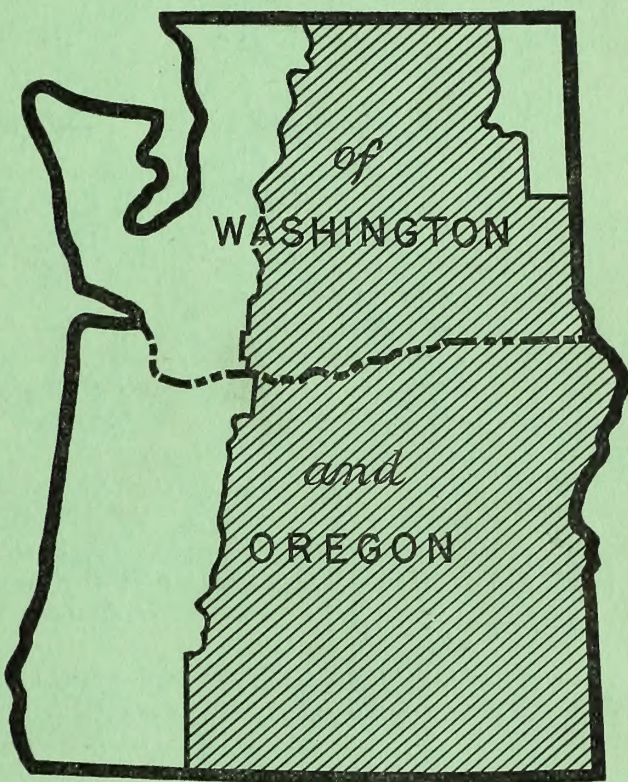
FOREST RESOURCES *of the* Ponderosa Pine Region



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Forest Resources of the Ponderosa Pine Region of Washington and Oregon

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PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
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The Forest Survey

DEPENDABLE information on the supply of forest products, as of all raw materials, is vital to the conduct of the war and to any plans for our postwar welfare. Intelligent land-use planning must be based upon reliable facts as to location, area, and condition of existing and prospective forest land, supply of timber and other forest products, forest depletion and forest growth, and production and consumption of forest products. This necessity for dependable and comprehensive data is now being met through the Nation-wide forest survey authorized by the McSweeney-McNary Forest Research Act of 1928. The Forest Service was directed by the Secretary of Agriculture to conduct the survey. The rapidly changing conditions of our economic and social life since the second world war began have accentuated the need for publishing the facts already gathered and the conclusions to be drawn from them.

The fivefold purpose of the Forest Survey is: (1) To make an inventory of forest land and timber supplies; (2) to ascertain the current and potential growth on forest areas; (3) to determine the drain upon the forests through cutting and through loss from fire, insects, disease, wind throw, and other causes; (4) to determine the present and prospective requirements of the United States for forest products; and (5) to analyze and correlate these findings with other economic data, as an aid in formulation of private and public policies for most effective and rational use of land suited to forest production.

In each forest region of the United States the forest survey is conducted by the regional forest experiment station. The survey of Oregon and Washington has been made by the Pacific Northwest Forest and Range Experiment Station, with headquarters at Portland, Oreg.

The results of this investigation are published, as they become available, in a series o reports applying to large forest areas such as regions, States, units, and counties. It is expected that the information presented in these reports for large geographic units will facilitate more intensive studies of small areas. Naturally, the recommendations made are adapted to the long-time character of timber growing and presuppose normal peacetime conditions. Any that are out of line with war requirements are obviously in abeyance for the present.

RAYMOND D. GARVER,
Director, Forest Survey.

Contents

Survey Findings in Brief

THE amount, character, geographic distribution, and ownership of the forest resources of the ponderosa pine region of Washington and Oregon are of vital concern, not only to local residents, but also to the entire Nation. These forests supply the principal local industries—the sawmills and woodworking plants—with raw material. They contribute to the prosperity of farming and stock raising, the other major economic pursuits. Upon this foundation, towns, schools, banks, shops, transportation systems, and other institutions necessary to modern life have been created. Preservation of the regional economy on the present level rests upon a continuous flow of material and services from the forests at the current annual rate. This can be accomplished only through sustained-yield forest management, which in turn depends upon forest owners accepting the responsibilities that must inevitably accompany ownership of natural resources.

It is not enough to know that this region has 22 million acres of forest land and 127 billion board feet of saw timber. To reap the full economic benefits of this resource a detailed understanding of how it can be made to contribute most to the welfare of the people is necessary. Based upon this understanding, plans for adoption of sustained yield must be formulated and effectuated immediately, to avoid wasteful migration of industry and people that follows exhaustion of forest resources.

A brief synopsis of the findings of the Forest Survey, as presented in detail in the following pages, is as follows:[1]

1. The ponderosa pine region of Oregon and Washington produces one-half of the total ponderosa pine lumber cut in the entire United States.

2. In 1939 this region produced 1.9 billion board feet of lumber, nearly nine-tenths of which was ponderosa pine.

3. The major problem in the ponderosa pine region is to bring about a general shift to a light, maturity-selection cutting practice. This will speed up transformation of old-growth stands to a net growth condition and reduce the severity of inevitable curtailment of cut if present practices continue.

4. Locally the timber-supply situation is acute. The Klamath Plateau and Deschutes River units

[1] Forest Survey progress releases on the ponderosa pine region issued by the Pacific Northwest Forest and Range Experiment Station previous to the publication of this major report are: (1) Forest statistics in separate form for Asotin, Chelan, Columbia, Ferry, Garfield, Kittitas, Klickitat, Okanogan, Walla Walla, and Yakima Counties, Wash., and Baker, Crook, Deschutes, Grant, Harney, Jefferson, Klamath, Lake, Morrow, Umatilla, Union, Wallowa, Wasco, and Wheeler Counties, Oreg. [Mimeographed.] No report was issued for Malheur County, Oreg., or Lincoln, Douglas, and Whitman Counties, Wash., because of the small acreage of forest land involved and its relative unimportance in the counties' economy. (2) Timber Volume and Type Acreage on the National Forests of the North Pacific Region. Forest Res. Notes No. 22. 1937. [Mimeographed.] (3) Forest Statistics for Eastern Oregon and Eastern Washington, Forest Res. Notes No. 25. 1938. [Mimeographed.] A summary of detailed and generalized forest-type areas, site quality, and timber volume. (4) Volume Distribution in Saw-Timber Types of the Ponderosa Pine Region. Forest Res. Notes No. 28. 1939. [Mimeographed.] (5) Forest Growth in the Ponderosa Pine Region of Oregon and Washington. Forest Surv. Rpt. 78. 1940. [Mimeographed.] (6) Detailed forest type maps of each of the above-listed 24 counties and for Douglas, Lincoln, and Whitman Counties, Wash., for which no reports were issued. Scale 1 inch equals 1 mile. Blue line print form. 1936. (7) State type maps—ponderosa pine region covered by eight sheets, NW Washington, SW Washington, NE Washington, SE Washington, NW Oregon, SW Oregon, NE Oregon, and SE Oregon. Scale ¼ inch = 1 mile. 1936–37. [Lithographed.]

furnish approximately three-fifths of the region's total lumber cut. Production in these two units must be reduced to about one-third of their present levels within three decades, if present trends continue.

5. Immediate adoption of sustained yield would mean drastic reductions in the cut of principal lumber-manufacturing centers. In spite of present sacrifice involved in reducing the cut now, the longer such reduction is postponed the greater will be the shock of eventual curtailment enforced by lack of merchantable raw material.

6. The forest industries are the only manufacturing industries of any importance in this region.

7. Forest lands of this region are valuable for many purposes other than timber production. These include furnishing summer range for the important livestock industry and the protection of watersheds which furnish water for irrigation of the most intensively farmed land in the region.

8. This region has 22.1 million acres of forest land, which is one-third of its total land area. Nearly three-fourths of the forest land is commercial conifer land.

9. A total of 13.4 million acres is occupied by stands of saw-timber size, of which 10.4 million acres or 78 percent supports ponderosa pine forests.

10. Second-growth conifers occupy 3.7 million acres, 43 percent well stocked, 42 percent medium stocked, and 15 percent poorly stocked. Only 0.3 million acres is totally deforested as a result of cutting or fire.

11. The region's total saw-timber stand is 127.1 billion board feet, log scale, Scribner rule, of which 81.5 billion board feet or 64 percent is ponderosa pine. Next is Douglas-fir with 18.5 billion board feet, followed by western larch with 6.7 and white fir with 6.4 billion board feet.

12. Total cubic volume in trees 5 inches and larger in breast-high diameter is 30.8 billion cubic feet. Roughly 80 percent of this volume is in trees of saw-timber size.

13. Approximately half the region's forest land and saw-timber volume is in national forests, about one-third is privately owned, and the remainder is in other public or Indian ownership.

14. Annual gross drain on saw-timber stands is 2.6 billion board feet. Approximately half results from cutting and half results from destruction by insects, fire, wind, and disease.

15. Approximately 1.1 billion board feet, or 87 percent of the total cutting depletion, was in the form of sawlogs. More than three-fourths of this was cut in Oregon.

16. Current annual gross growth is 1.1 billion board feet. Mortality from insects, wind throw, and disease is believed to offset growth in mature stands and a portion of growth in immature stands, thus reducing current annual net growth to 219 million board feet.

17. Ponderosa pine suffers 87 percent of total cutting depletion but provides only 48 percent of total current net growth; four-fifths of the drain is from trees 22 inches and larger, whereas only one-fifth of the total net growth is furnished by trees of these sizes.

18. Current growth can be increased by conversion of nongrowing mature forests to growing condition. This can be done most effectively by selective timber management. There is a dearth of saw-timber size growing stock.

19. Only one-third of the region total of ponderosa pine saw timber is in private ownership, but two-thirds of the drain on this species is from private timber.

Definitions and Specifications

General

THE forest inventory included determination (1) of areas of the several types, by ownership class; (2) of areas of the even-aged immature conifer types, by age class and degrees of stocking, and uneven-aged immature conifer types, by degrees of stocking of poles and reproduction combined; (3) a classification of forest areas according to site quality; and (4) computation of the volume of the present timber stands, including residual stands on cut-over lands, by species and ownership class.

For convenience and facility of analysis and discussion, the region was arbitrarily divided into 6 units. So far as was practical the units were delimited so as to be homogeneous in economic influence and industrial condition. Maps and timber-volume information were obtained by compiling and field-checking existing data available from public or private cruises, maps, and reports, and making a field examination of all forest land not covered by office data (fig. 1).

The extent and character of the annual drain on the forest capital was obtained by compiling, and checking in the field when necessary, existing records of cutting, insect, and fire loss, and of wind throw. These data were analyzed for past and present rates of depletion and future trends.

Information on present and future forest growth was obtained through application of growth and yield rates available from previous studies to inventory figures of the immature forests. Data for the mature forests were obtained from field examination.

Unless otherwise indicated, all board-foot volumes are in terms of Scribner Decimal C log scale, hereafter referred to as Scribner rule.

A complete account of field and office survey methods is contained in the Appendix.

Standards of Measurement

Timber volume estimates made according to fixed, recorded specifications can be correlated with estimates for other regions, can be adjusted to meet changed economic conditions if desired, and are stable. Standards were adopted that conformed, as far as was practical, with current utilization practice.

Estimates of timber volume were made in board feet, log scale, according to the Scribner rule, and in cubic feet. The board-foot estimates included only the stems of living trees that would make at least one log conforming to these specifications:

Conifers 16 feet long, 8 inches in diameter inside bark at small end.

Hardwoods 8 feet long, 10 inches in diameter inside bark at small end.

Practically, this means making the 12-inch diameter class (11.1 to 13.0 inches d. b. h.[2]) the minimum specification for both conifers and hardwoods.

Allowance was made in the volume estimates for decay, defects, and such breakage as is inevitable in logging. In other words, the estimates are for the net volume usable in saw-timber operations under good utilization practices.

The standards of utilization employed in the survey are undoubtedly slightly more intensive for the more valuable species, and considerably so for the less-valuable species, than the current average utilization practice of saw-timber operators, owing chiefly to the inclusion of trees as small as the 12-inch diameter class. The volume tables used in the forest survey estimated mature trees to a usable top, and consequently survey estimates of saw-timber volume would closely approximate for a given area the total amount removable by an average operation.

[2] "D. b. h." signifies diameter at breast height (4½ feet above average ground level), outside bark unless otherwise specified.

Cubic-foot volume was computed for the soundwood content of stems only, from stump to 4-inch tip inside bark, limbwood and bark excluded, of all trees of or above the 6-inch (5.1 to 7.0 inches) diameter class.

The estimates cover all timber areas, including farm woods, outside the platted limits of municipalities. Differences between present estimates and previous estimates for given areas are due principally to depletion which has taken place between the time the two estimates were made and to differences between present and previous cruises as to standards and as to completeness, and in some instances to insect losses that occurred subsequent to the date of early cruises.

Species Classification

An estimate of total volume of living timber was made and recorded separately for every species that usually attains saw-timber size and character and that was present in commercial types in quantity measurable according to survey standards. In some cases estimates were combined for pairs of species having similar dendrological characteristics. Western juniper and some hardwoods do not usually attain saw-timber size in the ponderosa pine region. Although not included in the board-foot volume estimates, these species are included in the cubic-volume estimates.

The species for which volume was recorded are given in the following list. The nomenclature used is that approved by the Forest Service (*17*),[3] as amended in a few cases by recent Forest Service decisions. Species bracketed were recorded as one.

CONIFERS

Ponderosa pine (*Pinus ponderosa*)
Sugar pine (*P. lambertiana*)
Western white pine (*P. monticola*)
Lodgepole pine (*P. contorta latifolia*)
Douglas-fir (*Pseudotsuga taxifolia*)
Western redcedar (*Thuja plicata*)
Alaska yellow-cedar (*Chamaecyparis nootkatensis*)
California incense-cedar (*Librocedrus decurrens*)
Western hemlock (*Tsuga heterophylla*)
Mountain hemlock (*T. mertensiana*)
{Grand fir (*Abies grandis*)
{White fir (*A. concolor*)
{Noble fir (*A. nobilis*)
{Shasta red fir (*A. magnifica shastensis*)
Pacific silver fir (*A. amabilis*)
Alpine fir (*A. lasiocarpa*)
{Western larch (*Larix occidentalis*)
{Alpine larch (*L. lyalli*)
Engelmann spruce (*Picea engelmanni*)
Sierra juniper (*Juniperus occidentalis*)

BROADLEAF TREES

Red alder (*Alnus rubra*)
Bigleaf maple (*Acer macrophyllum*)
{Northern black cottonwood (*Populus trichocarpa hastata*)
{Narrowleaf cottonwood (*P. angustifolia*)
Golden aspen (*P. tremuloides aurea*)

[3] Italic numbers in parentheses refer to Literature Cited, p. 84.

