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# THE FOREST RESOURCE OF COLORADO

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## COVER PHOTO

Timber and recreation resources on the San Juan National Forest in southern Colorado. The forest in the foreground is a sawtimber stand with Douglas-fir as the principal species. Part of the 239,000 acres of the San Juan Primitive Area appears in the mountains in the background.

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# THE FOREST RESOURCE OF COLORADO

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## FOREWORD

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This report is concerned primarily with the timber resource. However, because practically none of the forest area is managed for timber alone, the report also briefly describes demands for associated forest values — water, recreation, wildlife, and forage.

Timber inventory data in the report are from the first comprehensive survey of Colorado's forest resources. The survey was conducted as part of the continuing nationwide Forest Survey. Fieldwork started in 1956 and was completed in 1959. The survey was done on a cooperative basis by the Intermountain Forest and Range Experiment Station, Ogden, Utah, the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, and the Rocky Mountain Region, Denver, Colorado. Field sampling and compilation were done by the Intermountain Station, and mapping by the Rocky Mountain Region.

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# STATISTICAL HIGHLIGHTS<sup>1</sup>

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## FOREST AREA

- Colorado has 22.6 million acres of forest land. This is about one-third of the area of the State.
- 12.3 million acres are commercially important for timber production.
- 9.1 million acres or about 75 percent of the commercial forest area is in public ownership. About 92 percent of the public lands are in National Forests.
- About 52 percent of the commercial forest is in sawtimber stands.<sup>2</sup> These stands average 7,317 board feet per acre.<sup>3</sup>
- Fir-spruce is the biggest type and covers about 28 percent of the commercial forest area.

## TIMBER VOLUME

- Colorado's commercial forests have 17.3 billion cubic feet of wood in sound, live trees, and 52.7 billion board feet in sawtimber trees.
- About 85 percent of the volume is in public ownership.
- 72 percent of the cubic-foot volume in sound, live trees is in sawtimber stands.
- About 93 percent of the board-foot volume of sawtimber is in softwood trees

<sup>1</sup>This survey indicates that Colorado has almost 1.5 times the commercial forest area and more than twice the live sawtimber volume that was reported for 1952 by "Timber Resources for America's Future" (15). (Italic numbers in parentheses indicate numbered references on page 35). Actual changes in forest stand conditions are believed minor. The most recent figures are based on a statistically designed survey, whereas the previous estimates were not. Also, because of changed utili-

and more than one-half of this is Engelmann spruce.

## STAND CONDITIONS

- The net annual growth of sawtimber is about 1 percent of the sawtimber inventory.
- One out of five trees of sawtimber size in the commercial forest is either cull or salvable dead.
- Insects and diseases cause more than 80 percent of the annual mortality.

## TIMBER USE

- In 1962 Colorado's total timber cut was only 0.22 percent of the State's cubic-foot volume of sound live trees. This is one-third the cutting rate for the Mountain States.
- Saw logs intended for lumber accounted for 87 percent of the volume of primary timber products in 1962.
- Almost one-half of the 208 million board feet<sup>4</sup> of lumber produced in Colorado in 1962 (17) was Engelmann spruce.
- Lumber production increased about 11 percent between 1957 and 1962, but the number of active sawmills declined from 274 to 170 in the same period.

zation standards, a large area formerly classed as unproductive is now considered to be productive and is classified as commercial forest.

<sup>2</sup>Stands containing at least 1,500 board feet of sawtimber per acre.

<sup>3</sup>International 1/4-inch log rule board-foot volumes are used throughout this report unless otherwise stated.

<sup>4</sup>Lumber tally.



# COLORADO FORESTS

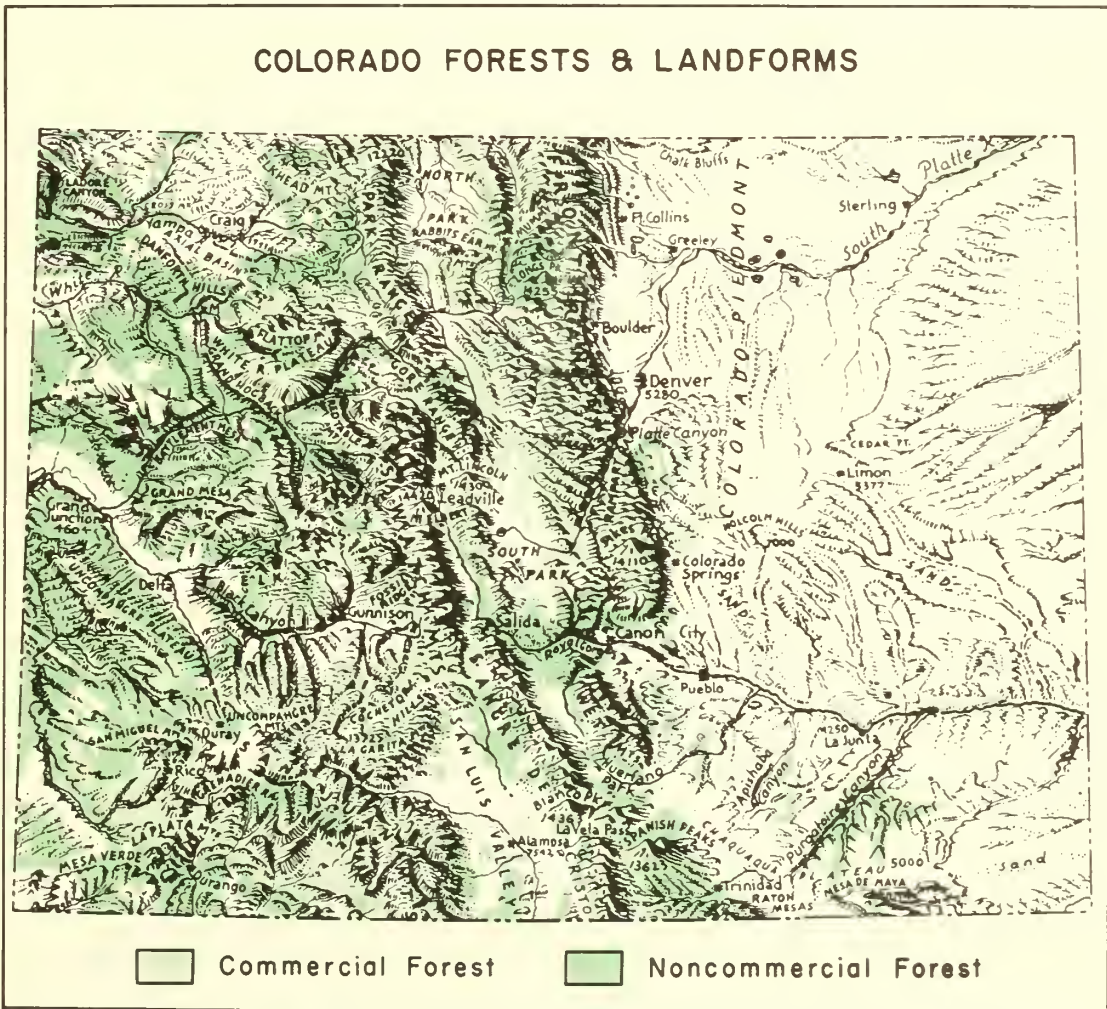
Colorado's famous landforms have made the State's forests unique in kind and distribution. As has been so aptly pointed out, "The second mile up is forested" (4).

The rolling, almost treeless eastern plains of Colorado tilt upward to the west; at about a mile above sea level in the middle of the State they give way to the timbered front ranges of the Continental Divide. A complex of forested mountain ranges, mesas, and plateaus interspersed with nontimbered val-

leys, foothills, and low ranges extends to the western border.

Below 5,500 feet, vegetation is largely grass or salt-desert shrubs. These cover types blend into sagebrush, oakbrush, pinyon pine, and juniper at about 5,500 to 6,500 feet. Under the more favorable moisture conditions at higher elevations, forest stands of commercial timber quality take over. Ponderosa pine, Douglas-fir, aspen, lodgepole pine, spruce, and fir types occur in that general succession up

## COLORADO FORESTS & LANDFORMS



Adapted from "Map of the Land Forms of the United States" by Erwin Raisz.

to timberline at about 11,500 feet.

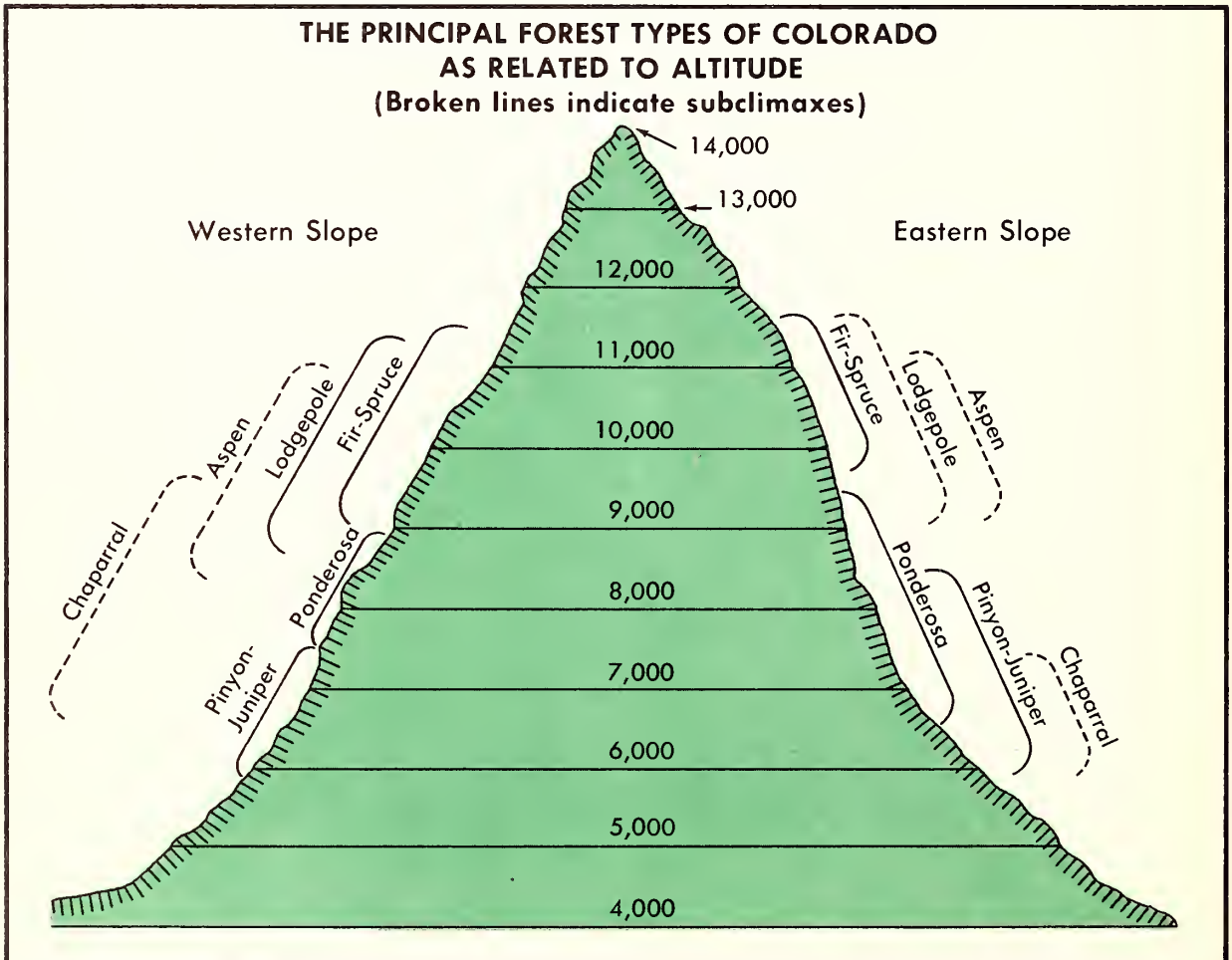
Extreme climatic and physiographic differences in Colorado cause correspondingly large differences in growing conditions and therefore in tree size and quality as well as species. Not only are there local variations in forest characteristics, but there are also variations from one part of the State to another. Geographical differences are especially noticeable when ponderosa pine, Douglas-fir, and Engelmann spruce trees in the more favored southwestern part of the State are compared with those in less productive areas.

Of the State's 22.6 million acres of forest, only a little more than one-half is commercially important for timber production. The rest is classed as noncommercial and consists

of lands reserved from timber cutting and sites that cannot grow trees of commercial size and quality. Much of the noncommercial forest occurs under the unfavorable growing conditions above and below the predominantly commercial zone, but there are also many areas of noncommercial forest within this zone. The following tabulation shows the area of major classes of forest.

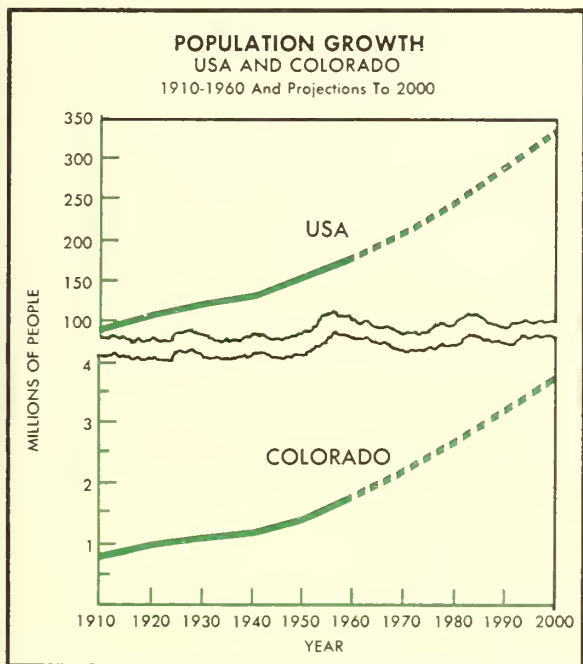
	<i>Thousand acres</i>
<b>Commercial forest land</b>	<b>12,275</b>
<b>Noncommercial forest land:</b>	
<b>Productive, reserved from timber use</b>	<b>465</b>
<b>Unproductive</b>	<b>9,843</b>
<b>Total</b>	<b>22,583</b>

The general range in elevation of most of the principal forest types on western and eastern slopes is shown schematically below. There are many local variations from this general situation because of differences in soils, precipitation, exposure, and other environmental factors.



Adapted from "The Principal Forest Types of Colorado as related to Altitude" by Herbert E. Schwan.

Although Colorado's forests cover only about one-third of the area of the State and are remote from the activities of most of the people, they are some of the most important lands in the State. Their importance to the State and the Nation lies in their multiple values — water, timber, recreation, wildlife, and livestock forage. In recent years, population growth has placed greatly increased demands on most of these forest benefits; past and projected future population increases are shown in the chart below.



Sources: U.S. Bureau of the Census and Select Committee on National Water Resources, U.S. Senate, 86th Congress.

### Demand for water from the forests is intense

None of Colorado's many natural resources is in greater demand than water. The major role of forest lands in meeting this demand is evident from the estimate that about 85 percent of the State's annual runoff originates from the mountain forests and areas above timberline (10).

