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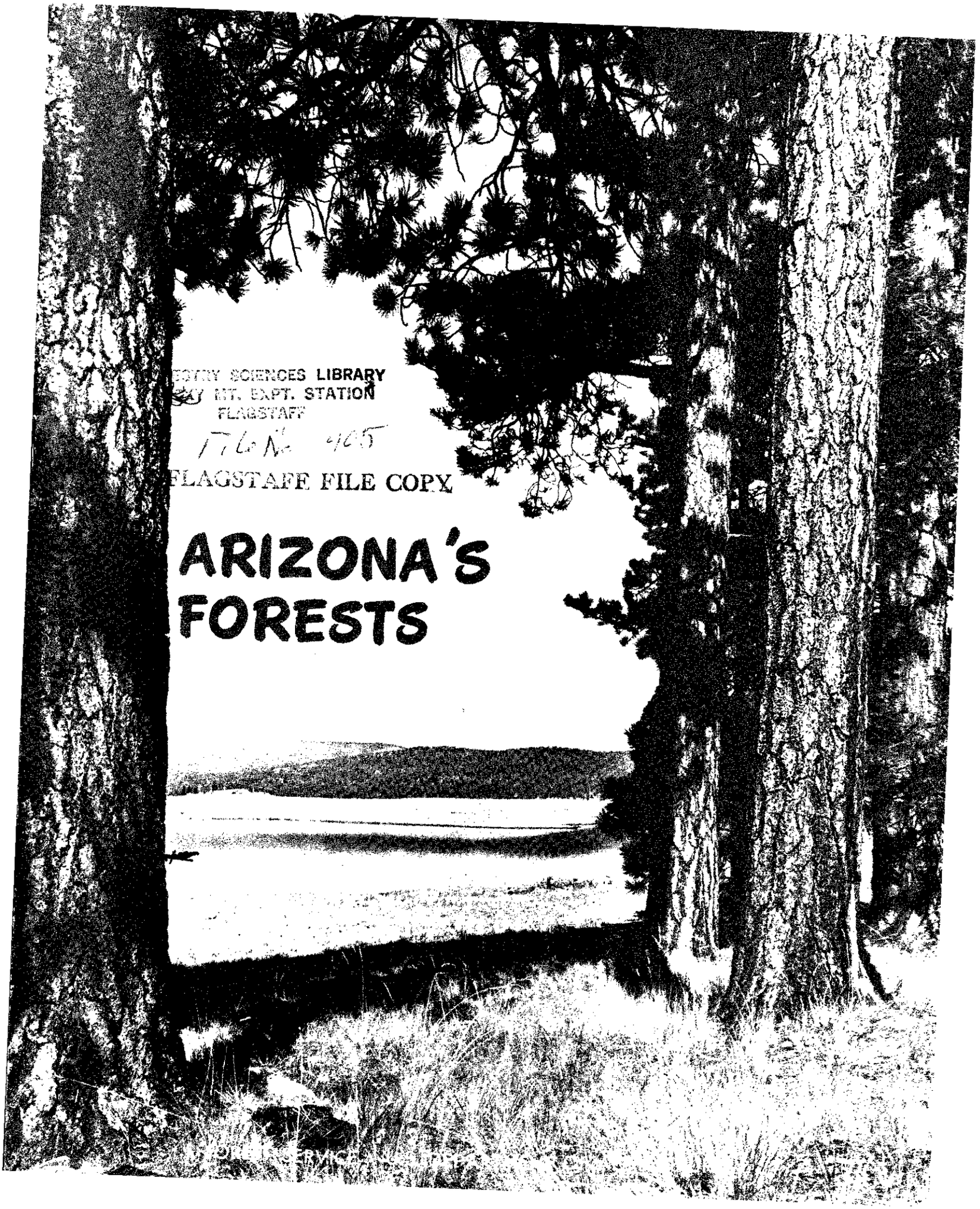
ARIZONA'S FORESTS



THE AUTHOR

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COVER PHOTO

Big Lake with the White Mountains in the background. This view from a ponderosa pine stand on the Apache National Forest near Springerville is one of the many scenic settings to be found on Arizona's forest lands.

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ARIZONA'S FORESTS

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FOREST SERVICE / U.S. DEPARTMENT OF AGRICULTURE

FOREWORD

This report is concerned primarily with timber. It presents figures regarding significant factors bearing on the present economics of this resource. Another purpose is to describe some of the most important considerations that bear on future development of the timber resource. Other forest values — water, recreation, and forage — are discussed briefly. Trends in use of these resources must be considered in relation to timber, because practically no forest lands are managed for timber alone.

Timber inventory statistics in this report are the most reliable that have ever been collected for Arizona's forests. The Southwestern Region of the U. S. Forest Service conducted surveys of National Forests, the Bureau of Indian Affairs of Indian Reservations, and the Intermountain Forest and Range Experiment Station of the other lands. A survey of timber cut and timber products output was done on a cooperative basis by the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, and Intermountain Forest and Range Experiment Station, Ogden, Utah. The Intermountain Station compiled data from these various surveys for this report.

Meaningful comparisons cannot be made between inventory statistics in this report and those shown in the last two national timber appraisals. Differences in figures in this report from those for 1952 as shown in **Timber Resources for America's Future** (U. S. Forest Serv. 1958)[1] do not reflect actual changes in forest conditions. The 1952 figures were not based on a complete survey. Also, in the intervening years, there have been changes in standards for classifying trees and commercial forest land. Inventory statistics in **Timber Trends in the United States** (U. S. Forest Serv. 1965) were not based on a complete inventory and therefore do not agree with figures in this report. The latter are based on fieldwork completed in 1962, but complete data were not available for the Timber Trends report because compilations were not finished until late 1964.

Definitions of terms, survey methods, reliability of estimates, and detailed timber statistics will be found in the Appendix, which also contains a generalized forest type map.

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[1]*Names and dates in parentheses refer to Literature Cited, page 37.*

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STATISTICAL HIGHLIGHTS

FOREST AREA

- The forest area is 20.6 million acres — 28 percent of Arizona's land area.
- The pinyon-juniper type covers 12.2 million acres — 17 percent of the land area of the State.
- The commercial forest includes 4 million acres.
- Ninety-six percent of the commercial forest area is in public ownership.
- The National Forests account for 66 percent of the commercial forest.
- Sawtimber stands comprise 94 percent of the commercial forest area — a higher proportion than for any other State.
- Ponderosa pine is the dominant timber type — it covers 92 percent of the commercial forest area.

TIMBER VOLUME

- Sawtimber stands average 7,132 board feet per acre[2] compared with a Rocky Mountain States[3] average of 9,957 board feet per acre.
- Commercial forests contain 6.1 billion cubic feet in sound, live trees; the volume in sawtimber trees is 27 billion board feet.
- Ponderosa pine accounts for 22.9 billion board feet of sawtimber — 85 percent of the total sawtimber inventory.
- Ninety-eight percent of both the cubic-foot and board-foot timber volume is publicly owned.
- Pinyon pine and juniper volume on noncommercial forest land is about 2 billion cubic feet.

[2]*Board-foot volume in saw logs and sawtimber trees is based on International ¼-inch log rule in this report. Lumber volume is based on lumber tally.*

[3]*The Rocky Mountain States are considered to be Montana, Idaho, Wyoming, Colorado, Utah, Nevada, Arizona, and New Mexico in this report.*

STAND CONDITIONS

- The area of sawtimber stands is about equally divided between old growth and young growth.
- About 17 percent of the area of sawtimber stands is less than 40 percent stocked.
- Net annual growth on commercial forest land is 23 cubic feet per acre compared with the average for the Rocky Mountain States of 14 cubic feet per acre.
- Mortality averages less than 6 cubic feet per acre annually. This is the lowest in the Rocky Mountain States, the average for which is 15 cubic feet per acre per year.
- Destructive agents kill 114 million board feet of sawtimber yearly, which is equivalent to one-fourth the gross annual sawtimber growth.

TIMBER USE

- The 1962 harvest of 65.9 million cubic feet amounted to more than 1 percent of inventory. This is the highest cutting rate of any of the Rocky Mountain States.
- Seventy-six percent of the output of timber products in 1962 was used for lumber and 12 percent for pulpwood.
- In 1962 there were 28 active sawmills which produced a total of 326 million board feet of lumber.
- The number of active sawmills dropped from 38 in 1960 to 28 in 1962 and total lumber production fell slightly, but the average annual production per mill rose from 8.7 million board feet to 11.6 million board feet.
- Coconino County was the only county in which more than 100 million board feet of saw logs were harvested.

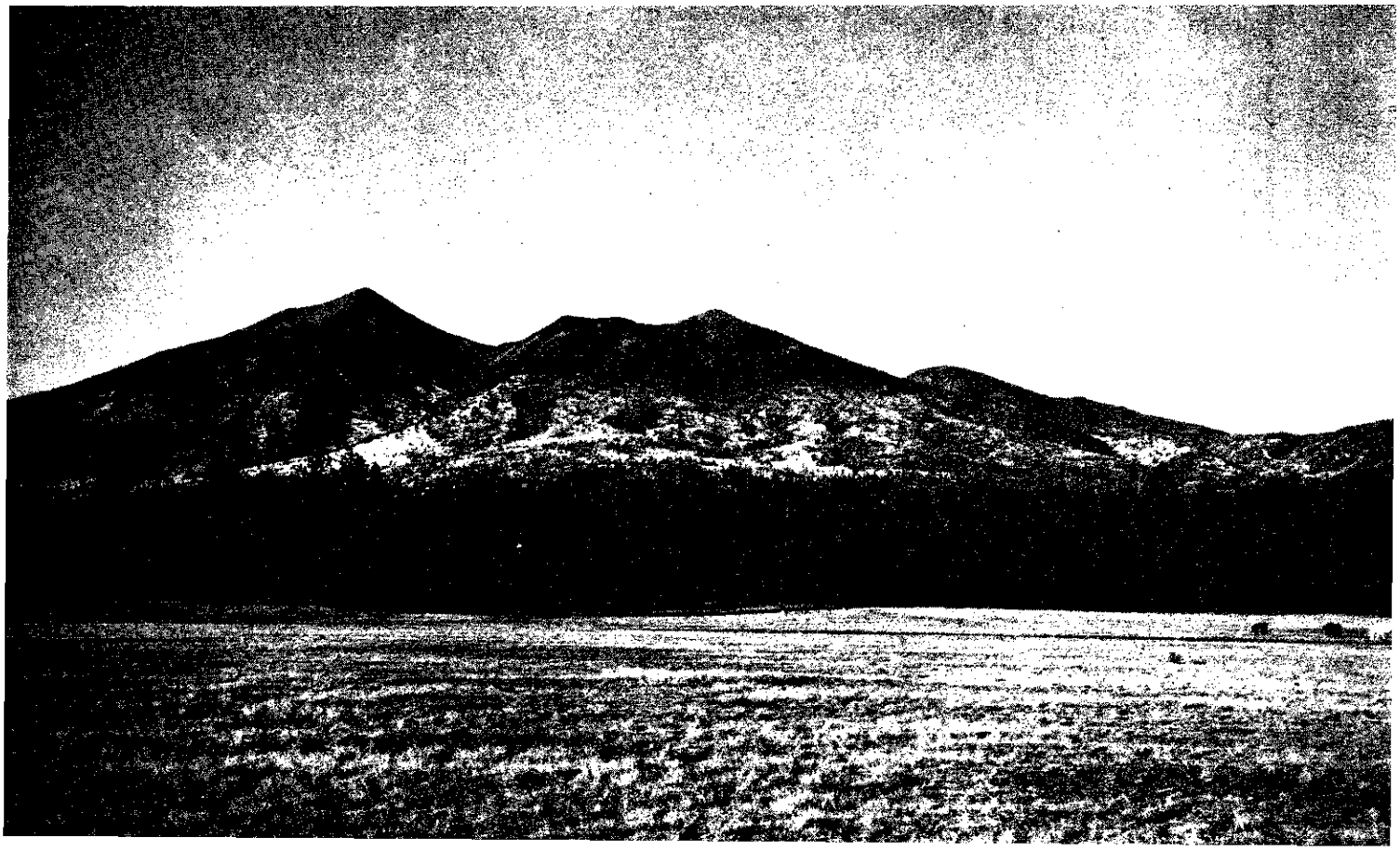
THE FOREST

Arizona's landforms and climate are a study in extremes. They range from the hot, flat desert of the south, on which snow rarely falls, to the 12,670-foot "high place of the snows" as the San Francisco Peaks near Flagstaff were known to the Hopi Indians. North of the desert lie the foothills and low mountains of central Arizona. This rugged topography rises in elevation northward and ends abruptly at the Mogollon Rim, a great escarpment running diagonally in a northwesterly direction across the center of the State. Beyond this rim — romanticized in the writings of Zane Grey as the "Tonto Rim" — the land flattens out to a high plateau that encompasses most of the northern half of the State. Arizona's forests are mostly found in a wide band along the rim.

These forests include 4 million acres of commercial forest land,[1] which contain the most extensive continuous area of ponderosa pine of any State in the country. There are also 17 million acres of noncommercial forest land, which principally produce scrub trees and brush. Besides timber, Arizona's forest lands have important values for water production, recreation uses, and forage for livestock and wildlife. Coronado and his band of conquistadores could only guess at the future significance of these resources in 1540 as they marched through the forests of what is today Arizona.

[1]*Land which is producing or is capable of producing crops of industrial wood and is not withdrawn from timber utilization.*

Forested slopes of the San Francisco Peaks near Flagstaff. Humphrey's Peak — the highest point in the State at 12,670 feet — is the sharp peak on the left. Forest types can be seen in elevational bands. Ponderosa pine at the base gives way to aspen and Douglas-fir in the center of the slope. The fir-spruce type appears as the dark upper band.



Timber types range from about 4,000 to 12,000 feet elevation

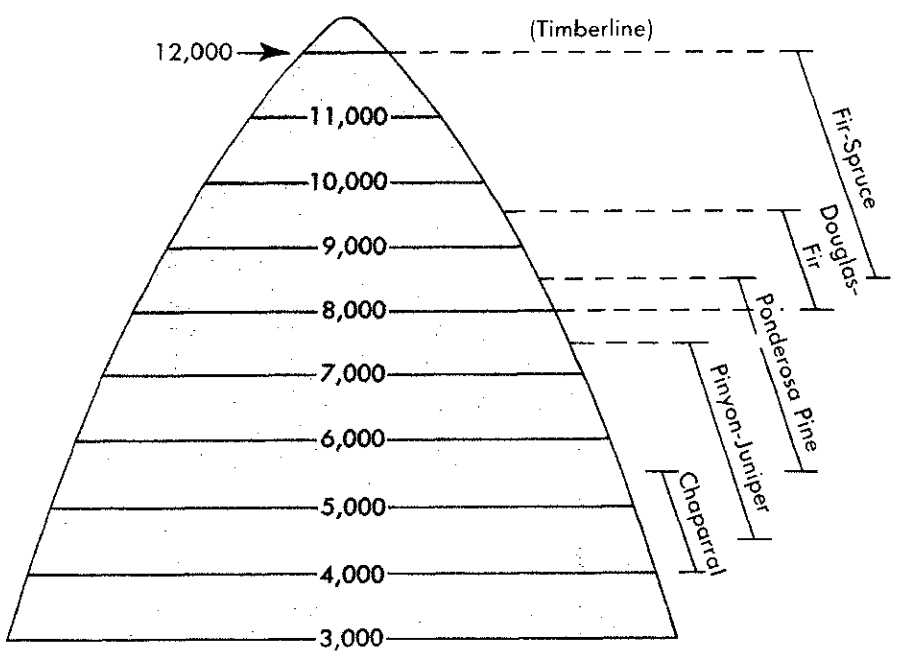
The chaparral type[5] begins at an elevation of about 4,000 feet (as shown schematically below). This mixture of scrub oak and brush species blends into the pinyon-juniper type at about 4,500 feet and soon drops out of the stand completely. The ponderosa pine type is first encountered at about 5,500 feet and is displaced at about 8,000 feet by the Douglas-fir type, which is a mixture of Douglas-fir, white fir, quaking aspen, and limber pine. In some areas at this elevation aspen predominates, and such stands are recognized as a distinct forest type. The fir-spruce type, which contains Engelmann spruce, subalpine fir, and corkbark fir, grows from about 8,500 feet up to timberline (around 12,000 feet). The stratification described above is quite general and local conditions of soil, topography, and climate cause many variations.

The distribution of species is largely determined by precipitation and other climatic influences. Ponderosa pine, sometimes called America's near-desert timber tree, requires at least 19 inches of annual precipitation to grow. In the northern part of Arizona, rain

[5] *"Chaparral" as used by Forest Survey is a loose term denoting a variety of brush and shrub species — principally scrub oak, manzanita, sumac, cliffrose, and ceanothus in Arizona. Forest Survey classifies it as a forest type even though the chaparral type does not usually support commercial forest trees.*

GENERAL ELEVATIONAL RANGES OF THE PRINCIPAL FOREST TYPES FOUND IN ARIZONA

(in feet above sea level)



Adapted from "Southwestern Trees — A Guide to the Native Species of New Mexico and Arizona," by Elbert L. Little, Jr.

Junipers, which have been pushed over by bulldozers, are burned in the Beaver Creek drainage of the Coconino National Forest.

and snow provide this amount of water at about 5,500 feet. Similar moisture conditions in the southern portion of the State are found nearly 1,000 feet higher.

Grazing and fire both have had their effects upon species distribution too. Past overgrazing and the resulting destruction of grass cover appear to have enabled ponderosa and pinyon pines and juniper trees to become established on some former grasslands. Before organized fire control efforts were initiated, frequent wildfires created openings in pinyon-juniper stands. Temporary communities of grass grew on these sites and were later replaced by trees. Now, however, with better protection the area of pinyon-juniper has tended to increase at the expense of grasslands because of the ability of the trees to dominate understory plants (Arnold et al. 1964).

About four-fifths of the forest area is classed as noncommercial

About 16.6 million acres or 81 percent of Arizona's forest are classed as noncommercial — mostly lands that are not suitable for commercial timber production. Three-fourths of this area is owned by the public. National Forests and Indian lands together account for 66 percent of the total noncommercial area.

