the forest. Sixty-eight percent of the biomass consists of lodgepole pine and Engelmann spruce. Total basal area is estimated at 92.7 million square feet, again 58 percent of it in roaded areas. Lodgepole pine and Engelmann spruce comprise 64 percent of basal area on nonreserved timberland. Roughly 65 percent each of the growing stock volume, biomass, and basal area of lodgepole pine and about 45 percent of Engelmann spruce on nonreserved timberland are in roaded portions of the forest.

Stand density index—Sixty-seven percent of the non-reserved timberland stands on the Medicine Bow National Forest are at 35 percent or more of SDI maximum, or considered to be fully occupied. One-hundred percent of Engelmann spruce stands, 86 percent of spruce-fir stands, 69 percent of Douglas-fir stands, 61 percent of lodgepole pine stands, and 70 percent of aspen stands are fully occupied, while only 23 percent of ponderosa pine stands and 34 percent of limber pine stands are fully occupied.

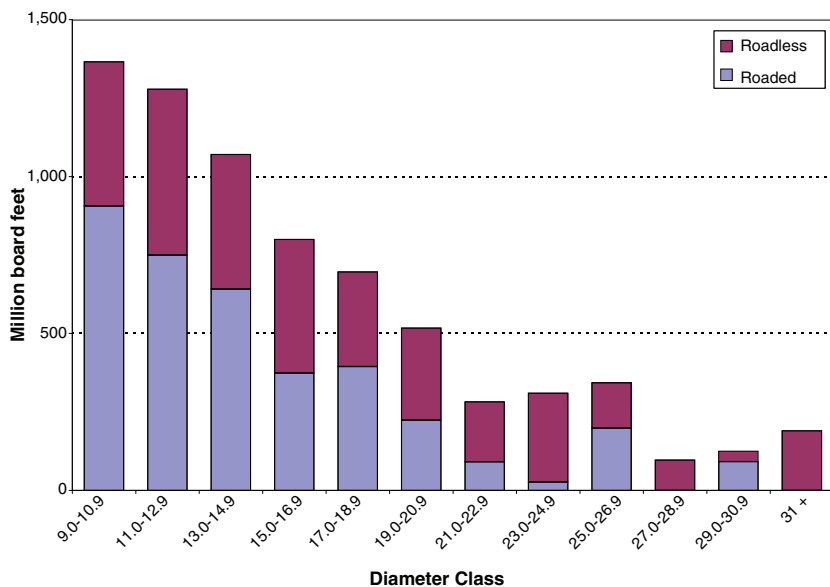
The net volume of sawtimber trees (sawtimber volume) on nonreserved timberland is estimated to be nearly 7.1 billion board feet (International 1/4-inch rule). This includes

Components of change: growth and mortality—Gross annual growth of growing-stock trees on nonreserved timberland on the Medicine Bow is estimated at 39.0 million cubic feet, while mortality is an estimated 10.8 million cubic feet. Sixty-four percent of the growth and 87 percent of the mortality occurred on the roaded portion of the non-reserved timberland. Gross annual growth is compared to

Table 3—Net volume, biomass, and basal area of growing-stock trees 5 inches diameter and greater per acre on nonreserved timberland by forest type, Medicine Bow National Forest, 2001.

Species	Volume (Million cubic feet)	Biomass (Million tons)	Basal area (Million square feet)
Lodgepole pine	910.5	14.9	38.8
Engelmann spruce	523.2	7.7	20.2
Subalpine fir	307.9	4.9	15.8
Aspen	172.7	2.9	9.0
Ponderosa pine	75.4	1.5	4.6
Douglas-fir	31.5	0.7	1.8
Limber pine	22.8	0.4	1.7
Blue spruce	19.0	0.3	0.7
Total (not exact due to rounding)	2,062.8	33.4	92.7

mortality for each species in figure 17. Mortality is 28 percent of growth on nonreserved timberland, 10 percent on the roadless portion, and 37 percent on the roaded areas. Mortality volume was highest in subalpine fir, followed by ponderosa pine, aspen, and lodgepole pine, with these four species accounting for 99 percent of all mortality on nonreserved timberland. Mortality relative to growth on all nonreserved timberland and on roaded areas only was highest in ponderosa pine, which had negative net growth, followed by aspen, subalpine fir, and lodgepole pine. However, on roadless areas mortality relative to growth was highest in subalpine fir, followed by aspen, ponderosa pine, and lodgepole pine. A major difference between growing-stock mortality in nonreserved timberland and live tree mortality in all forest land is much lower mortality of lodgepole pine on nonreserved timberland.



are assigned to each stratum based on the proportion of phase one points in that stratum.

Phase two plots were sampled using the mapped-plot design (see next section). There were 170 field plots on the Medicine Bow National Forest, 1 of which was determined to be entirely hazardous or inaccessible. A total of 133 field plots sampled only forest conditions, 24 sampled both forest and nonforest conditions, and 12 sampled only nonforest conditions. A total of 182 forest conditions were sampled on 157 plots that contain 146.5 forest and 10.5 nonforest condition proportions.