Type Definitions and Type Mapping

The definition of forest-cover and land-use types for an area as large and varied geographically as the ponderosa pine region was a difficult problem. Each type used in the survey had to have some significance in forest management. Types had to be within practical limits in number, and definitions had to be such that types could be determined from office records such as timber cruises and could easily be recognized in the field and sketched on field maps. Even in the primeval forests many species associations occur and fire, cutting, and land settlement make conditions more complex. However, by employing as a base a type scheme already in use by the Forest Service for intensive surveys, a scheme was devised that has been proved to be satisfactory.

The forest-cover types recognized in the forest survey of the ponderosa pine region are as follows:

Woodland Types

No. 4. Oak: A stand containing approximately 60 percent or more of one or more species of oak. No separation of age classes.

Nos. 5A and 5B. Juniper: A stand composed principally of juniper, often with more or less mountain mahogany. Not so classified: Land where the trees are so scattered that they occupy less than about 5 percent of the ground surface. The two juniper types are classed by size and density; in the dense type (5A) the juniper trees are so large or numerous that they occupy 10 percent or more of the land area; in the scattered type (5B) they are so small or scattered as to occupy between 5 and 10 percent.

No. 5½. Ponderosa pine woodland: A borderline zone, with solitary trees, or groups of trees too small to map separately, in which mature

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FIGURE 1.—*Forest survey field man mapping pine woodland on the desert's edge. The open areas of sagebrush and other shrubs with clusters of pine trees in the draws are typical of the woodland type of ponderosa pine.*

ponderosa pine is the predominating tree; characteristic of the fringes of the desert and of the breaks between timbered plateaus and treeless canyons, where the area of grass or sagebrush may be as great as the area of timber, or greater; merging at its upper boundary with timberland types and at its lower limit with open land. The trees are not necessarily noncommercial, but volume per acre is ordinarily less than 3,000 feet. Immature types are not included.

Timberland Types

Nos. 6, 7, 8, 9A, 9B, and 10. Douglas-fir: These are forests containing approximately 60 percent or more by volume of Douglass-fir. The six types, differentiated by the size class into which most of the volume falls or, in the case of the two smallest sizes, the diameter class of most of the dominant trees, are large old growth (6), 40 inches d. b. h. and more; small old growth (7), 22 to 40 inches; large second growth (8), 22 to 40 inches (coarse-grained timber yielding only a small percent of the upper grades of lumber); large poles (9A), 12 to 20 inches; small poles (9B), 6 to 10 inches; seedlings and saplings (10), less than 6 inches d. b. h.

Nos. 17, 19A, and 19B. Western redcedar: These forests, largely confined to swamps and stream margins on the national forests of eastern Washington, contain approximately 40 percent or more by volume of western redcedar. The three types are classified by size class of most of the volume or, in 19B, of the dominant trees, as follows: Large (17), more than 24 inches d. b. h.; poles (19A), 12 to 24 inches; seedlings and saplings (19B), less than 12 inches.

Nos. 20, 20½, 20A, 21, and 22. Ponderosa pine: These are forests containing approximately 50 percent or more by volume of ponderosa pine, sugar pine, or Jeffrey pine, or any combination of these species (except those in which sugar pine attains 20 percent and becomes the key tree); stands are continuous in contrast to the more open ponderosa pine woodland type. The five types, differentiated by mixture and size class, are large (20), the dominant stand averaging more than 22 inches d. b. h. (so-called "yellow pine," more than 150 or 200 years old), no material part cut, and including occasional stands of mature or overmature ponderosa pine averaging smaller than 22 inches; large, pure (20½), approximately 80 percent or more, by volume, ponderosa or Jeffrey pine; large ponderosa-sugar pine (20A), 22 inches d. b. h., or more, 20 to 50 percent sugar pine; small (21), containing at least 1 M board feet of ponderosa pine 12 inches d. b. h., or more, and comprising either (a) selectively cut stands of any age, or (b) immature "bull pine," usually 12 to 22 inches d. b. h. but including occasional immature stands of more than 22 inches; seedlings, saplings, and poles (22), on old burns or heavily cut-over land, less than 12 inches d. b. h., containing less than 1 M board feet per acre of saw timber, if any.

No. 20B. Sugar pine mixture, large; sugar pine containing 20 percent or more by volume, ponderosa pine less than 50 percent, usually in mixture with Douglas-fir, ponderosa pine, or white fir; most of the volume in trees more than 22 inches d. b. h.

Nos. 23 and 24. Fir-hemlock: Noble fir, Pacific silver fir, alpine fir, Shasta red fir, white fir, mountain hemlock (or, occasionally, western hemlock), or any combination of these species composes at least 50 percent of the volume of the stand. The two size classes, characteristic of the upper slopes of the Cascade Range, are large (23), most of the volume in trees 12 inches d. b. h., or more, and sawlog material (other mature stands ordinarily classed as subalpine, No. 33); small (24), dominant trees mostly less than 12 inches d. b. h., usually young trees on old burns.

Nos. 25, 26, and 26A. Lodgepole pine forests containing at least 50 percent by volume of lodgepole pine, often almost pure, the three types corresponding to size class of most of the dominant trees as follows: Large (25), 12 inches d. b. h., or more; medium (26), 6 to 10 inches; small (26A), less than 6 inches.

Nos. 27 and 28. Pine mixture: Characteristic of north slopes and cooler basins and consisting of about 20 to 50 percent by volume of ponderosa pine with a variable quantity of western larch, white fir, Douglas-fir, lodgepole pine, western white pine, or other species, or of any combination of these species. The two types recognized are large (27), including forests in which most of the volume is in trees 12 inches d. b. h., or more, and in which cutting has been immaterial; and small (28), in which dominant trees are mostly less than 12 inches d. b. h.

Nos. 27½ and 28½. The two types of the upper-slope mixture are characteristic of the colder, moister sites and are ordinarily above the ponderosa pine zone and contain only a negligible quantity of that species; variable proportions of western larch, white fir, alpine fir, Douglas-fir, Engelmann spruce, lodgepole pine, western white pine, and occasionally other species; where Engelmann spruce, western white pine, or larch forms 50 percent or more of stand by volume, mapped as a separate subtype (27½ ES); large (27½), most of volume in trees 12 inches d. b. h., or more; small (28½), dominant trees less than 12 inches d. b. h.

Nos. 29 and 30. White fir: 50 percent or more by volume of grand or white fir, usually within the range of ponderosa pine, and segregated into large type (29), having most of the volume in trees 12 inches d. b. h., or more, (over 150 years); and small (30), most of the dominant trees less than 12 inches (under 150 years).

Nos. 31 and 31½. Hardwood types, in which maple, aspen, cottonwood, etc., predominate, pure or in mixture; large (31½), 12 inches d. b. h., or more; small (31), less than 12 inches d. b. h.

No. 33. Subalpine: Alpine fir, mountain hemlock, Shasta red fir, lodgepole pine, whitebark pine, western white pine, and alpine larch predominating and usually interspersed with meadows and glades. At upper limits of tree growth, usually unmerchantable because of poor form and small size. No volume recorded.

Nos. 35A and 35B. Nonrestocked cut-over: Logged areas not satisfactorily restocked (less than 10 percent) or a residual stand of less than 1 M board feet per acre and put to no other use. Differentiated by age: (35A) cut 1920 or since; (35B) cut before 1920.

Nos. 37, 37B, and 37W. Deforested: (37) Uncut stands killed by fire and not restocked, remaining green timber, if any, being unloggable; (37B) similarly deforested by insects, (37W) by wind throw.

No. 38. Noncommercial rocky: Within range of commercial timber, below limits of subalpine type, too rocky, steep, or sterile to produce a stand of commercial availability, size, density, or quality; any species; unlikely ever to be of commercial value;

ordinarily less than 5 M board feet per acre (if ponderosa pine, less than 2 M board feet); no volume recorded; does not include upper portions of valleys or higher slopes now inaccessible but potentially loggable.

All type mapping in the region was done by a form of intensive reconnaissance and the same general procedure was followed on all forest lands. While in theory the mapping was to be limited principally to areas not previously covered by intensive cruises, in actual practice it amounted to an almost complete coverage of all forest land. Areas covered by acceptable cruises were examined extensively to determine type boundaries, to map out small openings such as meadows and glades, to determine site quality of the forest land, and to verify the coverage of the previous cruise. The intensity of examination varied considerably, depending upon character and species of timber and intensity and reliability of preexisting records.

In addition to type mapping according to composition and size, the even-aged immature forest stands, those in which most of the dominant trees are less than 22 inches in diameter, were classified according to age in 10-year classes and according to their density in three degrees of stocking. These data are not shown statistically in this report but were used in making growth estimates. If a forest of seedlings, saplings, or small second growth was dense enough to cover 70 to 100 percent of the area (as measured by the stocked-quadrat method), it was classified as well stocked; if 40 to 69 percent was covered it was called medium stocked; if 10 to 39 percent, it was called poorly stocked. Areas less than 10 percent stocked were termed nonrestocked. If uneven-aged the stands were classified on the basis of poles and reproduction combined.

Other Classifications

The term "site quality" denotes the forest-productive capacity of an area, determined by the composite effect of all climatic and soil conditions. Site-quality classifications based on height of dominant and codominant trees at a given age have been adopted for the ponderosa pine types and the Douglas-fir types, six classes being used for ponderosa pine and five for Douglas fir, the highest class being designated I. The ponderosa pine classification was used for the pure ponderosa pine, ponderosa pine, sugar pine, pine woodland, pine mixture, and white fir types; the Douglas-fir classification was used for the Douglas fir, upper-slope mixture, fir-mountain hemlock, and "cedar" types. Land occupied by other types was not classified by site quality, unless it was judged likely to support in the future one of the types previously listed. Deforested areas, cut-over land, and burns were classified on the basis of the original type.

Ownership status was determined for all lands surveyed, and all lands not shown as public property were classed as private. It is, of course, recognized that ownership is constantly changing and that the totals given for individual ownership classes probably fail in many cases to agree with statistics from other sources. Nonforest land was not classified as to ownership except on the national forests. The ownership classes considered are:

Private. All privately owned forest property, including farm woods.

State, available for cutting. Includes any State-owned forest property not reserved from cutting.

State, reserved from cutting. Includes State-owned forest property used for parks, National-Guard campgrounds, etc.

County. Forest property deeded to the county. (Tax-delinquent land not deeded to the county is classified as private.)

Municipal. Includes all municipally owned forest property outside the platted limits of municipalities.

Indian. Includes both tribal lands and trust allotments.

Revested land grant. Includes Oregon & California Railroad and other land grants that have reverted to Federal ownership, whether classified as timber, agricultural, or power withdrawals.

Federal, other than national forest and revested land grant, reserved from cutting. Includes national parks, wildlife refuges, military reservations, etc.

National forest available for cutting.

National forest reserved from cutting.

Railroad selection pending. Federal lands designated for selection as railroad grants but not yet deeded.

The term "reserved from cutting" as applied to State and national-forest land or other Federal land means that the timber on it is unavailable for cutting because of statute, proclamation, or policy. Land so classed usually had been officially dedicated either to watershed protection, to recreational use, or as national-forest primitive areas. The term "available for cutting" means simply that there was no legal or formal prohibition on timber cutting; it does not imply the presence of timber suitable for cutting or, in fact, of any timber at all.

Description of the Region

FOR the purposes of the survey, the ponderosa pine region of Oregon and Washington is defined as that part east of the summit of the Cascade Range (fig. 2), exclusive of Pend Oreille, Stevens, and Spokane Counties in northeastern Washington, which are principally western white pine type. Jackson and Josephine Counties, Oreg., already inventoried as part of the Douglas-fir region (*1*), are also excluded, although containing extensive ponderosa pine forests. The region thus defined extends 480 miles from north to south and varies in width from 200 to 275 miles. It includes 65.5 million acres, of which approximately 22.1 million acres (table 1), or one-third, is forest land and 43.4 million acres is farm, grazing, and nonforested wild land. Because the Cascade Range acts as a barrier to moisture-laden winds from the Pacific Ocean, extensive areas in eastern Oregon and eastern Washington have insufficient precipitation and are treeless. The "dry" timber line, the elevation below which forests cease to grow because of lack of moisture, ranges from about 1,500 feet in northern Washington to about 4,000 to 5,000 feet in southern Oregon. The "cold" timber line, the elevation at which temperature and shortness of growing season limit tree growth, ranges from about 6,000 feet in northern Washington to 8,000 feet in southern Oregon. On the Steens Mountains in southeastern Oregon the lower limit of tree growth is much higher and on a large part of this area the aridity is so intense and growing season so short that the dry and cold timber lines meet.

TABLE 1.—*Summary of forest land areas in the ponderosa pine region, 1936*

State	Commercial forest land [1]	Noncommercial forest land: Withdrawn from timber use [2]	Noncommercial forest land: Chiefly valuable for purposes other than timber	Noncommercial forest land: Total	Total
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
Oregon	10,030.5	147.9	3,906.9	4,054.8	14,085.3
Washington	5,818.8	170.4	2,011.6	2,182.0	8,000.8
Total	15,849.3	318.3	5,918.5	6,236.8	22,086.1

[1] Land capable of producing timber of commercial quantity and quality, and available now or prospectively for commercial use.
[2] Commercially valuable land.

Generally speaking, the forests are confined to the mountainous districts, of which there are three: (1) The Cascade Range, extending the length of the region from north to south, including the Klamath Plateau as its southern extremity in Oregon; (2) the Blue Mountains, including the Wallowa Mountains in northeastern Oregon and projecting a short distance into southeastern Washington; and (3) the Colville Mountains, an extension of the Rocky Mountains in northeastern Washington.