About 353,000 acres are classed as commercial, but are reserved from timber harvesting and are therefore considered noncommercial. Some of these reserved lands lie within Grand Canyon National Park, Lake Mead National Recreation Area, and National Monuments; others are in primitive, wild, and wilderness areas within National Forests.

The bulk of the noncommercial forest area — the chaparral and pinyon-juniper types — is found in the dry lower limits of the forest where precipitation is not sufficient to support commercially important species. Some areas of other types occur within the commercial zone on patches of shallow soils or otherwise harsh sites where tree growth and quality are minimal. Almost three-quarters of the noncommercial forest consists of pinyon-juniper woodlands. This

type covers more than 12 million acres in Arizona — three times the area of commercial forests in the State. This constitutes 17 percent of the total land area in the State. Nearly 4 million acres of chaparral and about 0.6 million acres of ponderosa pine, Douglas-fir, fir-spruce, and other types complete the noncommercial forest area.

Pinyon pine trees on noncommercial forest land contain an estimated 953 million cubic feet of wood, and junipers total about 1,040 million cubic feet. Some forest products — Christmas trees, fenceposts, fuelwood, and pinyon nuts — are harvested from these lands. However, demand for most of these products is small. Extremely slow growth rates, small tree size, poor form, high cost of harvesting wood, and a shortage of markets for wood products are factors that tend to discourage timber management on pinyon-juniper lands.

These woodlands are more important for forage than for timber even though forage yields per acre are low in the pinyon-juniper type. Demand for grazing land is high. Although sparse, the grasses that grow in pinyon-juniper stands are valuable feed for domestic livestock. Forage production is slim in these stands. Grasses are forced out by the trees because pinyon pines and junipers are better able to compete for the limited soil moisture. For this reason, many land managers have begun to remove these trees on both public and private woodlands by cabling, bulldozing, and/or fire and to replace them with perennial grasses. Between 1950 and 1961, more than 1 million acres of pinyon-juniper lands were cleared in Arizona (Arnold et al. 1964).

An intensive survey, designed to classify the 12 million acres of pinyon-juniper woodland into potential use categories, would be useful in determining which of these lands should receive treatment. A classification of this type is advisable because the removal of pinyon-juniper trees has significant effects on other resources.

Increases in forage production following pinyon-juniper removal are well documented. These have ranged from 200 to nearly 700 pounds (dry weight) of herbage per acre. However, the effects of this land treatment on big game food and cover, soil erosion, and water yields are not as well known. Studies are underway to learn more about these relationships.

The commercial forest is almost all publicly owned

Nearly all the commercial forest area (96 percent) and timber volume (98 percent) are in public ownerships — principally National Forest. The 4 percent in private holdings is the smallest proportion of privately owned commercial forest land area of any State except Alaska. The Rocky Mountain States average for commercial forest land in private ownership is 23 percent. Ownership distribution in Arizona is as follows:

	Thousand acres	*Million cubic feet*	*Million board feet*
National Forest	**2,630**	**4,389**	**19,153**
Indian	**1,144**	**1,533**	**7,218**
Bureau of Land Management	**2**	([1])	**1**
State	**32**	**22**	**74**
County and municipal	**2**	**1**	**4**
Farmer	**82**	**87**	**299**
Miscellaneous private	**85**	**59**	**202**
Total	**3,977**	**6,091**	**26,951**

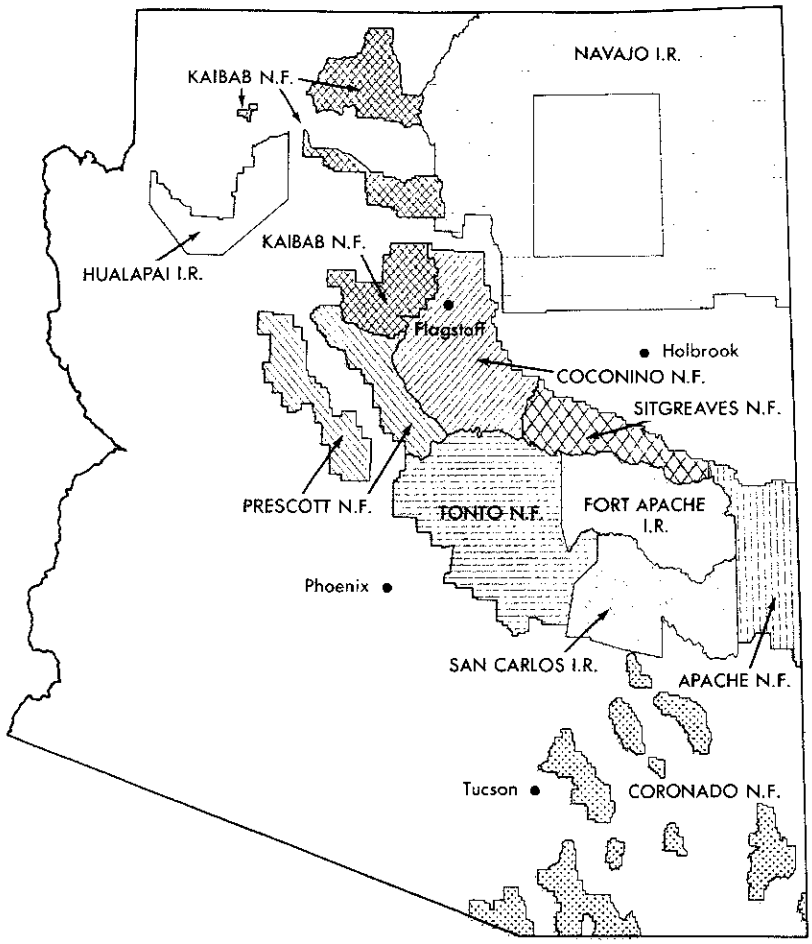
[1]*Less than 500,000 cubic feet.*

Accordingly, most of the harvest of timber products is on public lands. A report by Wilson (1964) on the 1962 output of timber products in Arizona shows the following distribution of yield by land ownership classes:

	Percent
National Forest	**69.3**
Other public	**21.6**
Private	**9.1**
Total	**100.0**

The lands that comprise Arizona's seven National Forests were set aside from the public domain between 1898 and 1908 to

NATIONAL FORESTS AND PRINCIPAL TIMBERED INDIAN RESERVATIONS IN ARIZONA



preserve watershed and timber values on these areas. The Prescott was the first National Forest established in the State. Most National Forests are found in the high plateau, foothill, and mountainous country of central Arizona. One, the Coronado, consists of scattered stringers in the short mountain chains of the southeastern corner of the State. The Apache and Coronado National Forests extend into New Mexico. Indian lands comprise 29 percent of the States' commercial forest area. Practically all of this area is found on the four Reservations shown in the map above — the Navajo, Fort Apache, San Carlos, and Hualapai. There are other Indian Reservations in Arizona, but none contain significant amounts of commercial forest land. The Fort Apache and Navajo Indian Reservations are the most important, with 63 percent and 25 percent of the total Indian commercial forest land, respectively. Indian Reservation lands are under Federal trusteeship and are managed by the Bureau of Indian Affairs.

Most of the commercial forest area is in sawtimber stands

Sawtimber stands dominate the commercial forest, constituting 94 percent of the

area! No other State has such a high proportion of sawtimber stands: the average for the Rocky Mountain States as a whole is only 59 percent while the average is much less for the United States (41 percent).

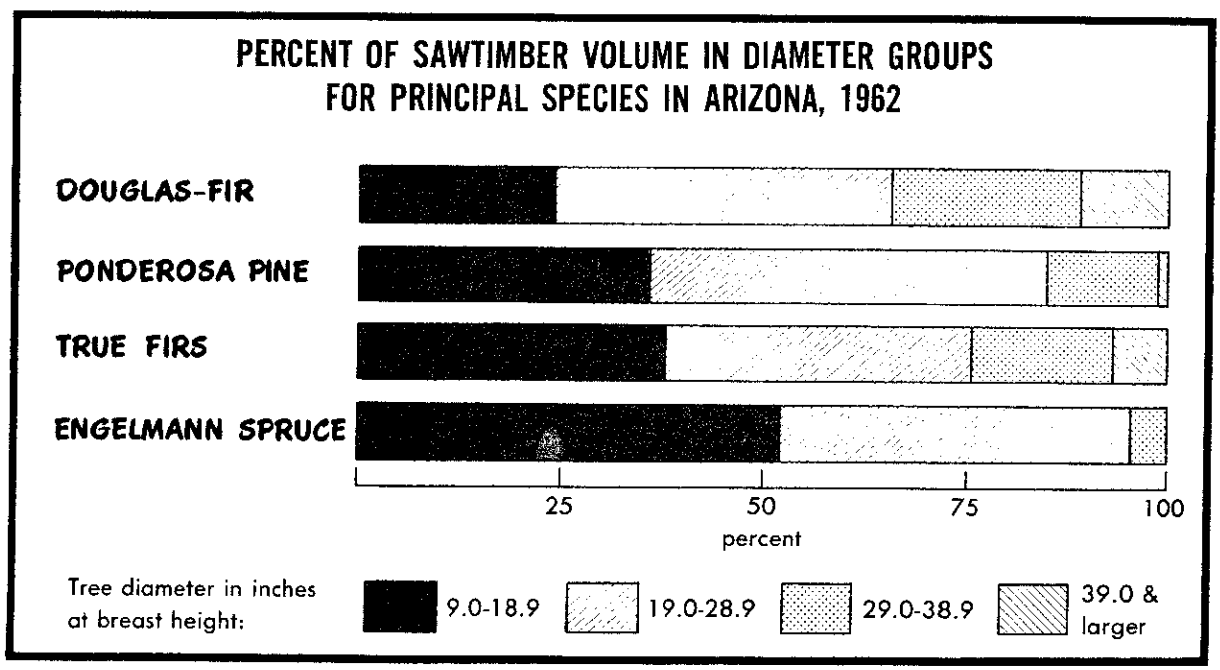
The area of sawtimber stands is divided almost equally between old growth stands (about 2 million acres) and young growth stands (about 1.8 million acres). The former are generally over 120 years old. In volume, sawtimber stands total about 6 million cubic feet or 26.7 million board feet. The remaining 6 percent of the commercial forest area is classed by area and volume as follows:

	Thousand acres	*Million cubic feet*	*Million board feet*
Poletimber stands	**128**	**136**	**238**
Sapling and seedling stands	**41**	**5**	**16**
Nonstocked areas	**65**	**1**	**3**
Total	**234**	**142**	**257**

Nearly one-half the sawtimber stands in the State have less than 5,000 board feet per acre. The average volume per acre in sawtimber stands in Arizona is only 7,132 board feet[6] compared to an average of 9,957 board feet for the Rocky Mountain States.

Approximately 41 percent of the commercial forest area is well stocked, while only 17 percent is either poorly stocked or nonstocked. These figures, however, fall short of giving an adequate picture of how well the land is being used by trees. Actually, many of the young stands that are classed as well stocked are overstocked to the point of stagnation. Unless overstocked stands are thinned while they are still young and vigorous enough to respond to better growing conditions, they will yield no appreciable volume of sawtimber. There is also evidence that only a minor portion of the area that is considered well stocked with live trees (including cull trees) has an adequate number of desirable trees. The latter are the healthy, vigorous, and well-formed trees that forest managers try to grow and feature in management.

[6] *Includes volume of all sound, live softwood trees 9.0 inches and larger and hardwood trees 11.0 inches and larger in diameter at breast height (d.b.h.).*



Of the nearly 27 billion board feet of sawtimber in Arizona, 85 percent is ponderosa pine. Douglas-fir (5 percent), Engelmann spruce (5 percent), and true firs (3 percent) account for most of the remaining sawtimber volume. Practically all this volume is found in sawtimber stands.

As shown in the chart at left, the bulk (64 percent) of the sawtimber volume is in trees 19 inches in diameter and larger. Seventeen percent is in trees 29 inches in diameter and larger.

Site index[7] is indicative of the height that the taller trees in a stand can attain at a certain age. The percentage distribution by area of Arizona's ponderosa pine type according to site index classes is as follows:

Site index class	*Percent of area*
40	**7**
50	**20**
60	**33**
70	**24**
80	**11**
90	**3**
100	**2**
Total	**100**

Growth rate is highest of Mountain States, but is far short of potential

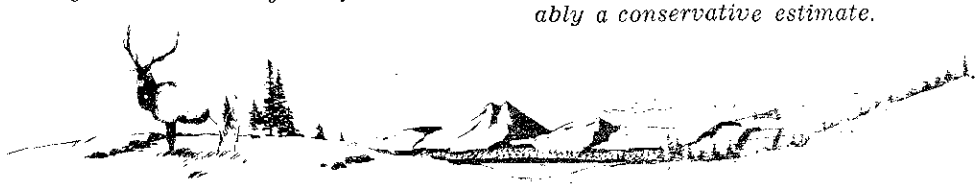
Net annual growth in the commercial forest averages 23 cubic feet per acre compared to the Mountain States average of 14 cubic feet per acre. Part of the reason for Arizona's comparatively high net growth rate is the extremely low rate of tree mortality (mortality is subtracted from gross growth to determine net growth). Less than 6 cubic feet per acre is lost annually to mortality. This is the lowest of the Rocky Mountain States, the average for which is 15 cubic feet per acre per year.

The principal reason for Arizona's low mortality rate is that mature trees have been harvested before they died. This resulted from the widespread selective logging in the past made possible by the State's relatively accessible timber stands. Arizona's overmature stands, consequently, are not as decadent as old growth stands in most of the other Rocky Mountain States. This is important because 52 percent of the State's sawtimber stands is classed as old growth.

Although Arizona's present net growth rate is impressive when compared with other Rocky Mountain States this is still only roughly one-half of its potential yield. The inherent capacity of the State's commercial forest lands to grow wood is estimated to average 43 cubic feet per acre per year.[8] Yield is the volume of wood that could be grown every year if all stands had an optimum distribution of age classes and were fully stocked and adequately protected. Because these ideal conditions do not exist presently, and probably will not exist for a long time, potential yield remains a goal toward which forest managers aim.

[7]*Site index is the height in feet of average dominant and codominant trees at a specified age (100 years for ponderosa pine). For example, "site index 60" for ponderosa pine means that the height of dominant and codominant trees in the area average or will average 60 feet in 100 years.*

[8]*Estimate developed for ponderosa pine by relating measurements of height and age of sample dominant and codominant trees to yield information shown in U. S. Dep. Agr. Tech. Bull. 630, "Yield of even-aged stands of ponderosa pine," by Walter H. Meyer, 1938, rev. 1961. Yields correspond to the mean annual growth of sound, live trees 5 inches d.b.h. and larger (not including thinnings) attainable in fully stocked stands at culmination of mean annual increment. The average estimate of 43 cubic feet per acre per year for the entire commercial forest is based on the assumption that potential yields of all species are the same as for ponderosa pine and is probably a conservative estimate.*



The area of commercial forest land within productivity classes and the estimated potential yield of all sound, live trees from each are shown below:

Productivity class	Area		Estimated potential yield
Cubic feet per acre	*M acres*	*Percent of total*	*M cubic feet*
85-120	56	1	5,748
50-85	880	22	59,405
20-50	3,041	77	106,424
Total	3,977	100	171,577

The total potential annual yield of sawtimber is estimated to be 617 million board feet or 169 board feet per acre. The above potentials will be pushed even higher to the extent that trees are harvested before they are lost through mortality. Sawtimber yields can be increased beyond the potentials cited above by thinning and other cultural work that will improve size and growth of trees.

Large areas, such as northern Idaho and western Montana, undoubtedly have much higher potentials than Arizona, but no reliable comparisons can be made until better data are available for these areas.

Destructive agents kill 114 million board feet of sawtimber a year

Nearly 114 million board feet of sawtimber trees are killed annually by disease, insects, fire, vertebrate animals, and other agents. This volume is equivalent to 25 percent of the gross growth of sawtimber. In addition, some of these destructive agents cause a reduction in growth rates and sometimes in tree quality. This retarding effect on tree growth is a big factor in holding down net growth of the forest.

Among the many diseases which attack forest trees in Arizona, dwarfmistletoe has the most damaging effect. This parasite is found principally on ponderosa pine and Douglas-fir and is widespread throughout their ranges. A recent survey in Arizona and New Mexico (Andrews and Daniels 1960) found dwarfmistletoe present on 36 percent of the plots examined in the ponderosa pine type and on nearly one-half the Douglas-fir plots. In Arizona, dwarfmistletoe was found to be most abundant on the Apache National Forest and the Fort Apache Indian Reservation. It is also severe on the Coconino, Kaibab, and Sitgreaves National Forests, and to a lesser extent on the Navajo Indian Reservation.

The survey mentioned above found infection in ponderosa pine to be more abundant as well as more severe in virgin than in cutover stands. Lightly infected virgin ponderosa pine stands averaged 6,620 board feet per acre compared with 5,470 board feet per acre in moderately infected stands — a 17-percent reduction in yield.

Western red rot is another damaging disease in Arizona's ponderosa pine forests. This fungus-caused heart rot is by far the greatest single cause of the 20 percent or more cull that is commonly found in virgin stands (Pearson 1950). The disease is found principally in trees over 150 years old. Red rot probably will become less prevalent as these stands are brought under management and most trees are harvested at ages less than 150 years.

Other diseases are of less economic importance although one, a species of root rot, has the potential for being the most destructive of all diseases in ponderosa pine stands. Paintbrush blister rust kills ponderosa pine trees and also reduces growth. Needle blights slow the growth of Douglas-fir, and aspen is afflicted with stem cankers. Broom rusts are destructive in the fir-spruce type.

Although losses from insects could be extreme in Arizona — a State dominated by one tree species — there is relatively little damage at present. This is partly attributable to the extensive logging of the past that accounts for the general absence of widespread areas of decadent, overmature timber.

Among the insects that are currently active, bark beetles cause most of the damage.