Competition for Colorado water is very keen among downstream States. About one-half of Colorado's annual runoff of 16 million

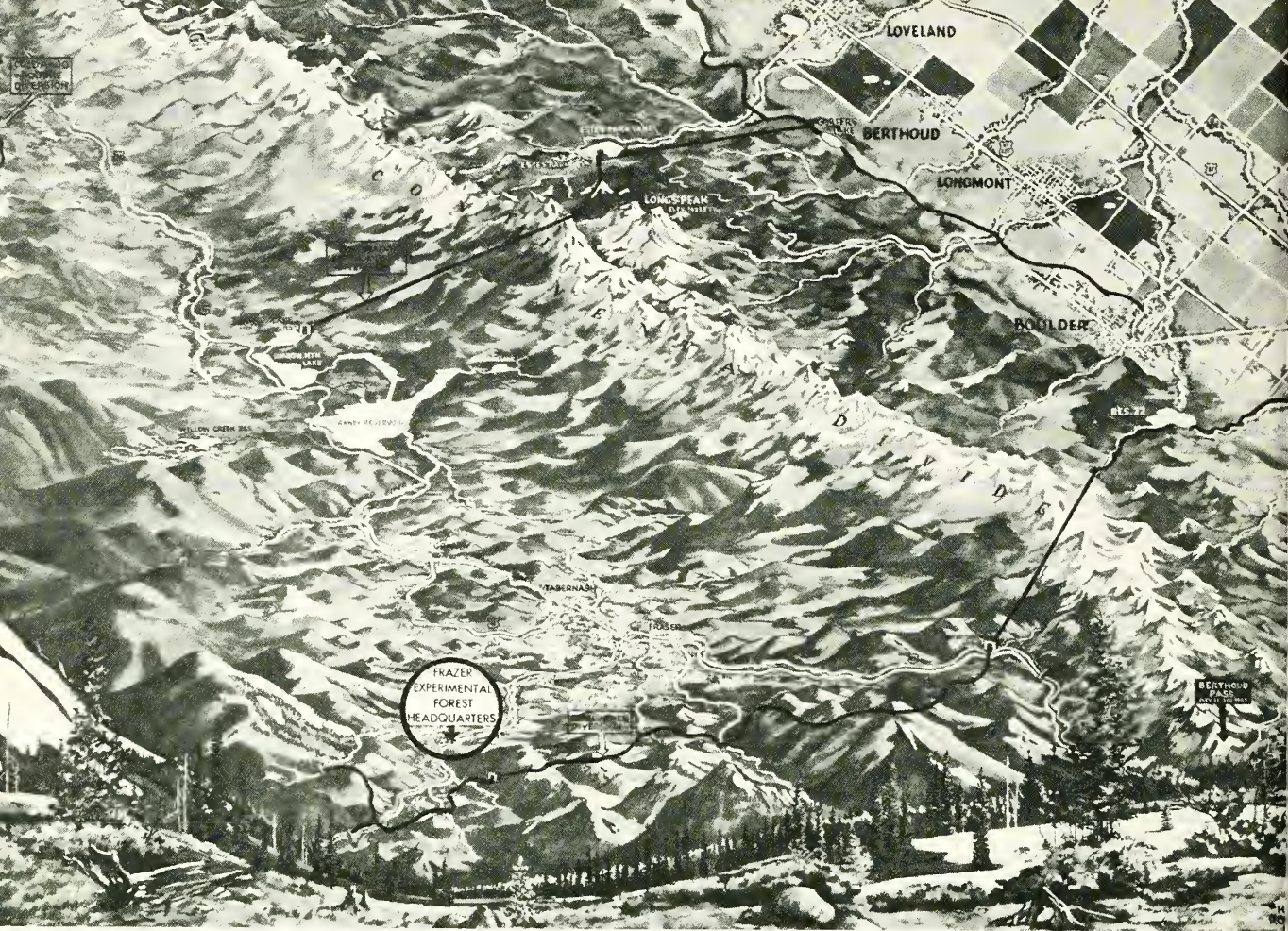
acre feet leaves the State. Some Colorado water flows thousands of miles — to the Gulf of Mexico via the North and South Platte, Arkansas, Rio Grande and other rivers, and to the Gulf of California via the Colorado River. The waters of Colorado's major rivers and aquifers flow in or to no less than 18 States and are of significant economic value to at least eight of them.

The best example of high intensity of demand is the Colorado River, which heads at the Continental Divide just west of Denver and flows through arid lands of Utah, Arizona, Nevada, California, and Mexico. Allocation of Colorado River water among these States for agricultural, industrial, and culinary use has been the subject of some of the most intense interstate controversies and litigations in recent times. As stated by an official concerned with Colorado River development:

Probably nowhere are problems more difficult and extraordinary, water more priceless, and rights to its use defended more vigorously than in planning and developing the Colorado. This is exemplified by the tremendous control and use structures on the lower Colorado River. Tremendous is the growth of agriculture and industry in the farming areas of Yuma, Imperial, and Salt River Valleys and in or about the metropolitan districts of Los Angeles, San Diego, Henderson, and Phoenix . . . (9).

The high value of Colorado water in faraway places is indicated by the level and trend of use in Los Angeles. The Metropolitan Water District of Los Angeles, with an area of 3,018 square miles and more than 6.5 million people, was using Colorado River water at the rate of 405,961 acre feet a year in 1957. According to an estimate for that year, "While it is now delivering about 5 percent of the area's water supply, it is expected the Colorado River will provide about 50 percent by 1970. With these increased demands, the Colorado River is of key importance to the future growth of the metropolitan area" (12).

The projected increase in water use with a bigger population and greater industrial development portends very heavy future demands



The vast transmountain water diversions of central Colorado, including the Colorado-Big Thompson, Fraser River, and part of the Colorado-Poudre systems are illustrated above. The diversion structure pictured is on the Cache la Poudre River, lying to the north of the area represented on the schematic illustration. This structure diverts water from the river by tunnel and canal to storage reservoirs for irrigation purposes.

on the Colorado forest watershed. Availability of water will be a major limiting factor in the long-term economic development of Colorado, where industry and population are basically dependent on the forested watershed. Colorado is already using its entire surface rights — 7.6 million acre feet a year. In addition, about 2 million acre feet of ground water is used annually. Almost 95 percent of the total water use is for irrigation. In areas where municipal demand is increasing, annual use is nearly equal to replacement supply; therefore future expansion of municipal (and industrial) use in these areas must be provided for by reuse or through a decrease in irrigation (6). Major projects to store and transfer water have been undertaken in Colorado. The latest of these are the Fraser River and the Colorado-Big Thompson transmountain diversions that transfer water from the Colorado River headwaters through the Continental Divide by tunnel to Denver and eastern Colorado (illustrated on page 4), and the Curicanti Reservoir now under construction on the Gunnison River.

### **Forest recreation use has increased fourfold in the last 10 years**

More people come in direct contact with the forest through recreation activities than through any other use. In Colorado a high proportion of the recreationists come from out-of-State, apparently attracted by the unexcelled summer climate, outstanding mountain and forest scenery, wide variety in recreation, and accessibility of the forests, many of which are crossed by main transcontinental travel routes and transportation facilities.

Outdoor recreation activity in many forms has burgeoned throughout Colorado's 22.6 million acres of forest. To meet this demand public land agencies — State and Federal — have developed expanding programs to provide a full range of outdoor recreation. About 465,000 acres of productive timberland has been set aside from timber use to protect scenic and wilderness values. Almost all of these lands lie in National Parks and in 10



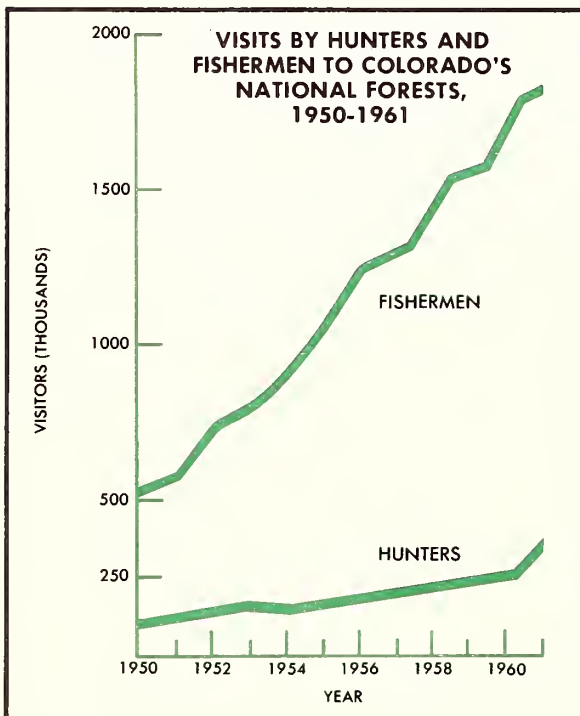
**Cross-country skiers at the  
foot of Crested Butte  
Mountain, Crested Butte  
Winter Sports Area, Gunnison  
National Forest.**



wild, primitive, and wilderness areas within National Forests.

The increase in recreation use is indicated by the following comparison: In 1962 the National Forests of Colorado received more than 12 million visits for recreation — about four times the 1952 figure. This rate of increase is about the same as the national trend. Colorado ranks second only to California in recreation visits to National Forests and receives almost 10 percent of the total for all National Forests in the country. Forest lands also provide much of the attraction for visitors to the State's numerous private developments — dude ranches, fishing and hunting lodges, and so forth. Although the value of recreation is difficult to compare with that of other forest uses, there is little question that in the long run it will be one of the most important uses of Colorado's forests.

Fish and game resources of Colorado's forests provide a highly important recreation use. The following chart indicates to some extent the spectacular increase in recent years in the numbers of fishermen using the many lakes and streams within Colorado's forests.



The rate of increase in hunter use is considerably less. Colorado, however, ranks among the five leading States in mule deer and elk populations and harvest. Game populations in 1955 were estimated at 56,000 elk, 325,000 mule deer, 5,100 bighorn sheep, and 12,000 wild turkey (18). Except for mule deer, harvest of each of the forest game species in the State has not changed much from year to year during the last decade. Although the mule deer harvest has shown a general increase over the years, there has been considerable annual fluctuation. The harvest was 65,200 in 1950, and a record of 147,848 in 1963. The elk harvest of 12,120 head in 1963 was also a record.

**Extensive areas of pinyon-juniper and chaparral and some of the commercial forest areas are valuable for game and livestock range**

Colorado's 8.4 million acres of pinyon-juniper and chaparral lands have been classified as noncommercial from the standpoint of timber production. As shown in the following tabulation these types make up the bulk of the noncommercial forest in the State.

	<i>Thousand acres</i>
<b>Pinyon-juniper</b>	<b>4,674</b>
<b>Chaparral<sup>1</sup></b>	<b>3,704</b>
<b>Other</b>	<b>1,930</b>
<b>All types</b>	<b>10,308</b>

<sup>1</sup>Includes Gambel oak, mountain mahogany, serviceberry, and other woody species.

Some of the better chaparral lands are being planted to ponderosa pine and are thus being converted to commercial forest. However, the preponderance of the State's non-commercial forest will continue to be used chiefly for domestic livestock grazing and game habitat.

These areas are particularly important as winter range for mule deer and elk. High

elevation game ranges, consisting principally of the commercial forests and small areas of mountain meadow and nonforested alpine country, are used in the summer and fall when free of snow. The good interspersion of vegetation types in western Colorado is probably the most important single factor contributing to the high populations of deer and elk. Commercial and noncommercial forests and intermixed nonforest areas complement each other, providing year-round game range.

Domestic livestock grazing was one of the earliest uses of Colorado's forests and continues to be important. While no specific information is available on the contribution

of the forest ranges to the State's livestock production, it was estimated in 1957 that the mountain range livestock industry included 49 percent of the State's total cattle and sheep numbers, and had an income of about \$146 million (10-year average, 1945-55) (3).

Gambel oak stands like this one in southwestern Colorado cover extensive areas of mesa tops and slopes in the western part of the State. They make up a major part of the chaparral type. These lands are chiefly useful for domestic livestock and game range. Many such areas present a problem in conversion of the land to better use.



In 1962 about 149,000 cattle and 490,000 sheep grazed on the National Forests. The forest ranges provide a large part of the total mountain range capacity, probably more than 50 percent. At least three-fourths of the forest range is west of the Continental Divide. Aspen, followed by ponderosa pine, chaparral,<sup>5</sup> and pinyon-juniper, are the leading types in forage productivity — in both yields per acre and in total production from the type.

In addition to the aspen and ponderosa pine lands, areas valuable for forage within the general commercial forest zone are interspersed mountain meadows, other natural nontimbered areas, and nonstocked or partially stocked cutover areas and burns.

After reaching a peak at the end of World War I, the number of cattle and sheep grazed on National Forests gradually declined. Most reductions were made to bring use in line with the range capacity. Range management and improvement practices have been greatly intensified in recent years. Forage production is being increased by control of undesirable plants with herbicides, by better control of stocking, and in some areas by rotation and deferred grazing practices. The potential for improvement is great, and the outlook is for more intensive management and stabilization of use on the better ranges.

The benefits or economic returns from grazing are difficult to compare with those from other land uses. However, it is clear that grazing has an important place in multiple use management of the forest lands in Colorado. Forest and other wild land grazing areas are significant complements to the highly productive valley hay meadows, irrigated pastures, and other resources of the specialized mountain range livestock industry.

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<sup>5</sup>Assumed to be about the same in productivity as the mountain brush range type.

### Timber cut should be accelerated

Although timber cutting has gone on since pioneer days and more than half of Colorado's forests are of commercial quality, present timber use is somewhat a stepchild among the various uses of the forest. In contrast to water, recreation, and grazing, which are rapidly approaching, or have nearly reached capacity under present management throughout the State, there are still extensive timbered areas that have not been tapped.

Despite the fact that Colorado's timber cut for lumber has more than doubled since 1940, the present timber cut for saw logs (about 178 million board feet) is far below the cut that is allowable and desirable under good management practice. Difficult access to much of the timberland and inadequate markets for Colorado timber have retarded utilization; more than one-half of the saw-timber stands are overmature virgin timber.

Desirable qualities of the wood, as well as the large untapped volume, favor industrial development of the timber resource. Slow growth rates combined with satisfactory wood characteristics result in exceptionally even-textured woods with a high strength-to-weight ratio. If markets can be developed, there are excellent opportunities for integrated operations producing lumber, pulpwood, composition board, railroad ties, poles, and other products.

A cash return is not the only benefit that can result from accelerated timber harvesting. On public lands the effect of timber cutting on other forest values is being considered more and more. As discussed later in this report, water, recreation, and wildlife management can be improved in many areas when these multiple values are considered in timber cutting.





# COMMERCIAL FORESTS

Difficult mountain terrain has hindered access, and has been a retarding factor in the development and management of Colorado's commercial forest. The commercial forest occurs on three major mountainous landforms. About 60 percent is on steep slopes of high mountain ranges where logging problems are particularly difficult. The trees are mainly spruce, fir, lodgepole pine, and Douglas-fir.

About 15 percent of the commercial forest is perched high on tablelands — plateaus and mesas. Although these are relatively flat, some are difficult to reach and far from main transportation systems and industrial centers. Timber types in tablelands are fir-spruce and aspen, and in more limited areas lodgepole and ponderosa pine. Tableland forests generally have high volumes per acre in virgin sawtimber stands and are considered above average in potential timber productivity. Tablelands are also valuable for domestic livestock and game range.

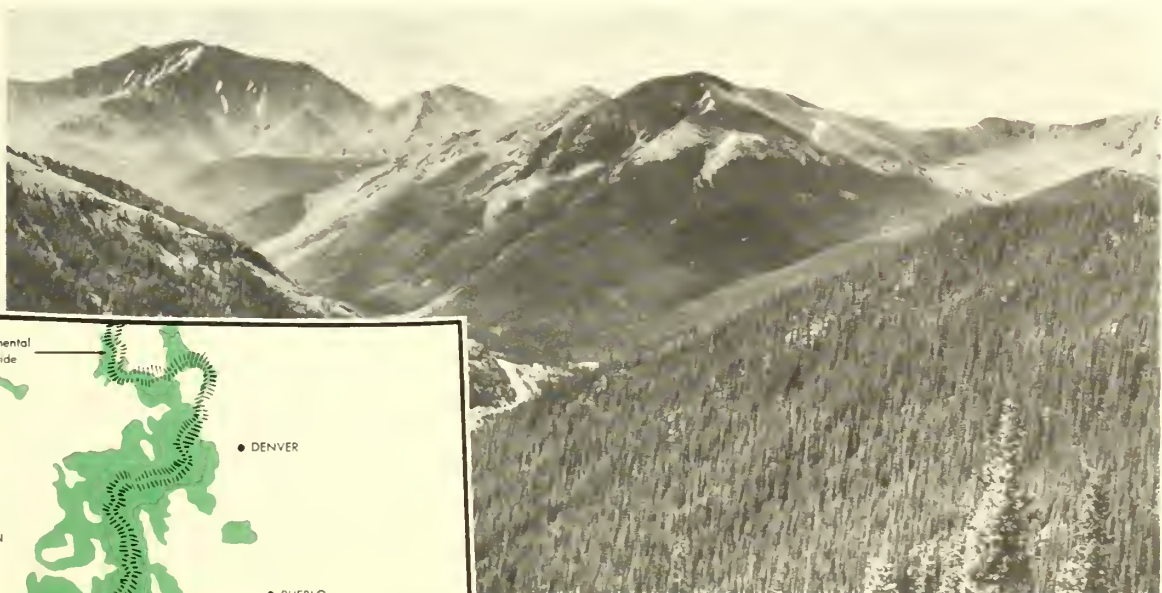
The remaining 25 percent of the commercial forest lies in rolling mountainous country at intermediate altitudes. Slopes are moderate to steep, although relatively short. Lodgepole

pine, ponderosa pine, aspen, and Douglas-fir types predominate. These are the most accessible lands within the commercial forest and as a result have been largely cutover. Furthermore, recreation use and human contact in general are more intense in these areas.