The forests of this region are almost entirely conifer, hardwoods seldom occurring. Ponderosa pine predominates over a very large part of the region and forms extensive pure stands (fig. 3). Important associates are Douglas-fir, western larch, white fir, lodgepole pine, sugar pine, and California incense-cedar. Ponderosa pine forms pure stands at the lower elevations. As elevation increases other species enter the stand until the pine forests give way to mixed conifer stands. In the northern part of the region ponderosa pine stands form a smaller proportion of the forest than in the southern part. On the colder, moister, upper slopes, Pacific silver fir, noble fir, Shasta red fir, Engelmann spruce, alpine fir, mountain hemlock, and western white pine commonly form

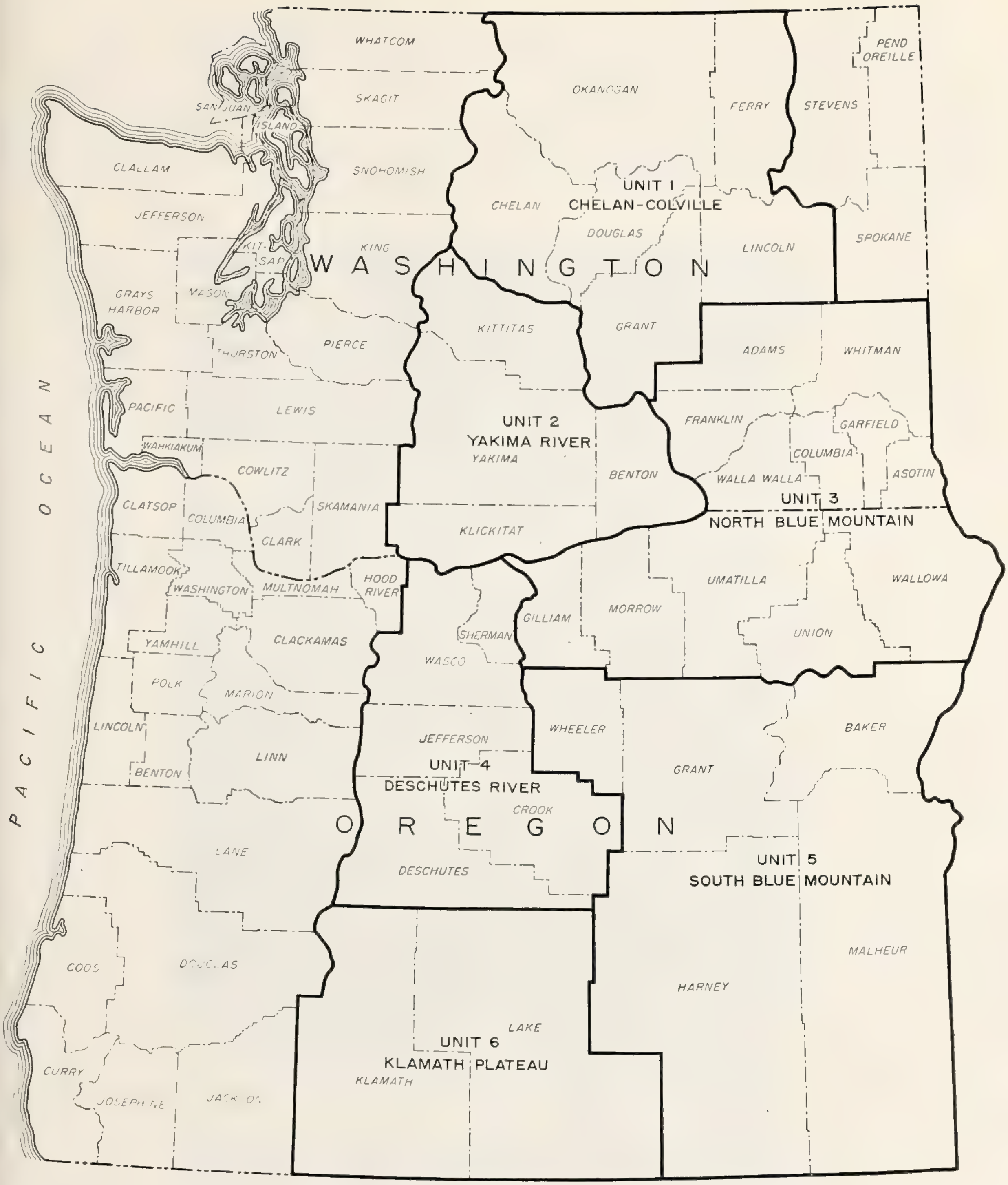

FIGURE 2.—*Map of Washington and Oregon showing region, survey-unit, and county boundaries*

mixed forests, sometimes of only two species but usually more. Douglas-fir, western larch, white fir, and lodgepole pine also occur in these mixed forests. At a few low points along the Cascade Range summit, where moisture conditions are favorable, Douglas-fir, western redcedar, and western hemlock form stands similar to those west of the summit. Extensive pure stands of lodgepole pine are usually at higher elevations, often occupying old burns originally held by other conifers.

Sierra juniper forms extensive stands on the drier sites, below elevations at which ponderosa pine occurs. In central Oregon more than 650,000 acres are occupied by practically continuous juniper stands.

FIGURE 3.—*Stand of virgin ponderosa pine, composed of trees averaging 36 inches to 40 inches d. b. h. This is the most extensive and important forest type in the ponderosa pine region of Oregon and Washington. (F321058)*

Forest Inventory

AN important factor immediately apparent from the inventory phase of the forest survey is that the distance from seaports and markets and lack of navigable waterways (figs. 4 and 5), together with the numerous light stands which necessitate extended log transportation systems, have unquestionably retarded utilization of the forest resources. On the other hand, lumbering has been furthered by the intrinsic value of ponderosa pine and the favorable topography for logging. Lumbering has been carried on in parts of this region for half a century or more, but it has been conducted on a large scale only for the past two or three decades. Extensive stands of virgin timber remain, most of them in public ownership, but a large part are not now economically available.

The forests of eastern Washington differ considerably in composition and character from those of eastern Oregon. (See forest type maps of the six survey units of the ponderosa pine region at end of this publication.) That part of the Chelan-Colville unit east and north of the Okanogan River occupies the slopes and hills of the Colville Mountains. This unit has large stands of virgin timber in which little cutting has taken place, chiefly because of inaccessibility and poor quality of the timber. In the south, ponderosa pine predominates; in the north, western larch, balsam firs, Engelmann spruce, and Douglas-fir are the chief species. The high ridges are occupied by lodgepole pine. This locality has had an unfortunate fire history; most of the larger burns have reforested, but in some instances lodgepole pine type has replaced the original type, usually upper slope.

The east slope of the Cascade Range in northern Washington is extremely rugged and is characterized by large areas of nonforest land and noncommercial forests. The larger valleys and foothills support commercial timber, chiefly ponderosa pine. Farther south the Cascade Range becomes less rugged and the proportion of ponderosa pine increases and the quality improves. Some of the finest ponderosa pine stands in the region grow in Klickitat County, the most southerly county in eastern Washington.

In Oregon the east slope of the Cascade Range is a high plateau surmounted by an occasional volcanic peak or butte. As a consequence the ponderosa pine zone extends from the dry timber line to within a few miles of the summit. Along the summit is a belt of upper-slope and lodgepole pine types which seldom exceeds 6 miles in width. Surrounding the high peaks are subalpine forests. In Oregon this zone varies in width from 10 to 15 miles on the north to as much as 75 miles on the broad Klamath Plateau on the south. Extensive areas of cut-over land supporting second-growth pine are found from Bend south to the California line.

The Blue Mountains, which except for several hundred square miles are entirely in eastern Oregon, have a greater variety of forest conditions than the east slopes of the Cascade Range. In the southern and western parts ponderosa pine forms the characteristic type. In the eastern and northern parts the mountains are higher and more rugged, the ponderosa pine is restricted to the valleys and foothills, and mixed types predominate. Large areas of lodgepole pine and subalpine types occur at the higher elevations of the Blue and Wallowa Mountain Ranges.

Farm land is generally limited to the nonforest zone except for grazing land.

FIGURE 4.—*Principal drainages, national forests, and principal cities of eastern Washington.*

Types and Areas

The area of commercial forest land is characterized by a large proportion of old growth and a small acreage deforested (table 2). The areas of the individual forest-cover types recognized in the survey are given in table 3 by ownership class and summarized. Table 4 presents type areas by forest-survey units. The national forests include the largest area of pine saw timber and also the largest area of noncommercial land (fig. 6).

TABLE 2.—*Summary of commercial forest land areas*

State	Saw-timber areas			All other second growth	Deforested areas [1]	Total
	Old growth	Second growth	Total			
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
Oregon	7, 842. 6	729. 9	8, 572. 5	1, 245. 0	213. 0	10, 030. 5
Washington	3, 803. 5	778. 6	4, 582. 1	1, 062. 4	174. 3	5, 818. 8
Total	11, 646. 1	1, 508. 5	13, 154. 6	2, 307. 4	387. 3	15, 849. 3

[1] Includes 131,700 acres temporarily noncommercial.

FIGURE 5.—*Principal drainages, national forests, and principal cities of eastern Oregon.*

Nonforest Land

No attempt was made to classify the nonforest land into barrens, agricultural, and nonforest land other than agricultural. In the first place, by far the greater part of the farm land is in the territory that was originally treeless and farm and forest are not intermingled as they are west of the Cascade Range. Very little forest land has been cleared for agriculture and there is little likelihood of any significant land clearing in the immediate future. Grazing of forest land and intermingled open grassland is a common practice. Over most of the region it is seasonal.

Conifer Sawlog Types

The ponderosa pine sawlog types occupy 10.4 million acres or 64 percent of the region's commercial conifer land; other conifer sawlog types total 3.0 million acres or 19 percent. The average volume per acre of the saw-timber types in eastern Oregon (table 5) is 10 M board feet and in eastern Washington (table 6) is 8.2 M board feet.

VIRGIN PONDEROSA PINE TYPES

Forest exploitation has been concentrated in

462119 42 2

TABLE 3.—*Area of all forest types in the ponderosa pine region, by ownership class, 1936*

INDIVIDUAL TYPES

Type definition [1] and No.	Private	State		County	Municipal	Federally owned or managed							Total
								Public domain			National forest		
		Available for cutting	Reserved from cutting			Indian	Revested land grants	Available for cutting	Railroad selection pending	Reserved from cutting [2]	Available for cutting	Reserved from cutting	
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
Woodland:													
Oak (4)	50.9	3.3	-----	2.1	0.5	4.1	0.4	3.0	-----	-----	2.1	-----	66.4
Dense juniper (or mountain mahogany) (5A)	127.1	8.3	(3)	30.8	.1	1.0	-----	247.1	-----	-----	4.8	-----	419.2
Scattered juniper (or mountain mahogany) (5B)	438.4	30.1	0.1	47.4	.2	17.9	.5	521.2	0.2	-----	61.3	-----	1,117.3
Scattered ponderosa pine (5½)	336.3	26.5	(3)	13.1	.1	136.1	1.5	80.3	1.0	-----	224.7	0.1	819.7
Ponderosa pine:													
Large (20)	350.1	41.7	-----	10.7	.1	305.8	6.1	14.5	12.6	1.6	731.3	11.6	1,486.1
Pure, large (20½)	2,084.7	133.5	.1	32.3	.4	982.3	4.5	82.9	24.3	5.6	2,610.3	12.3	5,973.2
Ponderosa pine-sugar pine, large (20A)	11.7	-----	-----	-----	-----	9.8	.9	-----	-----	-----	7.7	-----	30.1
Small (21)	509.8	28.0	(3)	19.6	.1	328.3	.4	14.9	1.5	.3	313.0	.3	1,216.2
Seedlings and saplings (22)	775.9	23.6	(3)	21.9	1.0	41.8	4.0	24.5	.6	.1	252.6	.4	1,146.4
Ponderosa pine mixture:													
Large (27)	194.5	16.7	-----	8.2	.6	135.5	3.8	7.2	4.9	1.5	455.5	10.4	838.8
Small (28)	159.3	6.0	-----	6.0	.5	31.4	-----	4.3	.8	-----	57.4	.7	266.4
Sugar pine mixture, large (20B)	23.6	.6	-----	-----	-----	.2	4.6	-----	-----	(3)	6.7	-----	35.7
Douglas-fir:													
Large old growth (6)	1.1	(3)	-----	-----	-----	-----	.6	-----	.1	-----	3.6	1.3	6.7
Small old growth (7)	88.8	18.9	-----	2.5	-----	21.1	3.7	2.9	8.6	.1	198.5	11.2	356.3
Large second growth (8)	48.5	16.6	-----	3.4	-----	17.0	-----	1.4	2.4	-----	56.3	.8	146.4
Large poles (9A)	34.8	3.5	-----	5.7	-----	4.3	-----	3.1	1.5	-----	94.4	.3	147.6
Small poles (9B)	29.8	1.7	-----	2.0	-----	1.8	-----	3.6	2.6	-----	73.7	.5	115.7
Seedlings and saplings (10)	25.6	4.1	-----	2.2	-----	1.2	(3)	.7	2.6	(3)	23.1	1.1	60.6
Western redcedar:													
Large (17)	.9	.1	-----	-----	-----	.3	-----	(3)	.1	-----	1.8	.2	3.4
Poles (19A)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	.1	-----	.1
Seedlings and saplings (19B)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	.1	-----	.1
Fir-mountain hemlock:													
Large (23)	40.8	1.1	-----	.3	-----	30.9	5.5	.2	25.0	43.7	403.1	60.8	611.4
Small (24)	12.1	.1	-----	-----	-----	11.6	.9	.1	6.3	1.0	66.0	6.9	105.0
Upper-slope mixture:													
Large (27½)	200.1	45.5	-----	10.9	.6	108.3	-----	10.7	14.5	-----	1,139.2	99.7	1,629.5
Small (28½)	113.4	13.6	-----	4.3	.2	72.3	-----	3.9	7.8	-----	405.5	32.3	653.3
White fir:													
Large (29)	26.4	.2	-----	.9	-----	3.5	1.2	.5	.4	.7	84.1	.3	118.2
Small (30)	2.1	-----	-----	.2	-----	-----	-----	(3)	-----	(3)	2.2	-----	4.5
Lodgepole pine:													
Large (25)	7.3	1.7	-----	.2	-----	4.1	-----	.2	.7	4.8	61.5	4.1	84.6
Medium (26)	199.0	37.5	-----	6.6	.1	184.0	1.9	53.3	1.9	45.0	1,020.1	47.2	1,596.6
Small (26A)	40.1	9.3	-----	1.6	(3)	50.6	-----	5.0	1.4	3.0	308.2	44.7	463.9
Hardwoods:													
Large (31½)	14.3	.1	-----	(3)	-----	3.2	-----	.2	(3)	-----	.9	-----	18.7
Small (31)	11.1	.3	-----	(3)	-----	1.1	-----	2.8	.1	-----	5.8	-----	21.2
Subalpine (33)	36.9	9.1	-----	.4	-----	26.3	-----	4.4	49.9	24.4	755.2	316.7	1,223.3
Nonrestocked cut-overs:													
Cut 1920 or later (35A)	65.0	1.0	-----	2.7	-----	.5	2.4	1.3	.2	-----	8.4	(3)	81.5
Cut before 1920 (35B)	8.5	.4	-----	.1	-----	.1	-----	.2	-----	-----	1.6	-----	10.9
Deforested area:													
Deforested burn (37)	33.6	8.9	-----	3.5	-----	25.4	2.0	9.3	4.0	1.1	75.6	7.7	171.1
Insect-killed (37B)	.2	-----	-----	.1	-----	-----	-----	.1	-----	-----	.6	-----	1.0
Noncommercial rocky area (38)	119.4	34.7	-----	5.9	.2	62.3	2.6	63.4	27.8	1.2	656.2	65.3	1,039.0
All types	6,222.1	526.7	.2	245.6	4.7	2,624.1	47.5	1,167.2	203.8	134.1	10,173.2	736.9	22,086.1

See footnotes at end of table.