Growth rates are diminished by these insects and severe attacks result in death of the trees. Control efforts generally include salvage logging and disposal of slash to prevent further insect population buildups. One bark beetle, the Douglas-fir beetle, causes significant loss in Douglas-fir throughout the State — especially on the Kaibab National Forest. New outbreaks of the Arizona five-spined ips occurred on the Prescott National Forest in 1964 and killed ponderosa pine in a heavily used recreation area. The white fir needle miner, previously unrecorded in the Southwest,[9] damaged several thousand acres of white fir stands on the Kaibab Plateau during 1964. Aspen was defoliated by the Great Basin tent caterpillar in small areas over northern Arizona during the same year.

[9]*In this report the Southwest includes Arizona and New Mexico.*

Severe infection of dwarfmistletoe on a ponderosa pine in the Coconino National Forest. Dead branches and holes in the crown of the tree shown above indicate reduced vigor and growth. "Witches brooms," such as those seen here, are also characteristic and cause the tree to grow stouter limbs to support them. This results in larger knots in lumber sawn from infected trees.

Ponderosa pine stand of mixed-age classes on the Fort Apache Indian Reservation. The old-growth trees in the background average 20 inches d.b.h. and about 70 feet tall. The seedlings and saplings in the foreground range from 3 to 5 feet tall. Large poles and young-growth sawtimber are largely missing in this part of the stand. The area of these two stand-size classes is rather small over much of Arizona.

Ponderosa pine dominates the commercial timber resource

Ponderosa pine predominates on 3,657,600 acres or 92 percent of the State's commercial forest land. It grows in many areas of the State, but the bulk of the type is found on the Mogollon Plateau in central Arizona where it grows as an unbroken stand for nearly 225 miles. Apache pine, Chihuahua pine, and Arizona pine replace ponderosa pine in the mountains of the extreme southern portion of the State. These species, which closely resemble ponderosa pine, are grouped with ponderosa pine in this report. Douglas-fir, Gambel oak, limber pine, and pinyon pine are the species usually associated with ponderosa pine.

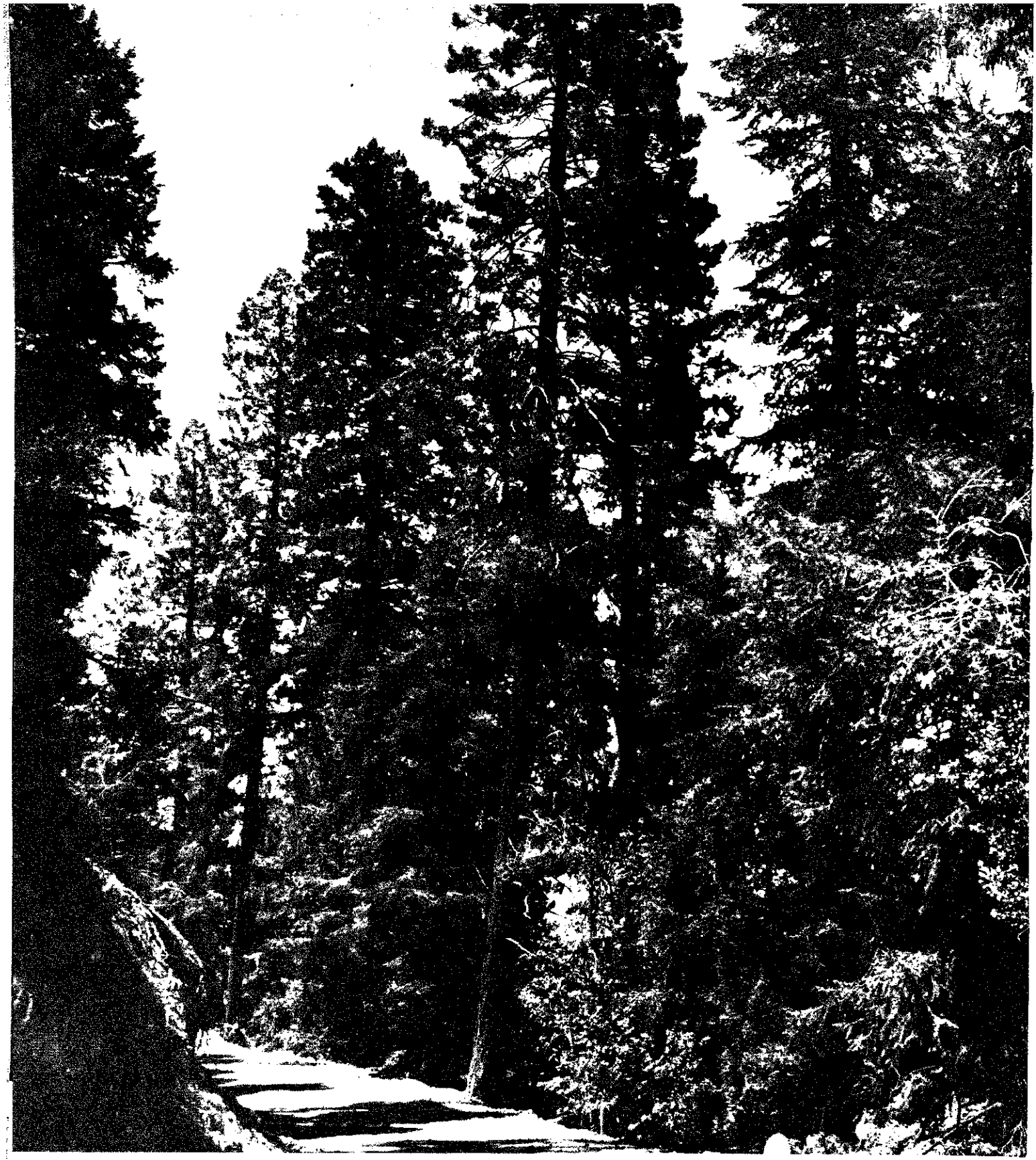
In the Southwest, ponderosa pine is usually classed into two broad categories — blackjack and yellow pines. The former, usually less than 150 years in age, have dark bark and relatively rapid taper. After a rain the bark appears nearly black until it has dried — hence the name. Yellow pines, on the other hand, usually exceed 150 years in age and have yellowish bark, often in broad, flat plates. Their crowns are usually rounded, indicating that full height growth has been reached.

There is about 22.9 billion board feet of ponderosa pine sawtimber in Arizona, which is 85 percent of all the sawtimber on commercial forest land in the State. About one-half of the area of ponderosa pine sawtimber stands is old growth; i.e., more than 120 years old.

Since 1869, about 95 percent of the lumber sawed in Arizona has been ponderosa pine. There are no records to indicate that lumber of any other species was produced until 1899 (Steer 1948). In 1962, ponderosa pine accounted for 279 million board feet or 86 percent of the State's lumber production and about 80 percent of the total roundwood harvest. The continued heavy use of ponderosa pine is partly due to the easy accessibility of many pine stands. In addition, the wood produced by this species is among the best for all-around use. Intermediate grades of lumber are used for framework, sheathing, and subflooring, the better grades for siding, and the highest grades for window sash, doors, and interior finish. All the pulpwood produced in Arizona during 1962 — nearly 8 million cubic feet — was ponderosa pine. Railroad ties, mine timbers, and utility poles are other products made from ponderosa pine.

Recreation use is heavy in the ponderosa pine type. Cattle and sheep grazing is also important in this type, especially in openings and meadows within the timber.

As mentioned in the caption on the opposite page, intermediate size classes — large pole and young-growth sawtimber stands — are present in less than desirable numbers over much of the ponderosa pine type. Pole-timber stands of all forest types represent 3 percent of the commercial forest area — about 128,000 acres. This uneven distribution of area of size classes complicates timber management planning. More intermediate-sized trees, which are presently in short supply, are needed to insure that a sufficient number of merchantable-sized trees is available in the future to maintain the current level of cutting of ponderosa pine. Thinnings are being made over wide areas to accelerate the growth rates of saplings and small poles and move these trees more rapidly into the larger size classes.



Stand of Douglas-fir small sawtimber at an elevation of 8,500 feet on the Apache National Forest. These trees average 80 feet in height and are mature.

Douglas-fir covers the second largest area among timber types

The Douglas-fir type predominates on 129,-900 acres (about 3 percent of the commercial forest). This type is found principally on scattered locations in northern Arizona—in the White, Chuska, and San Francisco Mountains, and on the Kaibab Plateau. The forest-type map in the Appendix does not show a Douglas-fir type because the map scale does not permit areas so small to be shown. This type generally is found in a band between the ponderosa pine and fir-spruce types. All of it is in public ownership.

Several different species make up this type. Although Douglas-fir is the predominant species, white fir accounts for most of the volume in some stands. Engelmann spruce, subalpine fir, limber pine, ponderosa pine, and quaking aspen are also found in this type.

Practically all of the type is in sawtimber stands. Less than 500 acres are classed as either poletimber or sapling-seedling stands. The volume in uncut sawtimber stands varies greatly but it probably averages about 15,000 board feet per acre (Krauch 1956). There are large areas of Douglas-fir in old-growth, decadent stands as evidenced by the estimate that annual mortality of Douglas-fir exceeds growth by nearly 12 million board feet. This is largely due to the fact that there has not been much logging in this relatively inaccessible type until recent years. Since the earliest logging of Douglas-fir lands (about 1900), slightly more than 3 percent of the lumber produced in Arizona has been Douglas-fir. In 1962, however, Douglas-fir accounted for 7.2 percent of the lumber sawn. Douglas-fir is used for lumber, flooring, railroad ties, and mine timbers.

The Douglas-fir type is highly important as a protective cover for watersheds. This type grows on a substantial portion of the most rugged mountainous country from which most of Arizona's surface water supply originates, primarily from snowmelt.

The Douglas-fir type, which is found in high country, is used extensively for recreation. Many summer homes are built there and some of the best big game hunting and winter sports areas are in this forest type.

An aspen stand with an understory of Douglas-fir and white fir growing at about 9,000 feet. The aspen trees provide the shade that is required for establishment of conifers, which will ultimately replace the aspen unless fire or other destructive agents alter this natural plant succession. The photo also shows an area of the fir-spruce type higher up on the slopes of Humphrey's Peak, tallest of the San Francisco Peaks, on the Coconino National Forest.

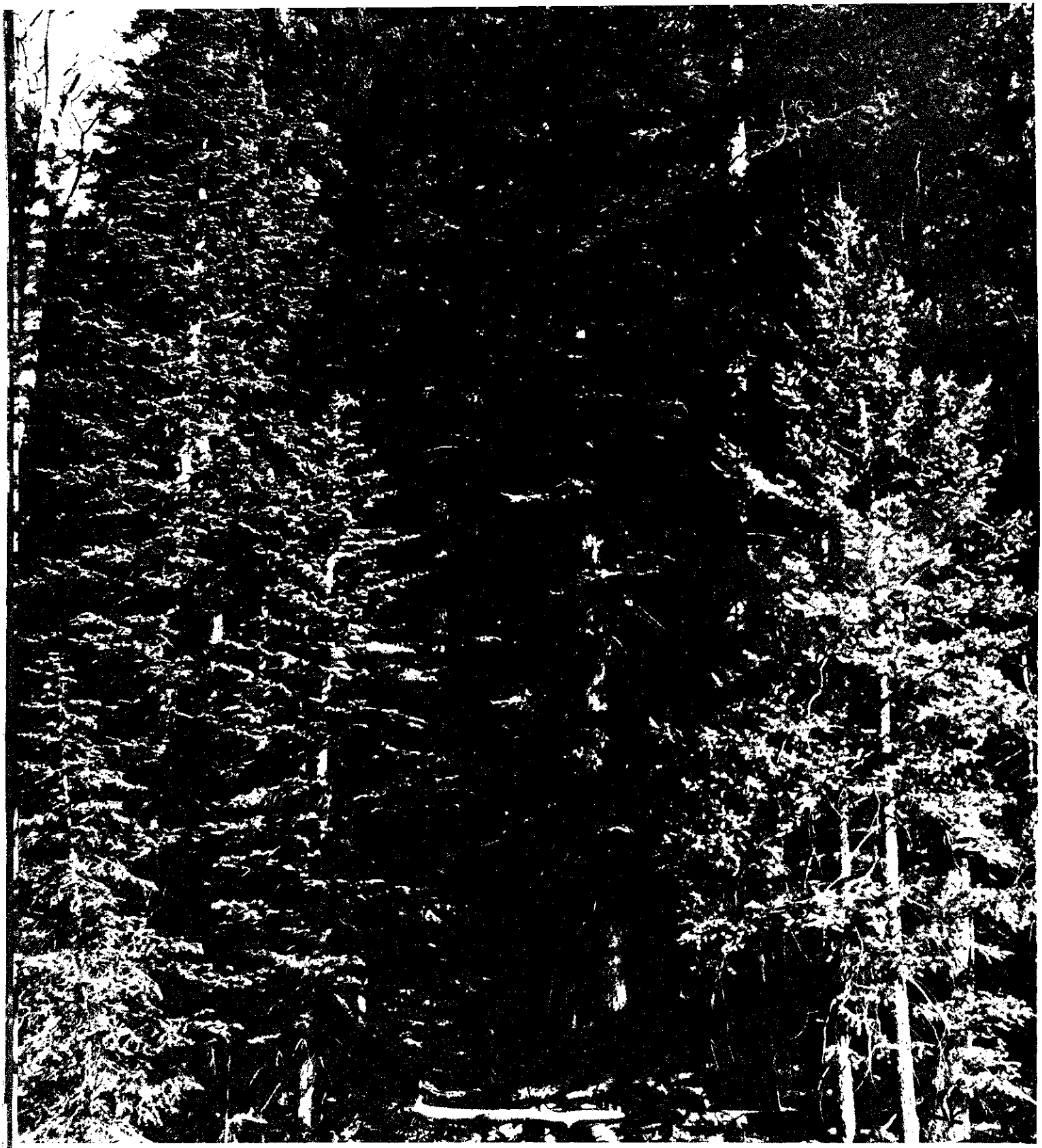
Untapped aspen resource fills other vital needs

The aspen type covers about 79,000 acres, or 2 percent of the commercial forest in Arizona. This species generally is found on most of the same sites as Douglas-fir, although it extends into both ponderosa pine and fir-spruce types. It grows best on moist sites and frequently occupies natural drainage channels and the toes of slopes. The aspen type is a temporary cover on some lands—it usually becomes established after fire or logging and is later invaded by conifers. A large proportion of the present aspen stands on Mt. Baldy in the White Mountains developed after extensive fires in the early years of this century (Arizona Watershed Program Staff 1956).

The area of commercial aspen type is about equally divided between sawtimber and poletimber stands — 46 percent and 49 percent respectively. Only 5 percent is classed as sapling and seedling stands. Seventy percent of this type is publicly owned, but the 24,000 acres of privately owned aspen represent 14 percent of all commercial forest in private ownership.

Aspen wood has many desirable properties, but its use in Arizona has been minor and limited principally to production of excelsior and fuelwood. Practically no lumber has been produced from aspen. It could become a significantly important source of fiber if interest in pulping the species develops.

However, the aspen forest is important in a number of other ways. Its value as a watershed-protecting cover is high and it is considered an important soil-building type. The aspen suckers and associated vegetation that usually develop rapidly and abundantly following fire or heavy cutting are valued forage for domestic livestock and big game animals. The aspen forest also provides a nurse crop under which commercially important species can become established. Aspen trees are outstanding esthetically, and many recreation areas are dominated by them. Their well-known, golden fall foliage is enjoyed by many, some of whom get no closer to the forest than an occasional Sunday drive.



Fir-spruce type at about 10,000 feet in elevation near Snow Bowl Winter Sports Area on the Coconino National Forest. These young growth sawtimber trees average 12 inches d.b.h. and 70 feet in height.

Timberline location obstacle to utilization of fir-spruce type

The fir-spruce type grows at higher elevations than any other commercial forest type in Arizona. It is found just below timberline and constitutes 3 percent of the commercial forest area, or 110,300 acres. Engelmann spruce, subalpine fir, and corkbark fir are characteristic of the type, although Douglas-fir, white fir, and aspen are fairly common. All of this type is publicly owned. All but about 1,000 acres of the fir-spruce type is in sawtimber stands. Engelmann spruce makes up 5 percent (1.2 billion board feet) of the State's sawtimber volume and the true firs[10] 3 percent (0.9 billion board feet).

Until the late 1940's, only a negligible amount of lumber was produced in Arizona from either spruce or the true firs. Since then, the volume of lumber produced from these species has increased rapidly. However, it still represents a minor part of the State's output. In 1962, the nearly 18 million board feet sawn from true firs and 5 million board feet sawn from Engelmann spruce represented less than 6 percent and 2 percent, respectively, of all lumber produced in Arizona.

The fir-spruce forest grows on the most inaccessible sites and on the most rugged topography within the commercial forest. Road construction is difficult and expensive under these conditions. These are the primary reasons why the fir-spruce type has not been harvested extensively.

Water yields are greater in the fir-spruce forest than in any other forest type because the greatest precipitation falls at the higher elevation. Annual precipitation in this type averages 30 to 35 inches of water, 60 percent of which is from snow. This compares with the annual precipitation in the ponderosa pine type of about 19 to 25 inches of water. The watershed protection value of the fir-spruce forest is understandably high.

Fir-spruce lands provide important summer range for big game and also offer recreational opportunities for high altitude lake and stream fishing, as well as winter sports.