Tabulations below summarize some of the important statistics relating to the commercial forest:

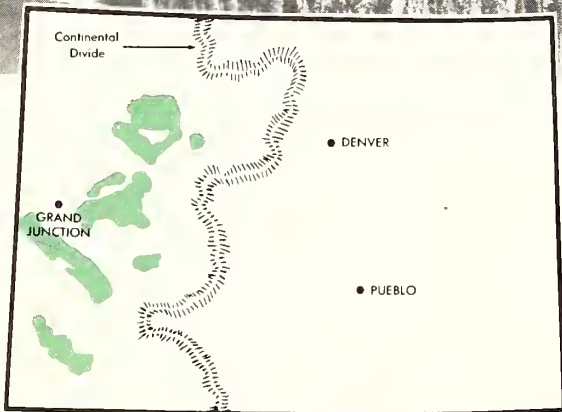
Forest type	Million acres	Principal species	Billion cubic feet <sup>1</sup>
Fir-spruce	3.4	Engelmann spruce	6.2
Ponderosa pine	2.3	True firs	2.4
Lodgepole pine	2.1	Ponderosa pine	1.0
Douglas-fir	1.5	Lodgepole pine	3.3
Aspen	2.8	Douglas-fir	1.6
Limber and bristle-cone pine	.1	Aspen	2.4
Cottonwood	.1	Other	.4
<b>Total</b>	<b>12.3</b>	<b>Total</b>	<b>17.3</b>

<sup>1</sup>Live noncull trees 5.0 inches d.b.h. and larger.



Engelmann spruce and subalpine fir on the long steep slopes of the Sawatch Range in central Colorado.

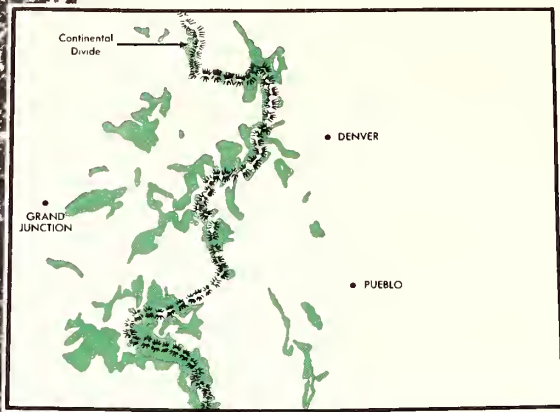




Forests on tablelands vary greatly in species composition and other stand characteristics. The photo above shows a stand of Engelmann spruce on Grand Mesa. Ponderosa pine stands on the Uncompahgre Plateau, across the Gunnison Valley about 50 miles southwest of this area, are a quite different type of tableland forest.



The forest shown above — lodgepole pine and Engelmann spruce on the Routt National Forest in southeastern Jackson County — is representative of timberlands on rolling mountain terrain at intermediate elevations.



## The Fir-Spruce Forest

	<i>Thousand acres</i>
Sawtimber	2,746
Poletimber	485
Seedling-sapling	27
Nonstocked	135
<b>Total</b>	<b>3,393</b>

These Engelmann spruce of large sawtimber size are about 125 feet in height, 200 years old, and range from 22 to 26 inches d.b.h. This stand is on the San Juan National Forest — an exceptionally good area for Engelmann spruce in Colorado.

### Fir-spruce<sup>6</sup> is the most important commercial forest type

Spruce and true fir forests are the major timber resource in Colorado. About 28 percent of the commercial forest area is in the fir-spruce type. Engelmann spruce is the most important tree from the standpoint of timber volume in the fir-spruce type, as well as in the commercial forest as a whole. Almost one-half of Colorado's sawtimber volume and about 36 percent of the cubic volume in sound live trees 5.0 inches and larger is Engelmann spruce.

Important factors contributing to the high

<sup>6</sup>*Fir-spruce is a recognized general western type group and is not separated into spruce and fir type acreages in the Forest Survey. Acreages shown for this type are largely for areas on which Engelmann spruce, subalpine fir, or both species, predominate. Although white fir is not usually an associate of these species, the relatively minor area on which it predominates has been included in the fir-spruce acreage in this report. White fir volumes are reported under true firs.*

*The designation spruce-fir was used for this type by Forest Survey until recent years, and is still used by many foresters.*

productivity of Engelmann spruce are its ability to sustain a good rate of growth (for mountain species) through a relatively long life and its habit of growing in the wettest climatic zone. The fir-spruce forests are located mainly on mountain slopes and on Grand Mesa and the White River Plateaus in western Colorado at elevations of about 10,000 to 11,500 feet — the zone of heaviest precipitation.

Engelmann spruce trees are in general the biggest in Colorado's commercial forest. The following tabulation shows present average volume per sawtimber tree of Colorado's principal sawtimber species:

	<i>Board feet</i>
<b>Engelmann spruce</b>	<b>209</b>
<b>True firs</b>	<b>137</b>
<b>Lodgepole pine</b>	<b>128</b>
<b>Douglas-fir</b>	<b>131</b>
<b>Aspen</b>	<b>120</b>
<b>Ponderosa pine</b>	<b>103</b>

The average diameter of spruce sawtimber trees is somewhat greater than of other species listed above, and trees are generally much taller. Mature spruce sawtimber trees vary from two to five logs<sup>7</sup> in merchantable height through most of the range, but grow to a height of as much as eight logs on parts of the San Juan National Forest in the southwestern part of the State, where the species reaches its best development in Colorado. Stands can be found in this area containing more than 50,000 board feet per acre.

In recent years access to Colorado's Engelmann spruce forests has improved and there has been a marked increase in acceptance of the species for lumber. Since about 1950 it has been the leading species for lumber production. In 1962 the Engelmann spruce saw log cut of about 89 million board feet amounted to almost one-half the State's output for all species. In Colorado, Engelmann spruce wood is particularly even-textured with a relatively high strength-to-weight ratio. Although now used almost entirely for lumber, Engelmann spruce is well suited for pulp,

<sup>7</sup>Unless otherwise specified, a log length of 16 feet is used throughout this report.

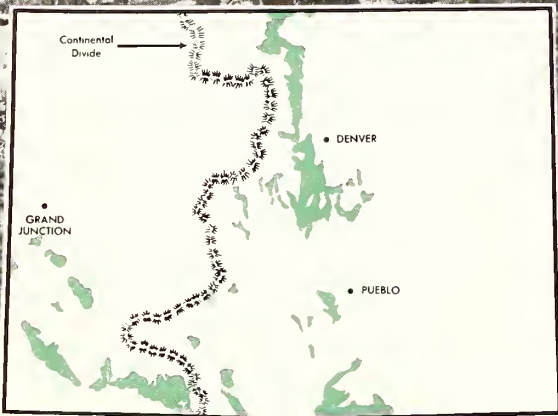
plywood, and other uses. Its resistance to preservative treatment has limited its use for commercial production of treated products.

Engelmann spruce usually grows in even-aged stands and frequently in mixture with other species. Probably at least two-thirds of the type in Colorado is in overmature virgin stands. Extensive areas of this old-growth timber make Engelmann spruce highly vulnerable to insects. Catastrophic outbreaks of Engelmann spruce beetles during the period 1939-55 killed all the Engelmann spruce on at least 261,000 acres of sawtimber stands in western Colorado. The threat of further outbreaks greatly complicates problems of harvesting and regenerating old-growth areas. In fact, development of techniques that will keep a lid on the insect population and still permit successful harvesting and subsequent regeneration of spruce is one of the major timber management problems in Colorado. The problem is discussed more fully in this report under forest development and management.

There are three true firs in Colorado — subalpine fir, corkbark fir, and white fir. Subalpine fir and corkbark fir are the principal associates of Engelmann spruce and are widely distributed at higher elevations. These two firs are relatively small, and in Colorado their total sawtimber volume is about one-fifth that of Engelmann spruce. In Colorado white fir grows only in the southern part of the State, usually in mixture with Douglas-fir. Most of the white fir volume is on the San Juan National Forest where the tree reaches large size. More than two-fifths of the sawtimber volume is in trees 21 inches or larger in diameter.

In 1962 saw log output for the two species of fir amounted to 6.4 million board feet, or about 3.5 percent of the total saw log production in the State.

Blue spruce is probably the most widely known of Colorado's trees, as its form and color give it unusual beauty. It is not important for lumber. Blue spruce trees grow singly or in small groups in all forest types along stream courses, canyon bottoms, and other moist sites.



### The Ponderosa Pine Forest

	<i>Thousand acres</i>
Sawtimber	1,504
Poletimber	553
Seedling-sapling	5
Nonstocked	285
<b>Total</b>	<b>2,347</b>

Virgin stand of ponderosa in the Piedra River Canyon, San Juan National Forest. The stand is small sawtimber, and trees range from 14 to 28 inches in diameter. Average height is 115 feet and average age 140 years. There are about 110 trees per acre.

## **Ponderosa pine was mainstay of early lumber use**

Since the Colorado Gold Rush in 1859, ponderosa pine has had a high and sustained rate of use. Many ponderosa pine stands east of the Continental Divide were clear cut during the Gold Rush and other early mining periods, and used for lumber, mine timbers, and fuelwood.

Of the sawtimber cut in Colorado within the last 90 years, about 2.6 billion board feet or 40 percent has been ponderosa pine. Until 1944 when it finally gave way to spruce, ponderosa pine was consistently the leading species in the volume of sawtimber cut. Accessibility, large tree size, and good lumber qualities have resulted in heavy cutting in the ponderosa pine type. Because most of the ponderosa pine acreage has been cut over at least once, present stands are low in volume. The present volume of ponderosa pine sawtimber is 3.8 billion board feet, or about 7 percent of all sawtimber in Colorado. In 1962 the saw log cut of this species was about 19.5 million board feet, or about 10 percent of the total saw log output for the State.

The ponderosa pine type occupies 19 percent of the commercial forest area and covers much of the forest below 8,000 feet elevation. It also grows on ridgetops, south-facing slopes, and other drier sites up to about 9,500 feet. Largest areas of the type are on the Uncompahgre Plateau and adjacent tablelands, lower southern extensions of the San Juan Mountains, and along the Front Range at lower elevations.

As shown in the tabulation on page 14, an unusually large proportion of the ponderosa

pine area is nonstocked and there are extremely few seedling-sapling stands. These conditions reflect the dry site conditions of ponderosa pine lands and the invasion of past cutover and burned areas by Gambel oak. Regeneration of the extensive areas under these conditions represents a big and costly job. Costs per acre are high due to the necessity for site preparation, planting, and in some cases replanting. A serious economic problem is presented by high costs which limit accomplishment and make many sites economically marginal. A technical problem remains in the need for developing more economical reforestation methods.

Within its elevational range, ponderosa pine is widely distributed in Colorado. Consequently, there is great variation in tree quality and size because of differences in climate and other site factors. Heavy cutting in the past has reduced tree size and quality in many areas. The percentage of logs in grades 1 and 2 (clear or almost clear logs that turn out a high percentage of knot-free lumber) varies among principal ponderosa pine areas from 6 percent or less on the Roosevelt, Pike, and San Isabel National Forests on the eastern slope, to as high as 26 percent in the San Juan National Forest in southwestern Colorado. Less than 14 percent of the ponderosa pine sawtimber volume is in large sawtimber trees (21 inches d.b.h. or larger) on the Pike and Roosevelt National Forests, but on the San Juan such trees make up about 56 percent of sawtimber volume.

Ponderosa pine has been cut largely for lumber but could be used for poles and pulpwood. The large volumes of low-grade ponderosa pine material that are suitable for pulpwood add to the opportunities for plants or processes to supplement sawmill operations.



This sawtimber stand on the Routt National Forest in Jackson County is representative of aged, virgin lodgepole pine forest on better-than-average sites in Colorado. Sawtimber trees in this stand range up to 18 inches in d.b.h., average about 80 feet in height, and are about 225 years old.

### The Lodgepole Pine Forest

	<i>Thousand acres</i>
Sawtimber	714
Poletimber	1,252
Seedling-sapling	95
Nonstocked	7
<b>Total</b>	<b>2,068</b>



## Lodgepole pine is northern Colorado's utility species and problem tree

Lodgepole pine is a versatile tree. It has been used for a longer time and has provided a greater variety of products than any other species in Colorado. Indians used the slim poles in their tepees and lodges. Pioneers built homesteads and fences and shored their mines with lodgepole pine timbers. Lodgepole pine has figured prominently in Colorado's commercial timber industry ever since the days of the tie hack. Colorado lodgepole pine ties hewn by those famed "timberbeasts" contributed to the development of the railroads and the West. Ties are now squared in a sawmill and the red man's lodge pole has evolved to the modern machined house log, but all the early commercial uses continue and are growing.

Growth of lodgepole pine is reduced by heavy dwarfmistletoe infections. Stagnation from overcrowding is also a problem. This growth reduction is the principal reason many thousands of acres bear lodgepole pine timber no larger than pole size even though they are mature in years — in some cases 150 or more years old.

In addition to the 1.3 million acres of lodgepole pine pole-timber stands, there are many pole-size trees in sawtimber stands. In fact, pole-timber trees make up about one-half the cubic volume in lodgepole pine sawtimber stands. Many of these trees are left unused in saw log operations because of lack of market. And because of a lack of growth potential, these pole-size trees are not considered desirable for future harvesting. Present National Forest practice is to destroy these residual trees. Although much sound volume is lost, there is an advantage in converting to a new even-aged stand free of mistletoe.

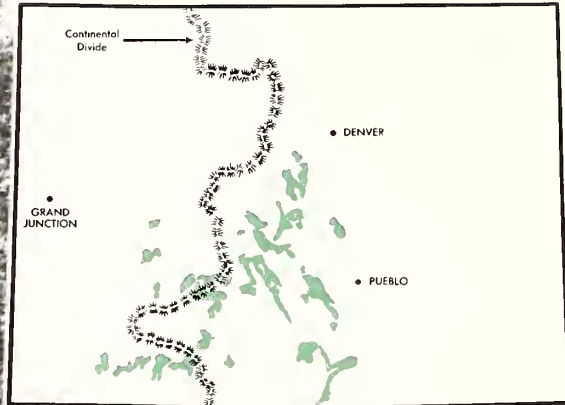
Lodgepole pine has many characteristics that can be at once bane and blessing to foresters and industry. For example, lodgepole pine regenerates well, but many stands soon become overstocked and stagnated. The dense even-aged stands produce straight clear boles, but at a great sacrifice in growth.

Open stands grow rapidly, but with limbs to the ground. Slow growth limits tree size and treatability, but contributes to even texture. Logs have clear surfaces and small, tight knots — but with little depth in clear wood. There are big volumes suitable for pulp — but so far there is practically no market. Clear cutting is the best management technique and is easy to carry out — but leaves large residual unmerchantable volumes to be removed. The small logs and nature of the terrain permit the use of light logging equipment — but output is low and costs per unit are consequently high.

And in still other ways good features are inseparably linked with bad. Despite long, largely clear stems suitable for poles, spiral grain is frequent and generally not identifiable in the tree. The lumber with small knots makes good paneling, but the knots lessen the strength. Lumber quality is comparable to ponderosa pine — but boards are narrow and hard to sell, and the high proportion of juvenile wood makes shrinkage uneven. Lodgepole pine supports a sawmill industry — but mills are frequently small, economically marginal, and handicapped by management and operating problems.

But despite its limitations, Colorado's lodgepole pine is a valuable timber resource with much potential for future production and use (19). Although lodgepole pine makes up only slightly more than one-tenth of Colorado's total sawtimber volume, it provides about one-third of the State's lumber production. Colorado is a leading State in lodgepole pine lumber production. Besides furnishing logs for sawmills, lodgepole is the principal species for a timber treating industry in northern Colorado. Its use for dimension lumber is also growing.

Lodgepole pine grows at intermediate elevations and to a large extent on relatively accessible areas — an advantage for all uses. In addition to present uses, it has qualities suitable for pulpwood, plywood, and particle board. However, before these uses can become significant, markets must develop and problems must be solved in the fields of harvesting, mistletoe infection, and management of young stands for sustained growth.



### The Douglas-fir Forest

*Thousand acres*

Sawtimber	1,046
Poletimber	397
Seedling-sapling	4
Nonstocked	4
<b>Total</b>	<b>1,451</b>

Douglas-fir sawtimber on the San Juan National Forest. The tall tree shown in the center of the photo represents nearly the maximum in development of Douglas-fir in Colorado. It is 120 feet in height, 33 inches in diameter, contains five logs, and is about 225 years old.

**Douglas-fir is of limited use for timber  
but has other important values**

As a timber species, Colorado Douglas-fir has a number of shortcomings. The better quality trees were removed in early-day logging. Furthermore, wood from Colorado Douglas-fir is slightly lower in strength and specific gravity than wood from the coastal and northern Mountain States. Because of the prevalence of knots and shake, Colorado Douglas-fir yields a much lower proportion of top-grade lumber than trees of this species do in other parts of its range. In most locations in Colorado, particularly in the north and along the Front Range, Douglas-fir trees grow on relatively unfavorable sites, frequently on rocky, shallow-soiled slopes. As a consequence trees in these areas are usually short and limby.