TABLE 3.—*Area of all forest types in the ponderosa pine region, by ownership class, 1936*—Continued

GENERALIZED TYPES

Type definition and No.	Private	State: Available for cutting	State: Reserved from cutting	County	Municipal	Federally owned or managed: Indian	Revested land grants	Public domain: Available for cutting	Public domain: Railroad selection pending	Reserved from cutting	National forest: Available for cutting	National forest: Reserved from cutting	Total
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
Woodland (4, 5A, and 5B)	616.4	41.7	0.1	80.3	0.8	23.0	0.9	771.3	0.2		68.2		1,602.9
Hardwood (31 and 31½)	25.4	.4		(3)		4.3		3.0	.1		6.7		39.9
Conifer saw timber, ponderosa and sugar pine (5½, 20, 20½, 20A, 20B, 21, and 27)	3,510.7	247.0	.1	83.9	1.3	1,898.0	21.8	199.8	44.3	9.0	4,349.2	34.7	10,399.8
Conifer second-growth, ponderosa pine (22 and 28):													
On cut-over areas	832.0	24.1	(3)	24.7	.8	41.3	4.0	17.2	.3		188.9	.1	1,133.4
On uncut areas [4]	103.2	5.5		3.2	.7	31.9	(3)	11.6	1.1	.1	121.1	1.0	279.4
Total	935.2	29.6	(3)	27.9	1.5	73.2	4.0	28.8	1.4	.1	310.0	1.1	1,412.8
Conifer saw timber (6, 7, 8, 9A, 17, 19A, 23, 27½, and 29)	441.4	85.9		23.7	.6	185.4	11.0	18.8	52.6	44.5	1,981.1	174.6	3,019.6
Conifer second growth (9B, 10, 19B, 24, 28½, and 30):													
On cut-over areas	92.7	3.7		5.5		1.7		2.8		(3)	14.0		120.4
On uncut areas [4]	90.3	15.8		3.2	.2	85.2	.9	5.6	19.3	1.0	556.6	40.8	818.9
Total	183.0	19.5		8.7	.2	86.9	.9	8.4	19.3	1.0	570.6	40.8	939.3
Lodgepole pine, large (25)	7.3	1.7		.2		4.1		.2	.7	4.8	61.5	4.1	84.6
Lodgepole pine, medium and small (26 and 26A)	239.1	46.8		8.2	.1	234.6	1.9	58.3	3.3	48.0	1,328.3	91.9	2,060.5
Noncommercial (33 and 38)	156.3	43.8		6.3	.2	88.6	2.6	67.8	77.7	25.6	1,411.4	382.0	2,262.3
Nonrestocked cut-overs and deforested areas (35A, 35B, 37, and 37B)	107.3	10.3		6.4		26.0	4.4	10.8	4.2	1.1	86.2	7.7	264.4
All types	6,222.1	526.7	.2	245.6	4.7	2,624.1	47.5	1,167.2	203.8	134.1	10,173.2	736.9	22,086.1

[1] For description of types, see p. 4.

[2] Crater Lake National Park and Upper Klamath Wildlife Refuge.

[3] Less than 50 acres.

[4] Original stand removed by agencies other than cutting.

TABLE 4.—*Area of all forest types in the ponderosa pine region, by State and forest-survey unit, 1936*

Type definition [1] and No.	Eastern Washington [2]				Eastern Oregon					Region total
	Chelan-Colville	Yakima River	North Blue Mountain	Total	North Blue Mountain	Deschutes River	South Blue Mountain	Klamath Plateau	Total	
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*	*1,000 acres*
Woodland:										
Oak (4)		30. 2		30. 2		35. 6		0. 6	36. 2	66. 4
Dense juniper (or mountain mahogany) (5A)					0. 1	313. 6	19. 6	85. 9	419. 2	419. 2
Scattered juniper (or mountain mahogany) (5B)		. 3		. 3	. 8	575. 7	311. 6	228. 9	1, 117. 0	1, 117. 3
Scattered ponderosa pine (5½)	275. 8	49. 1	9. 2	334. 1	50. 7	122. 5	218. 5	93. 9	485. 6	819. 7
Ponderosa pine:										
Large (20)	406. 7	204. 9	27. 9	639. 5	280. 9	195. 9	208. 4	161. 4	846. 6	1, 486. 1
Pure, large (20½)	661. 5	481. 8	36. 7	1, 180. 0	469. 2	975. 0	1, 551. 8	1, 797. 2	4, 793. 2	5, 973. 2
Ponderosa pine-sugar pine, large (20A)						1. 4		28. 7	30. 1	30. 1
Small (21)	323. 5	207. 7	5. 0	536. 2	159. 6	100. 6	156. 0	263. 8	680. 0	1, 216. 2
Seedlings and saplings (22)	192. 1	134. 2	27. 5	353. 8	164. 5	230. 9	226. 0	171. 2	792. 6	1, 146. 4
Ponderosa pine mixture:										
Large (27)	233. 9	139. 6	15. 7	389. 2	202. 7	78. 0	109. 1	59. 8	449. 6	838. 8
Small (28)	58. 0	32. 1	29. 3	119. 4	109. 3	19. 5	17. 2	1. 0	147. 0	266. 4
Sugar pine mixture, large (20B)								35. 7	35. 7	35. 7
Douglas-fir:										
Large old growth (6)		1. 0		1. 0				5. 7	5. 7	6. 7
Small old growth (7)	153. 1	143. 1		296. 2	1. 0	24. 9	6. 1	28. 1	60. 1	356. 3
Large second growth (8)	65. 4	64. 1		129. 5	14. 4	. 2	2. 3		16. 9	146. 4
Large poles (9A)	93. 5	20. 4		113. 9	30. 2	1. 2	2. 2	. 1	33. 7	147. 6
Small poles (9B)	53. 1	25. 5	1. 0	79. 6	27. 4	3. 7	4. 8	. 2	36. 1	115. 7
Seedlings and saplings (10)	26. 6	26. 8	. 1	53. 5	3. 6	. 7	1. 9	. 9	7. 1	60. 6
Western redcedar:										
Large (17)	2. 2	1. 0		3. 2		. 2			. 2	3. 4
Poles (19A)	. 1			. 1						. 1
Seedlings and saplings (19B)	. 1			. 1						. 1
Fir-mountain hemlock:										
Large (23)	69. 0	192. 2		261. 2		128. 0		222. 2	350. 2	611. 4
Small (24)	18. 8	55. 0	1. 2	75. 0		18. 9		11. 1	30. 0	105. 0
Upper-slope mixture:										
Large (27½)	493. 0	265. 7	62. 8	821. 5	403. 6	51. 0	346. 7	6. 7	808. 0	1, 629. 5
Small (28½)	261. 4	87. 2	59. 2	407. 8	203. 1	23. 0	19. 1	. 3	245. 5	653. 3
White fir:										
Large (29)	. 6	3. 2	10. 1	13. 9	64. 1	7. 1	15. 4	17. 7	104. 3	118. 2
Small (30)		. 2	. 9	1. 1	1. 4		. 1	1. 9	3. 4	4. 5
Lodgepole pine:										
Large (25)	9. 8	17. 2		27. 0	. 8	6. 3	. 3	50. 2	57. 6	84. 6
Medium (26)	229. 5	36. 0	6. 2	271. 7	135. 7	332. 7	105. 6	750. 9	1, 324. 9	1, 596. 6
Small (26A)	210. 2	10. 7	1. 9	222. 8	86. 3	38. 6	62. 4	53. 8	241. 1	463. 9
Hardwoods:										
Large (31½)	2. 9	8. 5	. 4	11. 8	3. 1	. 7	2. 6	. 5	6. 9	18. 7
Small (31)	4. 1	2. 8	. 2	7. 1	. 1	. 2	7. 3	6. 5	14. 1	21. 2
Subalpine (33)	679. 0	115. 4	13. 5	807. 9	150. 1	52. 6	121. 6	91. 1	415. 4	1, 223. 3
Nonrestoked cut-overs:										
Cut 1920 or later (35A)	9. 1	14. 9		24. 0	5. 4	10. 6	3. 3	38. 2	57. 5	81. 5
Cut before 1920 (35B)	. 8	2. 4		3. 2	1. 5	1. 1	1. 5	3. 6	7. 7	10. 9
Deforested area:										
Deforested burn (37)	61. 5	24. 8	1. 7	88. 0	5. 2	26. 5	8. 5	42. 9	83. 1	171. 1
Insect-killed (37B)						. 3		. 7	1. 0	1. 0
Noncommercial rocky area (38)	509. 6	116. 0	71. 4	697. 0	192. 3	14. 6	97. 3	37. 8	342. 0	1, 039. 0
All types	5, 104. 9	2, 514. 0	381. 9	8, 000. 8	2, 767. 1	3, 391. 8	3, 627. 2	4, 299. 2	14, 085. 3	22, 086. 1

[1] For description of types, see p. 4.

[2] Exclusive of Spokane, Stevens, and Pend Oreille Counties.

the virgin ponderosa pine sawlog types (5½, 20, 20A, 20B, 20½, 27) where cutting coupled with insect epidemics and fire have reduced the stands from an estimated original area of 12.0 million acres to 9.2 million acres.

By far the most important type of this group is pure ponderosa pine (20½) covering 4.8 million acres in Oregon and 1.2 million in Washington. Stands average 12 M board feet per acre in Oregon and 8.8 in Washington, occasionally exceeding 30 M feet. The type is remarkably pure, averaging 94 percent ponderosa pine in Oregon and 92 percent in Washington. Stands are characteristically uneven-aged and open, with little heavy underbush. The ground cover is chiefly grass or low shrubs. Originally a virgin forest of this type extended the length of Oregon along the east slopes of the Cascade Range from within a few miles of the summit to the desert's edge. From about 10 miles in width on the north it ranged to nearly 100 miles on the Klamath Plateau in the south, interrupted only by comparatively small openings of nonforest land. Extensive cutting from Bend south has broken it up with large areas of pine second growth, but unbroken virgin timber of 200,000 acres or more in one block still exists in this section of the region.

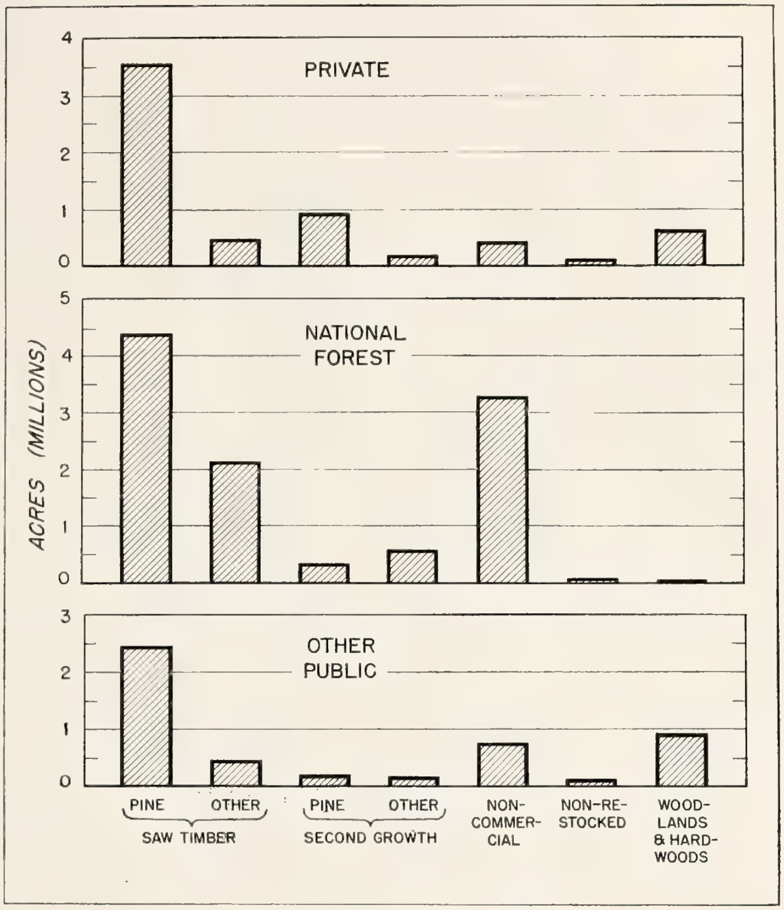

FIGURE 6.—*Areas of generalized forest types in the ponderosa pine region in private and public ownership. (With "noncommercial" are included lodgepole pine types 25, 26, and 26A, as shown in table 3.)*

There has been less disturbance to the primeval forests in the Blue Mountains but physical characteristics of this district have limited the pure ponderosa pine type. Extensive areas in the Blue Mountains on the south slopes and lower north slopes are broken up by nonforested valleys and high ridges occupied by mixed conifer types. Several areas of a hundred thousand acres or more of practically unbroken pure ponderosa forests occur in this territory, however.

In Washington the type is confined to the lower slopes and narrow mountain valleys of the Cascade Range and the southern foothills and plateaus of the Colville Mountains. There are few unbroken areas of more than 50,000 acres.

Ponderosa pine type 20, containing 50 to 80 percent ponderosa pine and averaging about 65 percent, occupies 1.5 million acres, made up of small areas scattered throughout the larger pure ponderosa pine forests where climatic and topographic conditions favor the intrusion of other species. Common associates of ponderosa pine are Douglas-fir, white fir, California incense-cedar, and lodgepole pine in the south and Douglas-fir, western larch, and lodgepole pine in the north (fig. 7).