[10] *White, subalpine, and corkbark firs.*

THE FOREST IN USE

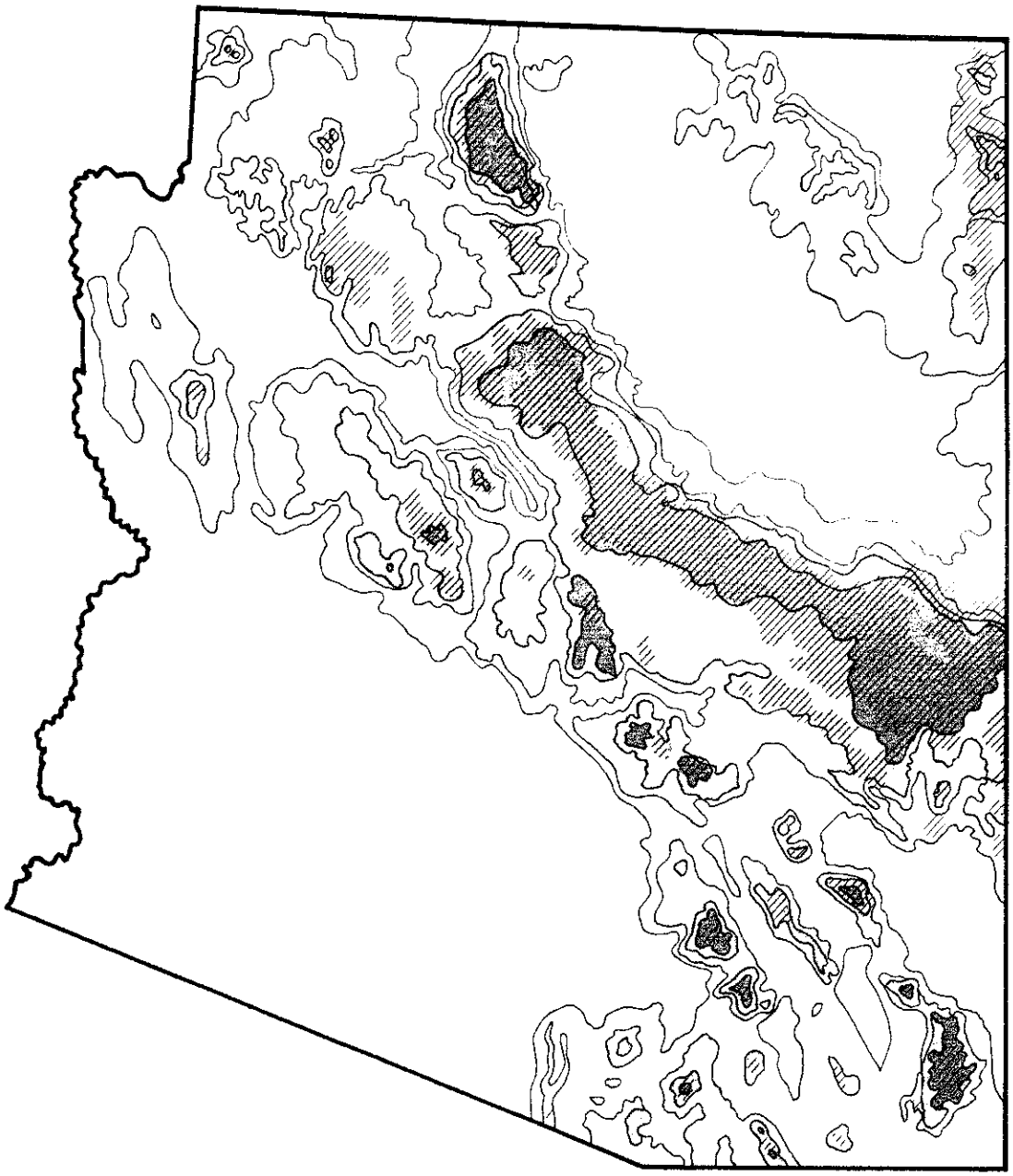
Arizona's 21 million acres of forest lands have been used ever since there has been someone to use them. Primitive Indian tribes made use of products from the forest as did the Spanish explorers and missionaries and, later, the American mountain men and settlers. Then, as now, these forests had more than one use. Today people in the parched lowlands rely heavily on water produced in the forested high country. Many acres within the forest provide forage and browse for livestock and wildlife. Trees have been felled and used from much of the commercial forest. Almost all of the forest is open to the public for a wide variety of outdoor recreation.

Below is a view of the Apache National Forest taken from near the top of Baldy Peak in the Mt. Baldy Primitive Area. The second highest peak in Arizona (11,590 feet), Baldy Peak provides visitors a unique perspective of the timber, lakes, streams, meadows, and grassy openings found on the surrounding slopes. The dynamic plant and animal community that makes up the forest presents challenging problems to land managers who are charged with planning wise resource use.

Forest runoff plays critical role in meeting State's increasing water needs

The rapid burgeoning of Arizona's population and economy and the resulting strident demands for more water attach particular importance to the State's forested watersheds. Water from the forests has always been vital to the very existence of people in the arid lowlands. This is indicated by remains of ancient irrigation canals used by the Hohokam Indians to wrest a living from the desert near Phoenix about 200 B.C. Irrigation has traditionally consumed far more water than any other use. Even today, agriculture accounts for about 95 percent of the estimated 6.6 million acre-feet of surface and ground water consumed annually in the State (U. S. Senate 1960). Now, however, increasing amounts are needed for urban and industrial uses. Between 1950 and 1960, Phoenix's population quadrupled and Tucson's increased nearly five times. As a result, the rate of water use by municipalities and industry is increasing about eight times faster than that of crop irrigation. Today, the State's need for water is critical, and future growth is largely dependent on the availability of water.

Runoff from melting snow in the ponderosa pine type swells Beaver Creek on the Coconino National Forest (left). Nearly all surface water flows are impounded in Arizona and are serving some useful purpose such as irrigation (right).



AVERAGE ANNUAL RUNOFF — ARIZONA

(in inches of water)

over 2	.5- 1	less than .1
1- 2	.1-.5	Commercial forest land

Based on an unpublished map by J. H. Dorroh, Jr., Soil Conservation Service

Arizona's forest lands play a big role in providing water to the consumer. Much of the 2.1 million acre-feet of surface water consumed annually originates within the State as runoff from the relatively high water-yielding forest.

In general, precipitation and resulting water yields per acre are greatest for forest types at high elevations. The Forest Service in the Southwestern Region made the following conservative estimates of water yield by forest types on National Forests:

Forest type	Average annual runoff[1]
	Inches
Fir-spruce and Douglas-fir	4.7
Ponderosa pine	2.8
Pinyon-juniper	1.1
Average[2]	1.7

[1]*Runoff estimates made by George D. Hardaway of the Regional Forester's staff, U. S. Forest Service, Southwestern Region, Albuquerque, New Mexico.*

[2]*Average weighted according to area of forest types.*

About 80 million acre-feet of precipitation fall annually in Arizona (U. S. Senate 1960). Of the large amount of this water used and then transpired into the atmosphere by plants, approximately 4.2 million acre-feet are used by timber and forage crops alone. If research can point the way toward better use of a portion of this water, the contribution to Arizona's economy will be invaluable.

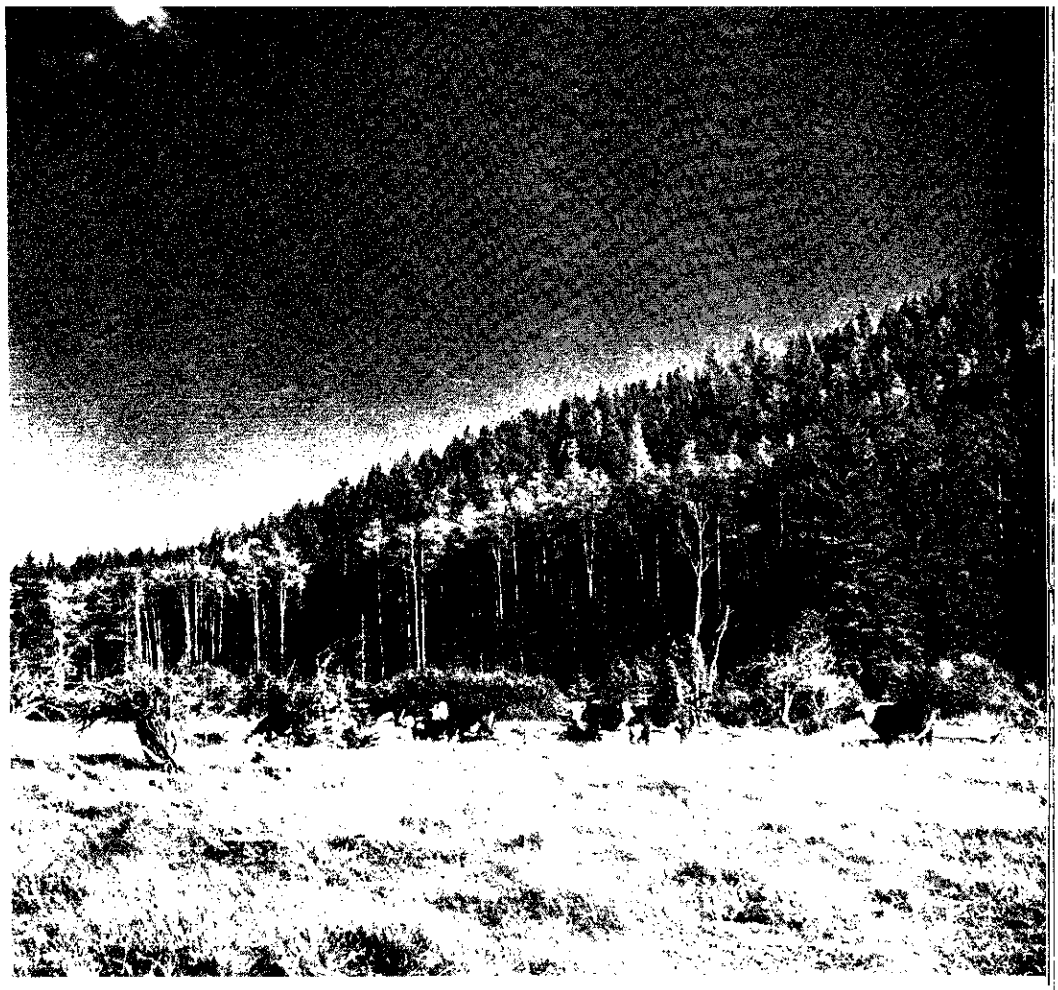
An important part of present research is the work being done to determine the effects of various kinds of land treatment practices on water yield and other resource uses. Such practices as converting pinyon-juniper and ponderosa pine stands to grass, intensive thinning of ponderosa pine, clear-cutting pine and fir timber in moist stream bottoms, and prescribed burning of chaparral and ponderosa pine show promise for increasing water yield. However, the same population increase that has brought greater demands on the water resource has brought greater demands on other resources as well. Recreation, timber, and forage uses of the forest also will be affected by vegetative manipulation. Land managers must consider these values, too, and weigh carefully the advantages and disadvantages to each resource.

Modern range management replaces destructive overgrazing of past

Livestock have grazed intermittently on Arizona's forest range since 1540 when Coronado brought with him 1,000 horses, 500 cattle, and 5,000 sheep. Before that, deer, elk, bear, and antelope found forage and browse on these lands — principally chaparral, pinyon-juniper, and ponderosa pine lands. Spanish missions became livestock centers about 1700 and by 1880 large cattle companies began intensive use of the range. Following recovery from the depression of 1873 the cattle industry expanded rapidly and by 1883 the number of livestock brought into the State had reached large proportions. Ranges that for permanent and regular use would have been overstocked with one cow to every 100 acres were overloaded until they carried one cow to every 10 acres.

The attendant overgrazing from this unrestricted use of the range had disastrous effects. Starvation of cattle on the depleted ranges followed the drought years of 1893-94. It was estimated that over 250,000 cattle out of about 800,000 perished on the Arizona range during the period 1891-94 (Thornber 1910). Much of the thin layer of topsoil on grazed lands was lost through sheet and gully erosion, and with it the ability of the range to produce maximum yields of forage. Also, overgrazing may have favored expansion of the pinyon-juniper type.

The establishment of the National Forests and government controls on the public domain brought a degree of stability to the livestock industry. Figures on the number of livestock permitted to graze on the National Forests of Arizona are indicative of



Cattle grazing on forest range in the Apache National Forest. Livestock must be fenced out of forest plantations until the young trees are no longer susceptible to browsing damage. This is a necessary action if grazing and timber use of the forest are to remain compatible.

the trend of use since 1910. These data show that cattle numbers peaked during World War I when the demand for meat intensified range use. The 367,000 cattle on National Forest ranges in 1918 thinned to 141,000 in 1963 — a decline of 62 percent. Sheep, which were brought into the State in large numbers after the collapse of the cattle boom, reached a peak on the National Forests in 1912. In that year there were 454,000 sheep — nearly eight times as many as the 57,000 permitted in 1963.

Grazing practices have improved measurably since the days of unrestricted range use. Present livestock use of the forest range involves consideration of timber, water, recreation, and wildlife values of the land. Considerable effort has been put into rehabilitating depleted ranges and in making others more productive. The Bureau of Land Management, the Bureau of Indian Affairs, and the Forest Service — the principal administrators of the public range — all have programs of range improvement which benefit both livestock and wildlife. In 1963, for example, the Forest Service seeded nearly 26,000 acres to desirable grasses and eradicated undesirable plants on another 18,000 acres in Arizona's National Forests. During the same year, 270 miles of range fences and 191 stock ponds and reservoirs were constructed to permit better distribution of livestock. Much of this work was accomplished as a cooperative effort between the grazing permit holder and the Forest Service. Projects to improve wildlife habitat are sometimes undertaken jointly with the Arizona Game and Fish Department.

Rate of recreation use is climbing rapidly

Arizonians, like other Americans, are taking to the outdoors in ever-increasing numbers in pursuit of recreation. The desire to escape the summer heat of the desert cities is a compelling reason to seek out the higher, cooler forest. The Tonto National

A family enjoys a campground at Woods Canyon Lake on the Sitgreaves National Forest. This is one of more than 190 public campgrounds in the State. The manmade lake was constructed by the Arizona Game and Fish Department and provides boating, fishing, and swimming to recreationists. Campground facilities were constructed by the U.S. Forest Service.

Forest, which is the most accessible forest area to residents of Phoenix, received 2.4 million recreation visits in 1963 and ranked twentieth among the 154 National Forests in the country in volume of recreation use.

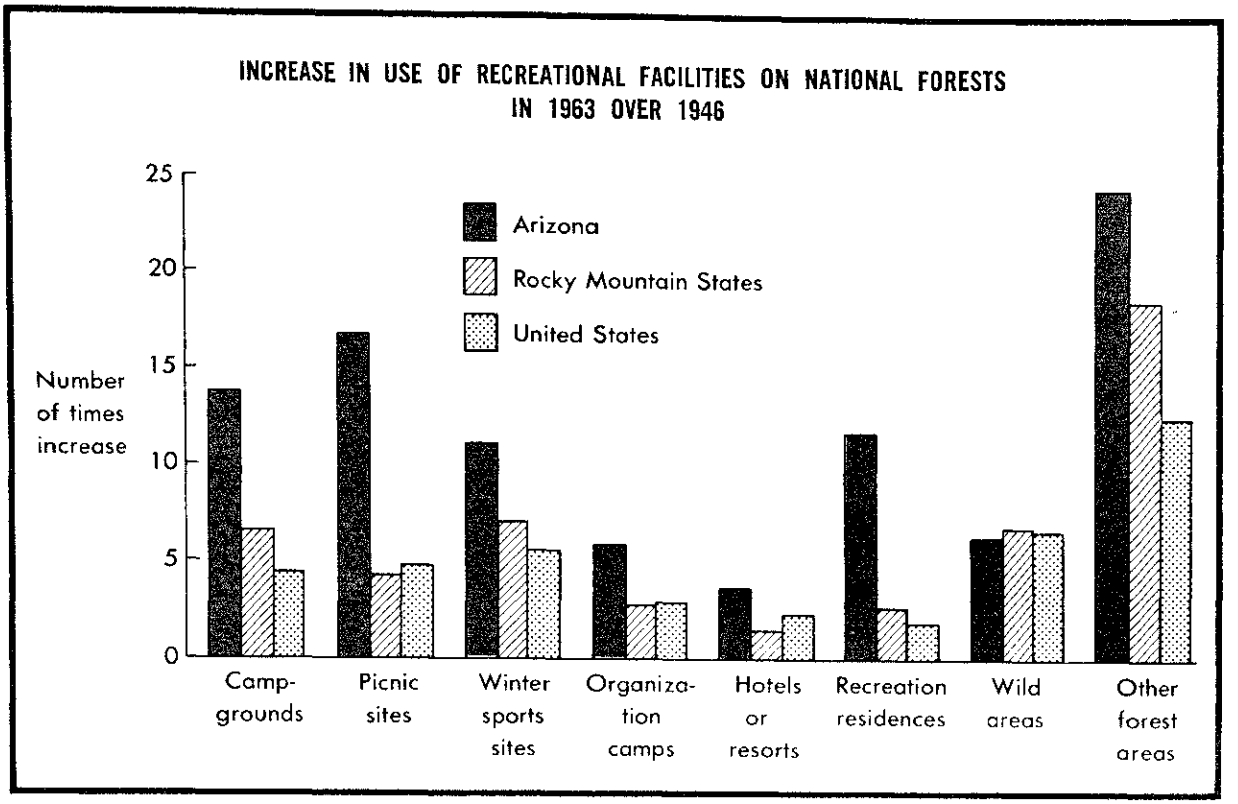
Since World War II, the number of recreation visits to Arizona's National Forests has climbed at a rate about double that of the Mountain States average.[11] Such visits in 1963 were nearly 16 times the figure for 1946. Several other Mountain States had more recreation visits than Arizona in 1963, but none had experienced as great an increase when compared with 1946. Recreation visits to Arizona's National Forests accounted for less than 8 percent of all such visits in the Mountain States in 1946; by 1960 Arizona's share reached 15 percent.

The following tabulation shows the number of recreation visits to National Forests in 1946 and 1963 for each of the Rocky Mountain States:

State	1946	1963
Arizona	477,000	7,457,000
Colorado	1,449,000	12,460,000
Idaho	719,000	4,561,000
Montana	547,000	6,654,000
Nevada	102,000	817,000
New Mexico	336,000	4,940,000
Utah	2,261,000	8,882,000
Wyoming	402,000	4,006,000
Total	6,293,000	49,777,000

Arizona's swelling population accounts for part of this rise. Other factors include the increasing mobility, affluence, and free time of the public. In 1960 the census of

[11] *National Forest statistics on number of recreation visits are used here and elsewhere in this report for two reasons: (1) they are practically the only data available for forest land as distinguished from all lands that are used for outdoor recreation, and (2) they permit ready comparisons among States.*



the State showed 1,302,161 residents — an increase of 74 percent over the 1950 figure of 749,587 persons. This compares with a national population increase of 19 percent during the same period.