Figure 16—Net volume of sawtimber trees (International 1/4" rule) on nonreserved timberland by 2-inch diameter class and roadless designation on Medicine Bow National Forest, 2001.

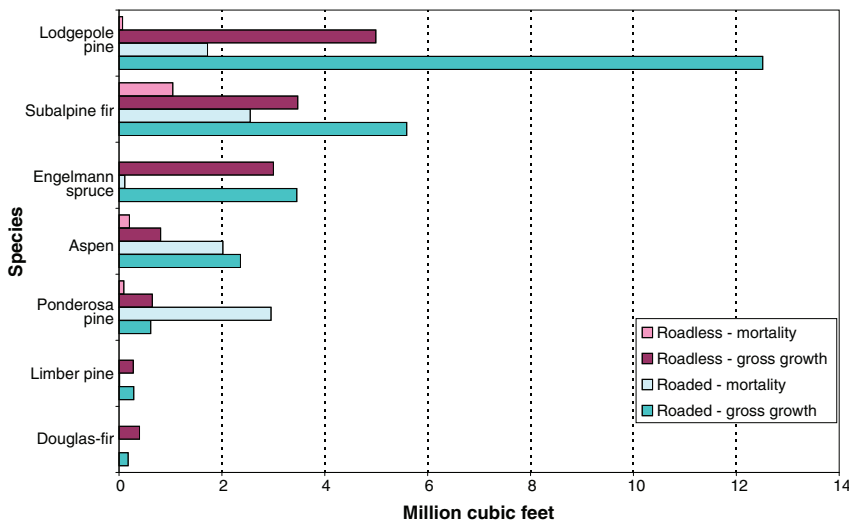


Figure 17—Gross annual growth of growing-stock trees 5.0 inches diameter and greater compared to mortality for seven high-volume species on nonreserved timberland, Medicine Bow National Forest, 2001.

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.

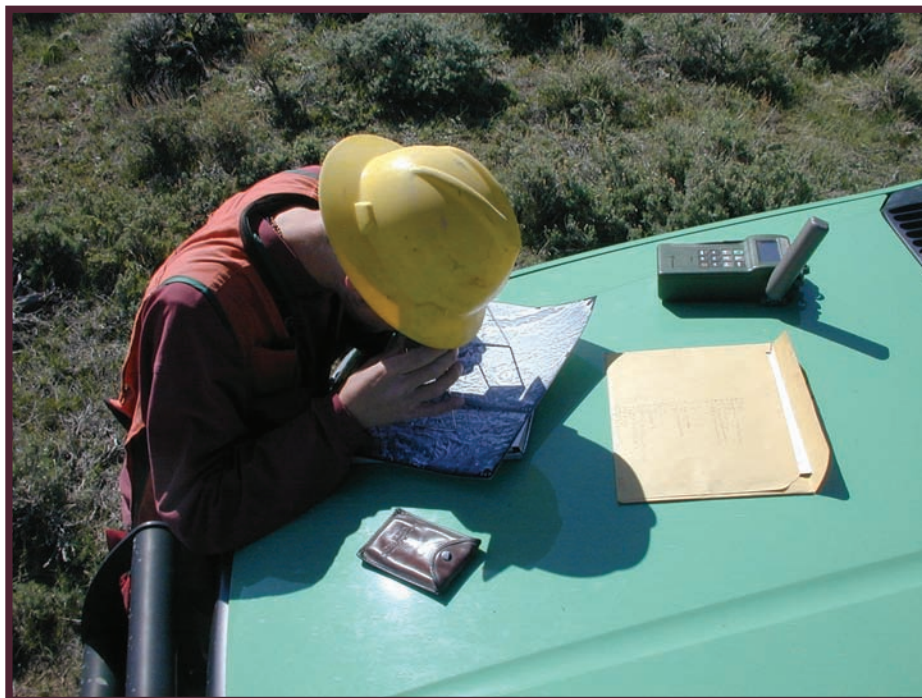
Conditions were separated, or mapped, based on differences in any of five attributes: forest/nonforest, forest type, stand-size class, stand origin, and stand density. The condition proportion is the fraction of plot area sampled in each condition. The sum of all condition proportions for any given plot 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 errors for area estimates on total forest land and nonreserved timberland, and percent standard errors for estimates of net volume, net annual growth, and annual mortality for both live and growing-stock trees (5.0 inches d.b.h. and greater) on total forest land and nonreserved timberland, Medicine Bow National Forest, 2001.