The large pine-mixture type 27 usually occurs in comparatively small areas on north slopes and cool

TABLE 5.—*Area and average volume per acre, and total volume of saw-timber types in eastern Oregon by forest-survey unit, 1936*

Type definition [1] and No.	North Blue Mountain unit			Deschutes River unit			South Blue Mountain unit		
	Area	Volume per acre		Area	Volume per acre		Area	Volume per acre	
		Ponderosa pine	All species		Ponderosa pine	All species		Ponderosa pine	All species
	1,000 acres	*M board feet*	*M board feet*	*1,000 acres*	*M board feet*	*M board feet*	*1,000 acres*	*M board feet*	*M board feet*
Woodland, scattered ponderosa pine (5½)	50.7	1.2	1.3	122.4	1.9	1.9	218.5	1.1	1.1
Ponderosa pine:									
Large (20)	280.9	5.0	8.2	195.9	9.7	14.4	208.4	6.1	9.4
Pure, large (20½)	469.2	7.9	8.8	975.0	12.6	13.3	1,551.8	9.7	10.2
Ponderosa pine-sugar pine, large (20A)	-----	-----	-----	1.4	8.3	13.6	-----	-----	-----
Small (21)	159.6	2.2	2.5	100.6	3.8	3.8	156.0	2.8	3.2
Ponderosa pine mixture, large (27)	202.7	2.2	6.6	78.0	4.5	12.8	109.1	2.3	7.0
Sugar pine mixture, large (20B)	-----	-----	-----	-----	-----	-----	-----	-----	-----
Summary pine types	1,163.1	5.1	7.1	1,473.3	10.3	11.8	2,243.8	7.7	8.6
Douglas-fir:									
Large old growth (6)	-----	-----	-----	-----	-----	-----	-----	-----	-----
Small old growth (7)	1.0	-----	4.3	25.0	-----	17.8	6.0	-----	5.0
Large second growth (8)	14.4	-----	7.1	.2	-----	5.2	2.3	-----	9.4
Large poles (9A)	30.2	-----	4.0	1.3	-----	1.4	2.2	-----	3.7
Western redcedar, large (17)	-----	-----	-----	.2	-----	7.5	-----		-----
Fir-mountain hemlock, large (23)	-----	-----	-----	128.0	-----	15.0	-----		-----
Upper-slope mixture, large (27½)	403.6	-----	6.9	51.0	-----	14.1	346.7	-----	6.1
White fir, large (29)	64.1	-----	8.0	7.1	-----	8.1	15.4	-----	5.9
Lodgepole pine, large (25)	.8	-----	4.2	6.3	-----	4.3	.3	-----	1.0
Hardwoods, large (31½)	3.0	-----	2.1	.8	-----	2.8	2.6	-----	1.2
Summary, all types	1,680.2	-----	7.0	1,693.2	-----	12.2	2,619.3	-----	8.2

Type definition [1] and No.	Klamath Plateau unit			Total eastern Oregon				
	Area	Volume per acre		Area	Volume per acre [2]		Total volume [2]	
		Ponderosa pine	All species		Ponderosa pine	All species	Ponderose pine	All species
	1,000 acres	*M board feet*	*M board feet*	*1,000 acres*	*M board feet*	*M board feet*	*Million board feet*	*Million board feet*
Woodland, scattered ponderosa pine (5½)	93.9	1.5	1.5	485.5	1.4	1.4	679.7	679.7
Ponderosa pine:								
Large (20)	161.4	11.5	17.9	846.6	7.6	11.8	6,434.2	9,989.9
Pure, large (20½)	1,797.2	12.9	13.7	4,793.2	11.3	12.0	54,163.2	57,518.4
Ponderosa pine-sugar pine, large (20A)	28.7	11.3	17.9	30.1	11.1	17.6	334.1	529.8
Small (21)	263.8	3.2	3.6	680.0	3.0	3.3	2,040.0	2,244.0
Ponderosa pine mixture, large (27)	59.8	4.7	12.2	449.6	3.0	8.5	1,348.8	3,821.6
Sugar pine mixture, large (20B)	35.7	6.5	20.2	35.7	6.5	20.2	232.1	721.1
Summary pine types	2,440.5	11.0	12.5	7,320.7	8.9	10.3	65,232.1	75,504.5
Douglas-fir:								
Large old growth (6)	5.7	-----	20.9	5.7	-----	20.9	-----	119.1
Small old growth (7)	28.1	-----	3.5	60.1	-----	9.6	-----	577.0
Large second growth (8)	-----	-----	-----	16.9	-----	7.4	-----	125.1
Large poles (9A)	-----	-----	-----	33.7	-----	3.9	-----	131.4
Western redcedar, large (17)	-----	-----	-----	.2	-----	7.5	-----	1.5
Fir-mountain hemlock, large (23)	222.2	-----	10.3	350.2	-----	12.0	-----	4,202.4
Upper-slope mixture, large (27½)	6.7	-----	6.2	808.0	-----	7.0	-----	5,656.0
White fir, large (29)	17.8	-----	8.3	104.4	-----	7.8	-----	814.3
Lodgepole pine, large (25)	50.1	-----	2.6	57.5	-----	2.8	-----	161.0
Hardwoods, large (31½)	.5	-----	3.1	6.9	-----	1.9	-----	13.1
Summary all types	2,771.6	-----	12.0	8,764.3	-----	10.0	-----	87,305.4

[1] For description of types, see p. 4.

[2] The difference between total volumes in this table and table 10 is accounted for by volume in nonsaw-timber types. Since average volume per acre values are rounded off to nearest 100 board feet, the sum of unit total volumes computed by applying volume per acre to area will not exactly equal regional totals.

TABLE 6.—*Area and average volume per acre, and total volume of saw-timber types in eastern Washington* [1] *by forest-survey unit, 1936*

Type definition [2] and No.	Chelan-Colville unit			Yakima River unit			North Blue Mountain unit			Total eastern Washington				
	Area	Volume per acre		Area	Volume per acre		Area	Volume per acre		Area	Volume per acre		Total volume [3]	
		Ponderosa pine	All species		Ponderosa pine	All species		Ponderosa pine	All species		Ponderosa pine	All species	Ponderosa pine	All species
	1,000 acres	*M board feet*	*M board feet*	*1,000 acres*	*M board feet*	*M board feet*	*1,000 acres*	*M board feet*	*M board feet*	*1,000 acres*	*M board feet*	*M board feet*	*Million board feet*	*Million board feet*
Woodland, scattered ponderosa pine (5½)	275. 8	0. 9	1. 1	49. 1	1. 3	1. 3	9. 2	1. 0	1. 0	334. 1	1. 0	1. 1	334. 1	367. 5
Ponderosa pine:														
Large (20)	406. 7	5. 0	7. 6	205. 0	7. 7	11. 4	27. 8	3. 7	6. 1	639. 5	5. 8	8. 8	3, 709. 1	5, 627. 6
Pure, large (20½)	661. 5	7. 2	7. 9	481. 8	9. 5	10. 2	36. 7	6. 7	7. 0	1, 180. 0	8. 1	8. 8	9, 558. 0	10, 384. 0
Small (21)	323. 5	1. 9	2. 1	207. 6	3. 1	3. 2	5. 0	1. 3	1. 3	536. 1	2. 4	2. 5	1, 286. 6	1, 340. 3
Ponderosa pine mixture, large (27)	233. 9	2. 2	6. 6	139. 6	4. 0	10. 8	15. 7	1. 7	6. 1	389. 2	2. 8	8. 1	1, 089. 8	3, 152. 5
Summary pine types	1, 901. 4	4. 3	5. 7	1, 083. 1	6. 9	8. 8	94. 4	4. 1	5. 7	3, 078. 9	5. 2	6. 8	15, 977. 6	20, 871. 9
Douglas-fir:														
Large old growth (6)	----	----	----	. 9	----	17. 7	----	----	----	. 9	----	17. 7	----	15. 9
Small old growth (7)	153. 0	----	10. 5	143. 1	----	17. 5	----	----	----	296. 1	----	13. 9	----	4, 115. 8
Large second growth (8)	65. 4	----	9. 2	64. 1	----	14. 5	----	----	----	129. 5	----	11. 8	----	1, 528. 1
Large poles (9A)	93. 5	----	4. 4	20. 4	----	3. 7	----	----	----	113. 9	----	4. 3	----	489. 8
Western redcedar:														
Large (17)	2. 3	----	20. 5	1. 0	----	13. 3	----	----	----	3. 3	----	18. 4	----	60. 7
Poles (19A)	. 1	----	5. 8	----	----	----	----	----	----	. 1	----	5. 8	----	. 6
Fir-mountain hemlock, large (23)	69. 0	----	20. 3	192. 2	----	14. 2	----	----	----	261. 2	----	15. 8	----	4, 127. 0
Upper-slope mixture, large (27½)	493. 0	----	8. 3	265. 7	----	11. 8	62. 8	----	6. 8	821. 5	----	9. 3	----	7, 640. 0
White fir, large (29)	. 5	----	20. 6	3. 2	----	13. 0	10. 1	----	5. 8	13. 8	----	8. 0	----	110. 4
Lodgepole pine, large (25)	9. 8	----	4. 2	17. 3	----	2. 4	----	----	----	27. 1	----	3. 1	----	84. 0
Hardwoods, large (31½)	2. 9	----	7. 0	8. 5	----	3. 4	. 4	----	1. 2	11. 8	----	4. 6	----	54. 3
Summary all types	2, 790. 9	----	6. 9	1, 799. 5	----	10. 6	167. 7	----	6. 1	4, 758. 1	----	8. 2	----	39, 098. 5

[1] Exclusive of Spokane unit.

[2] For description of types, see p. 4.

[3] The difference between total volumes in this table and table 10 is accounted for by volume in nonsaw-timber types. Since average volume per acre values are rounded off to nearest 100 board feet, the sum of unit total volumes computed by applying volume per acre to area will not exactly equal regional totals.

moist locations within the range of ponderosa pine (fig. 8), well scattered throughout the region.

Sugar pine and sugar pine-mixture types 20A and 20B are confined to southern Oregon and are comparatively unimportant.

Different forms of partial cutting are widely practiced in ponderosa pine stands. Determination of the proper system of management, particularly selection of trees to be cut, requires detailed knowledge of the composition of loggable stands. Of first importance is the distribution by diameter classes of saw-timber volume in types 20 and 20½, to which practically all logging in these stands is confined (figs. 9, 10, and 11).

In formulating management plans, some indication of stand structure or percentage of volume by maturity and vigor class is needed. In figure 12, presenting such a distribution of saw-timber volume in the principal ponderosa pine types for eastern Washington and eastern Oregon, the three classes shown—immature, thrifty-mature, and mature-overmature—approximate those employed by Meyer (*11*) and represent a grouping of the ponderosa pine tree classes defined by Dunning (*5*). Briefly, the first class consists of trees less than 150 years old (Dunning classes 1, 2, and 6); the second of trees 150 to 300 years old, but of moderate to good vigor (Dunning class 3); all other trees (Dunning classes 4, 5, and 7) are grouped in the third class, which is composed predominantly of trees comparatively poor in vigor and beyond the age of most rapid growth.[4] The striking prepon-

[4] Obviously more detailed structure analyses are needed for framing specific management plans. Since completion of the forest-survey field work, the tree classification by F. P. Keen (*8*) has been commonly used for this purpose in this region.

F320935

FIGURE 7.—*A mixed ponderosa pine and larch stand (type 20) in eastern Washington.*

derance of mature and overmature trees, shown in figure 12, typifies the important saw-timber stands of the region and points significantly to the problems in their management.

IMMATURE PONDEROSA PINE SAW-TIMBER TYPE (21)

The immature ponderosa pine saw-timber stands occur on old burns or cut-over land and cover 1.2 million acres. Both even-aged and uneven-aged stands make up this type. The even-aged stands, commonly called bull pine, usually occur on old burns and often are very dense, ranging from about 4 to 10 M board feet per acre. They are usually pure in composition. The uneven-aged stands generally occur on selectively cut-over land. Approximately 850,000 acres of cut-over land is now occupied by ponderosa pine stands of saw-timber size which average 2.4 M board feet per acre. They vary considerably in density and often contain scattered mature trees as well as the younger age classes. A large part of this type is in southern Oregon, and more than a fourth of the regional total is in the Klamath Plateau unit. The Klamath Plateau stands average 3.2 M board feet per acre, much higher than the regional average. Stands on cut-over land are not so well stocked as those on old burns, the former averaging about 33 percent well stocked, 51 percent medium stocked, and 16 percent poorly stocked (table 7), and the latter 50 percent well stocked, 42 percent medium stocked, and 8 percent poorly stocked.