All forms of forest recreation have increased since 1946, some much more than others. As indicated by the chart below, picnicking and camping have become especially popular in Arizona in recent years. The numbers of visits to Arizona's National Forests in 1946 and 1963 by class of use were as follows:

	1946	1963
Campgrounds	**75,470**	**1,032,800**
Picnic sites	**140,575**	**2,372,100**
Winter sports sites	**12,292**	**135,200**
Organization camps	**10,320**	**58,800**
Hotels or resorts	**88,801**	**328,100**
Recreation residences	**5,257**	**61,500**
Wilderness areas	**2,353**	**14,500**
Other forest areas	**141,523**	**3,454,000**
Total	**476,591**	**7,457,000**

Recreation use of forest lands other than the National Forests has also increased sharply in recent years. The National Park Service, Fish and Wildlife Service, Navajo Tribal Parks Commission, and Arizona State Park Board all have active programs for forest recreation.

Hunting and fishing use of the forest, on the upswing in every State, is high in Arizona. Roughly one out of five Arizona residents 12 years or older participated in the sport during 1960 (Davis 1962). Fishermen paid over one million visits to waters in the National Forests in 1963. This represents an increase of 21 times the 1946 use, which was far above the Mountain States average rate of increase (7 times). The 316,000 visits by hunters in 1963 represent a tenfold gain over the number in 1946 compared with a Mountain States average increase of eight times during this period. An estimated 27,000 deer, elk, antelope, javelinas, and wild turkeys were harvested from Arizona's National Forests in 1963.

The amount of spending generated by hunting, fishing, and other forest recreation is an important addition to the economy of the State (Davis 1962). For example, estimates for 1960 indicate that big game hunters spent a total of more than $8.3 million during the year for lodging, additional food, special clothing, sporting equipment, and transportation. Cold water (trout) fishing—a large share of which is done in the streams and lakes within the forest—contributed another $12.2 million for the above items. Spending by out-of-State residents amounted to nearly 5 percent of the big game hunting expenditures and almost 9 percent of the trout fishing expenditures.

Arizona's rate of timber harvest is highest of the Mountain States

Timber harvesting in Arizona's forests has a history of long and fairly heavy use. As demand for Arizona wood increased, particularly since World War II, early selective logging practices gave way to intensified management that is among the best in the Mountain States. A concurrent development is that Arizona's cutting rate has become the highest of the Mountain States.

In 1962, 65.9 million cubic feet was harvested from an inventory of 6,091 million cubic feet of sound, live trees in Arizona. A comparison of 1962 cutting rates for each of the Mountain States follows:

State	*Percent of inventory cut*
Arizona	**1.08**
Idaho	**1.02**
Montana	**.83**
New Mexico	**.60**
Nevada	**.36**
Wyoming	**.29**
Colorado	**.22**
Utah	**.22**
Average	**.69**

Arizona's saw log cutting rate was even higher — 1.5 percent (404.9 million board feet from a sawtimber inventory of 26,951 million board feet). This was also more than 50 percent greater than the average for the Rocky Mountain States.

The first lumber produced in the territory of Arizona was pitsawed in 1856 in the Santa Rita Mountains south of Tucson. The location of the first sawmill in Arizona is not definitely known, but according to rec-

Edward E. Ayer's sawmill and crew in 1882 in Flagstaff. The town of Flagstaff developed because of the mill, which was engaged in supplying the Mexican Central and Atlantic and Pacific Railroad companies with ties and bridge timbers. Sawn railroad ties, which could be produced in much greater quantities than the previously used handhewn ties, permitted the rapid westward extension of the railroad. Today, timber and other forest uses are mainstays in Flagstaff's economy. (Photo courtesy of Arizona Pioneers' Historical Society.)

ords of the Arizona Pioneers' Historical Society, A. O. Noyes and George Lount built a steampowered sawmill near Prescott on Granite Creek in 1864.

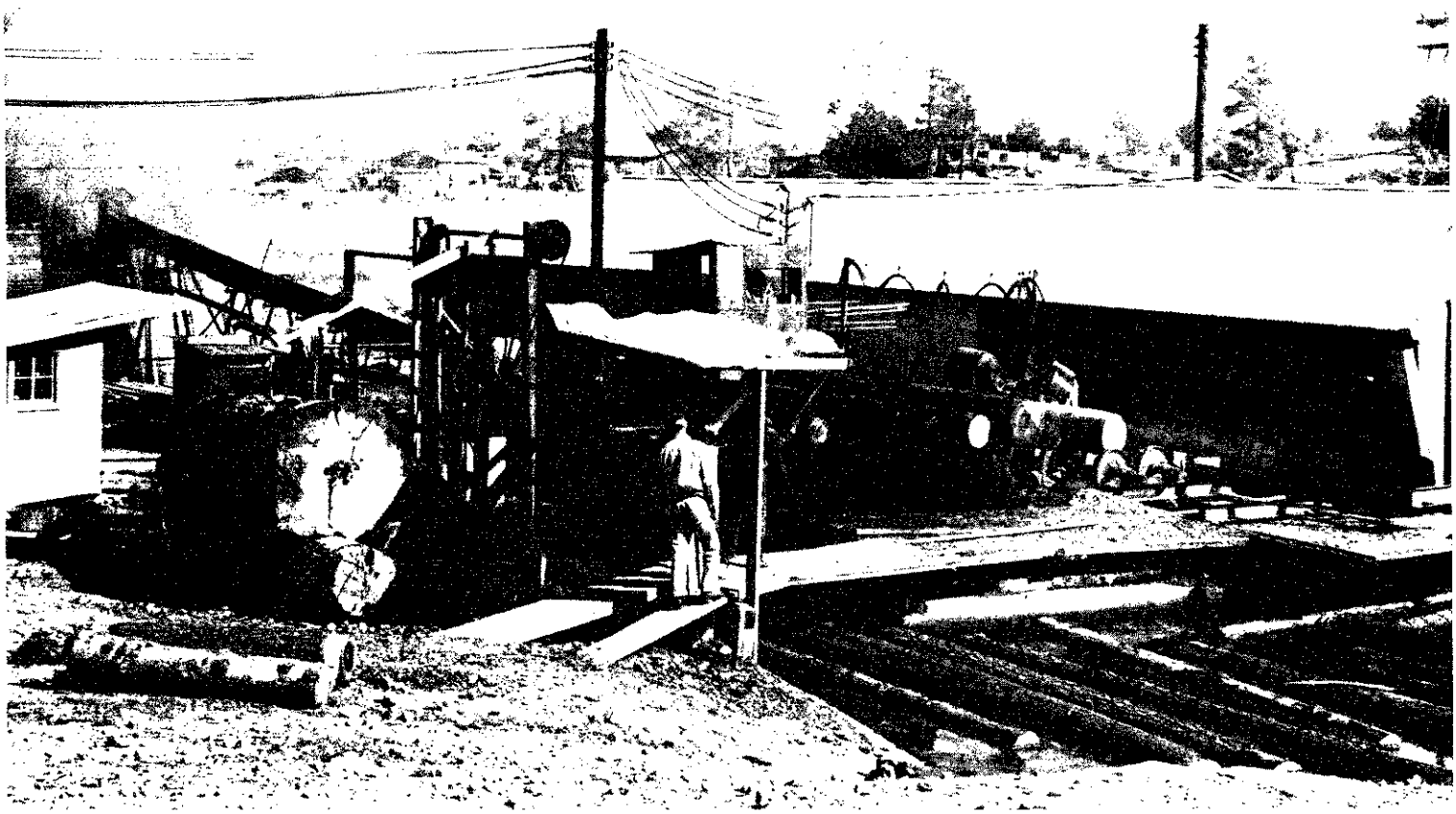
Construction of the transcontinental railroads gave impetus to the sawmill industry. Several mills sprang up to produce bridge timbers and the millions of railroad ties needed to span the State. In addition, rail transport opened new markets for lumber. By 1899, there were 13 sawmills in Arizona having a combined production of 36.2 million board feet of lumber (Steer 1948). During those early years of development, a large volume of timber also was used for house logs, fuelwood, posts, poles, mine props, and other roundwood products.

In the early 1900's the larger lumber companies constructed their own railroad facilities to transport saw logs from the woods to the mill. In order to amortize their large investments in track-laying and equipment, these lumber companies found it necessary to harvest large volumes per acre. These logging activities covered a wide area, as presently evidenced by the large stumps scattered over much of the forested area in northern Arizona. With the advent of truck hauling of logs in the 1930's, it became economically feasible to harvest smaller volumes per acre.

Lumber production is still the principal timber industry

The number of sawmills in Arizona has declined from a peak in 1946 but lumber output for the State has increased. This has obviously caused average production per mill

Reidhead Lumber Company sawmill in Show Low. This mill produces 6 to 7 million board feet of lumber annually from logs harvested on National Forest and Indian lands. Logs are debarked before being sawed, and slabs, edgings, and trim ends are chipped and hauled by a contractor to a pulpmill 35 miles away. A market for these residues is a substantial benefit to sawmills.



to rise as shown by the following tabulation for selected years:

Year	Number of Sawmills	Lumber production Total	Per mill
		Million board feet[1]	
1946	66	240.7	3.6
1954	31	258.2	8.3
1960	38	329.9	8.7
1962	28	326.0	11.6

[1]*Lumber tally*

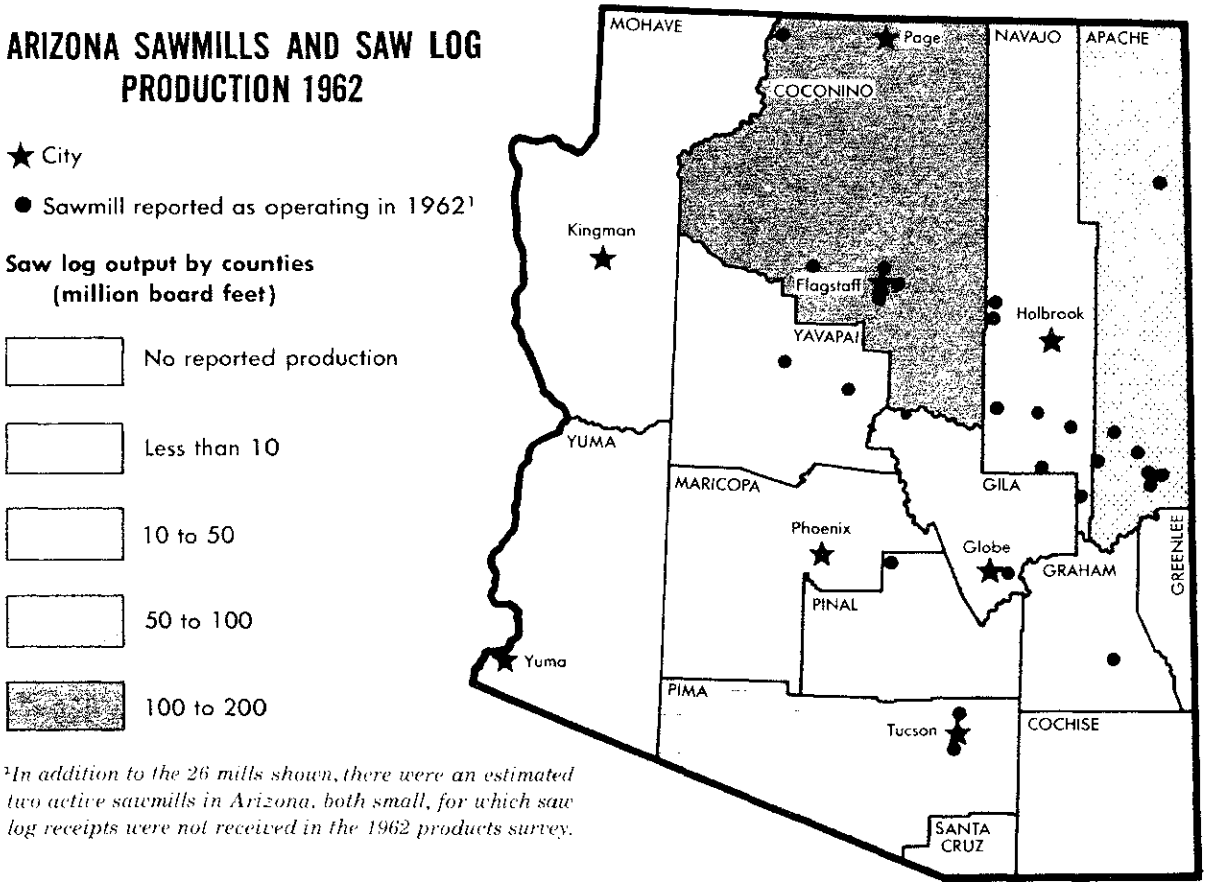
Arizona's average production per mill during 1962 was higher than the average for the Mountain States, which was 4.3 million board feet.

This trend toward fewer but larger and more efficient mills has occurred throughout the Mountain States. In 1962 most of Arizona's sawmills produced more than 1 million board feet of lumber as shown below:

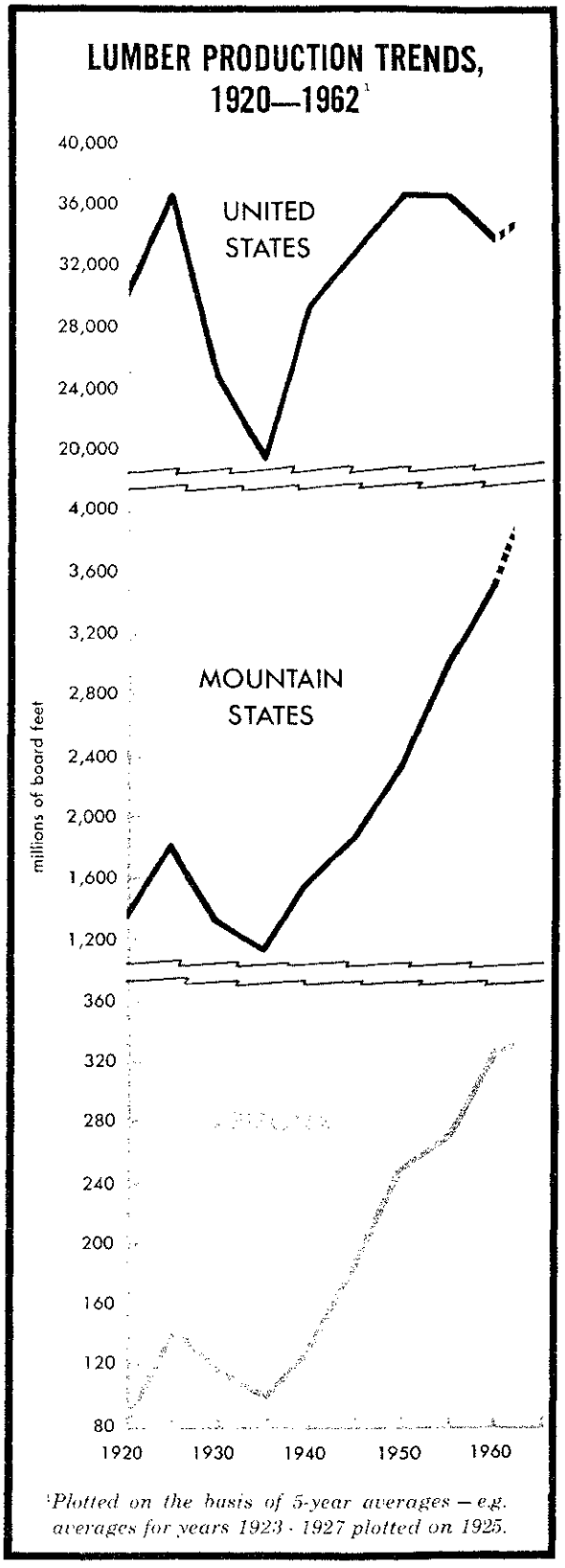
Sawmill size class[1] *Thousand board feet per year*	Number of sawmills
Less than 50	0
50 to 199	5
200 to 499	3
500 to 999	0
1,000 to 4,999	7
5,000 and over	13
Total	28

[1]*Saw log receipts rather than lumber production were used as the basis for classifying sawmills because lumber production statistics were not available in sufficient detail.*

The map below shows the distribution of active sawmills as well as the principal saw log producing counties in 1962. Coconino



[1]*In addition to the 26 mills shown, there were an estimated two active sawmills in Arizona, both small, for which saw log receipts were not received in the 1962 products survey.*



County was the only county in which more than 100 million board feet of saw logs was harvested.

The trend of lumber output in Arizona has closely paralleled that of the Mountain States as illustrated by the graph on this page which also provides a comparison with the lumber output of the United States since 1920.

In recent years, saw logs have comprised the bulk of the harvest of timber products. In 1962, they made up 76 percent of all products. Round pulpwood production — practically nonexistent before 1961 — ranked next to saw logs in volume harvested in 1962, constituting 12 percent of the harvest. The output of other roundwood products — commercial poles, round mine timbers, posts, fuelwood, and miscellaneous farm and industrial timbers — has declined sharply. Even with the addition of pulpwood, the 1962 yield of other roundwood amounted to only 58 percent of the 1952 harvest. The diminishing market for small roundwood products is a handicap to good timber management. However, the downward trend may be slowed, or even reversed, to the extent that the market for round pulpwood increases to meet the needs of the State's two pulpmills — one of which will rely solely on roundwood. In addition to the volume presently needed to supply these mills, an estimated annual cut of 75,000 to 85,000 cords of round pulpwood is feasible for at least the next 20 years.