Most Douglas-fir stands are quite important for values other than timber. At lower elevations on dry sites older stands of Douglas-fir are fairly open and have a substantial understory of forage for wildlife and domestic livestock. Along with more extensive areas of ponderosa pine, Douglas-fir stands are a principal winter range for mule deer, elk, and bighorn sheep, particularly along the Front Range.<sup>8</sup> Large areas of Douglas-fir, accessible to the centers of population, are heavily used for recreation. And in many areas, Douglas-

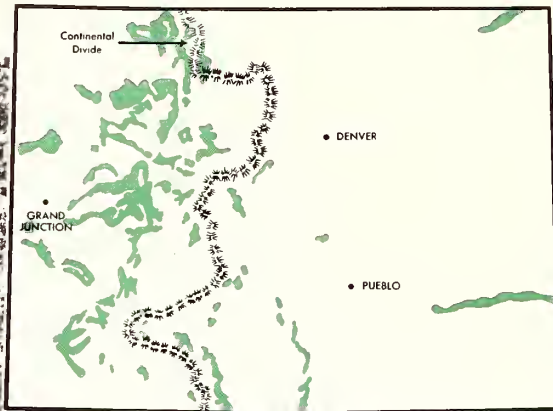
fir stands are extremely important for watershed protection.

The Douglas-fir type covers about 12 percent of Colorado's commercial forest area and lies largely between 8,000 and 10,000 feet in elevation. The main concentration of the type is in the southern half of the State, where the species reaches its best growth on the San Juan National Forest. The favorable size of trees in this area is indicated by the photo on page 18, and the cover photo. The latter shows a stand about 120 years old with many trees more than 110 feet high and 18 inches in diameter.

Colorado's 5.4 billion board feet of Douglas-fir sawtimber represents about 10 percent of all sawtimber in the State. Although less than 4 percent of the State's saw-log output is Douglas-fir, the species is of considerable local importance for production of structural lumber, particularly in counties along the Continental Divide in the southern half of the State. Douglas-fir is Colorado's strongest commercial wood. When slight adjustments are made in the size and spacing called for in specifications, Colorado's Douglas-fir lumber is suitable for the same construction uses as west coast Douglas-fir, in grades and sizes available (5).

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<sup>8</sup>Smith, Dwight R. *Forest game and fish habitat research in the central Rocky Mountains. A project analysis and working plan. Rocky Mountain Forest & Range Expt. Sta., unpubl. 1962.*



### The Aspen Forest

	<i>Thousand acres</i>
Sawtimber	201
Poletimber	2,226
Seedling-sapling	365
Nonstocked	2
<b>Total</b>	<hr/> <b>2,794</b>

These large sawtimber aspen trees are representative of the size attained by many aspen trees in Colorado. They range from 21 to 24 inches d.b.h., average 90 feet in height, are about 110 years of age, and contain three to four logs per tree.

## Aspen grows exceptionally well in Colorado

Aspen, the most widely distributed tree in North America, is at its best in Colorado. About 23 percent of the commercial forest or 2.8 million acres is aspen type. This type is the second largest in the State. Colorado's 3.5 billion board feet of aspen sawtimber, and 2.4 billion cubic feet in sound live trees, is more than is found in any other State.

Aspen varies widely in size, quality, and vigor. In many stands, particularly in the noncommercial forest, trees are short, poorly developed, badly cankered, and infected with heart rot. Elsewhere trees grow to large size and yield big volumes per acre. The best aspen are in the southwestern part of the State where trees reach 24 inches in diameter and 100 feet in height.

Although many aspen stands do not appear sufficiently productive to justify timber management investments, they are valuable for other uses. Yellow, orange, and red foliage of aspen in the fall provides one of the State's scenic attractions. Aspen stands frequently have root sprouts and other understory vegetation that are excellent forage for big game and livestock. Colorado aspen stands on the western slope with a forb understory have been characterized as probably the finest summer lamb and game range in the central Rocky Mountain area (14). Aspen, like other hardwoods, is valuable for its soil-building capability.

Most aspen stands in Colorado originated following fires, many within the last 100 years. Many stands came in on poor sites. This factor and the short-lived nature of the species are important reasons why only about 7 percent of the aspen type is in sawtimber stands. However, at present aspen sawtimber trees have an average volume of 120 board feet per acre, and in this respect rank well above ponderosa pine and somewhat below Douglas-fir.

Aspen, long considered a weed tree, has many desirable characteristics (13). It is very satisfactory for many industrial uses because

it is light, uniform in texture, soft but tough, straight-grained, easy to work, and is tasteless and odorless. It also is quite shock resistant and low in shrinkage. The principal uses in Colorado are for match-splint veneer, core stock for doors, excelsior, lumber, and dimension stock. Actual output of aspen saw logs in 1962, however, was a little less than 1 million board feet.

## Limber and bristlecone pine and cottonwood are minor types

Desirable watershed and scenic values pretty well sum up the importance of the 139,000 acres of limber and bristlecone pine types. Trees of these two species, which are in the general white pine group, are small, limby, and with poor form for timber use. The type always occurs on poor sites — thin-soiled ridgetops and other dry and exposed rocky locations. Practically all of the 472 million board feet in these species is limber pine.

Cottonwood is one of the best known trees in the State, but its inventory volume and timber cut are insignificant. On the plains of eastern Colorado it has esthetic value, and is important as a shade tree and a source of farm lumber. Its major commercial use is for pallets.

Estimates of 83,000 acres of cottonwood type and 288 million board feet of sawtimber in Colorado are actually low because trees frequently occur singly or in small clumps and narrow stringers that are not classed as forest land and not included in the inventory.

Both eastern and western species of cottonwood are native to Colorado. The type is limited to stream courses and flood plains. Eastern or plains cottonwood is generally limited to less than 6,000 feet in altitude. Black cottonwood, the western species, grows to commercial size up to 9,000 feet in some areas.

More than nine-tenths of the cottonwood type is located outside National Forest boundaries and most of it is in private ownership.

# FOREST OWNERSHIP

## The public owns a preponderance of the commercial forest area and timber volume

The present ownership pattern is largely the result of the establishment of National Forests between 1891 and 1908. With preservation of watershed and timber values as primary objectives, National Forest boundaries were established along lower limits of the predominantly mountainous forest area. Since establishment of the White River National Forest in 1891, about 8.4 million acres or about two-thirds of the commercial forest area has been brought under administration of 12 National Forests lying wholly or partly in Colorado. These lands support about 80 percent of the State's commercial timber volume. National Forest ownership of sawtimber volume varies by species from about 58 percent for ponderosa pine to 90 percent for fir and spruce.

Other public ownership totals about three-quarters of a million acres, a little more than one-half of which is administered by the Bureau of Land Management<sup>9</sup> and consists of isolated areas or lower extensions of the commercial forest. Indian lands are within the Ute Reservation in southern Colorado. State forest lands are mainly in the Colorado State Forest on the western slope of the Medicine Bow Range in Jackson County.

Other variations in the general pattern include: the Federal-private checkerboard pattern of ownership in northern Larimer County which resulted from original railroad grants; a scattering of privately owned tracts obtained by mineral patent on the National Forests; and the large private ownerships in southern Colorado which have origin in Span-

<sup>9</sup>The Bureau of Land Management, which has a policy of sustained yield management of commercial forest lands similar to that of the Forest Service, is presently conducting an intensified forest survey of their lands. This survey will soon provide much more detailed data than are now available on timber inventory and management needs.

ish grants. Distribution of ownership by principal classes is as follows:

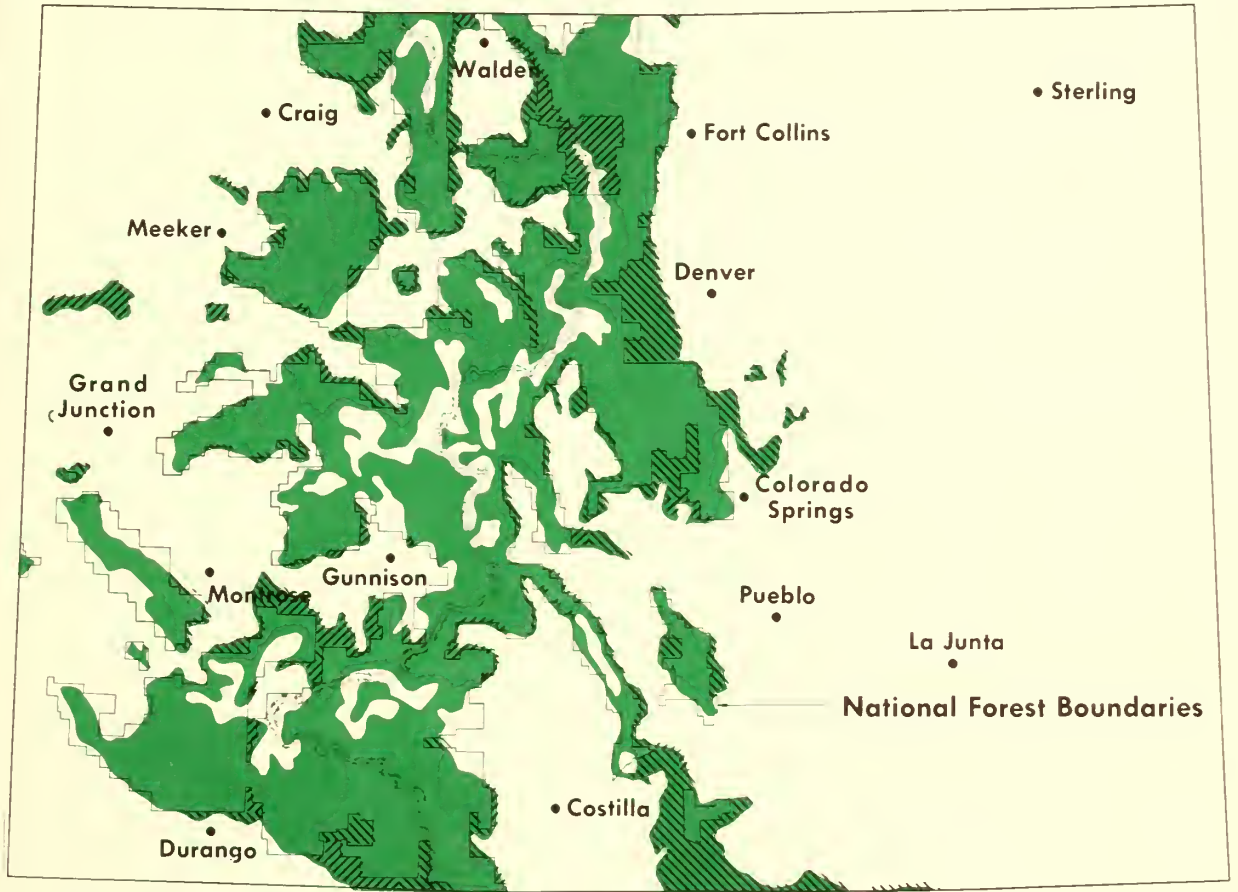
	<i>Com- mercial</i>	<i>Noncom- mercial</i>	<i>Total</i>
	<i>Thousand acres</i>		
<b>National Forest</b>	<b>8,384</b>	<b>2,224</b>	<b>10,608</b>
<b>Other Federal</b>	<b>523</b>	<b>3,582</b>	<b>4,105</b>
<b>State, county, and municipal</b>	<b>235</b>	<b>338</b>	<b>573</b>
<b>Private</b>	<b>3,133</b>	<b>4,164</b>	<b>7,297</b>
<b>Total</b>	<b>12,275</b>	<b>10,308</b>	<b>22,583</b>

## More than one-third of all forest lands are non-Federal and most of these are private

Nearly 8 million acres or about 35 percent of all forest lands in Colorado are in non-Federal holdings. Private ownerships comprise about 93 percent of the non-Federal holdings and consist of 3.1 million acres of commercial forest and 4.2 million acres of noncommercial — largely pinyon-juniper and chaparral.

The ratio of public to private ownership of the commercial forest area is about 3 to 1. However, the ratio varies substantially when timber types are considered. The fir-spruce type, which occurs at high elevations and is relatively inaccessible, is almost 80 percent public ownership. On the other hand, ponderosa pine lands, which are at the lower ranges of the commercial forest and are more accessible, are almost 50 percent in private ownership, principally in farms and ranches. Heavier timber harvesting, together with clearing to improve yields of livestock forage have reduced stocking of ponderosa pine on farms and ranch lands. On these lands about 24 percent of the type is non-stocked as compared with 3 percent on National Forests.

Survey statistics on present acreages, volumes, and stocking are an inadequate basis



**PRODUCTIVE FOREST AREA IN COLORADO BY PREDOMINATING OWNERSHIP, 1959**

National Forest
  Other Public
  Private

In the map above almost all the forest area delineated within the National Forest boundaries is National Forest land. Outside the National Forests, Private, and Other Public ownerships are in general much interspersed. Exceptions are large blocks of State and Indian lands, and Spanish grant lands. Private and Other Public areas are separated on the map on the basis of predominance (more than 50 percent) of ownership.

In addition to the productive forest area shown above there are 9.8 million acres of unproductive forest. These lands are all classed as noncommercial and comprise 95 percent of the noncommercial forest shown by the map on page 1. Fifty-eight percent of the unproductive lands are in public ownership, the remainder are largely farm and ranch lands.

for comparing the relative economic importance of private and public holdings. For example, although private lands comprise about 26 percent of the commercial forest area and have 14 percent of the sawtimber volume in the State, they provided only 8 percent of the sawtimber cut in 1962.

On the other hand, private lands have certain potential advantages. Because they generally have younger, more vigorous trees, growth rates are higher than on most public lands. Furthermore, private lands are usually more accessible for protection, planting, cultural treatment, and harvesting. However, these advantages will not result in better yields unless management improves. At present most private owners have a secondary or minor interest in timber production, and for the most part, have little knowledge of sound timber management. The Colorado State

Forest Service is active in developing the potentials of private holdings, and as one of its projects is now compiling intensive county-by-county inventories of non-Federal forest lands. In some areas, such as Larimer County, non-Federal ownerships are a significant secondary source of supply (2).

Non-Federal lands are of great importance for forest uses other than timber. Pinyon-juniper and chaparral types and some of the commercial forest lands provide livestock forage and serve as winter game ranges. Recreation use is high and will undoubtedly increase rapidly. Most dude ranches, hunting and fishing lodges, and other private recreation facilities are located on private lands. And many of these lands will also be in demand for summer homesites or other residential use.

**This stand in Archuleta County is characteristic of much of Colorado's privately owned ponderosa pine area. It is vigorous second growth but because trees are not closely spaced they will be too limby to produce high quality saw logs. Poor stocking also encourages invasion by oak brush.**





# DEVELOPMENT AND MANAGEMENT OF THE FOREST RESOURCE

From the standpoint of timber use and management — the principal concern of this report — the most urgent and complex problems relate to Colorado's 12 million acres of commercial forest. Here are the most rapidly developing water, recreation, and forage uses. All of these are affected by and have an effect on timber use. The situation in the noncommercial forest is generally less urgent and management is less complicated. On these lands timber use is negligible, there is less competition among uses, and the forest itself is undergoing less rapid change. Problems in the noncommercial forest — how much and what area to reserve and protect for recreation, and how to improve forage production and game habitat on pinyon-juniper and chaparral lands — have little bearing on development of timber use. For these reasons the remainder of this report discusses mainly

opportunities and problems on commercial forests.

## Timber use is increasing but economic returns are much too low

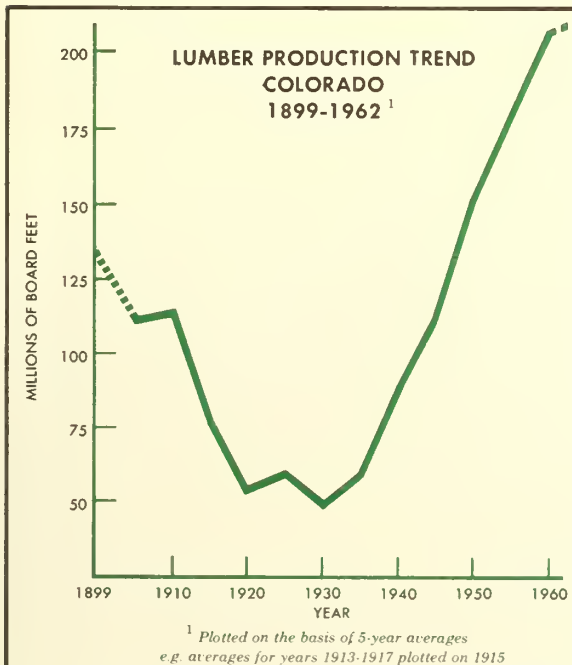
Since 1900 timber use in Colorado has had many ups and downs. This is reflected in a general way by figures on lumber, which has been the major product over the years and accounted for about 87 percent of the wood that went into timber products in 1962. As shown in the chart on this page, the decline between 1899 and 1935 was followed by an increase that about quadrupled production by 1962. Output for 1962 is estimated at 208 million board feet (lumber tally) (17). Less information is available on the trend in other products, but there are no indications of any upward trend greater than that of lumber.