F320916

FIGURE 8.—*Mixed stand of ponderosa pine, Douglas-fir, and western larch (type 27).*

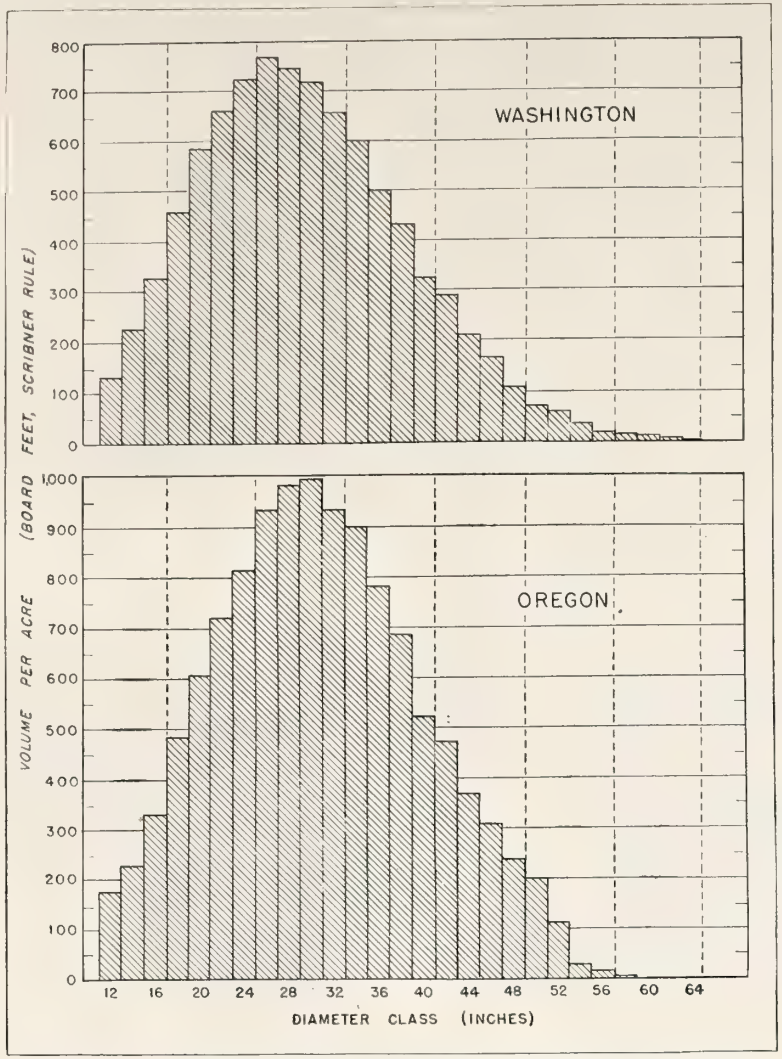

FIGURE 9.—*Distribution of saw-timber volume in the large ponderosa pine type (20), by diameter class.*

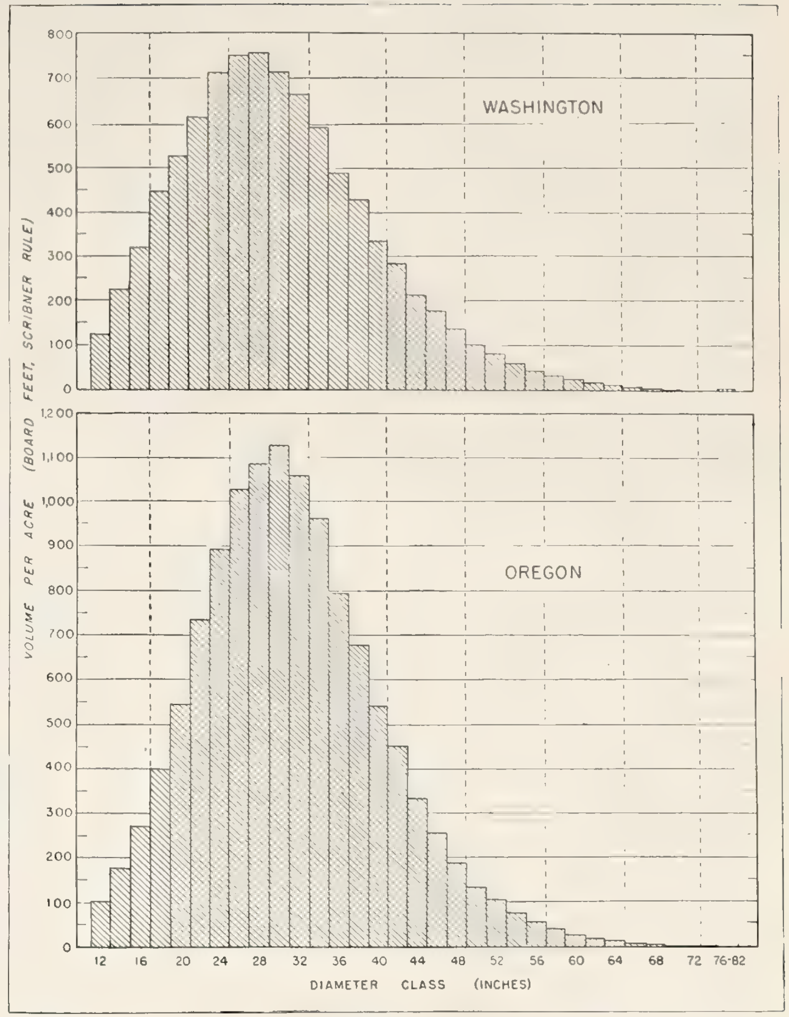

FIGURE 10.—*Distribution of saw-timber volume in the pure large ponderosa pine type (20½), by diameter class.*

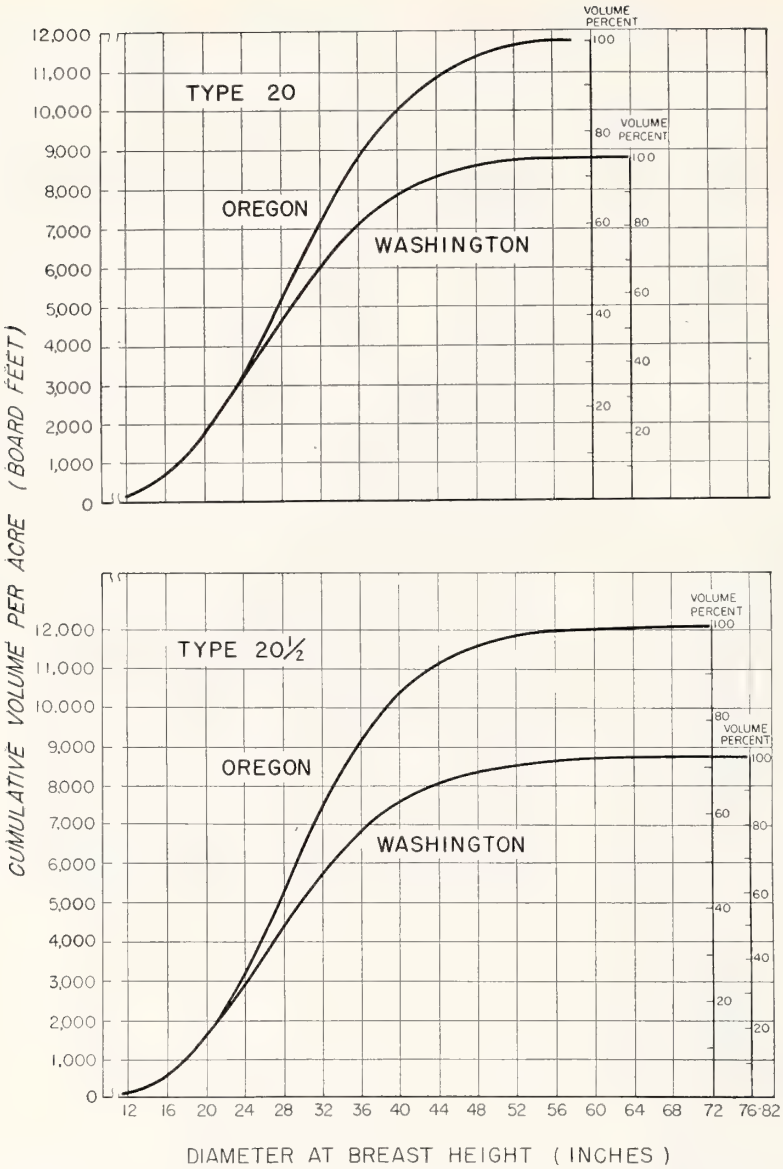

FIGURE 11.—*Cumulative saw-timber volume per acre in the large ponderosa pine types (20 and 20½), by diameter class.*

OTHER CONIFER SAWLOG TYPES

(6, 7, 8, 9A, 17, 19A, 23, 27½, AND 29)

This group of types occupies the cooler, more moist sites on the upper or north slopes, such as along the crest of the Cascade Range, the higher elevations in the Blue Mountains, and generally throughout northeastern Washington. Many of them are comparatively inaccessible.

In a few locations on the east slope of the Cascade Range, where the summits are low, Douglas-fir forms a type resembling the forests of western Oregon and western Washington. The largest area of these stands is in the upper Yakima River drainage in Washington. Otherwise the Douglas-fir types have little present commercial value.

Likewise, the upper-slope mixture, fir-mountain hemlock, and white fir stands have little present value for commercial timber.

Conifer Saw-Timber Types

Less Than Sawlog Size

The types in this group, comprising the two conifer second-growth groups in tables 3 and 4 and consisting chiefly of trees below saw-timber size, cover 2.4 million acres, one-seventh of the commercial forest area.

The 1.1 million acres of the ponderosa pine seedling and sapling type (22) occurs chiefly on land that has been clear cut or practically so (fig. 13). It is extremely accessible and much of it would have been ready to yield another crop by now if it had been selectively cut over. Two-thirds of the area of this land is privately owned and most of such land in national forests was acquired by the Federal Government from private owners after cutting. Stocking of this type combined with type 28 (table 7) averages 34 percent well stocked, 43 percent medium stocked, and 23 percent poorly stocked. Ponderosa pine small mixed (28) occupies 0.3 million acres, mostly old burns.

The small upper-slope mixed type, chiefly on old burns and nearly two-thirds of it in Washington, covers 0.7 million acres, or considerably less than the area occupied by type 22. A large part

TABLE 7.—*Area of immature conifer forest types [1] in the ponderosa pine region, on cut-over and other areas, by degree of stocking*

Degree of stocking and type of second growth	On cut-over areas	On uncut areas [2]	All areas
	1,000 acres	*1,000 acres*	*1,000 acres*
Good stocking:			
Ponderosa pine, large (21)	277.7	184.5	462.2
Ponderosa pine, small (22, 28)	404.2	80.2	484.4
Other conifer, large (9A, 19A)	5.0	75.5	80.5
Other conifer, small (9B, 10, 19B, 24, 28½, and 30)	86.6	464.4	551.0
Total	773.5	804.6	1,578.1
Medium stocking:			
Ponderosa pine, large (21)	433.7	153.6	587.3
Ponderosa pine, small (22, 28)	476.0	127.2	603.2
Other conifer, large (9A, 19A)	12.6	47.3	59.9
Other conifer, small (9B, 10, 19B, 24, 28½, and 30)	27.6	289.6	317.2
Total	949.9	617.7	1,567.6
Poor stocking:			
Ponderosa pine, large (21)	137.8	28.9	166.7
Ponderosa pine, small (22, 28)	253.3	71.9	325.2
Other conifer, large (9A, 19A)	1.4	5.9	7.3
Other conifer, small (9B, 10, 19B, 24, 28½, and 30)	6.3	64.7	71.0
Total	398.8	171.4	570.2
All stockings:			
Ponderosa pine, large (21)	849.2	367.0	1,216.2
Ponderosa pine, small (22, 28)	1,133.5	279.3	1,412.8
Other conifer, large (9A, 19A)	19.0	128.7	147.7
Other conifer, small (9B, 10, 19B, 24, 28½, and 30)	120.5	818.7	939.2
Total	2,122.2	1,593.7	3,715.9

[1] Does not include large second-growth Douglas-fir (type 8) which was not mapped by degrees of stocking.

[2] "Uncut areas" signifies original forest removed by agencies other than cutting, i. e., fire, insects, wind throw, etc.

of it is in national forests at high altitudes and remote locations.

Lodgepole Pine and Other Noncommercial Conifer Types

The three lodgepole pine types cover a total area of 2.1 million acres (fig. 14), little of which will support commercial forests. Lodgepole pine stands in this region have little or no commercial value at present and can on the whole be so classified.

Noncommercial rocky and subalpine types (38 and 33) total 2.3 million acres, approximately two-thirds of which is in Washington where the Cascade Range is more rugged. Very little land of this kind is privately owned. Of no value for timber production, it protects the headwaters of streams and has definite value for recreational use. The most beautiful roads and trails in the region are in the subalpine type (fig. 15).

Deforested Lands

Fortunately only a comparatively small portion of the land is deforested—only about 1 percent as a result of fire or cutting, and fire is the principal cause. Deforested burns, about equally divided between Oregon and Washington, are chiefly at high elevations and inaccessible locations in the national forests where the original forest was noncommercial or of low value. Most of the nonrestocked cut-overs are in Oregon, where cutting has been more extensive, on accessible and usually good growing sites that should be restored to productivity.

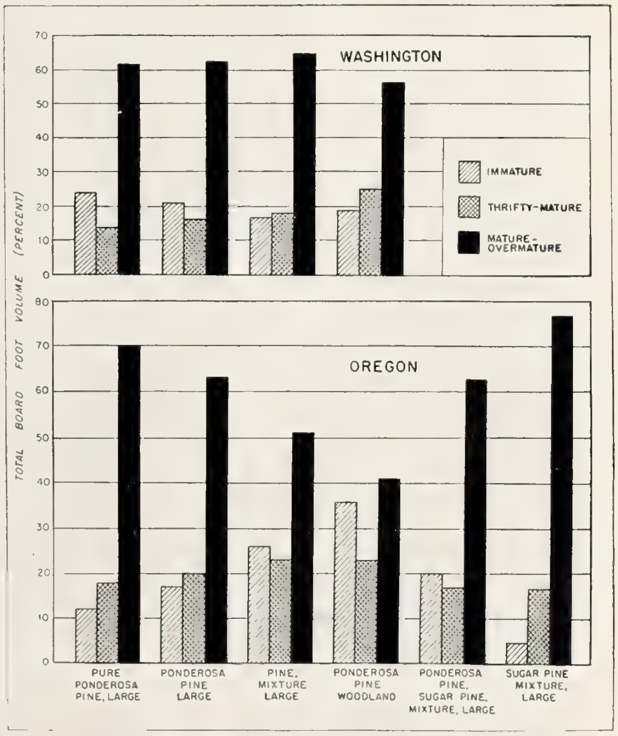

FIGURE 12.—*Distribution of saw-timber volume in principal ponderosa pine types, by maturity class.*

F320995

Figure 13.—*Mixed reproduction predominately ponderosa pine on cut-over land (survey type 22).*

F321054

Figure 14.—*Lodgepole pine forest on the Pringle Falls Experimental Forest, central Oregon.*

Woodland and Hardwood Forests

The juniper woodland types (5A, 5B) are much more common in this region than in the Douglas-fir region, occupying 1.5 million acres, practically all in eastern Oregon (fig. 16). These forests are of low commercial value for timber production, their chief products being fence posts and fuel wood for nearby rural residents, but they are so open as to be extensively grazed. The oak-madrone type (4) and hardwood types (31, 31½) (fig. 17) are of little economic significance here.

Forest Site Quality

The index of site quality, or the relative productive capacity of a forest area determined by climate, soil, topography, and other factors, was taken as average height of the dominant stand at 100 years of age. Six site-quality classes are recognized for ponderosa pine and five for Douglas-fir, class 1 being the highest in both cases (table 8). The ponderosa pine site classification was applied to 12 million acres consisting of land now supporting ponderosa pine, pine mixture, and white fir types and deforested land which originally supported such types. The Douglas-fir site classification was applied to all the remaining commercial conifer land aggregating 4.1 million acres.

F321041

FIGURE 15.—*Subalpine forest of alpine fir and whitebark pine.*

F321063

FIGURE 16.—*Juniper forest near Bend, Oreg.*

F320919

FIGURE 17.—*A stand of aspen bordering the Sanpoil River in northeastern Washington. These trees range from 4 inches to 10 inches d. b. h.*

Nearly two-thirds of the total ponderosa pine land is site IV, which is the most common site class in every forested county. More than three-fourths of the remainder, however, is site V or VI.