A breakdown of the 1962 timber products output follows:

	Cubic feet
Saw logs (for lumber)	**49,555,000**
Pulpwood (round)	**7,947,000**
Poles	**125,000**
Mine timbers (round)	**556,000**
Converter poles, excelsior bolts, charcoal wood, and house logs	**389,000**
Posts, fuelwood, miscellaneous farm timbers	**6,957,000**
Total	**65,529,000**

Pulpwood production in Arizona began in earnest with completion of the Southwest Forest Industries, Inc., pulpmill near Snowflake in 1961. This mill, shown above, uses round pulpwood and chipped sawmill residues (foreground) to produce about 140,000 tons of kraft linerboard and newsprint per year. Another pulpmill in Flagstaff plans to use round pulpwood exclusively.

Value of timber products higher than average for Rocky Mountain States

The economic value generated from Arizona's timber resource is high compared to that of other Mountain States. Even before the advent of a pulp and paper industry in 1961, the State's timber industries ranked high in value produced. For 1958,[12] it was estimated that the average value of roundwood timber products cut in the State was $80.60 per thousand cubic feet (U. S. Forest Serv. 1963). This ranked highest in the Mountain States, the average for which was $48.84 per thousand cubic feet, but below the average for the United States, which was $99.37 per thousand cubic feet.

Value added by manufacture is another useful yardstick in evaluating the economic impact of the timber resource. Such data show the amount of money added to the economy by the harvesting and processing of the resource. Such information is available for all timber industries in the Mountain States, except the pulp and paper industry, for 1963.[13] Even without the latter, Arizona's timber harvest generated more than $24 million into the State's economy. This amounts to a value added of about $368,000 for each million cubic feet cut of sound, live trees. In this respect, Arizona ranks above the average for the Mountain States, which is about $340,000.

Capital expenditures on plant and equipment — an expression of industry's confidence in the future — is still another basis for comparison. Such long-term investments by Arizona's timber industries, except the pulp and paper industry, increased from about $1½ million in 1958 to over $2½ million in 1963. The latter figure represents investments of about $428,000 for each billion cubic feet of growing stock inventory in the State. This is more than 1.4 times the aver-

[12] *1958 is the latest year for which there is Census of Manufactures data of the type used for this analysis.*

[13] *U.S. Bureau of the Census provides an estimate of value added by manufacture for Standard Industrial Classification Code 24. This classification includes logging operations, sawmills, planing mills, millwork plants, wood preserving concerns, and similar wood conversion industries. An estimate of value added by manufacture of pulp and paper (SIC Code 26) has not been published by the Bureau of the Census for any of the Mountain States.*

age for the Mountain States, which is about $300,000.

If similar comparisons could be made using data that includes the pulp and paper industry, Arizona probably would appear in an even more favorable position. Paper industry products are of relatively high value and are manufactured from wood in only two of the Mountain States other than Arizona. The two operating pulpmills in Arizona provide many benefits to the State in the form of profits, wages, and taxes. The market they provide for saw log residues and small roundwood (see photo page 33) benefits sawmills and management of many timberlands.

The lumber industry has inherent problems

Despite the cheerful economic picture presented by these analyses, the lumber industry is faced with serious problems. Primary among these is the fact that the major wood product manufactured in Arizona, in terms of volume of wood, is still 1-inch-thick lumber. This provides cause for concern in view of the increasing encroachment by plywood and other sheet product manufacturers into the market for sheathing and subflooring materials — a high volume market formerly dominated by the lumber industry. This concern is accentuated because no plywood or veneer presently is produced in Arizona. Another problem is the high proportion of low-grade lumber produced from Arizona sawtimber. Lumber grade recovery from Southwest ponderosa pine commonly includes as much as 40 percent grades 4 and 5 common lumber (Barger and Fleischer 1964). These poor grades have always been marginal profit items, especially so in a sluggish market. They command low prices and are difficult to market. Therefore, their value added by manufacture is small.

The secondary manufacture of wood products is a small factor in Arizona's forest industries. There were only 28 millwork plants in Arizona in 1958 (U. S. Bureau of the Census 1961), most of which were small. The potential exists for expansion of millwork operations because a large volume of lumber is shipped out of the State to be remanufactured. A stronger industry producing such items as moulding, trim, window sash, and doors would be desirable for the economy of the State.

A combination of the above factors and a generally depressed national lumber market during the mild recession of 1960-61 caused lumber production and prices in Arizona to sag in the early 1960's. Recovery has been slow, but some indicators point to a small recent improvement in market conditions. The lumber output, which declined from 340 million board feet in 1959 to 326 million board feet in 1962, spurted to a new high of 411 million board feet in 1964.[14] Stumpage prices bid for ponderosa pine sawtimber sold on National Forests in the Southwest also suggest the economic climate may be improving somewhat for the lumber industry. Stumpage prices, which averaged $10.49 per thousand board feet in 1960 and slumped to $4.78 in 1962, rose slightly to $5.79 in 1964.

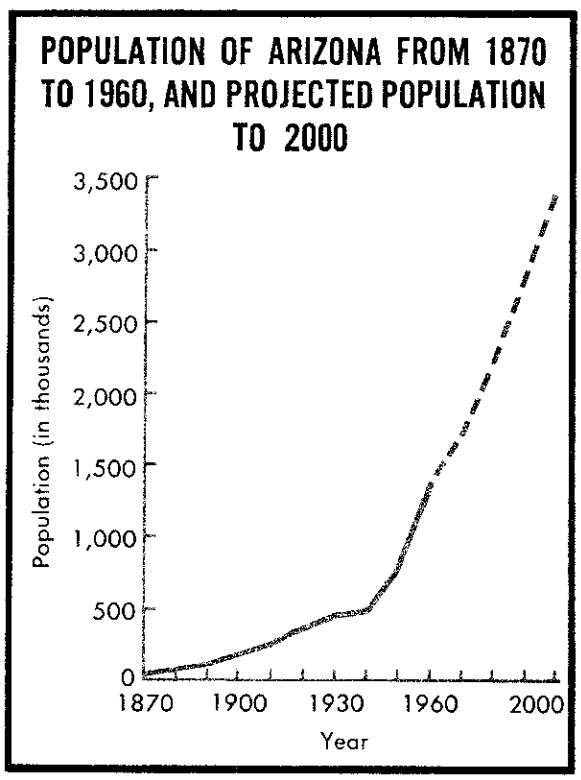
[14] *U. S. Bureau of the Census preliminary figure, subject to change.*

Harvesting mature ponderosa pine on the Coconino National Forest. Sawtimber trees in the Southwest usually produce a high proportion of low-grade saw logs, largely because of the presence of many large, live limbs. Eighty-five percent of the total ponderosa pine sawtimber volume is from grade 4 saw logs — poorest in the log grading system used. (See Terminology in the Appendix for definitions of log grades.)

THE FUTURE

Demands on the forest will grow

Future demands on Arizona's forest resources will intensify and become increasingly competitive. Projections of demands on forest resources are unanimous in estimating that future use will be much heavier than it is presently. The projected rate of increase of use, however, differs markedly for each resource. Demand for water, for instance, is expected to mount sharply between now and the year 2000 in contrast to the slower growing demand for timber. There will also be big differences in the extent to which these demands on the forest can be met. In general, opportunities appear greatest for expanding recreation and timber uses in the next few decades. A much more vigorous program of range improvement work will be necessary before there can be any substantial increase in range use. And considerably more research is needed in both watershed and multiple use management before water yields can be materially increased.



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

Projections of any kind require assumptions, and an important assumption basic to this discussion is the growth of the country's population. The latest median projection by the Bureau of the Census indicates the 1965 United States population of 195 million persons will swell to about 325 million in 2000. In Arizona, a conservative projection to 2000 indicates a number about 2½ times the 1960 census (U. S. Senate 1960). The graph on this page shows population of the State from 1870 to 1960 and a projection to 2000.

Assumptions, such as projected disposable personal income, use of competing resources or materials, technological changes, consumer preference, and others, cause the projected rates of use to differ among individual resources.

As discussed earlier, water is critical to the growth of Arizona because water needs in the future are going to be much greater than at present. Approximately 3.5 million acre-feet of additional surface water will be needed by 1980 (U. S. Senate 1960).

Most of the needed supply of surface water probably will come ultimately from diversion of water to the State from areas of water surplus. But this will require an interstate geopolitical approach to water problems — a situation which may not come to pass for a considerable time. Therefore, the role of the forest in helping to supply a small part of the water deficit is important.

There is some opportunity to increase the availability of water by vegetative manipulation, but the amount of increase that can be achieved and the best methods to achieve it remain to be learned. If research points the way to watershed management

practices that will increase water yield from the forest even slightly, the immediate returns will be significant in relaxing the stringency of this resource. However, it is probable that any significant amounts of additional water yield resulting from vegetative manipulation will compete in some degree with timber outputs and, perhaps, with recreation benefits because these practices are likely to be most effective in increasing water yields in the commercial forest. If such practices are adopted widely over the State, important questions will be raised regarding new timber management objectives and the best management programs to accomplish them.

The present use of the forest for recreation pales beside what may be expected in future years. Projections for the period 1960 to 2000 indicate that the Nation's population will nearly double and participation in outdoor recreation will nearly triple (Outdoor Recreation Resources Review Commission 1962).

The increased pressures on public recreation lands during this period are expected to vary as shown in the following projections made by Resources for the Future, Inc. (Landsberg et al. 1963):

	1960	2000
	Million visits	
National Parks, Monuments, and Recreation Areas	**41**	**390**
National Forests	**93**	**2,010**
State Parks	**259**	**2,770**

Based upon these projections, the greatest impact will be felt on National Forests because the number of projected visits for 2000 amounts to 21.6 times the number of such visits made in 1960. At the same time, the number of visits to State Parks is expected to increase about 10.7 times and to areas administered by the National Park Service 9.5 times.

Future demand for forage for livestock and wildlife undoubtedly will remain heavy. Principal opportunities for increasing the forage supply in the forest involve more intensive management of existing grazing lands, rehabilitation of depleted ranges, conversion of pinyon-juniper forests to grasslands, and thinning overstocked young stands of pine.

Demand for timber is expected to rise, too. Use of timber products nationally is projected to increase about 81 percent by 2000 (U. S. Forest Serv. 1965). The estimated demand by the end of the century for pulpwood, plywood, and veneer is 2.7 times the 1962 level of consumption. These are the products for which future demand is expected to increase most sharply. Lumber demand is expected to rise only 43 percent during the same period.

The harvest of sound, live trees in the Mountain States in 1962 is expected to double by 1992. A projection of Arizona's estimated cut suggests an increase of only 78 percent during the same period. The reason for Arizona's lower projection is twofold: (1) Its current cutting rate is already the highest of the Mountain States; and (2) the present harvest already is close to established allowable annual cutting rates. Arizona's projected cut in 1992 — 118 million cubic feet — is only 69 percent of the potential yield mentioned earlier. In 1962, only 38 percent of this potential yield was harvested — 66 million cubic feet.

However, future harvest rates depend to some extent on the action program that evolves from the current study of means of increasing water production from the forests of the State. If drastic cutting measures are deemed advisable, it is conceivable that many watersheds will be harvested on a greatly accelerated schedule during the next few decades.

The future increased harvest must come in the face of a shrinking area of commercial forest land as more of these lands are used for highways, roads, powerlines, reservoirs, or urban and industrial development. The accelerated harvest also will be accomplished despite the continuing need for careful management of all uses to prevent de-

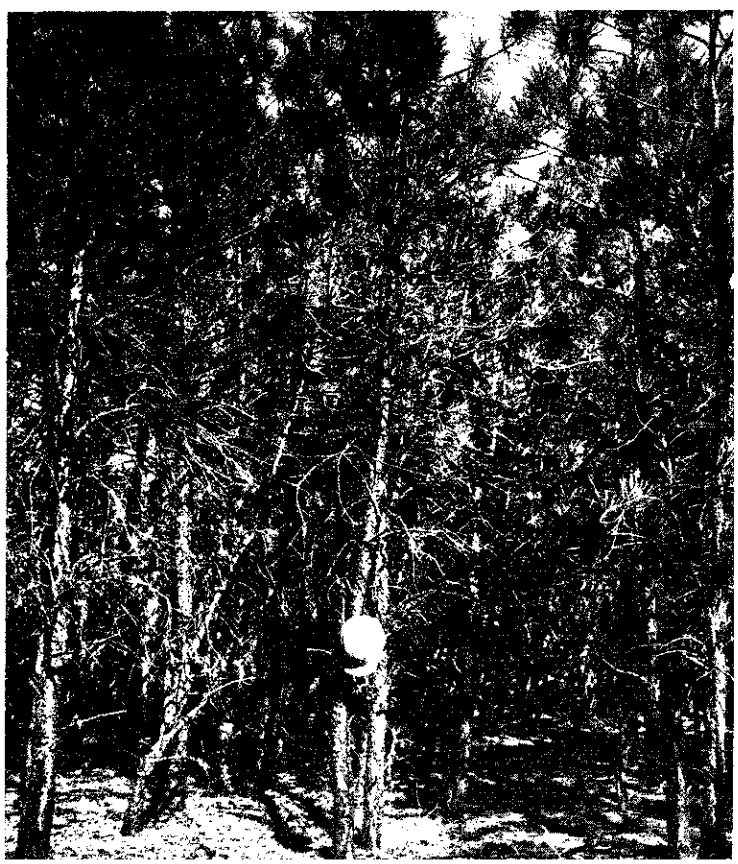
terioration of fragile soils. Some areas may be deferred from logging rather than risk damage to soils, which take a long time to restore in this dry country. Most of the increased timber demands must be met by closer utilization in the woods and mill and by more intensive timber management.

Arizona enjoys a fairly favorable location with respect to markets for her forest products. The rapid population growth of the West in general and the Southwest in particular has meant expanded market opportunities. The future looks equally bright. Population in 2000 in the Mountain and Pacific Coast States is expected to be 2.2 times that of 1960, compared with an increase of 1.8 times the 1960 population for the country as a whole (U. S. Senate 1960). This westward migration suggests an improving market situation. Markets for lumber have been largely in States that lie east of Arizona. In the future, a larger share of these markets probably will be in the Mountain and Pacific Coast States. Proximity to mushrooming southern California makes this a particularly inviting market area.

Thinning is needed to accelerate growth

There are big opportunities for increasing yields from Arizona's timberlands in the future. In most western States, the harvest of large areas of virgin timber is a necessary first step before real timber management can begin. As mentioned previously, Arizona is not handicapped by large areas of old, decadent timber that should be harvested and replaced by vigorous young growth. However, Arizona does have large areas of cutover and young-growth timberlands that are growing at rates far less than their potential. Some of these lands are overstocked

The photo on the left illustrates an all too common problem in Arizona — the overcrowding of young ponderosa pines in wild stands. These saplings on the Fort Apache Indian Reservation average 2 to 3 inches d.b.h., 10 to 12 feet in height, and are 40 to 50 years old. Growth has stagnated and quality and form of the trees are poor. Precommercial thinning is costly but necessary if stands like this are to be brought into useful production. The stand shown in the photo on the right is several hundred yards from the unthinned stand described above. This sapling-pole stand was thinned to a spacing of about 12 by 12 feet.



and need to be thinned. However, surveys are needed to locate stands in which thinning would be most profitable. Work also is needed over a wide area to remove trees of poor species, form, or vigor, or that are overtopping more desirable young growth. In spite of the large amount of stand improvement work accomplished over the years, much remains to be done. In 1964, over 18,000 acres were treated in this manner on National Forests in the State, but there are many areas still in need of such treatments.

Tree diameter growth usually shows good response to thinning where this work has been done properly. Some of the early thinning done in Arizona removed too few trees per acre to cause anything but a short-lived increase in growth. It probably will be necessary to thin stands much more heavily than is presently being done to accelerate growth of small trees sufficiently to insure a continuous high flow of saw logs. Studies underway by the Rocky Mountain Forest and Range Experiment Station are designed to provide better thinning guidelines.

The system of harvesting ponderosa pine in the Southwest is in the process of shifting from all-aged to even-aged management. In the past, the largest and oldest trees usually were selected for cutting. This practice left a residual stand composed of trees of many age classes. Recently the seed-tree method has gained wide acceptance. A few prolific seed-producing trees per acre are left to regenerate the area after logging. If natural regeneration has not become established within several years, the area is artificially regenerated. Artificial regeneration, in most cases, requires site preparation, an important part of which is the removal of competing vegetation from the area to be planted. These practices are expensive — combined costs may average $80 to $100 per acre. For some areas another system of cutting, such as the shelter-wood method, may prove most satisfactory. When this method is used, mature timber is removed in a series of cuttings, which extend over a period of years. Natural regeneration is encouraged under the partial shelter of seed trees left standing.

Artificial regeneration will increase

Not much artificial regeneration had been done in Arizona until recently, and the total number of acres planted or seeded to date is small compared with similar figures for other western States. Almost all of the 6,489 acres that have been planted or seeded to forest trees in the State have been within the National Forests. During 1964, only 521 acres were planted and 235 acres were seeded, and these were all on National Forest lands.

There is an estimated 65,000 acres of nonstocked commercial forest land in the State. In addition, there are 627,000 acres of poorly stocked commercial forest land, a sizable portion of which requires regeneration. More exact figures on areas needing regeneration will be known when the more detailed ground surveys currently underway on National Forests are completed. Also, as more areas are logged, they will have to be planted or seeded as necessary to assure adequate stocking. Obstacles to reforestation in the Southwest are formidable — drought, excessive vegetative competition, and damage to seedlings by rodents, insects, large vertebrate animals, and other agents. However, most foresters in Arizona are confident that artificial regeneration can be successful. Direct seeding costs much less than planting seedlings, and probably will be used much more in the future.

How to utilize low-quality sawtimber is a major problem

Arizona's forests have large volumes of ponderosa pine sawtimber that have too many knots for manufacture into good quality lumber. This poor quality is largely the result of the failure of ponderosa pine to prune well naturally. The quality of sawtimber is expected to decline further as the remaining old-growth stands are liquidated.

These stands yield the higher grade saw logs. Pruning, of course, will improve tree quality, but at present it is not considered economically justified for most stands. Not much pruning has been done in the past. Only 344 acres were pruned on the National Forests in Arizona during 1964. If pruning remains at about the same level, it is unlikely that future timber quality will improve substantially.