In 1962 Colorado had an estimated 170 active sawmills.<sup>10</sup> Distribution of active mills on the basis of production class is as follows:

<sup>10</sup>Estimate based on a survey conducted in 1963 by the Intermountain and Rocky Mountain Forest & Range Experiment Stations for the purpose of estimating the output of roundwood products in 1962.

Production class <sup>1</sup> (Thousand board feet)	Number of mills
10,000 or more	5
5,000 to 9,999	3
1,000 to 4,999	37
500 to 999	20
200 to 499	19
50 to 199	49
Less than 50	37
<b>Total</b>	<b>170</b>

<sup>1</sup>It is usual practice to base mill production class on annual lumber output, but in this tabulation it is based on volume of log receipts in 1962.



Although the number of active sawmills decreased from 274 in 1957 to 170 in 1962, lumber production increased from 188 to 208 million board feet. A comparison of number of active mills by size class for the 2 years shows that dropouts were largely small mills. In 1957 there were 47 mills, or 17 percent of all mills in the State, with a production capacity of 1 million board feet or more a year. In 1962, there were still 45 mills of this size and they constituted 26 percent of the State's mills. On the basis of saw log receipts these 45 mills produced 85 percent of the State's lumber in 1962. In 1957, the 47 mills of this size produced 72 percent of the lumber. Big mills got bigger (and somewhat fewer); small mills got fewer. In 1957, average production per sawmill in Colorado was 0.686 million board feet; in 1962 it was 1,224 million.

The map on this page shows the geographic distribution of sawmills and indicates the counties that individually produced at least 10 million board feet of saw logs in 1962.

During the 1957-62 period, wood cut into saw logs for the lumber industry increased from 78 to 87 percent of the cut for all primary products. The latter figure is about the same as for the Mountain States as a whole, and therefore Colorado is not an exception in relying on lumber as the bulwark of the timber industry. A very minor amount of pulpwood was cut in Colorado in 1962, and this was shipped out of the State. An increase in pulpwood cut would be highly

desirable. There would be still further economic gain if pulpwood were converted into paper or other secondary products within Colorado.

Several methods of measurement show that, in relation to inventory, Colorado's timber use and economic returns from timber are among the lowest in the Mountain States. In 1962 Colorado cut only 0.22 percent of its inventory of sound live trees and cut only 2.1 million of its 3,329 million cubic feet of dead but usable timber. The following tabulation reveals that Colorado and Utah are the lowest of the eight Mountain States in annual percentage of cut from inventory of sound live trees.

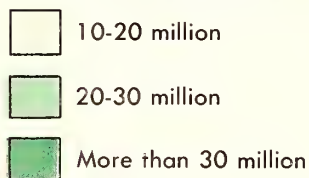
	<i>Percent of inventory cut, 1962</i>
<b>Colorado</b>	<b>0.22</b>
<b>Utah</b>	<b>.22</b>
<b>Wyoming</b>	<b>.29</b>
<b>Nevada</b>	<b>.36</b>
<b>New Mexico</b>	<b>.53</b>
<b>Montana</b>	<b>.79</b>
<b>Idaho</b>	<b>.93</b>
<b>Arizona</b>	<b>1.06</b>
<b>Mountain States</b>	<b>0.66</b>

And as shown in the table on page 27, Colorado also compares unfavorably with other Mountain States in economic returns from timber harvesting.

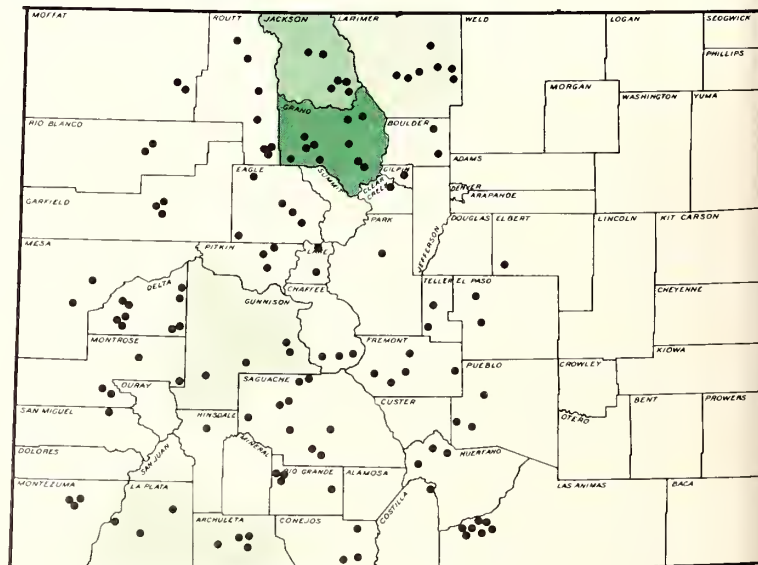
### COLORADO SAWMILLS AND PRINCIPAL SAW LOG PRODUCING COUNTIES — 1962

- Sawmill known to have operated in 1962<sup>1</sup>

*Counties that each produced more than 10 million board feet of saw logs in 1962.*



<sup>1</sup>In addition to the 126 mills shown on the map there were an estimated 44 active mills that did not furnish a report in the 1962 timber products survey.



**Estimated Employment in Timber Harvesting<sup>1</sup> and Estimated Value of Shipments from Primary Manufacturing Industries<sup>2</sup> in Relation to Inventory,<sup>3</sup> Mountain States, 1958**

State	Employees	Value of shipments
	Per billion cu. ft. of inventory	
	Number	M dollars
Colorado	46	1,722
Arizona	168	4,835
New Mexico	128	3,476
Idaho	156	5,554
Montana	102	1,989
Wyoming, Utah, Nevada	54	1,263
All Mountain States	108	3,152

<sup>1</sup>All employment involved in harvesting and transporting timber and related products from forest to local points of delivery.

<sup>2</sup>Includes sawmills and planing mills, veneer and plywood plants, paper and paperboard mills, and other industries manufacturing such minor products as shingles, excelsior, and charcoal.

<sup>3</sup>Volume of all sound live trees 5 inches and larger in diameter.

Source: Dwight Hair. *The economic importance of timber in the United States*. U.S. Forest Serv. Misc. Pub. 941. 1963. Wash., D.C.

**A bigger cut can improve management in Colorado's old-growth forests**

Sluggish development of Colorado's timber resource has tended to perpetuate the overmature condition of much of the forest. Survey data indicate that for practically all forest types the preponderance of sawtimber volume is in overage, slow-growing trees. Most of the spruce-fir and lodgepole pine sawtimber stands are beyond rotation age. At least 25 percent of the lodgepole pine poletimber stands are more than 100 years old, and most of these are stagnated. Substantial proportions of other types are also overmature.

These old-growth stands are the major timber management problem in Colorado. Protection is of special concern because of the catastrophic changes that may result from insects and blowdowns. The potential in devastation by forest insects in Colorado has been amply demonstrated. Between 1940 and 1951, the Engelmann spruce beetle killed an estimated 5 billion board feet of Engelmann spruce in Colorado following blowdowns that provided large amounts of host material for insects (20).<sup>11</sup> This volume is equal to almost 10 percent of the present sawtimber inventory of all species. In aged stands such as these the constant presence of dying trees and blowdowns is so favorable to the spruce beetle

<sup>11</sup>This loss is not revealed by the mortality tables in the appendix because it occurred before the period of the survey.

**Extensive area of beetle-killed Engelmann spruce on the Routt National Forest.**



that costly surveillance and treatments are required to prevent epidemic losses.

Other insects are active throughout the forests: The Black Hills beetle is causing heavy losses along the Front Range and in other ponderosa pine forests on the eastern slope; spruce budworm attacks have defoliated Douglas-fir and white fir on 600,000 acres in the State in the last 6 years; the Douglas-fir beetle causes high local mortality.

The effects of disease, diffuse and less spectacular than insect damage, nevertheless are major factors in timber cutting needs. Dwarfmistletoe is not only very damaging to lodgepole pine as already described, but is very prevalent in ponderosa pine stands. Wood rotting fungi, rusts, and other diseases are also widespread.

Combined effects of insects and disease result in an annual sawtimber mortality of 453 million board feet, or far more than the annual cut of 196 million board feet. However, not all of this mortality is in species that are now of economic importance for timber; 188 million board feet is in subalpine fir, a species which accounted for only about 3 percent of the sawtimber cut in 1962.

Insects and diseases also have a big effect in retarding tree growth. The growth loss from these agencies is not known, but it probably greatly exceeds losses from mortality.

The decadent condition of Colorado's old growth forest is indicated by the fact that one out of five trees of sawtimber size is either cull or dead (but sound). These trees, not presently salable, handicap harvesting and postharvesting treatment and furthermore are esthetically undesirable.

These characteristics of the old growth — big protection costs, constant high mortality and growth losses, and (especially) the high risk of catastrophic losses of spruce — point to the need for a much bigger cut. Risk of major losses through insect outbreaks is extremely critical because of the large volumes of timber involved. However, other problems in resource use and management created by sudden, uncontrolled changes over extensive fir-spruce forests are even more significant. A faster rate of harvest would not only utilize much timber that would otherwise be lost, but since harvesting is one of the means of preventing outbreaks of the Engelmann spruce

**Small mill sawing trap logs from a project for controlling Engelmann spruce beetle on the San Juan National Forest. The location of this temporary mill — at a high elevation and about 50 miles from the nearest paved road — illustrates difficult access problems and resulting high costs encountered in protecting much of the forest area.**



beetle, it would be of even greater importance as a management measure in controlling changes in Engelmann spruce stands. Protection, silviculture, and the anticipated future timber demands would benefit from the orderly conversion of the old growth to young vigorous stands.

On the other hand, it is necessary to consider that too rapid a cut will result in a scarcity of mature stands at some later time. Also, regeneration is a major problem in some stands and large-scale harvesting with poor regeneration would reduce productivity for a long time to come. Such actions would defeat objectives of sustained yield and industrial stability.

### **Difficult problems of regeneration are restrictive to harvesting**

Difficulties in regenerating ponderosa pine and Engelmann spruce have been mentioned earlier. Of the two species, Engelmann spruce is technically more difficult to regenerate and the costs are greater; its regeneration cannot be considered apart from interrelated problems of insect protection and harvesting.

The two methods of preventing and controlling bark beetle buildups in Colorado — harvesting and use of insecticides — have advantages and disadvantages from the standpoint of regeneration. Harvesting, supplemented by trap tree measures, and the burning of all residual host material, is now used almost exclusively as the control method in overmature spruce stands. It is an especially attractive method because it provides some returns to offset road and artificial regeneration costs. However, as a control measure, harvesting has serious limitations under some conditions. When harvesting is begun in an aged spruce stand, balances are upset, and to use a current expression, “The forest tends to unravel.” Blowdowns occur along cutting boundaries and require subsequent treatment for bark beetle control. The most serious problem resulting from harvesting is frequently the failure to get natural regeneration in the cut areas. The usual beetle-control practice of burning residual material leaves the cut areas without enough

shade and moisture for the establishment and development of spruce seedlings. Planting and replanting is often necessary and may cost more than the value of timber harvested. The success of Engelmann spruce regeneration, planted and natural, is estimated at not more than 30 percent; it may actually be considerably less, particularly where cutting is in larger blocks.

When harvesting is not feasible or desirable, insecticides can be used to control the bark beetle population. This control method does not destroy existing reproduction or deteriorate shade and moisture conditions favorable to the establishment of seedlings.

The variations in productivity, age, vigor, and size among stands are important factors complicating the problems of harvesting, protecting, and regenerating spruce stands. Some stands have substantial advance reproduction, while others do not. Stands differ in susceptibility to blowdown. These variations suggest two things: first, that there is probably no single solution to the problems and that treatment must vary according to local conditions; and second, that there is a real need for more detailed stand data, more silvicultural research, and the development of improved management techniques.

In forest types other than Engelmann spruce, it appears at the present time that there is less risk of catastrophic losses and, therefore, more opportunity to spread out the cut and avoid future fluctuations in yield. A prolongation of cut for other species would have the advantage of partly offsetting any future temporary declines in the yield of spruce.

It is difficult to estimate volumes available for cutting in future years because of problems and inadequacies of knowledge described above. Other factors complicating management, such as the overriding importance of uses other than timber in some areas, and operability limitations due to steep slopes and soil instability, will also tend to limit timber use. Although improved knowledge in multiple use management, and better technology, logging equipment, and markets can alleviate the latter problems, the extent of these developments is indeterminate.

## Timber Volume on Commercial Forest Land by Class of Timber and by Species

Class of timber	All species	Ponderosa pine	Lodgepole pine	Engelmann spruce	Other softwoods	Aspen and other hardwoods
<i>Million cubic feet</i>						
<b>Sawtimber trees:</b>						
Saw log portion	8,807	740	1,041	4,126	2,368	532
Upper stem portion	923	69	55	410	223	166
<b>Total</b>	<b>9,730</b>	<b>809</b>	<b>1,096</b>	<b>4,536</b>	<b>2,591</b>	<b>698</b>
<b>Poletimber trees</b>	<b>7,607</b>	<b>208</b>	<b>2,190</b>	<b>1,665</b>	<b>1,802</b>	<b>1,742</b>
<b>Sound wood in cull and salvable dead trees</b>	<b>4,777</b>	<b>77</b>	<b>527</b>	<b>1,859</b>	<b>1,143</b>	<b>1,171</b>
<b>Total, all timber</b>	<b>22,114</b>	<b>1,094</b>	<b>3,813</b>	<b>8,060</b>	<b>5,536</b>	<b>3,611</b>

The table on this page shows the present volume of all species in terms of broad product groups: (1) saw logs and veneer logs, and (2) small diameter and other material suitable only for products in round or converted form, such as poles and pulpwood.

How much of the 8.8 billion cubic feet of saw log volume should be budgeted for annual cut within the next few years can vary greatly, depending on management decisions regarding the many complex factors described above. The preponderance of saw log volume in Engelmann spruce and the species associated with it (40 percent of the volume in *Other softwoods* is subalpine fir), indicates the big influence that decisions on managing and harvesting the old-growth stands of fir-spruce will have in the allowable cut. It would be desirable to spread the old-growth harvest over a rotation (about 140 years) in order to obtain optimum conditions of stocking, age, and species distribution in the shortest possible period. It is highly unlikely, however, that many of the present old stands with high mortality will last that long. Even in the absence of massive losses as a result of insect outbreaks, large areas of the old, even-aged, spruce forest can be expected to go out long before the end of the next rotation. Existing spruce beetle control methods are

limited in capability to forestalling outbreaks. In fact, additional blowdowns as a result of roadbuilding and harvesting could result in insect buildups and accelerate the rate of loss of old growth. It is apparent, therefore, that many complicated decisions must be made in managing and utilizing old-growth Engelmann spruce, in the process of converting to young, more productive forests and, at the same time, managing for other uses.

A thorough analysis of the many factors to be considered in estimating the allowable sawtimber cut is beyond the limited scope of this report. However, it does appear that the sawtimber inventory will permit a big increase in cut beyond the present level of about 30 million cubic feet, or 196 million board feet a year. The increase probably could be about triple the present cut.

In addition to the live sawtimber there is a big volume in poletimber trees, cull trees, and salvable dead trees available for harvest. In 1962 the cut of such trees amounted to only about 9.5 million cubic feet. A sustained yield of at least seven times this amount is feasible. Probably about one-half of the 2.2 billion cubic feet of lodgepole pine poletimber is in stagnated poletimber stands or in poletimber trees in saw log stands. In lodgepole pine and fir-spruce stands most of the pole-

timber trees are destroyed during postlogging treatment; and this volume is also available for harvest.

National Forests with four-fifths of the wood volume in Colorado obviously have a major influence on the allowable cut for the State. Allowable cut on Colorado's National Forests has increased substantially within the last 10 years and is now considerably higher than the actual cut of about 196 million board feet a year from all lands. Industry is not absorbing the available supply.