More than two-thirds of the 712,000 acres of site III land is in Oregon, and half of it is in the Klamath unit. Most of the small area of site classes I and II is in Washington, on the east slope of the Cascade Range immediately north of the Columbia River. The small area of site II that occurs in Oregon is scattered along the east slope of the Cascade Range from Warm Springs Indian Reservation south to the California line.

Lands judged by the Douglas-fir site classification are decidedly substandard. There is no Douglas-fir site I land, very little site II, and comparatively little site III. The area of Douglas-fir site V land is nearly three times that of site V in all of western Oregon and western Washington where Douglas-fir is the predominant forest type.

Timber Volume

The determination of the extent and character of the region's timber stand was one of the most important parts of the forest survey. The resulting data can be used in analyzing the immediate supply of raw materials for the region's forest industries and for other markets.

TABLE 8.—*Land areas in the ponderosa pine region, forest-land areas, and commercial conifer areas, by site-quality class,*[1] *1936*

Kind of forest and site-quality class	Total land area		Area in forest land	Area in commercial conifers
	Acres	*Percent*	*Percent*	*Percent*
Commercial conifer:				
Ponderosa pine:				
Class I	480			
Class II	18, 018	0. 03	0. 08	0. 11
Class III	711, 604	1. 09	3. 22	4. 40
Class IV	7, 849, 633	11. 99	35. 54	48. 55
Class V	3, 193, 731	4. 88	14. 46	19. 76
Class VI	268, 801	. 41	1. 22	1. 66
Total	12, 042, 267	18. 40	54. 52	74. 48
Douglas-fir:				
Class II	320			
Class III	117, 400	. 18	. 53	. 73
Class IV	971, 641	1. 48	4. 40	6. 01
Class V	3, 036, 152	4. 64	13. 75	18. 78
Total	4, 125, 513	6. 30	18. 68	25. 52
Total commercial conifer	16, 167, 780	24. 70	73. 20	100. 00
Lodgepole pine	2, 001, 875	3. 06	9. 06	
Juniper and mountain mahogany	1, 537, 700	2. 35	6. 96	
Noncommercial rocky	1, 039, 005	1. 58	4. 71	
Subalpine	1, 233, 465	1. 88	5. 59	
Oak	66, 380	. 10	. 30	
Hardwood	39, 905	. 07	. 18	
Total other than commercial conifer	5, 918, 330	9. 04	26. 80	
All forest types	22, 086, 110	33. 74	100. 00	
Nonforest types	43, 373, 830	66. 26		
Grand total	65, 459, 940	100. 00		

[1] Deforested areas, types 35A, 35B, and 37, were classified as to site on the basis of original type; some lodgepole pine type areas were assigned ponderosa pine or Douglas-fir site qualities; and some deforested burns and insect-killed areas were included in the lodgepole pine, subalpine, western juniper, or noncommercial rocky areas.

Saw-Timber Volume

The region's saw-timber volume, in millions of board feet, log scale, Scribner Decimal C rule, is given in table 9 and figure 18 by species and ownership and in table 10 by species and forest-survey unit. Table 11 summarizes saw-timber volume data on commercial forest land by broad type and ownership class.

Practically all of the total volume of 127.1 billion board feet is conifer. Eighteen conifer and 4 hardwood species were found of saw-timber size and quantity. Approximately 87.7 billion board feet occurs in Oregon and 39.4 billion board feet in Washington.

Ponderosa pine is the most widely distributed conifer in the United States. In saw-timber volume it ranks second in the country, exceeded only by Douglas-fir. In this region it is the preeminent timber species. The wood is moderately soft, light in weight, fine grained, and easily worked. Its excellent properties make it valuable for interior finish, sash and doors, and boxes. It is also used for sheathing, small dimension, and siding. Four-fifths of the 81.5 billion feet of ponderosa pine in the region is in Oregon. Approximately two-thirds of the total volume is publicly owned or managed, a situation almost the reverse of that in the Douglas-fir region where nearly two-thirds of the Douglas-fir volume (*1*), the most important species, is privately owned.

Douglas-fir is second in point of volume. As already noted, this species fails to attain the size or quality here that it does west of the Cascade Range, and consequently it is restricted in use to common boards, dimension, and small timbers, for which, however, it answers satisfactorily. Only in a few localities near low summits of the Cascade Range do Douglas-fir trees produce the highly prized fine-grained "yellow fir" typical of the west side of the summit. Approximately three-fifths of the Douglas-fir volume in this region is in Washington.

Western larch volume totals 6.7 billion board

TABLE 9.—*Volume of timber, log scale, Scribner rule, in the ponderosa pine region, by species and ownership class, 1936*

[In million board feet—i. e., 000,000 omitted]

Species	Private	State	County	Municipal	Federally owned or managed							Total
					Indian	Revested land grants	Public domain		Reserved from cutting[1]	National forest		
							Available for cutting	Railroad selection pending		Available for cutting	Reserved from cutting	
Ponderosa pine	27,214.4	1,616.0	378.5	7.8	14,948.0	143.4	770.5	345.3	168.3	35,618.5	279.8	81,490.5
Sugar pine	386.0	5.8			179.8	34.8	.3		.5	128.7	.6	736.5
Western white pine	70.0	5.1	(2)		47.6	7.1	.2	32.0	6.6	568.3	58.9	795.8
Lodgepole pine	135.8	21.9	1.9	(2)	33.0	.4	3.4	10.9	30.8	772.7	104.6	1,115.4
Douglas-fir	4,662.8	712.7	161.4	7.4	1,999.2	61.0	126.8	262.0	4.2	10,120.5	400.2	18,518.2
Western redcedar	39.0	1.4	.3		13.3		.4	18.1		144.2	12.0	228.7
Alaska yellow-cedar	.2	.1			.8			1.9		23.7	3.3	30.0
California incense-cedar	120.3	1.1	.3		47.4	1.0	.7		.5	49.6	.7	221.6
Western hemlock	289.4	6.4	.1		7.4		.7	66.4	5.1	783.5	85.3	1,244.3
Mountain hemlock	85.5	2.4	1.9		207.9			102.2	166.7	1,948.1	222.8	2,737.5
White fir and grand fir	1,856.3	53.6	20.3	3.9	616.1	45.0	15.4	26.3	22.1	3,606.4	92.2	6,357.6
Noble fir and Shasta red fir	84.9	.9			47.7	69.0	3.3	6.1	198.6	752.7	123.1	1,286.3
Pacific silver fir	374.0	9.1	.1		.6		(2)	217.6		1,629.2	276.1	2,506.7
Alpine fir	38.5	5.8	.1	.7	115.2		(2)	20.8		401.9	115.2	698.2
Western larch	1,132.0	256.2	62.5	1.5	683.7		62.7	46.7		4,327.5	114.8	6,687.6
Engelmann spruce	127.6	41.9	3.9	.8	96.0		2.5	39.0	.1	1,343.3	700.3	2,355.4
Red alder	.1						(2)					.1
Bigleaf maple	(2)									(2)		(2)
Northern black cottonwood	43.5	.7	.1	(2)	14.3		.5	.7		18.2	2.4	80.4
Aspen	2.3									.1		2.4
Total	36,662.6	[3] 2,741.1	631.4	22.1	19,058.0	361.7	987.4	1,196.0	603.5	62,237.1	2,592.3	127,093.2

[1] Crater Lake National Park. [2] Less than 50M board feet. [3] Includes 0.3 million feet of ponderosa pine reserved from cutting.

Table 10.—*Volume of timber, log scale, Scribner rule, in the ponderosa pine region, by species and forest-survey unit, 1936*

[In million board feet—i. e., 000,000 omitted]

Species	Eastern Washington				Eastern Oregon					Region total
	Chelan-Colville	Yakima River	North Blue Mountain	Total	North Blue Mountain	Deschutes River	South Blue Mountain	Klamath Plateau	Total	
Ponderosa pine	8, 207. 8	7, 453. 0	394. 7	16, 055. 5	6, 003. 7	15, 226. 1	17, 321. 0	26, 884. 2	65, 435. 0	81, 490. 5
Sugar pine						13. 8		722. 7	736. 5	736. 5
Western white pine	166. 3	269. 4	. 3	436. 0	4. 2	128. 7	2. 5	224. 4	359. 8	795. 8
Lodgepole pine	172. 8	237. 8	13. 6	424. 2	76. 3	148. 6	64. 9	401. 4	691. 2	1, 115. 4
Douglas-fir	5, 336. 8	5, 233. 1	180. 6	10, 750. 5	2, 357. 6	2, 272. 2	1, 949. 6	1, 188. 3	7, 767. 7	18, 518. 2
Western redcedar	127. 5	95. 8		223. 3		5. 4			5. 4	228. 7
Alaska yellow-cedar	. 6	28. 9		29. 5		. 5			. 5	30. 0
California incense-cedar						53. 3		168. 3	221. 6	221. 6
Western hemlock	362. 4	656. 7		1, 019. 1		179. 2		46. 0	225. 2	1, 244. 3
Mountain hemlock	226. 1	796. 1		1, 022. 2	3. 2	1, 208. 8		503. 3	1, 715. 3	2, 737. 5
White fir	97. 7	759. 2	193. 3	1, 050. 2	1, 262. 2	804. 2	964. 2	2, 276. 8	5, 307. 4	6, 357. 6
Noble fir		35. 6		35. 6		212. 2		1, 038. 5	1, 250. 7	1, 286. 3
Pacific silver fir	879. 0	1, 596. 8		2, 475. 8		30. 9			30. 9	2, 506. 7
Alpine fir	198. 2	299. 4	31. 6	529. 2	96. 8	28. 1	33. 8	10. 3	169. 0	698. 2
Western larch	2, 119. 1	1, 222. 4	166. 0	3, 507. 5	1, 685. 7	258. 4	1, 236. 0		3, 180. 1	6, 687. 6
Engelmann spruce	1, 358. 5	366. 4	65. 6	1, 790. 5	344. 6	72. 6	114. 9	32. 8	564. 9	2, 355. 4
Red alder		. 1		. 1						. 1
Bigleaf maple	(1)			(1)						(1)
Northern black cottonwood	33. 5	29. 3	. 6	63. 4	10. 5	2. 3	4. 1	. 1	17. 0	80. 4
Aspen	. 5	. 2		. 7				1. 7	1. 7	2. 4
Total	19, 286. 8	19, 080. 2	1, 046. 3	39, 413. 3	11, 844. 8	20, 645. 3	21, 691. 0	33, 498. 8	87, 679. 9	127, 093. 2

[1] Less than 50 M board feet.

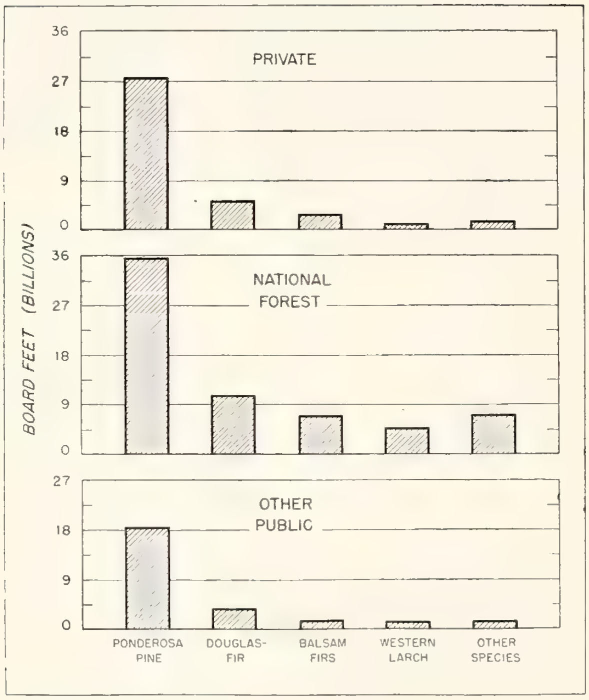

Figure 18.—*Volume of saw timber in the ponderosa pine region, by species and ownership class.*

feet, more than half of which is in Washington. The wood is of moderate durability, weight, and strength. It is used locally for posts and poles and cut in limited quantities for siding, common lumber, and timbers. Larch also makes satisfactory heavy-duty and finish flooring.

Of the 6.4 billion feet of white fir more than four-fifths occurs in Oregon. It is cut in small quantities

Table 11.—*Saw-timber volume on commercial forest land,[1] by broad type and species class, 1936*

[In billion board feet, i. e., 000,000,000 omitted]

State and species	Ponderosa pine types		Other types	Total
	Old growth	Second growth		
Eastern Oregon:				
Ponderosa pine	62. 9	2. 0		64. 9
All species	72. 9	2. 2	10. 8	85. 9
Eastern Washington:				
Ponderosa pine	14. 6	1. 3		15. 9
All species	19. 4	1. 4	16. 8	37. 6
Region total:				
Ponderosa pine	77. 5	3. 3		80. 8
All species	92. 3	3. 6	27. 6	123. 5

[1] Includes all unreserved commercial conifer land. Excludes volume in noncommercial and nonsaw-timber type.

and used chiefly for common boards and dimension and for box shook. The wood is nonresinous and odorless when dry, and therefore desirable for boxes used as food containers.

Western white pine, per unit of volume, is the most valuable species in the region, but its scant occurrence renders it of little commercial importance. A little more than half of the total of 0.8 billion board feet is in Washington. The wood is highly prized for interior finish, patterns, cut stock, sash and doors, and many specialty uses.

The remaining conifers and the hardwoods are now of little commercial significance by reason of limited quantity, unsuitability of the wood for commercial use, or inaccessibility. At one time considerable quantities of "cedar" poles were produced in northeastern Washington but the supply is now nearly exhausted.

Economic Availability

No classification by economic availability was made of the saw-timber volume, as was done for the Douglas-fir region (*1*), owing to the very different situation prevailing. In the ponderosa pine region, all species except ponderosa pine, sugar pine, and white pine may be considered for all practical purposes as being low in economic availability. Usually these species are not logged except when they occur in mixture with the pines and often not then.

Although the quality of ponderosa pine saw timber varies considerably, the range in size, quality, and location is not comparable to that of the principal commercial species in the Douglas-fir region, where several large navigable bodies of water and extensive areas of rough mountainous topography combine with wide variation in size and quality of timber to give to some Douglas-fir stands a comparatively high value and others a comparatively low value.