Perhaps the biggest problem facing the forest products industry in the State is how to utilize low-grade sawtimber profitably. As mentioned earlier, much of this material is of poor quality for the production of lumber. It seems likely that the future course of industry will move toward the fabrication of wood substitutes for lumber. Barger and Fleischer (1964) have demonstrated the technical feasibility of manufacturing several of these products utilizing low-grade ponderosa pine sawtimber. Among these products are glue-laminated beams, underlayment plywood, overlaid siding, flooring made with a lumber core and a veneer surface, and particle board.

A diversification of at least part of the industry along these or similar lines would mean a further healthy departure from the single-product operations of the past. As mentioned previously, there are no veneer or plywood plants in the State at present. Few "peeler" logs are produced in the forests of the Southwest from which conventional high-grade plywood can be manufactured. However, recent veneer volume and grade recovery tests have indicated that Southwest ponderosa pine will yield commercially acceptable sheathing grade plywood (Barger 1965).

Accelerated road construction is essential

A good network of roads is necessary not only to manage timber but to permit access for fire protection, recreation, and other uses of the forest. While many stands have been made accessible for timber harvesting, a large number of the roads constructed in the past are substandard — particularly from the standpoint of multiple use needs. Reconstruction of these roads and new construction of others must go ahead rapidly on public lands if projected demands on the forest are to be met. The National Forest road development program for fiscal years 1963 to 1972 calls for the following new road construction and reconstruction:

	Miles
Timber roads	**869**
Recreation roads	**496**
Other roads	**1,184**
Total	**2,549**

This means that an average of over 250 miles of roads per year need to be built or rebuilt on the National Forests to meet the program goal. Funds in fiscal years 1963 and 1964 permitted completion of 122 and 137 miles, respectively.

The necessity for building many multipurpose roads will ultimately benefit timber management, especially in financing of road construction. At present, some remote stands cannot be logged profitably if the full cost of access roads must be borne by the timber operation; volumes per acre and timber quality are low and logging costs are high in relation to current market prices for timber. However, when road construction is financed on the basis of benefit to all uses served, a greater area will become economically feasible to log. In the future a great proportion of road financing on public lands will undoubtedly be by direct appropriations rather than solely by timber sale monies.

Technical and fire protection assistance now available from State Forester

The establishment of a state forestry organization in early 1966 — Arizona was the last State to appoint a State Forester — marked the beginning of better management for State and privately owned forest lands. Owners of private forest land now can obtain technical assistance on tree planting and the management of their lands. The State will

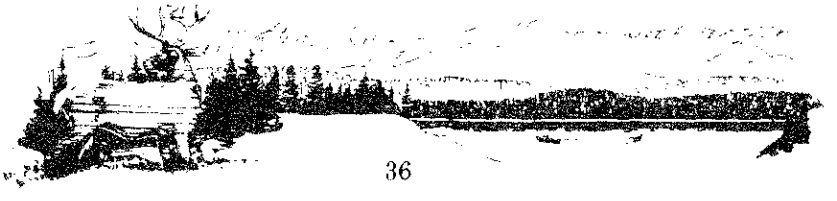
‹perimental stripcutting of ponderosa pine in the Beaver Creek watershed, Coconino al Forest. Experiments using other vegetative manipulation treatments are also be- ıducted in this watershed — aimed at providing economic evaluations of the forest :es. Changes in water yields are weighed against the effects of these treatments sion abatement, timber and forage production, wildlife habitat, and recreation uses.

a cooperative forest fire control ı recent study requested by the f Arizona prior to his appoint- State Forester indicated a need ection on about 2¾ million acres ıercial forest land in State and ership in Arizona. This coopera- n will insure adequate protection ds.

ı will help to smooth the way into the future

a long history of forest research The Fort Valley Experimental :ed on the Coconino National established in 1908 — the first riment station in the United ·mation learned there over the ne much to improve the methods · ponderosa pine in the South- gations into other related fields were necessary as multiple use demands became stronger. Today research projects by several agencies are underway elsewhere in Arizona in timber management, range management, forest protection, watershed management, wood utilization, wildlife habitat, and multiple use management.

Multiple use management will be required if the mounting demands are to be met. The challenge of the future will be to do more on a fixed land base — 21 million acres of forest area, including 4 million acres of commercial forest. Conflicts among users will inevitably arise as more people, with a wide variety of needs, make use of the forest. Pressure on forest land managers from single-interest groups can be expected to increase in the future. Research will help to show the way toward minimizing these conflicts and in using the forest most efficiently.



LITERATURE CITED

Andrews, Stuart R., and John P. Daniels
1960. A survey of dwarfmistletoes in Arizona and New Mexico. U.S. Forest Serv., Rocky Mountain Forest and Range Exp. Sta. Sta. Pap. 49, 17 pp., illus.

Arizona Watershed Program Staff
1956. Recovering rainfall — more water for irrigation. Joint publication by the Arizona State Land Dep.—Water Div., Salt River Valley Water Users' Assoc., and Univ. Ariz. 33 pp., illus.

Arnold, Joseph F., Donald A. Jameson, and Elbert H. Reid
1964. The pinyon-juniper type of Arizona: Effects of grazing, fire, and tree control. U. S. Dep. Agr., Forest Serv., Prod. Res. Rep. 84, 28 pp., illus.

Barger, Roland L.
1965. Veneer grade and volume recovery from ponderosa pine in the Southwest. U.S. Forest Serv., Rocky Mountain Forest and Range Exp. Sta. Mimeo report, 16 pp., illus.

Barger, Roland L., and Herbert O. Fleischer
1964. New products from low-grade ponderosa pine timber. U.S. Forest Serv., Rocky Mountain Forest and Range Exp. Sta. Res. Pap. 10, 54 pp., illus.

Davis, William C.
1962. Values of hunting and fishing in Arizona 1960. Bur. of Business and Public Res., Univ. Ariz. Spec. Studies 21, 61 pp., illus.

Krauch, Herman
1956. Management of Douglas-fir timberland in the Southwest. U. S. Forest Serv., Rocky Mountain Forest and Range Exp. Sta., Sta. Pap. 21, 59 pp., illus.

Landsberg, Hans H., Leonard L. Fischman, and Joseph L. Fisher
1963. Resources for America's future. Published for Resources for the Future, Inc., 1,017 pp., illus. Baltimore: The Johns Hopkins Press.

Outdoor Recreation Resources Review Commission
1962. Outdoor recreation for America. A report to the President and to the Congress, 246 pp., illus. Wash., D. C.: U. S. Govt. Printing Office.

Pearson, G. A.
1950. Management of ponderosa pine in the Southwest. U.S. Dep. Agr., Forest Serv., Agr. Monogr. 6, 218 pp., illus.

Steer, Henry B.
1948. Lumber production in the United States, 1799-1946. U.S. Dep. Agr., Forest Serv. Misc. Pub. 669, 233 pp.

Thornber, J. J.
1910. The grazing ranges of Arizona. Arizona Agr. Exp. Sta. Bull. 65, 360 pp., illus.

U.S. Bureau of the Census
1961. Census of manufactures, 1958: Special Report MC58(S)-2.3, 90 pp., Wash., D. C.: U. S. Govt. Printing Office.

U.S. Forest Service
1958. Timber resources for America's future. U.S. Dep. Agr. Forest Resource Rep. 14, 713 pp., illus. Wash., D. C.: U. S. Govt. Printing Office.

———
1963. The economic importance of timber in the United States. U.S. Dep. Agr. Misc. Pub. 941. Wash., D. C.; U. S. Govt. Printing Office.

———
1965. Timber trends in the United States. Forest Res. Rep. 17, 235 pp., illus. Wash., D. C.: U. S. Govt. Printing Office

U. S. Senate
1960. Water resources activities in the United States, population projections and economic assumptions, Select Committee on National Water Resources, Eighty-sixth Congress, second session, Comm. Print 5.

———
1960. Water resources activities in the United States, views and comments of the States, Select Committee on National Water Resources, Eighty-sixth Congress, second session, Comm. Print 6.

Wilson, Alvin K.
1964. Timber products output in Arizona and New Mexico, 1962. U. S. Dep. Agr., U. S. Forest Serv., Intermountain Forest and Range Exp. Sta. Res. Pap. INT-15.

APPENDIX

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 forseeable 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 poletimber 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	Fir-spruce
Ponderosa pine	Aspen

Additional forest types which occur only on noncommercial forest land are:

Pinyon-juniper

Chaparral

Other (unclassified)

Tree-Size Classes

Sawtimber-size tree

A tree 9.0 inches d.b.h. or larger for softwoods and 11.0 inches d.b.h. or larger for hardwoods.

Pole-size tree

A tree 5.0 to 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods.

Sapling-seedling 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, 9.0 inches d.b.h. or larger for softwoods and 11.0 inches d.b.h. or larger for hardwoods, that contains at least one 12-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 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods, 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 5.0 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 12-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 at least 10 percent stocked, with half or more of this crown density stocking in sawtimber and poletimber trees and with sawtimber stocking at least equal to poletimber stocking.

Old-growth sawtimber.—A sawtimber stand in which 50 percent or more of the net board-foot volume is in trees of rotation age and older.

Young-growth sawtimber. — A sawtimber stand in which 50 percent or more of the net board-foot volume is in trees under rotation age.

Poletimber stand

A stand at least 10 percent stocked, with half or more of this crown density stocking in sawtimber and/or poletimber trees and with poletimber stocking exceeding that of sawtimber stocking.

Sapling and seedling stand

A stand at least 10 percent stocked, with more than half of this crown density stocking in saplings and/or seedlings.

Nonstocked area

An area not qualifying as a sawtimber, poletimber, or a sapling-seedling 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 live 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 ¼-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 ranges from 5 to 10 inches inside bark depending on d.b.h. and species.

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

Those logs that have 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.

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.

County and municipal lands

Lands owned by counties and municipalities.

Forest-industry lands

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

Farmer-owned lands

Lands owned by operators of farms or ranches.

Miscellaneous private lands

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

Principal Tree Species

Softwoods	
Douglas-fir	*Pseudotsuga menziesii*
Fir, subalpine	*Abies lasiocarpa*
Fir, corkbark	*A. lasiocarpa var. arizonica*
Fir, white	*A. concolor*
Juniper	*Juniperus spp.*
Pine, limber	*Pinus flexilis*
Pine, ponderosa	*P. ponderosa*
Pinyon	*P. spp.*
Spruce, Engelmann	*Picea engelmannii*
Hardwoods	
Aspen, quaking	*Populus tremuloides*

SURVEY METHODS

Area statistics were determined by two methods:[15] (1) On National Forests, forest lands were mapped on aerial photographs according to forest type, stand size, and crown density. Photo delineations were transferred to base maps. Maps were then dot counted to obtain the estimates of area by the various land and forest classes. (2) For all lands not in National Forest ownership (except certain Indian Reservations), 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 photo estimates of proportions. Acreages were determined by applying the adjusted proportions to the total acreage of the sampled area.

Volume estimates are based on tree measurements taken on 3,207 sample areas located at random on commercial forest land. Sample locations were pricked on aerial photos, then located on the ground and established on a permanent basis to permit remeasurement on future surveys. Two different sampling procedures were used: (1) On National Forests measurements were taken on circular plots of fixed radius. Each plot consisted of four circular and concentric subplots. The area of subplots and size class of trees (live and dead) of commercial species tallied on each are as follows:

1/250-acre — seedlings
1/50-acre — saplings
1/10-acre — pole-size
1/4-acre — sawtimber-size

(2) On non-National Forest lands, sample locations were approximately 1 acre in size. Each location was subsampled at 10 points. At each point, trees were tallied on two plots — one of fixed radius (1/250-acre) and one of variable radius. On the former, all trees were measured and live noncull trees were classified as crop trees or excess trees from the standpoint of management treatment. The variable radius plot (trees are sampled in proportion to their basal area) was used for live sawtimber trees and for mortality sawtimber trees.

Under both of the systems described above the customary measurements and classifications of trees were made for volume and quality, and increment borings were taken for growth estimates.

Per-acre values of volume, growth, and mortality were obtained from the field samples. These averages, applied to area estimates, provided volumes shown in appendix tables.

Estimates of timber cut are based on periodic surveys of forest industries. The latest survey was in 1962 and is the basis for data shown in the appendix tables. Utilization trends discussed in the text are based mainly on lumber production data, since information on output of all products is available only for 1952, 1960, and 1962.

[15] *Methods described here are those that were used for inventorying all forest lands except those within the Navajo, Ft. Apache, San Carlos, and Hualapai Indian Reservations. Data for these lands were provided by the Bureau of Indian Affairs from their management plan inventories.*

RELIABILITY OF ESTIMATES

Accuracy objectives for the timber inventory of Arizona were as follows:

	Allowable sampling error[1]
Commercial forest area	3 percent per million acres
Noncommercial forest area	10 percent per million acres
Growing stock volume on commercial forest land	10 percent per billion cubic feet
Net annual growth of growing stock on commercial forest land	15 percent per billion cubic feet

[1]*In terms of one standard error.*

Sampling errors actually obtained for the State as a whole are not known. They have been computed for certain parts of the State from basic data provided by some of the several agencies that made inventories of their own lands. For certain large areas, however, the basic field and photo data necessary for computing errors were not available.

The following sampling errors have been computed for timber cut and timber products output in 1962:

	Volume	Sampling error[1] percent
Timber cut from growing stock	65,941 M cu. ft.	5.2
Timber cut from sawtimber	404,850 M bd. ft.	5.5
Timber products output	65,529 M cu. ft.	5.2

[1]*In terms of one standard error.*

Table 1.—**Area by land classes, Arizona, 1962**

Land class	Thousand acres
Commercial forest land	3,977
Unproductive forest land	16,268
Productive-reserved forest land	353
Total forest land	20,598
Nonforest land	52,090
All land	[1]72,688

[1]*From U.S. Bureau of the Census, Land and Water Areas of the United States, 1960.*

Table 2.—**Area of commercial forest land by ownership classes, Arizona, 1962**

Ownership class	Thousand acres
National Forest	2,630
Other Federal:	
Bureau of Land Management	2
Indian	1,144
Miscellaneous Federal	—
Total other Federal	1,146
State	32
County and municipal	2
Farmer-owned	82
Miscellaneous private[1]	85
All ownerships	3,977

[1]*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, Arizona, 1962**

Stand-size class	All ownerships	National Forest	Other Public	Farmer[1] and misc. private
	- - - - - *Thousand acres* - - - - -			
Sawtimber stands:				
Old growth sawtimber	1,957	1,110	804	43
Young growth sawtimber	1,786	1,346	347	93
Total	3,743	2,456	1,151	136
Poletimber stands	128	93	21	14
Sapling and seedling stands	41	20	4	17
Nonstocked area	65	61	4	—
All classes	3,977	2,630	1,180	167

[1]*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-volume classes for sawtimber and other stand-size classes, Arizona, 1962**

Stand volume per acre[1]	Area by stand-size classes		
	All stands	Sawtimber stands	Other stands
	Thousand acres		
Less than 1,500 board feet	243	44	199
1,500 to 5,000 board feet	1,771	1,736	35
5,000 to 10,000 board feet	1,315	1,315	—
10,000 to 20,000 board feet	433	433	—
More than 20,000 board feet	215	215	—
All classes	3,977	3,743	234

[1]*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, Arizona, 1962**

Stocking class	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	Thousand acres				
70 percent or more	1,638	1,615	13	10	xx
40 to 70 percent	1,647	1,581	43	23	xx
10 to 40 percent	627	547	72	8	xx
Less than 10 percent	65	xx	xx	xx	65
All classes	3,977	3,743	128	41	65

Table 6.—**Area of commercial forest land, by forest types and ownership classes, Arizona, 1962**

Forest type	All ownerships	Public ownerships	Private ownerships
	Thousand acres		
Douglas-fir	130	130	—
Ponderosa pine	3,658	3,515	143
Fir-spruce	110	110	—
Aspen	79	55	24
All types	3,977	3,810	167

Table 7.—**Area of commercial forest land by forest types and by stand-size classes, Arizona, 1962**

Forest type	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	Thousand acres				
Douglas-fir	130	130	([1])	([1])	—
Ponderosa pine	3,658	3,468	89	37	64
Fir-spruce	110	109	([1])	—	1
Aspen	79	36	39	4	—
All types	3,977	3,743	128	41	65

[1]*Less than 0.5 thousand acres.*

Table 8.—**Area of noncommercial forest land, by forest types, Arizona, 1962**

Forest type	All areas	Productive reserved areas	Unproductive areas
	Thousand acres		
Douglas-fir	7	7	—
Ponderosa pine	624	345	279
Fir-spruce	1	1	—
Chaparral	3,728	—	3,728
Pinyon-juniper	12,249	—	12,249
Other	12	—	12
All types	16,621	353	16,268

Table 9.—**Number of growing-stock trees on commercial forest land, by diameter classes and by softwoods, and hardwoods, Arizona, 1962**

D.B.H. class (inches)	All species	Softwood	Hardwood
	Thousand trees		
1.0-2.9	499,297	489,428	9,869
3.0-4.9	258,648	241,092	17,556
5.0-6.9	137,699	124,954	12,745
7.0-8.9	79,912	75,891	4,021
9.0-10.9	45,015	43,092	1,923
11.0-12.9	31,597	31,126	471
13.0-14.9	20,823	20,146	677
15.0-16.9	16,232	15,791	441
17.0-18.9	10,797	10,651	146
19.0-28.9	25,710	25,636	74
29.0-38.9	3,326	3,326	—
39.0 and larger	276	276	—
All classes	1,129,332	1,081,409	47,923

Table 10.—**Volume of timber on commercial forest land, by class of timber and by softwoods and hardwoods, Arizona, 1962**