Questions of allowable cut and the need for cutting as a forest management measure are only of academic interest unless timber is marketable. An expanded cut can materialize only if and when timber can be logged and marketed profitably. This hinges on two related factors — demand for timber and access to it — discussed in the following sections.

### **Colorado needs a diversified and integrated timber industry**

Colorado's timber industry is mainly a sawmill industry with little or no integrated

processing. A number of explanations for lack of development have been offered. Instability,<sup>12</sup> intermittent operation, and inconsistent quality of manufacture have been cited as serious limitations to efficient production and increased output in the sawmill industry (1). Poor marketing practices and prejudice in Colorado against locally produced lumber have been found to be limitations to adequate use of Colorado's timber.<sup>13</sup>

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<sup>12</sup>A suggested drawback to a program of accelerated harvesting is that operations with large capital investments may be reluctant to move in when abrupt reductions in supply can be foreseen. That this may not be true (at least of sawmills) is indicated by a sale made on the San Juan National Forest in 1962. The sale contract provided that the estimated 106 million board feet on the sale area is to be cut by late 1968. The purchaser, a local operator, is installing additional mill capacity to handle the sale. The three other bidders were west coast firms. Even in the case of a papermill, the amortization period in relation to the period for available adequate supply does not appear to be a limiting factor (8).

<sup>13</sup>Hughes, Jay M. *Price and prejudice in the marketing of Colorado lumber*. Master's thesis, Colorado State Univ. 171 pp. typewritten, 1958.

Engelmann spruce and subalpine fir logging residues piled at a landing on the Roosevelt National Forest. This material, averaging about 7 inches in diameter at the large end, ranges up to 20 feet in length to a top diameter of 4 inches. A market for these woods residues would defray some of the logging costs chargeable to saw logs.





**This small sawmill on the Colorado State Forest in Jackson County operates on small lodgepole pine and Engelmann spruce saw logs. It is representative of the numerous small mills in northern Colorado.**

Figures in the following tabulation of output of primary products in 1962 show that the preponderance of cut is saw logs. These are used almost exclusively for lumber. Only about 13 percent of the cut is for other products.

	<i>Thousand cubic feet</i>
<b>Saw logs</b>	<b>31,563</b>
<b>Poles</b>	<b>482</b>
<b>Mine timbers</b>	<b>1,411</b>
<b>Miscellaneous industrial wood</b>	<b>1,946</b>
<b>Posts</b>	<b>329</b>
<b>Fuelwood</b>	<b>702</b>
<b>All products</b>	<b>36,433</b>

One important source of raw material for a more diversified and integrated industry is the big volume of sawmill residues — sawdust, slabs, edgings, and trim. Most of this material now has to be burned and at some cost. In many small sawmills these residues amount to as much as 50 percent of the saw log volume. Profitable conversion of coarse residues to chips for pulp making would strengthen the Colorado lumber industry and encourage a bigger timber cut.

The large amounts of low-grade and small-diameter material standing in the woods represent another very important source of supply for a wood-fiber industry. And until there is a market for much of this material, timber managers are greatly handicapped in



putting timberlands in better shape to meet anticipated demands in the future.

Currently, sawmill residue is preferred to roundwood by the pulping industry as a source of raw material, and the availability of residues is likely to outweigh availability of roundwood in selection of a mill site. This situation could reduce the benefits which a pulpwood market would otherwise provide for improving management of timberlands. The amount of available sawmill residue, however, is hinged to lumber production and consequently supply is subject to some fluctuations. It is therefore unlikely that a pulp and papermill would rely on residue entirely. Anticipated benefits of a pulpwood market for timber management would therefore still apply.

A market for pulpwood offers the best possibilities for using mill residues as well as small dimension and low-grade roundwood. A study has just been completed that reports adequate supplies and facilities for a papermill on the Colorado River in western Colorado (8). Papermill operations may be feasible in other areas of the State. Development of substantial pulpwood export is a possibility, but is largely dependent on transportation costs and on economic conditions and development (i.e., those affecting pulpwood costs) outside the State. Encouraging signs are production of roundwood and chips in the Black Hills, production of pulpwood recently begun in west-central Wyoming, a small volume of dead spruce cut for pulpwood in Colorado in 1962, and initiation in early 1964 of shipments of chips from a sawmill in Kremmling. All pulpwood from these areas is being shipped to mills in Wisconsin.

Integrated plants with production and markets based on a variety of sizes and types of materials would have greater insurance against instability in supply. Even though supplies of sawtimber might decline, prospects of a continuing supply of small material suitable for fiber appear excellent. These prospects will become even better as forests are converted to young, fast-growing stands that will need thinning.

Development of a diversified and integrated industry will not occur without substantial research and promotional effort. Research is needed in the fields of marketing, product development, and in techniques and economics of harvesting, transportation, and product use. The most valuable contribution of research is likely to be in the area of reduction of costs in production and use. In view of the present economically marginal nature of many potential operations, substantial favorable shifts in cost relationships between Colorado and other timber producing areas may be basic to the development of a more adequate industry. As an example, important needs are to reduce production costs of lumber, and to develop cheaper methods of lumber assembly or installation in construction. Strengthening the lumber industry is particularly important because of the role of lumber production as the basis for needed secondary industries.

#### **Road financing is not geared to problems of management and utilization**

Inadequate road development is a major bottleneck to efficient forest management and timber utilization. Most of the operable old-growth stands lack access roads. In fact, success in handling the principal old-growth resource, Engelmann spruce, will stand or fall on whether those parts of the planned road system that lead to concentrations of over-mature, high-risk stands are developed *in advance* of beetle outbreaks or dangerous beetle population buildups. These roads are necessary for insect control whether by harvesting or by use of chemicals. Because spruce beetle outbreaks cannot be precisely predicted, many of the access road into spruce timber should be established years in advance of actual need for harvesting or for chemical control measures.

The present system of financing does not permit construction of an adequate network of roads in advance of protection needs on National Forests, which contain almost all of the Engelmann spruce resource. On the Na-

tional Forests, road development frequently has been tied to timber sale contracts or to meet current exigencies in insect control. As a result, it has not been possible to follow an orderly program of harvesting in priority of risk. Under these timber sale procedures, the size of a given sale must be sufficiently large to provide the operator a margin for profit and risk, cover estimated costs (including roads, and leave a residual for stumpage. But the location and limited area of some high risk stands precludes adequate returns unless other areas of low risk are included in the sale. And after an access road is constructed there is a tendency to harvest accessible stands, rather than higher risk stands not yet reached by road.

Although a greater proportion of new roads on National Forests is now being financed through direct appropriations than previously, the construction program is still far from adequate. Without a greatly accelerated program, timber management, protection, and utilization will continue to fall far short of realizing present values and attaining the potential in the future.

#### **Other forest uses can benefit from increased timber use**

Colorado's extensive areas of old-growth forest invite changes — devastating changes from natural causes or controlled beneficial changes from timber harvesting. Changes from blowdown and insects can be sudden, rapid, and extensive. Fire can effect major alterations in vegetative cover of both old and young growth. These changes, whether by natural causes or by logging, significantly affect all forest values — timber, water, recreation, wildlife, and grazing.

The forests have important beneficial influences in stabilizing streamflow and in controlling sediment. Also, opening some coniferous forests can have significant effects on water yield. Research on the Fraser Experimental Forest<sup>14</sup> and elsewhere provides some evidence that it is possible to improve water yields and seasonal distribution of runoff by carefully planned logging (7). On the White River Plateau streamflow increased about 25 percent following the extensive kill

of spruce by the Engelmann beetle (16). Cutting in the fir-spruce and lodgepole pine types can greatly affect streamflows and consequently water project plans, reservoir design and operation, power generation, and other facilities and uses (11). Although logging inevitably causes soil disturbance and silt movement, proper application of control measures can prevent serious effects on water quality.

Effects of logging on recreation, wildlife, and grazing are very complex and are not well documented for Colorado. It is possible, however, to mention a few general results that may be expected from controlled harvesting. Scenic and other recreational values need not be impaired if timber is removed gradually along roads and waterways. This is the current practice on most public lands. Harvesting of high risk timber tends to minimize blowdown and insect devastation, and the subsequent danger of big fires. The practice of clear cutting in small areas can favor habitat conditions for wildlife by increasing edge environment, interspersions of vegetation types, and amount, variety, and distribution of food vegetation. Many access roads needed for timber cutting will permit fuller development of other values — and if timber foots much of construction cost, many roads will be built sooner than they otherwise would.

These examples of effects of timber cutting on other forest values and the indicated complex resource relationships illustrate the big problems facing timber managers in meeting future demands on Colorado's forests. There is little doubt that these demands will be big — much bigger than heretofore. Underlying these expected increases in demand is, of course, a predicted increase in population from the present 190 million to about 329 million by 2000. Forecasts of increased timber demands, sharp upward trends in water, recreation, and wildlife use in recent year, and use of grazing lands at or near current capacity all portend heavy future use. It can be expected that Colorado's forests will be called on to make much bigger contributions to the Nation's output of timber and other forest benefits than they have in the past.

<sup>14</sup>U.S. Forest Service, Fraser, Colorado.

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# APPENDIX

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## TERMINOLOGY

### Forest Land

The term *forest land* includes (a) land which is at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10 percent stocking, and which has not been developed for other use; (c) afforested areas.

At the time the fieldwork for this report was performed, the minimum unit of area for forest land classification was 10 acres with a minimum width of stringer strips of 120 feet.

The principal classes of forest land are:

*Commercial forest land.* — Forest land which is (a) producing, or is physically capable of producing, usable crops of wood (usually sawtimber); (b) economically available now or prospectively; (c) not withdrawn from timber utilization.

*Noncommercial forest land.* — Three classes of noncommercial forest land are recognized: *Productive-reserved*, *Unproductive-nonreserved*, and *Unproductive-reserved*.

*Productive-reserved* is public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land.

*Unproductive* indicates forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions or forest land so physically inaccessible as to be unavailable economically in the foreseeable future.

### Forest Types

Forest land is classified into types on the basis of tree species; the type name is that of the predominant species. The predominant species is the one which has a plurality of (a) gross cubic volume in sawtimber and pole-timber stands, or (b) the number of stems in seedling and sapling stands. Both growing stock and cull trees are considered in the classification. Forest types which occur on both commercial and noncommercial forest land are:

Douglas-fir	Bristlecone pine
Ponderosa pine	Fir-spruce
Lodgepole pine	Aspen
Limber pine	Cottonwood

Two additional forest types which occur only on noncommercial forest land are:

Pinyon-juniper  
Chaparral

### Tree-Size Classes

*Sawtimber-size tree*

A tree 11.0 inches d.b.h. or larger

*Pole-size tree*

A tree 5.0 to 10.9 inches d.b.h.

*Seedling-sapling trees*

Trees at least 1 foot high and less than 5.0 inches d.b.h.

### Tree-Merchantability Classes

*Sawtimber tree*

Live tree of commercial species, 11.0 inches d.b.h. or larger, that contains at least one 10-foot log to a merchantable top diameter and having the likelihood of eventually containing at least a 16-foot minimum saw log. Also, at least one-third of the board-foot volume must be free from rot or other defect.

### *Poletimber tree*

Live tree of commercial species, 5.0 to 10.9 inches d.b.h., free of rot and having the likelihood of growing into a sawtimber tree.

### *Sapling and seedling trees*

Live trees of commercial species, less than 5.0 inches d.b.h., with form and quality to qualify as potential poletimber trees.

### *Growing stock trees*

Sawtimber trees, poletimber trees, saplings and seedlings; i.e., all live trees except cull trees.

In discussion and tables on volumes, growth, and mortality, the term *growing stock* refers only to sawtimber trees and poletimber trees; i.e., all live trees 5 inches d.b.h. and larger (except cull trees). Saplings and seedlings are not part of growing stock in this usage of the term.

### *Cull tree*

Live tree of sawtimber or poletimber size that is unmerchantable for saw logs, now or prospectively, because of rot or other defect, or species.

### *Sound cull trees* include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull with at least one-half of this cull the result of sweep, crook, or other sound defect. Also included are sound trees which do not contain at least one 10-foot saw log.

b. Poletimber-size trees that are unlikely to grow into sawtimber trees because of serious fire and basal scars, broken tops, severe mistletoe, crooks, or girdling by porcupine. No rot may be present.

### *Rotten cull trees* include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull, with more than half of the cull due to rot.

b. Poletimber-size trees showing any evidence of rot in the main stem.

### *Mortality tree*

A tree 5.0 inches d.b.h. or larger, standing or down, which has died within the past 5 years and was not a cull tree at time of death.

### *Salvable dead tree*

Dead tree 5.0 inches d.b.h. or larger, standing or down (but not lying on the ground) which has 50 percent or more of its cubic-foot volume in sound wood.

## Stand-Size Classes

### *Sawtimber stands*

A stand with a minimum net volume per acre of 1,500 board feet (International ¼-inch rule) in sawtimber trees. Two classes of sawtimber stands are recognized:

*Large sawtimber.*—A stand in which the majority of the net board-foot volume is in sawtimber trees 21.0 inches d.b.h. and larger.

*Small sawtimber.*—A stand in which the majority of the net board-foot volume is in sawtimber trees from 11.0 to 20.9 inches d.b.h.

### *Poletimber stand*

Stand failing to meet the sawtimber stand specifications, but at least 10 percent stocked with poletimber and larger (5.0 inches d.b.h. and larger) trees and with at least half the stocking in poletimber trees.

### *Seedling and sapling stand*

A stand not qualifying as either a sawtimber or poletimber stand, but having at least 10 percent stocking of trees of commercial species and with at least half the stocking in seedling and sapling trees.

### *Nonstocked area*

An area not qualifying as a sawtimber, poletimber, or a seedling-sapling stand; i.e.,

normally an area less than 10 percent stocked.

### Stocking

Stocking is a measure of the degree to which growing space is utilized by trees. In this report it is expressed as the percentage of the available space that is occupied by tree crowns as viewed on aerial photographs.

#### *Well-stocked stand*

A stand that is 70 percent or more covered by tree crowns.

#### *Medium-stocked stand*

A stand with 40 to 70 percent coverage by tree crowns.

#### *Poorly stocked stand*

A stand with 10 to 40 percent coverage by tree crowns.

#### *Nonstocked area*

An area with less than 10 percent coverage by tree crowns.

### Timber Volume

#### *All-timber volume*

Volume in cubic feet of sound wood in the bole of growing stock, cull, and salvable dead trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top inside bark.

#### *Growing stock volume*

Net volume in cubic feet of sawtimber trees and poletimber trees from stump to a minimum 4.0-inch top inside bark.

#### *Live sawtimber volume*

Net volume in board feet, International  $\frac{1}{4}$ -inch rule, of the saw log portion of sawtimber trees.

#### *Saw log portion*

That portion of the bole of sawtimber trees between the stump and the merchantable top.

#### *Merchantable top*

The point at which the upper limit of saw log merchantability is limited either by limbs or by a minimum diameter. The latter varies with diameter class, ranging from 5 inches inside bark for trees 11 inches at breast height to 10 inches for trees 26 inches or larger.

#### *Upper-stem portion*

That part of the bole of sawtimber trees above the merchantable top to a minimum top diameter of 4.0 inches inside bark.

#### *Quality class*

A classification of sawtimber volume in terms of log grades. Four grades are recognized and distinguished by the occurrence and characteristics of knots. The log grades corresponding to the quality classes are:

*Grade 1 (select logs)* are essentially smooth and surface clear, except that in logs 16 inches and larger in diameter a few visible knots are permitted, providing there are no more than 1 large knot, or 2 medium or small knots, or 4 pin knots. Knot sizes for all grades are:

Pin knots—0.5 inch or less

Small knots—0.5 to 0.75 inch

Medium knots—0.75 to 1.5 inches

Large knots—over 1.5 inches

Occasional logs having a greater number of knots are admitted provided these knots may be boxed in an area not exceeding one-third the area of one face or an equivalent area of two faces.

*Grade 2 (shop logs)* display relatively few knots of any size, so spaced that at least 50 percent of the surface of the log is in smooth, clear areas, the size of which must be at least one-fourth the girth of the log in width, by 4 feet or more in length.

A log with no more than 12 medium or smaller knots, or more than 8 large ones, may be immediately classed as grade 2. If this number of knots is exceeded, the clear area basis governs.

*Grade 3 (common logs)* display either (a) pin, small, or medium knots of which 80 percent are either live or will cut out red (intergrown) beneath the slab, or (b) 16 dead knots (an average of 4 per face) averaging medium in size.

*Grade 4 (low common logs)* display medium, large, and very large live and/or dead knots in excess of the numbers permitted in grades 2 and 3.