Land class or type of trees	Attribute	Area or volume	Percent standard error
Total forest land (acres)	Area	960,360	±2.2
Total forest land (all trees cubic feet)	Volume	2,360,030,014	±6.7
	Growth	32,370,886	±12.8
	Mortality	12,417,489	±26.7
Nonreserved timberland (acres)	Area	875,234	±2.5
Nonreserved timberland (growing-stock trees cubic feet)	Volume	2,062,808,915	±6.9
	Growth	28,247,774	±14.3
	Mortality	10,775,626	±29.7



Documentation

- Long, James N. 1985. A practical approach to density management. *The Forestry Chronicle* 61:23-27.
- Long, James N., Daniel, Theodore W. 1990. Assessment of growing-stock in uneven-aged stands. *Western Journal of Applied Forestry* 5(3):93-96.
- Reineke, L.H. 1933. Perfecting a stand density index for even-aged forests. *J. Agric. Res.* 46:637-638.
- Shaw, John D. 2000. Application of Stand Density Index to Irregularly Structured Stands. *Western Journal of Applied Forestry* 15(1):40-42.
- U.S. Department of Agriculture, Forest Service. 1999. Forest Survey field procedures, 1999. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station.
- U.S. Department of Agriculture, Forest Service. 2000. Land Areas of the National Forest System. FS-383. As of September 1999.
- U.S. Department of Agriculture, Forest Service. 2002. Periodic mapped-plot design inventory terminology. [Online]. Available: <http://www.fs.fed.us/rm/ogden/publications/wyoming.shtml> (also available on file at: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT).
- Van Dyck, M.G. 2002. Keyword reference guide to the Forest Vegetation Simulator. WO-Forest Management Service Center, Fort Collins, CO.

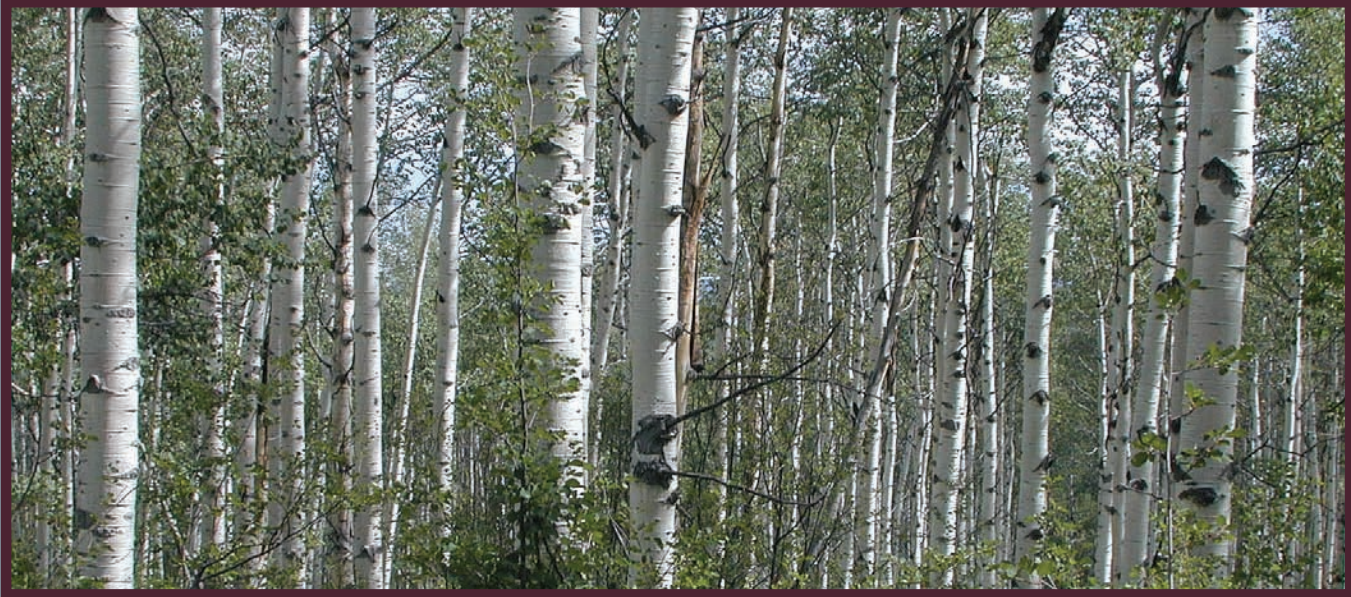
For further information

Interior West Forest Inventory and Analysis Program (IWFIA)
Rocky Mountain Research Station
c/o Program Manager
507 25th Street, Ogden, UT 84401
Phone: 801-625-5388
FAX: 801-625-5723
World Wide Web: <http://www.fs.fed.us/rm/ogden>

Medicine Bow-Routt National Forests
Thunder Basin National Grassland
Supervisor's Office
2468 Jackson Street
Laramie, Wyoming 82070-6535
Phone: 307-745-2300
FAX: 307-745-2398
World Wide Web: <http://www.fs.fed.us/r2/mbr>

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (800) 795-3272 or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.