Class of timber	All species	Softwoods	Hardwoods
	- - - - - -	*Thousand cubic feet*	- - - - - -
Sawtimber trees:			
Saw-log portion	5,148,202	5,108,355	39,847
Upper-stem portion	385,732	378,302	7,430
Total	5,533,934	5,486,657	47,277
Poletimber trees	557,257	480,548	76,709
All growing-stock trees	6,091,191	5,967,205	123,986
Sound cull trees:			
Sawtimber-size trees	115,651	56,935	58,716
Poletimber-size trees	106,152	31,176	74,976
Total	221,803	88,111	133,692
Rotten cull trees:			
Sawtimber-size trees	82,049	39,287	42,762
Poletimber-size trees	45,459	6,170	39,289
Total	127,508	45,457	82,051
Salvable dead trees:			
Sawtimber-size trees	360,341	359,922	419
Poletimber-size trees	17,117	9,071	8,046
Total	377,458	368,993	8,465
All timber	6,817,960	6,469,766	348,194

Table 11.—**Volume of growing stock and sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Arizona, 1962**

Ownership class	All species	Softwoods	Hardwoods
		GROWING STOCK *(Million cubic feet)*	
National Forest	4,389	4,345	44
Other public	1,556	1,512	44
Farmer and misc. private[1]	146	110	36
All ownerships	6,091	5,967	124
		SAWTIMBER *(Million board feet)*[2]	
National Forest	19,153	19,105	48
Other public	7,297	7,203	94
Farmer and misc. private[1]	501	384	117
All ownerships	26,951	26,692	259

[1]*Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2]*International 1/4-inch rule.*

Table 12.—**Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by softwoods and hardwoods, Arizona, 1962**

Stand-size class	All species	Softwoods	Hardwoods
		GROWING STOCK *(Million cubic feet)*	
Sawtimber stands	5,949	5,892	57
Poletimber stands	136	69	67
Sapling and seedling stands	5	5	—
Nonstocked areas	1	1	—
All classes	6,091	5,967	124
		SAWTIMBER *(Million board feet)*[1]	
Sawtimber stands	26,694	26,529	165
Poletimber stands	238	144	94
Sapling and seedling stands	16	16	—
Nonstocked areas	3	3	—
All classes	26,951	26,692	259

[1]*International 1/4-inch rule.*

Table 13.—**Volume of growing stock on commercial forest land by species and diameter classes, Arizona, 1962**

Species	Diameter class (inches at breast height)										
	All classes	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-28.9	29.0-38.9	39.0 & larger
	Million cubic feet										
Softwoods:											
Douglas-fir	283	9	7	10	10	10	18	21	109	58	31
Ponderosa pine[1]	5,204	173	235	216	312	319	426	581	2,313	594	35
Limber pine[2]	39	1	2	1	2	5	4	3	16	3	2
True firs[3]	210	21	15	10	16	15	17	12	63	30	11
Engelmann spruce	231	6	11	9	20	27	29	31	88	10	—
Total	5,967	210	270	246	360	376	494	648	2,589	695	79
Hardwoods:											
Aspen	124	34	24	19	8	15	14	6	4	—	—
Total	124	34	24	19	8	15	14	6	4	—	—
All species:	6,091	244	294	265	368	391	508	654	2,593	695	79

[1]*Includes a negligible amount of Apache, Arizona, and Chihuahua pine.*
[2]*Includes a negligible amount of Mexican white and bristlecone pines.*
[3]*Includes subalpine, white, and corkbark firs.*

Table 14.—**Volume of sawtimber on commercial forest land, by species and diameter classes, Arizona, 1962**

Species	Diameter class (inches at breast height)								
	All classes	9.0-10.9[1]	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-28.9	29.0-38.9	39.0 & larger
	Million board feet[2]								
Softwoods:									
Douglas-fir	1,476	48	56	51	91	103	613	340	174
Ponderosa pine[3]	22,883	920	1,354	1,397	1,890	2,585	11,079	3,389	269
Limber pine[4]	186	7	10	25	19	15	82	18	10
True firs[5]	932	48	78	77	88	62	349	167	63
Engelmann spruce	1,215	50	111	150	162	173	510	59	—
Total	26,692	1,073	1,609	1,700	2,250	2,938	12,633	3,973	516
Hardwoods:									
Aspen	259	—	40	85	78	34	22	—	—
Total	259	—	40	85	78	34	22	—	—
All species	26,951	1,073	1,649	1,785	2,328	2,972	12,655	3,973	516

[1]*Softwoods only.*
[2]*International 1/4-inch rule.*
[3]*Includes a negligible amount of Arizona, Apache, and Chihuahua pine.*
[4]*Includes a negligible amount of Mexican white and bristlecone pines.*
[5]*Includes subalpine, white, and corkbark firs.*

Table 15.—**Volume of sawtimber on commercial forest land, by species[1] and quality classes, Arizona, 1962**

Species	Quality classes				
	All classes	1	2	3	4
	Million board feet[2]				
Softwoods:					
Ponderosa pine[3]	22,883	533	856	2,021	19,473
Total	22,883	533	856	2,021	19,473

[1]*Ponderosa pine is the only species log-graded.*
[2]*International 1/4-inch rule.*
[3]*Includes a negligible amount of Arizona, Apache, and Chihuahua pine.*

Table 16.—**Volume of salvable dead sawtimber-size trees on commercial forest land, by softwoods and hardwoods, Arizona, 1962**

Species group	Volume
	Thousand board feet[1]
Softwoods	1,674,663
Hardwoods	2,287
All species	1,676,950

[1]*International 1/4-inch rule.*

Table 17.—**Net annual growth and annual cut of growing stock on commercial forest land, by species, Arizona, 1962**

Species	Net annual growth	Annual timber cut
	Thousand cubic feet	
Softwoods:		
Douglas-fir	−1,398	4,115
Ponderosa pine[1]	84,669	57,558
Limber pine[2]	693	85
True firs[3]	289	3,142
Engelmann spruce	2,348	845
Total	86,601	65,745
Hardwoods:		
Aspen	3,652	196
All species	90,253	65,941

[1]*Includes a negligible amount of Arizona, Apache, and Chihuahua pines.*
[2]*Includes a negligible amount of Mexican white and bristlecone pines.*
[3]*Includes subalpine, white, and corkbark firs.*

Table 18.—**Annual cut of growing stock on commercial forest land, by ownership classes and by softwoods and hardwoods, Arizona, 1962**

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
	Thousand cubic feet			
Softwoods	65,745	47,862	11,177	6,706
Hardwoods	196	143	33	20
All species	65,941	48,005	11,210	6,726

[1]*Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 19.—**Net annual growth and annual cut of sawtimber on commercial forest land, by species, Arizona, 1962**

Species	Net annual growth	Annual timber cut
	Thousand board feet[1]	
Softwoods:		
Douglas-fir	−11,626	25,481
Ponderosa pine[2]	340,022	353,899
Limber pine[3]	2,572	404
True firs[4]	−1,890	19,414
Engelmann spruce	12,665	5,258
Total	341,743	404,456
Hardwoods:		
Aspen	2,335	394
All species	344,078	404,850

[1]*International 1/4-inch rule.*
[2]*Includes a negligible amount of Arizona, Apache, and Chihuahua pines.*
[3]*Includes a negligible amount of Mexican white and bristlecone pines.*
[4]*Includes subalpine, white, and corkbark firs.*

Table 20.—**Annual cut of sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Arizona, 1962**

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
	Thousand board feet[2]			
Softwoods	404,456	294,444	68,757	41,255
Hardwoods	394	287	67	40
All species	404,850	294,731	68,824	41,295

[1]*Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*
[2]*International 1/4-inch rule.*

Table 21.—**Annual mortality of growing stock and sawtimber on commercial forest land, by species, Arizona, 1962**

Species	Growing stock	Sawtimber
	Thousand cubic feet	*Thousand board feet*[1]
Softwoods:		
Douglas-fir	5,176	30,591
Ponderosa pine[2]	12,246	63,741
True firs[3]	3,257	15,320
Engelmann spruce	71	—
Total	20,750	109,652
Hardwoods:		
Aspen	1,044	3,851
All species	21,794	113,503

[1]*International 1/4-inch rule.*
[2]*Includes a negligible amount of Arizona, Apache, and Chihuahua pines.*
[3]*Includes subalpine, white, and corkbark firs.*

Table 22.—**Annual mortality of growing stock and sawtimber on commercial forest land, by causes and by softwoods and hardwoods, Arizona, 1962**

Cause of death	Growing stock			Sawtimber		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
	Thousand cubic feet			*Thousand board feet*[1]		
Fire	8,619	8,619	—	45,830	45,830	—
Insects	2,564	2,564	—	11,596	11,596	—
Disease	7,703	7,283	420	44,358	42,635	1,723
Other	1,450	826	624	6,339	4,211	2,128
Weather	1,458	1,458	—	5,380	5,380	—
All causes	21,794	20,750	1,044	113,503	109,652	3,851

[1]*International 1/4-inch rule.*

Table 23.—**Total output of timber products, by products, by type of material used, and by softwoods and hardwoods, Arizona, 1962**

Product and species group	Total output in standard units		Output from roundwood from growing stock		Output from roundwood from nongrowing stock		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.[1]	341,757	330,137	47,870	11,620	1,685	—
Hardwood	M bd. ft.[1]	—	—	—	—	—	—
Total	M bd. ft.[1]	341,757	330,137	47,870	11,620	1,685	—
Pulpwood:							
Softwood	M std. cds.	88	88	7,947	—	—	—
Hardwood	M std. cds.	—	—	—	—	—	—
Total	M std. cds.	88	88	7,947	—	—	—
Poles:							
Softwood	M pcs.	9	9	125	—	—	—
Hardwood	M pcs.	—	—	—	—	—	—
Total	M pcs.	9	9	125	—	—	—
Mine timbers:							
Softwood	M cu. ft.	556	524	524	32	32	—
Hardwood	M cu. ft.	—	—	—	—	—	—
Total	M cu. ft.	556	524	524	32	32	—
Miscellaneous industrial wood:[2]							
Softwood	M cu. ft.	111	82	82	29	29	—
Hardwood	M cu ft.	375	196	196	179	179	—
Total	M cu. ft.	486	278	278	208	208	—
Posts:							
Softwood	M pcs.	171	31	25	140	112	—
Hardwood	M pcs.	2	—	—	2	2	—
Total	M pcs.	173	31	25	142	114	—
Fuelwood:							
Softwood	M std. cds.	94	5	353	75	5,197	14
Hardwood	M std. cds.	17	—	—	17	1,171	—
Total	M std. cds.	111	5	353	92	6,368	14
All products:							
Softwood	M cu. ft.	—	—	56,926	—	7,055	—
Hardwood	M cu. ft.	—	—	196	—	1,352	—
Total	M cu. ft.	—	—	57,122	—	8,407	—

[1]*International 1/4-inch rule.*
[2]*Includes converter poles, excelsior bolts, charcoal wood, house logs, and miscellaneous farm timbers.*

Table 24.—**Total output of roundwood products, by source and by softwoods and hardwoods, Arizona, 1962**

Source	All species	Softwoods	Hardwoods
	- - - *Thousand cubic feet* - - -		
Growing-stock trees:[1]			
Sawtimber	56,930	56,812	118
Poletimber	192	114	78
Total	57,122	56,926	196
Cull trees[1]	—	—	—
Salvable dead trees[1]	7,455	6,537	918
Other[2]	952	518	434
All sources	65,529	63,981	1,548

[1]*On commercial forest land.*
[2]*Includes noncommercial forest land, nonforest land such as fence rows, trees less than 5.0 inches in diameter, and tree tops and limbs.*

Table 25.—**Annual timber cut from growing stock on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Arizona, 1962**

Products and residues	All species	Softwoods	Hardwoods
	- - - *Thousand cubic feet* - - -		
Roundwood products:			
Saw logs	47,870	47,870	—
Pulpwood	7,947	7,947	—
Poles	125	125	—
Mine timbers	524	524	—
Miscellaneous industrial wood[1]	278	82	196
Posts	25	25	—
Fuelwood	353	353	—
All products	57,122	56,926	196
Logging residues	8,819	8,819	—
Timber cut	65,941	65,745	196

[1]*Includes converter poles, excelsior bolts, charcoal wood, house logs, and miscellaneous farm timbers.*

Table 26.—**Annual timber cut from live sawtimber on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Arizona, 1962**

Products and residues	All species	Softwoods	Hardwoods
	Thousand board feet[1]		
Roundwood products:			
Saw logs	330,137	330,137	—
Pulpwood	54,834	54,834	—
Poles	862	862	—
Mine timbers	1,790	1,790	—
Miscellaneous industrial wood[2]	559	165	394
Posts	77	77	—
Fuelwood	390	390	—
All products	388,649	388,255	394
Logging residues	16,201	16,201	—
Timber cut	404,850	404,456	394

[1]*International 1/4-inch rule.*
[2]*Includes converter poles, excelsior bolts, charcoal wood, house logs, and miscellaneous farm timbers.*

Table 27.—**Volume of plant residues by industrial source and type of residue, and by softwoods and hardwoods, Arizona, 1962**

Industrial source	Species and character of residues								
	All species			Softwoods			Hardwoods		
	Total	Coarse[1]	Fine[2]	Total	Coarse	Fine	Total	Coarse	Fine
	Thousand cubic feet								
Lumber industry	10,268	3,896	6,372	10,268	3,896	6,372	—	—	—
Veneer and plywood industry	0	0	0	0	0	0	0	0	0
Other primary industries	103	103	—	21	21	—	82	82	—
All industries	10,371	3,999	6,372	10,289	3,917	6,372	82	82	—

[1]*Unused material suitable for chipping, such as slabs, edgings, and veneer cores.*
[2]*Unused material not suitable for chipping, such as sawdust and shavings.*

Table 28.—**Timber growth projections, all species, Arizona, 1962-92**[1]

Year	Assumed cut	Projected growth
	GROWING STOCK *(Thousand cubic feet)*	
1962	65,941	90,253
1972	86,700	112,200
1982	103,400	131,200
1992	117,700	149,100
	SAWTIMBER *(Thousand board feet)*[2]	
1962	404,850	344,078
1972	444,600	381,400
1982	468,100	408,800
1992	479,600	419,200

[1]*These projections assume that: (1) There will be practically no change in the area of commercial forest land, (2) demands for timber products will rise along with predicted increases in the nation's population and income, (3) timber will maintain its market position relative to competing materials, and (4) timber management will become more intensive, especially with respect to improving the number, spacing, vigor, and age-class distribution of trees.*

[2]*International 1/4-inch rule.*

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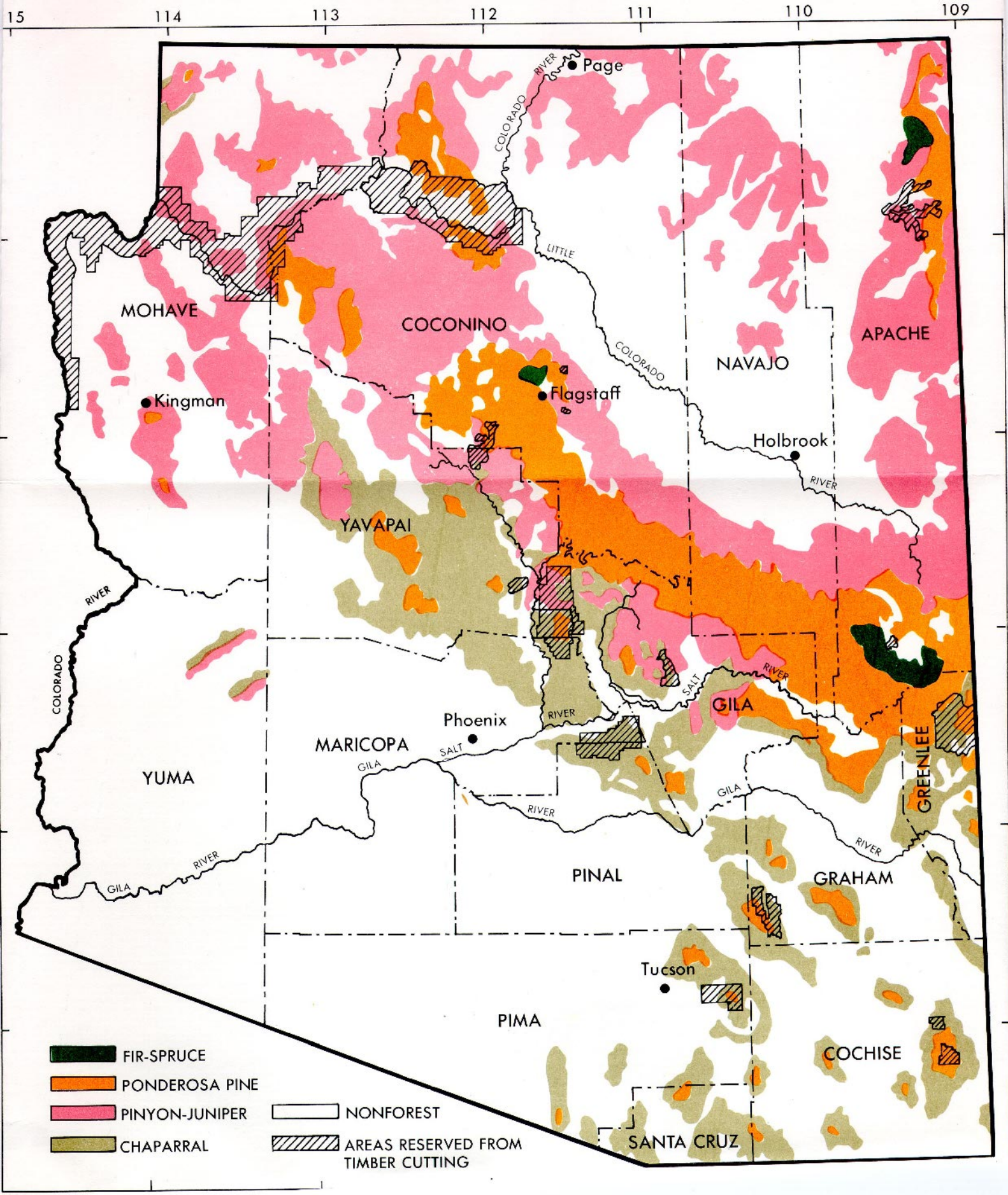

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Title	Number	Date
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*The Forests of Wyoming	Resource Bulletin INT-2	1963
*The Forest Resources of Colorado	Resource Bulletin INT-3	1964
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