#### Growth

*Net annual growth of sawtimber or growing stock*

The average annual change, calculated from the total change over a 10-year period, in net board-foot or cubic-foot volume of live sawtimber or growing stock on commercial forest land.

#### Mortality

*Net annual mortality of sawtimber or growing stock*

The average annual net board-foot or cubic-foot volume removed from live sawtimber or growing stock through death, calculated from the total net volume removed by such causes over a 10-year period.

#### Timber Cut

*Timber cut from growing stock*

The volume of sound wood in live sawtimber and poletimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

*Timber cut from sawtimber*

The net board-foot volume of live sawtimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

*Logging residues from growing stock*

The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging on commercial forest land and not converted to timber products.

#### Ownership Classes

*National Forest lands*

Federal lands which have been designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands.

*Other Federal lands*

Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies.

*State lands*

Lands owned by the State.

*Forest industry lands*

Lands owned by companies or individuals operating wood-using plants.

*Farmer-owned lands*

Lands owned by operators of farms.

*Miscellaneous private lands*

Privately owned lands other than forest-industry or farmer-owned lands.

#### Principal Tree Species

##### *Softwoods*

Douglas-fir	<i>Pseudotsuga menziesii</i>
Fir, subalpine	<i>Abies lasiocarpa</i>
Fir, corkbark	<i>A. lasiocarpa arizonica</i>
Fir, white	<i>A. concolor</i>
Juniper	<i>Juniperus spp.</i>
Pine, bristlecone	<i>Pinus aristata</i>
Pine, limber	<i>P. flexilis</i>
Pine, lodgepole	<i>P. contorta</i>
Pine, ponderosa	<i>P. ponderosa</i>
Spruce, Engelmann	<i>Picea engelmannii</i>
Spruce, blue	<i>P. pungens</i>

##### *Hardwoods*

Aspen, quaking	<i>Populus tremuloides</i>
Cottonwood, black	<i>Populus trichocarpa</i>

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## SURVEY METHODS

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Area statistics were determined by two methods: (1) On National Forests, forest lands were mapped on aerial photographs according to type, stand size, and crown density. Photo delineations were then transferred to base maps. Non-National Forest lands within National Forest were delineated on the maps according to the ownership class. Maps were then dot-counted to obtain the estimates of area by the various land and forest classes and by ownership. (2) For lands outside National Forests a sampling procedure was used. Points were classified on aerial photos to determine the proportion of area by forest versus nonforest, class of forest, and ownership. A percentage of the points was checked on the ground for correctness of classification. Results of the field check were then used to adjust the map and photo estimates of proportions. Acreages were determined by applying the adjusted proportions to the area outside National Forests.

Volume estimates are based on tree measurements taken on 2,196 sample areas located at random on commercial forest lands. Sample locations were pricked on aerial photos then located on the ground and established on a permanent basis to permit remeasurement on future surveys. Each location consisted of a pair of circular plots, 5 chains apart. Each plot consisted of four circular subplots with a common center. The area of subplots and kind of trees tallied on them

are as follows:

- 1/500 acre — live seedling-sapling-size trees
- 1/50 acre — live pole-size trees
- 1/5 acre — live sawtimber-size trees, and all salvable dead trees (pole-size and saw-timber-size)
- 1/3 acre — mortality trees of pole-size and larger

In addition to making the customary measurements and classifications of trees for volume and quality, increment borings were taken for growth estimates.

Formulas equating field measurements to volume, growth, and mortality were applied as part of the machine data processing to provide average volumes per acre for the various classifications based on type, size, stocking, etc. These averages, applied to area estimates, provided volumes shown in statistical tables.

Estimates of timber cut are based on periodic surveys of forest industries. The latest surveys are for 1962 and are the basis for data shown in the appendix tables. Utilization trends discussed in the text are based mainly on lumber production data, since complete information on output of all products for years prior to 1957 is not available. Data for estimating the volume of logging residues are obtained by special studies on active woods operations.



## RELIABILITY OF ESTIMATES

Data collected by sampling are not entirely reliable; i.e., there is a sampling error. Sufficient samples are taken to insure that the error is not above a specified maximum. Magnitude of the errors associated with area and volume estimates for Colorado have been determined by statistical analysis of the data.

Estimates of acreage of the various classes

of forest land were determined by two procedures — mapping (11.8 million acres) and sampling (10.8 million acres). There are no sampling errors for the mapped area. Sampling errors for the sampled portion and for the total estimates of commercial and noncommercial breakdowns are shown in the following tabulation:

	Mapped area		Sampled area			Total forest area		
	<i>Area</i> <i>M acres</i>	<i>SE</i>	<i>Area</i> <i>M acres</i>	<i>SE</i> <i>Acres</i>	<i>SE</i> <i>Percent</i>	<i>Area</i> <i>M acres</i>	<i>SE</i> <i>Acres</i>	<i>SE</i> <i>Percent</i>
<b>Commercial</b>	9,149	0	3,126	41,888	1.34	12,275	41,888	0.34
<b>Noncommercial</b>	2,614	0	7,694	148,492	1.93	10,308	148,492	1.44
<b>Total</b>	11,763		10,820			22,583		

The sampling error for the estimated 17,337 million cubic feet of growing stock in Colorado is  $\pm 1.8$  percent.

The sampling error for the total timber cut in 1962 from growing stock (37,556 cubic

feet) is estimated at  $\pm 2.1$  percent.

All errors are computed on the basis of odds of two out of three that values which would result from a 100-percent cruise would lie within the range indicated by the error.

## APPENDIX TABLES

Table 1.—Area by land classes,  
Colorado, 1959

Land class	Thousand acres
Commercial forest land	12,275
Unproductive forest land	9,843
Productive-reserved forest land	465
Total forest land	22,583
Nonforest land	43,927
All land	166,510

<sup>1</sup>From U.S. Bureau of the Census, *Land and Water Areas of the United States, 1950.*

Table 2.—Area of commercial forest land by  
ownership classes, Colorado, 1959

Ownership class	Thousand acres
National Forest	8,384
Other Federal:	
Bureau of Land Management	415
Indian	103
Miscellaneous Federal	5
Total other Federal	523
State	190
County and municipal	45
Farmer-owned	2,649
Miscellaneous private <sup>1</sup>	484
All ownerships	12,275

<sup>1</sup>Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 3.—Area of commercial forest land by stand-size and  
ownership classes, Colorado, 1959

Stand-size class	All ownerships	National Forest	Other public	Farmer <sup>1</sup> and misc. private
	<i>Thousand acres</i>			
Sawtimber stands:				
Large sawtimber	449	388	38	23
Small sawtimber	5,903	4,252	393	1,258
Total	6,352	4,640	431	1,281
Poletimber stands	4,990	3,240	300	1,450
Sapling and seedling stands	499	342	20	137
Nonstocked areas	434	162	7	265
All classes	12,275	8,384	758	3,133

<sup>1</sup>Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 4.—Area of commercial forest land, by stand-size volume classes for sawtimber and other stand-size classes, Colorado, 1959

Stand volumes per acre <sup>1</sup>	Area by stand-size classes		
	All stands	Sawtimber stands	Other stands
	<i>Thousand acres</i>		
Less than 1,500 board feet	5,090	8	5,082
1,500 to 5,000 board feet	4,436	3,599	837
5,000 to 10,000 board feet	968	964	4
10,000 to 20,000 board feet	1,774	1,774	—
More than 20,000 board feet	7	7	—
All classes	12,275	6,352	5,923

<sup>1</sup>Net volume, International 1/4-inch rule.

Table 5.—Area of commercial forest land, by stocking classes of all live trees and by stand-size classes, Colorado, 1959

Stocking class	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
70 percent or more	3,561	1,741	1,658	162	—
40 to 70 percent	5,789	3,099	2,395	295	—
10 to 40 percent	2,491	1,512	937	42	—
Less than 10 percent	434	—	—	—	434
All classes	12,275	6,352	4,990	499	434

Table 6.—Area of commercial forest land, by forest types and ownership classes, Colorado, 1959

Forest type	All ownerships	Public ownerships	Private ownerships
Douglas-fir	1,451	1,056	395
Ponderosa pine	2,347	1,180	1,167
Lodgepole pine	2,068	1,693	375
Limber and bristlecone pine	139	98	41
Fir-spruce	3,393	3,067	326
Aspen	2,794	2,025	769
Cottonwood	83	23	60
All types	12,275	9,142	3,133

Table 7.—Area of commercial forest land by forest types and by stand-size classes, Colorado, 1959

Forest type	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
<i>Thousand acres</i>					
Douglas-fir	1,451	1,046	397	4	4
Ponderosa pine	2,347	1,504	553	5	285
Lodgepole pine	2,068	714	1,252	95	7
Limber pine <sup>1</sup>	139	62	73	3	1
Fir-spruce	3,393	2,746	485	27	135
Aspen	2,794	201	2,226	365	2
Cottonwood	83	79	4	(2)	(2)
All types	12,275	6,352	4,990	499	434

<sup>1</sup>Includes the area of bristlecone pine.

<sup>2</sup>Less than 0.5 thousand acres.

Table 8.—Area of noncommercial forest land, by forest types, Colorado, 1959

Forest type	All areas	Productive reserved areas	Unproductive areas
<i>Thousand acres</i>			
Douglas-fir	15	15	(1)
Ponderosa pine	22	22	—
Lodgepole pine	89	89	—
Limber pine <sup>2</sup>	10	(1)	10
Fir-spruce	341	315	26
Aspen	341	24	317
Cottonwood	(1)	(1)	—
Chaparral	3,704	—	3,704
Pinyon-juniper	4,674	(1)	4,674
Other	1,112	—	1,112
All types	10,308	465	9,843

<sup>1</sup>Less than 0.5 thousand acres.

<sup>2</sup>Includes the area of bristlecone pine.

Table 9.—Number of growing-stock trees on commercial forest land, by diameter classes and by softwoods and hardwoods, Colorado, 1959

D.B.H. class (inches)	All species	Softwood	Hardwood
	<i>Thousand trees</i>		
1.0- 2.9	2,143,927	1,195,509	948,418
3.0- 4.9	1,650,491	832,373	818,118
5.0- 6.9	869,598	549,654	319,944
7.0- 8.9	482,383	354,717	127,666
9.0-10.9	261,666	220,327	41,339
11.0-12.9	141,913	125,164	16,749
13.0-14.9	84,814	76,822	7,992
15.0-16.9	49,008	45,350	3,658
17.0-18.9	27,510	25,791	1,719
19.0-28.9	32,804	31,694	1,110
29.0-38.9	1,787	1,787	—
39.0 and larger	58	58	—
All classes	5,745,959	3,459,246	2,286,713

Table 10.—Number of cull and salvable dead trees on commercial forest land, by diameter groups and by softwoods and hardwoods, Colorado, 1959

D.B.H. class (inches)	Cull trees	Salvable dead trees
	<i>Thousand trees</i>	
Softwoods:		
5.0- 8.9	58,929	80,351
9.0-18.9	24,144	84,343
19.0 and larger	2,380	8,919
Total	85,453	173,613
Hardwoods:		
5.0-10.9	255,030	38,032
11.0-18.9	8,480	2,692
19.0 and larger	312	94
Total	263,822	40,818
All species	349,275	214,431

Table 11.—Volume of timber on commercial forest land, by class of timber and by softwoods and hardwoods, Colorado, 1959

Class of timber	All species	Softwoods	Hardwoods
	<i>Thousand cubic feet</i>		
Sawtimber trees:			
Saw-log portion	8,807,057	8,274,777	532,280
Upper-stem portion	922,261	756,035	166,226
Total	9,729,318	9,030,812	698,506
Poletimber trees <sup>1</sup>	7,607,288	5,866,135	1,741,153
All growing-stock trees	17,336,606	14,896,947	2,439,659
Sound cull trees:			
Sawtimber-size trees	41,441	37,424	4,017
Poletimber-size trees	234,757	183,165	51,592
Total	276,198	220,589	55,609
Rotten cull trees:			
Sawtimber-size trees	297,054	183,784	113,270
Poletimber-size trees	875,241	98,568	776,673
Total	1,172,295	282,352	889,943
Salvable dead trees:			
Sawtimber-size trees	2,390,611	2,317,901	72,710
Poletimber-size trees	938,457	785,005	153,452
Total	3,329,068	3,102,906	226,162
All timber	22,114,167	18,502,794	3,611,373

<sup>1</sup>Poletimber trees are trees 5.0 inches d.b.h. to 10.9 inches d.b.h.

Table 12.—Volume of growing stock and sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Colorado, 1959

Ownership class	All species	Softwoods	Hardwoods
	GROWING STOCK (Million cubic feet)		
National Forest	13,796	12,044	1,752
Other public	782	650	132
Farmer and misc. private <sup>1</sup>	2,759	2,203	556
All ownerships	17,337	14,897	2,440
	SAWTIMBER (Million board feet) <sup>2</sup>		
National Forest	43,231	40,573	2,658
Other public	2,172	1,920	252
Farmer and misc. private <sup>1</sup>	7,328	6,457	871
All ownerships	52,731	48,950	3,781

<sup>1</sup>Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

<sup>2</sup>International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.

Table 13.—Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by softwoods and hardwoods, Colorado, 1959

Stand-size class	All species	Softwoods	Hardwoods
GROWING STOCK (Million cubic feet)			
Sawtimber stands	12,562	11,818	744
Poletimber stands	4,635	2,982	1,653
Sapling and seedling stands	107	65	42
Nonstocked areas	33	32	1
All classes	17,337	14,897	2,440
SAWTIMBER (Million board feet) <sup>1</sup>			
Sawtimber stands	46,477	44,206	2,271
Poletimber stands	6,052	4,561	1,491
Sapling and seedling stands	83	64	19
Nonstocked areas	119	119	—
All classes	52,731	48,950	3,781

<sup>1</sup>International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.

Table 13a.—Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by species, Colorado, 1959

Stand-size class	All species	Douglas-fir	Ponderosa pine	Lodgepole pine	Limber pine <sup>1</sup>	True firs <sup>2</sup>	Spruce <sup>3</sup>	Other softwoods	Aspen	Cottonwood	Other hardwoods
GROWING STOCK (Million cubic feet)											
Sawtimber stands	12,562	1,216	805	1,675	131	2,117	5,873	1	665	75	4
Poletimber stands	4,635	365	192	1,574	56	282	512	1	1,650	1	2
Sapling and seedling stands	107	9	4	37	2	6	7	—	42	—	—
Nonstocked areas	33	—	16	( <sup>4</sup> )	—	4	12	—	1	—	—
All classes	17,337	1,590	1,017	3,286	189	2,409	6,404	2	2,358	76	6
SAWTIMBER (Million board feet) <sup>5</sup>											
Sawtimber stands	46,477	4,649	3,264	4,644	392	6,358	24,899	—	1,975	285	11
Poletimber stands	6,052	752	432	1,365	73	427	1,512	—	1,488	3	—
Sapling and seedling stands	83	10	13	15	7	8	11	—	19	—	—
Nonstocked areas	119	—	74	—	—	4	41	—	—	—	—
All classes	52,731	5,411	3,783	6,024	472	6,797	26,463	—	3,482	288	11

<sup>1</sup>Includes a minor volume of bristlecone pine.

<sup>2</sup>Subalpine and white firs.

<sup>3</sup>Engelmann and blue spruce.

<sup>4</sup>Less than 0.5 million cubic feet.

<sup>5</sup>International 1/4-inch log rule. Volumes are for trees 11.0 inches d.b.h. and larger.

Table 14.—Volume of growing stock on commercial forest land, by species and diameter groups, Colorado, 1959

Species	Diameter group (inches at breast height)					
	All classes	5.0 to 10.9	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
<i>Million cubic feet</i>						
Softwoods:						
Douglas-fir	1,590	555	757	209	67	2
Ponderosa pine	1,017	208	581	174	53	1
Lodgepole pine	3,286	2,191	1,075	20	—	—
Limber pine <sup>1</sup>	189	97	84	8	—	—
White fir	328	76	147	99	6	—
Subalpine fir	2,081	1,026	985	68	2	—
Spruce <sup>2</sup>	6,404	1,712	3,591	1,037	64	—
Other softwoods	2	1	1	—	—	—
Total	14,897	5,866	7,221	1,615	192	3
Hardwoods:						
Aspen	2,358	1,720	631	7	—	—
Cottonwood	76	17	48	11	—	—
Other hardwoods	6	4	2	( <sup>3</sup> )	—	—
Total	2,440	1,741	681	18	—	—
All species	17,337	7,607	7,902	1,633	192	3

<sup>1</sup>Includes a minor volume of bristlecone pine.

<sup>2</sup>Engelmann and blue spruce.

<sup>3</sup>Less than 0.5 million cubic feet.

Table 14a.—Volume of sawtimber on commercial forest land, by International ¼-inch log rule, species, and diameter groups, Colorado, 1959

Species	Diameter group (inches at breast height)				
	All classes	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
<i>Million board feet</i>					
Softwoods:					
Douglas-fir	5,411	3,801	1,207	393	10
Ponderosa pine	3,783	2,586	850	344	3
Lodgepole pine	6,024	5,910	114	—	—
Limber pine <sup>1</sup>	472	432	40	—	—
White fir	1,342	751	557	34	—
Subalpine fir	5,455	5,069	375	11	—
Spruce <sup>2</sup>	26,463	19,885	6,174	401	3
Other softwoods	—	—	—	—	—
Total	48,950	38,434	9,317	1,183	16
Hardwoods:					
Aspen	3,482	3,445	37	—	—
Cottonwood	288	234	54	—	—
Other hardwoods	11	9	2	—	—
Total	3,781	3,688	93	—	—
All species	52,731	42,122	9,410	1,183	16

<sup>1</sup>Includes a minor volume of bristlecone pine.

<sup>2</sup>Engelmann and blue spruce.



Table 14b.—Volume of sawtimber on commercial forest land by Scribner log rule, species, and diameter groups, Colorado, 1959

Species	Diameter group (inches at breast height)				
	All classes	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
<i>Million board feet</i>					
<b>Softwoods:</b>					
Douglas-fir	4,550	3,122	1,059	359	10
Ponderosa pine	3,043	2,006	718	316	3
Lodgepole pine	5,020	4,918	102	—	—
Limber pine <sup>1</sup>	386	350	36	—	—
White fir	1,156	629	496	31	—
Subalpine fir	4,614	4,270	334	10	—
Spruce <sup>2</sup>	22,862	17,011	5,482	367	2
Other softwoods	—	—	—	—	—
<b>Total</b>	<b>41,631</b>	<b>32,306</b>	<b>8,227</b>	<b>1,083</b>	<b>15</b>
<b>Hardwoods:</b>					
Aspen	2,966	2,933	33	—	—
Cottonwood	245	197	48	—	—
Other hardwoods	10	8	2	—	—
<b>Total</b>	<b>3,221</b>	<b>3,138</b>	<b>83</b>	<b>—</b>	<b>—</b>
<b>All species</b>	<b>44,852</b>	<b>35,444</b>	<b>8,310</b>	<b>1,083</b>	<b>15</b>

<sup>1</sup>Includes a minor volume of bristlecone pine.

<sup>2</sup>Engelmann and blue spruce.

Table 15.—Volume of sawtimber on commercial forest land, by species<sup>1</sup> and quality classes, Colorado, 1959

Species	All classes	Quality classes			
		1	2	3	4
<i>Million board feet<sup>2</sup></i>					
<b>Softwoods:</b>					
Ponderosa pine	3,783	138	258	792	2,595
<b>Total</b>	<b>3,783</b>	<b>138</b>	<b>258</b>	<b>792</b>	<b>2,595</b>

<sup>1</sup>Ponderosa pine is the only species graded.

<sup>2</sup>International -inch rule. Volumes are for trees 11.0 inches d.b.h. or larger.

Table 16.—Volume of salvable dead sawtimber-size trees on commercial forest land, by softwoods and hardwoods, Colorado, 1959

Species group	Volume
	<i>Thousand board feet<sup>1</sup></i>
Softwoods	12,779,000
Hardwoods	393,000
<b>All species</b>	<b>13,172,000</b>

<sup>1</sup>International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.

Table 17.—Net annual growth and annual cut of growing stock on commercial forest land, by species, Colorado

Species	Net annual growth	Annual timber cut
	1959	1962
	<i>Thousand cubic feet</i>	
Softwoods:		
Douglas-fir	8,385	1,410
Ponderosa pine	14,992	4,269
Lodgepole pine	44,299	12,611
True firs	-9,831	1,183
Spruce <sup>1</sup>	63,625	16,415
Other softwoods	2,297	0
Total	123,767	35,888
Hardwoods	37,589	1,668
All species	161,356	37,556

<sup>1</sup>Engelmann and blue spruce.

Table 18.—Net annual growth and annual cut of sawtimber on commercial forest land, by species, Colorado

Species	Net annual growth	Annual timber cut
	1959	1962
	<i>Thousand board feet<sup>1</sup></i>	
Softwoods:		
Douglas-fir	-895	7,574
Ponderosa pine	58,486	23,112
Lodgepole pine	70,753	68,364
True firs	-75,027	6,409
Spruce <sup>2</sup>	269,047	88,757
Other softwoods	6,858	0
Total	329,222	194,216
Hardwoods	90,513	1,385
All species	419,735	195,601

<sup>1</sup>International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.

<sup>2</sup>Engelmann and blue spruce.

Table 19.—Net annual growth and annual cut of growing stock on commercial forest land, by ownership classes and by softwoods and hardwoods, Colorado

Species group	All	National	Other	Farmer <sup>1</sup>
	ownerships	Forest	public	and misc. private
	NET ANNUAL GROWTH, 1959 ( <i>Thousand cubic feet</i> )			
Softwoods	123,767	89,235	7,657	26,875
Hardwoods	37,589	30,159	1,542	5,888
All species	161,356	119,394	9,199	32,763
	ANNUAL TIMBER CUT, 1962 ( <i>Thousand cubic feet</i> )			
Softwoods	35,888	29,393	3,445	3,050
Hardwoods	1,668	1,366	160	142
All species	37,556	30,759	3,605	3,192

<sup>1</sup>Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 20.—Net annual growth and annual cut of sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Colorado

Species group	All ownerships	National Forest	Other public	Farmer <sup>1</sup> and misc. private
NET ANNUAL GROWTH, 1959 (Thousand board feet) <sup>2</sup>				
Softwoods	329,222	235,469	23,577	70,176
Hardwoods	90,513	60,892	5,478	24,143
All species	419,735	296,361	29,055	94,319
ANNUAL TIMBER CUT, 1962 (Thousand board feet) <sup>2</sup>				
Softwoods	194,216	159,063	18,645	16,508
Hardwoods	1,385	1,134	133	118
All species	195,601	160,197	18,778	16,626

<sup>1</sup>Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

<sup>2</sup>International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.

Table 21.—Annual mortality of growing stock and sawtimber on commercial forest land, by species, Colorado, 1959

Species	Growing stock	Sawtimber
	Thousand cubic feet	Thousand board feet <sup>1</sup>
Softwoods:		
Douglas-fir	14,968	82,679
Ponderosa pine	3,967	20,178
Lodgepole pine	12,593	42,509
True firs	54,844	219,133
Spruce	20,439	108,835
Other softwoods	269	1,133
Total	107,080	474,467
Hardwoods	33,191	75,051
All species	140,271	549,518

<sup>1</sup>International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.

<sup>2</sup>Engelmann and blue spruce.

Table 22.—Annual mortality of growing stock and sawtimber on commercial forest land by ownership classes and by softwoods and hardwoods, Colorado, 1959

Ownership class	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Thousand cubic feet			Thousand board feet <sup>1</sup>		
National Forest lands	108,740	88,049	20,691	451,378	399,141	52,237
Other public lands	5,916	3,700	2,216	18,010	14,129	3,881
Farmer and miscellaneous private lands <sup>2</sup>	25,615	15,331	10,284	80,130	61,197	18,933
All ownerships	140,271	107,080	33,191	549,518	474,467	75,051

<sup>1</sup>International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.

<sup>2</sup>Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 23.—Annual mortality of growing stock and sawtimber on commercial forest land, by causes and by softwoods and hardwoods, Colorado, 1959

Cause of death	Growing stock			Sawtimber		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
	<i>Thousand cubic feet</i>			<i>Thousand board feet<sup>1</sup></i>		
Fire	279	266	13	1,076	1,074	2
Insects	45,301	44,743	558	204,574	202,815	1,759
Disease	70,650	42,436	28,214	248,193	185,122	63,071
Other	20,156	16,715	3,441	81,930	74,390	7,540
Unknown	3,885	2,920	965	13,745	11,066	2,679
All causes	140,271	107,080	33,191	549,518	474,467	75,051

<sup>1</sup>International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.

Table 24.—Total output of timber products by products, by type of material used, and by softwoods and hardwoods, Colorado, 1962

Product and species group	Total output in standard units		Output from roundwood from growing stock		Output from nongrowing stock sources		Output from plant by-products (standard units)
	Unit	Number	Standard units	M cubic feet	Standard units	M cubic feet	
Saw logs:							
Softwood	M bd. ft. <sup>1</sup>	183,490	177,251	30,300	6,239	1,066	0
Hardwood	M bd. ft. <sup>1</sup>	1,155	1,116	190	39	7	0
Total	M bd. ft. <sup>1</sup>	184,645	178,367	30,490	6,278	1,073	0
Pulpwood: <sup>2</sup>							
Poles:							
Softwood	M pieces	53	53	482	0	0	0
Hardwood	M pieces	0	0	0	0	0	0
Total	M pieces	53	53	482	0	0	0
Mine timbers:							
Softwood	M cu. ft.	1,409	1,329	1,329	80	80	0
Hardwood	M cu. ft.	2	2	2	0	0	0
Total	M cu. ft.	1,411	1,331	1,331	80	80	0
Miscellaneous industrial wood <sup>3</sup>							
Softwood	M cu. ft.	605	409	409	196	196	0
Hardwood	M cu. ft.	1,341	1,331	1,331	10	10	0
Total	M cu. ft.	1,946	1,740	1,740	206	206	0
Posts:							
Softwood	M pieces	368	361	323	7	6	0
Hardwood	M pieces	0	0	0	0	0	0
Total	M pieces	368	361	323	7	6	0
Fuelwood:							
Softwood	M std. cords	26	0	0	8	549	18
Hardwood	M std. cords	2	0	0	2	153	0
Total	M std. cords	28	0	0	10	702	18
All products:							
Softwood		0	0	32,843	0	1,897	0
Hardwood		0	0	1,523	0	170	0
Total		0	0	34,366	0	2,067	0

<sup>1</sup>International 1/4-inch rule.

<sup>2</sup>Included in miscellaneous industrial wood to avoid disclosure of a single operation.

<sup>3</sup>Includes excelsior bolts, house logs, match-splintlogs, pulpwood.

Table 25.—Total output of roundwood products, by source and by softwoods and hardwoods, Colorado, 1962

Source	All species	Softwoods	Hardwoods
	<i>Thousand cubic feet</i>		
Growing-stock trees: <sup>1</sup>			
Sawtimber trees	27,520	27,293	227
Poletimber trees	6,846	5,550	1,296
Total	34,366	32,843	1,523
Cull trees <sup>1</sup>	0	0	0
Salvable dead trees <sup>1</sup>	2,067	1,987	170
Other sources <sup>2</sup>	0	0	0
All sources	36,433	34,740	1,693

<sup>1</sup>On commercial forest land.

<sup>2</sup>Includes noncommercial forest land, nonforest land such as fence rows, trees less than 5.0 inches in diameter, and treetops and limbs.

Table 26.—Annual timber cut from growing stock on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Colorado, 1962

Products and residues	All species	Softwoods	Hardwoods
	<i>Thousand cubic feet</i>		
Roundwood products:			
Saw logs	30,490	30,300	190
Poles	482	482	0
Mine timbers	1,331	1,329	2
Miscellaneous industrial wood	1,740	409	1,331
Posts	323	323	0
All products	34,366	32,843	1,523
Logging residues	3,190	3,045	145
Timber cut	37,556	35,888	1,668

Table 27.—Annual timber cut from live sawtimber on commercial forest land, by products and logging residues and by softwoods and hardwoods, Colorado, 1962

Products and residues	All species	Softwoods	Hardwoods
Roundwood products:			
Saw logs	178,367	177,251	1,116
Poles	2,820	2,820	0
Mine timbers	391	385	6
Miscellaneous industrial wood	533	326	207
Posts	1,105	1,105	0
All products	183,216	181,887	1,329
Logging residues	12,385	12,329	56
Timber cut	195,601	194,216	1,385

<sup>1</sup>International 1/4-inch rule.

Table 28.—Volume of plant residues by industrial source and type of residue, and by softwoods and hardwoods, Colorado, 1962

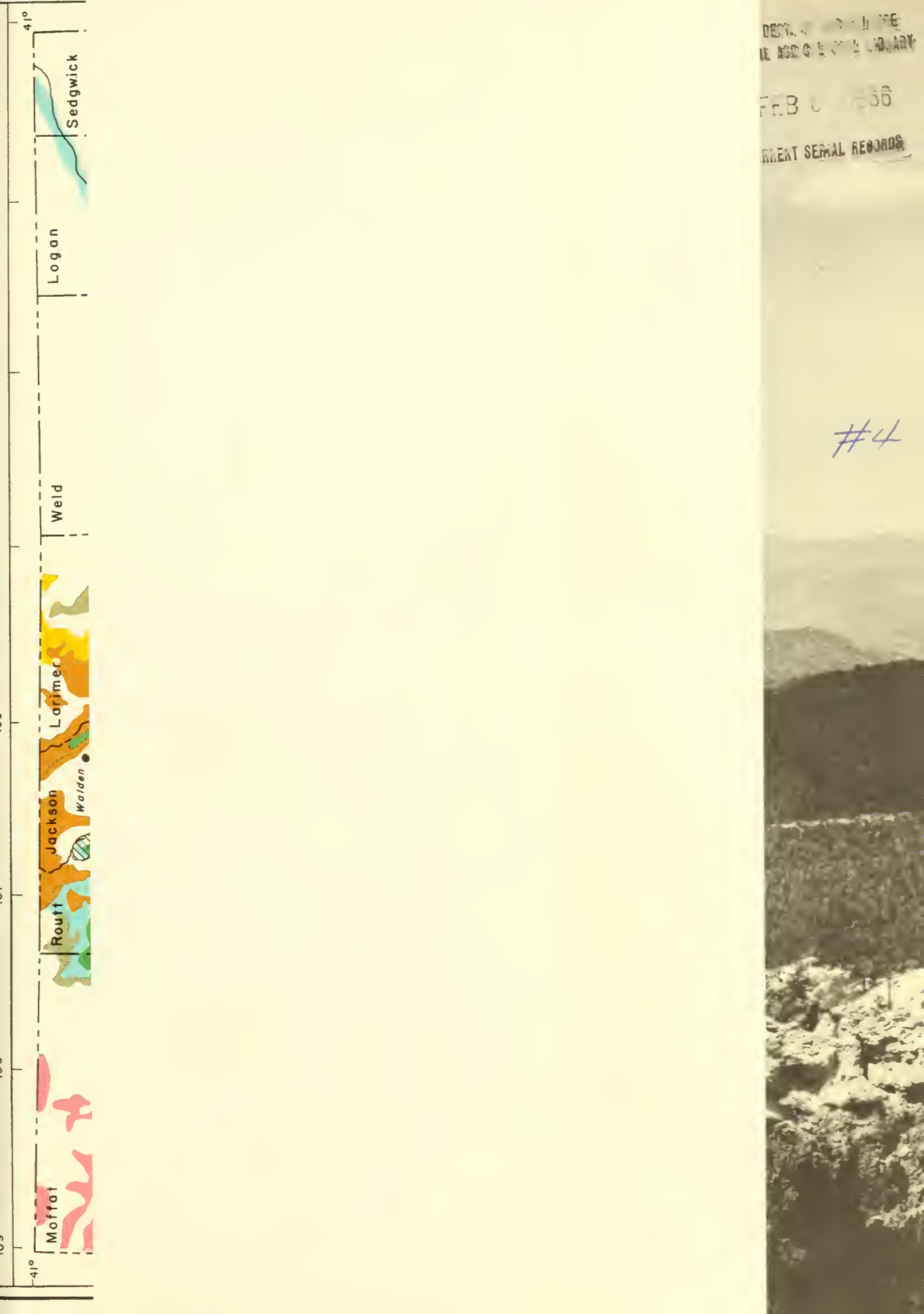
Industrial source	Species and character of residues								
	All species			Softwoods			Hardwoods		
	Total	Coarse <sup>1</sup>	Fine <sup>2</sup>	Total	Coarse	Fine	Total	Coarse	Fine
	<i>Thousand cubic feet</i>								
Lumber industry	15,019	7,436	7,583	14,929	7,391	7,538	90	45	45
Veneer and plywood industry	0	0	0	0	0	0	0	0	0
Other primary industries	856	856	0	300	300	0	556	556	0
All industries	15,875	8,292	7,583	15,229	7,691	7,538	646	601	45

<sup>1</sup>Unused material suitable for chipping, such as slabs, edgings, and veneer cores.

<sup>2</sup>Unused material not suitable for chipping, such as sawdust and shavings.

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