Cubic Volume

Cubic measure is seldom used in this region because practically all material utilized is in sawlog form. Since interregional comparisons of timber volume, however, can be accurately made only in cubic feet, cubic volumes were computed (table 12) by ownership class and species. Of the total, 80 percent is in sawlog-size trees (12 inches d. b. h. or more), 10 percent is in understory trees in saw-timber stands (less than 12 inches d. b h.), and 10 percent in trees less than saw-timber size in second growth stands.

Ownership of Forest Resources

One of the characteristic features of the forest situation already noted is the large proportion of the forest resource in public ownership. Unquestionably this has had a stabilizing influence on forest-land management and a restraining effect on forest exploitation. Continuity of tenure, including a consciousness of the public interest in all forests, is the key to sustained-yield management of forest resources in both public and private holdings.

Private Ownership

Approximately 32 percent of the commercial forest land and 29 percent of the saw-timber volume is in private ownership. This disparity does not denote that the private land is less productive or the timber on it smaller or more scattered. Actually the reverse is true. But most of the cutting has taken place on private lands and consequently a larger percent of the area of second-growth and deforested lands is privately held. About 56 percent of the private forest land supports ponderosa pine saw-timber stands, 15 percent ponderosa pine second growth, and 7 percent other conifer saw timber. Very little other conifer second growth, lodgepole pine, and noncommercial land is privately owned.

Approximately a third of the total ponderosa pine saw-timber volume remains in private ownership, despite heavy cutting for two decades. About three-quarters of the privately owned saw timber is ponderosa pine and a large part of the remaining volume is in species growing in pine stands as a minor component of the forest.

The concentration of the most productive land and best timber in private hands carries an added responsibility to conserve this valuable resource through management for continuous production. Private owners are aware of this responsibility and some are making a conscious effort to fulfill their obligations. Unfortunately private action toward resource management is not universal and sustained-yield practices have made slight headway on private lands.

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TABLE 12.—*Cubic volume of timber,*[1] *in the ponderosa pine region, by species and ownership class, 1936*

[In million cubic feet—i. e., 000,000 omitted]

Specie	Private	State	County	Municipal	Federally owned or managed							Total
					Indian	Revested land grants	Public domain		Reserved from cutting [2]	National forest		
							Available for cutting	Railroad selection pending		Available for cutting	Reserved from cutting	
Ponderosa pine	5,362.2	321.2	76.6	1.5	2,939.9	27.6	154.8	67.5	32.0	6,932.2	54.3	15,969.8
Sugar pine	74.0	1.1	(3)	-----	34.8	6.6	.1	-----	.2	25.2	.1	142.1
Western white pine	21.5	2.1	.1	(3)	14.4	1.8	.1	8.9	1.8	152.3	15.7	218.7
Lodgepole pine	278.4	65.3	9.6	.4	148.2	1.8	31.2	7.9	29.5	1,447.0	125.5	2,144.8
Douglas-fir	1,248.1	185.4	49.5	1.7	553.8	13.0	40.5	68.1	1.0	2,752.4	103.6	5,017.1
Western redcedar	16.1	1.6	.2	-----	6.0	-----	.2	5.4	-----	48.1	4.4	82.0
Alaska yellow-cedar	.3	(3)	-----	-----	.4	-----	-----	.6	-----	7.3	.9	9.5
California incense-cedar	31.5	.3	.1	-----	12.8	.3	.2	-----	.1	13.7	.2	59.2
Western hemlock	68.5	2.2	.2	-----	6.3	-----	.3	14.6	.9	164.8	16.6	274.4
Mountain hemlock	19.6	.8	(3)	-----	53.5	.4	(3)	21.7	35.2	417.3	47.7	596.2
White and grand fir	600.4	26.1	10.0	1.3	195.9	12.3	8.5	18.9	6.8	1,366.2	44.8	2,291.2
Noble and Shasta red fir	18.3	.4	.3	-----	12.1	15.5	.9	1.3	41.7	165.8	26.6	282.9
Pacific silver fir	80.8	2.0	.1	-----	1.3	-----	.1	46.6	-----	367.6	57.7	556.2
Alpine fir	15.0	1.9	.1	.2	28.0	-----	(3)	6.9	-----	136.0	34.3	222.4
Western and alpine larch	309.5	63.4	16.5	.4	185.9	-----	17.8	11.8	-----	1,175.0	33.5	1,813.8
Engelmann spruce	57.5	17.9	2.7	.3	34.7	.2	2.5	10.2	1.8	473.0	179.4	780.2
Red alder	.8	.3	(3)	-----	.7	-----	(3)	.2	-----	2.2	.4	4.6
Bigleaf maple	.2	(3)	(3)	-----	(3)	-----	(3)	(3)	-----	.1	(3)	.3
Northern black cottonwood	10.5	.2	(3)	(3)	3.2	-----	.1	.2	-----	4.0	.5	18.7
Aspen	3.3	.1	.1	-----	.5	-----	.5	(3)	-----	2.0	(3)	6.5
Oregon white oak	8.8	.5	.5	(3)	.8	-----	.4	(3)	-----	.1	(3)	11.1
Sierra juniper	77.1	5.3	17.0	(3)	3.7	.1	134.2	.1	1.1	13.7	.1	252.4
Mountain mahogany	.5	(3)	(3)	-----	(3)	-----	.3	.4	-----	.6	-----	1.8
Willow	(3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	(3)
Total	8,302.9	[4] 698.1	183.6	5.8	4,236.9	79.6	392.7	291.3	152.1	15,666.6	746.3	30,755.9

[1] Including all sound wood in stems of all living trees and all standing dead trees 5.1 inches d. b. h. and larger from stump to 4-inch tip inside bark, excluding bark and limbwood.

[2] Crater Lake National Park.

[3] Less than 50 M cubic feet.

[4] Includes 0.1 million cubic feet of ponderosa pine and some lodgepole pine, white and grand fir, and Sierra juniper reserved from cutting.

National-Forest Ownership

The national forests, as in other parts of the West, were originally created from the public domain. Although they contain practically all of the inaccessible mountainous areas and noncommercial forest land, they also contain vast areas of high quality timberland. Alienation had not advanced so rapidly prior to their creation as in the Douglas-fir region. In recent years the national-forest areas have increased by exchange and purchase.

Sustained-yield principles govern the management of the national forests, and cutting on each operating unit is limited to the maximum specified in the working plan. Administration of national-forest timber sales makes adequate provision for protection of growing stock and for prompt regeneration. Disposal of national-forest timber is coordinated wherever possible with private operations to encourage sustained-yield practice on the part of private owners.

Actual cutting on most national forests has been less than the sustained-yield capacity owing mainly to lack of a market. Cutting of the more inaccessible national-forest timber will be deferred until the private timber supply is diminished. Eventually cutting will probably be extended to all the commercial timber areas of the national forests.

The national forests contain approximately half the region's forest land and saw-timber volume. Approximately 737,000 acres of forest land supporting 2.6 billion board feet of saw timber is reserved from cutting for one reason or another. Generally speaking, the reserved timber is remote and includes very little ponderosa pine. A large part of it is in little used species.

Considerably more than half the national-forest timber available for cutting is ponderosa pine. This timber is practically all economically available, that is, operable from the standpoints both of accessibility and quality.

Other Federal Ownership

This group includes unappropriated public domain, Federal lands designated for selection as railroad grants but not yet patented, and reserved lands. The latter category includes Crater Lake National Park, national monuments, wildlife refuges, and military reservations.

The unappropriated public domain totals 1.2 million acres but more than half this acreage is in juniper type and is chiefly valuable as grazing land. The total saw-timber volume on public domain lands is 1.0 billion board feet, most of which occurs on scattered parcels on the fringe of the commercial timber zone.

Indian Ownership

Approximately 2.6 million acres of forest land and 19.1 billion board feet of timber is on Indian land, a class of ownership that is a major factor in the forest situation. Roughly two-thirds of the Indian-owned timber in the country is in this region. This timber compares favorably in quality and value with privately owned timber and more than three-quarters of it is ponderosa pine.

The Indian timberland is managed under the direction of technical foresters in much the same manner as the national forests. Cutting on the Klamath Reservation, the largest in the region, has advanced rapidly, partly because of the necessity of salvaging large quantities of timber which were seriously jeopardized by pine beetle epidemics and partly because of the accessibility of the timber to an active market for stumpage. There has been very little cutting on the Warm Springs and Yakima Reservations and only moderate cutting on the Colville Reservation.

State Ownership

The total volume of State-owned saw timber is 2.7 billion board feet, practically all of which is in Washington. A little more than half of this is ponderosa pine. With the exception of one area in Yakima County, State holdings are usually scattered, an obstacle to effective management. However, Okanogan County, an extremely large county, has a total volume of nearly 1 billion board feet of State-owned timber, and Klickitat County, a small county, has nearly 0.5 billion. Practically all of this timber is on land granted by the Federal Government to finance education and internal improvements; such timber is sold at public auction in small parcels.

County and Municipal Ownership

Although the counties owned 0.25 million acres of forest land in 1936, the volume of the saw-timber stand was but 631 million board feet. Generally speaking, these forest lands rank low in timber productivity. They occur in scattered parcels too small to qualify as independent operating units and must be integrated with adjoining properties for efficient management. No counties have taken positive steps to manage their forest lands; instead a policy of disposal and attempted restoration of this land to tax rolls has been followed. Obviously, since these lands came into possession of the counties through tax forfeiture, such policies cannot be successful.

Municipally owned forest land consists of a few small watersheds and is not extensive enough to be of any regional significance.

Forest Depletion

DEPLETION involves the drain caused by cutting, forest insects, fires, disease, and wind throw. The rate of drain was determined separately for ponderosa pine and for all other species combined. Determination of depletion of ponderosa pine on account of cutting, fire, and insects was based on past records covering a recent and representative period. For depletion due to disease and wind throw, since no reliable records were available, rates were estimated. For species other than ponderosa pine, records of cutting and fire depletion were available, but insect, disease, and wind-throw depletion had to be estimated for these other species.

The drain on stands of saw-timber size was calculated in board feet, log scale, Scribner rule, and that on smaller sizes in cubic feet.

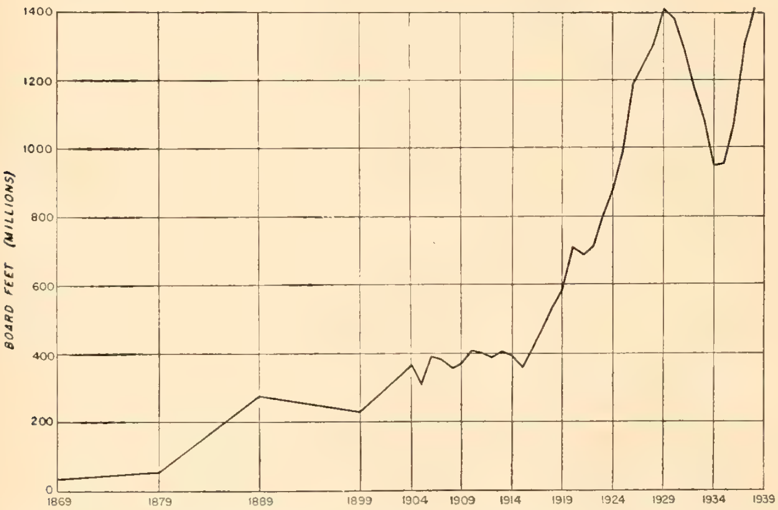

FIGURE 19.—*Trend of ponderosa pine production in Washington and Oregon, nearly all of which was from the eastern portions of the two States. (1869–89, Forest Service estimates from Census totals; 1899–1924, Census figures, with 5-year averages from 1908 to 1936.)*

Cutting Depletion

From the beginning of settlement by white men, cutting of the forests has kept pace with the economic growth of the region; the forests furnished building material, fuel wood, fence posts and rails for domestic development, later ties and timber for the construction of railroads, and finally sawlogs for a huge lumber industry.

Detailed statistics for the years prior to 1925 are not available, but Bureau of the Census records of ponderosa pine lumber production in Oregon and Washington from 1899 to 1924, together with Forest Service estimates for the 3 preceding decades, show the trends in eastern Oregon and eastern Washington, since practically all of the ponderosa pine lumber was milled there (fig. 19).

Lumber cut prior to 1889 was small averaging less than 100 million board feet annually. From 1889 to 1915 it was fairly stable. During the World War production soared, especially in Oregon, fell off slightly in 1921, only to increase again rapidly up to 1929, after which it declined sharply. In 1935 the downward trend was arrested and in 1939 an all-time high was attained.

Since 1925 the Forest Service, in cooperation with the Bureau of the Census, has compiled annual sawlog cut by species and counties in the ponderosa pine region and it is largely upon this statistical record for the period 1925–36 that cutting depletion is based. Statistics of the estimate of cutting

TABLE 13.—*Average annual cut of timber products in the ponderosa pine region by State and forest-survey unit* [1]

Forest-survey unit	From trees of saw timber size [2]						From smaller trees		
	Sawlogs	Fuel wood [3]	Poles	Piling	Posts	Total	Fuel wood [3]	Posts	Total
	M board feet	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M cubic feet*	*M cubic feet*	*M cubic feet*
Eastern Washington:									
Chelan-Colville	123, 298	33, 986	485	10	3, 174	160, 953	343	36	379
Yakima River	124, 082	19, 179	270	205	1, 994	145, 730	110	27	137
North Blue Mountain	3, 811	14, 528		4	2, 502	20, 845	87	119	206
Total	251, 191	67, 693	755	219	7, 670	327, 528	540	182	722
Eastern Oregon:									
North Blue Mountain	81, 782	29, 085	10	6	2, 276	113, 159		123	123
Deschutes River	231, 637	23, 951			738	256, 326	507	194	701
South Blue Mountain	109, 000	22, 233	8	1	1, 728	132, 970	247	306	553
Klamath Plateau	416, 479	12, 125	33	31	635	429, 303	18	112	130
Total	838, 898	87, 394	51	38	5, 377	931, 758	772	735	1, 507
Region total	1, 090, 089	155, 087	806	257	13, 047	1, 259, 286	1, 312	917	2, 229

[1] Data for sawlog production are averages for the period 1925–36; other data are for 1930 only.

[2] Figures given are log scale, based on Scribner rule.

[3] In addition to the quantities of material shown under this heading, considerable quantities of slabs, edgings, mill waste, and sawdust were used as fuel.

depletion, given in table 13, account for an average of 1.26 billion board feet in trees of saw-timber size and 2.2 million cubic feet of small trees removed annually from the forests as sawlogs or as minor products, such as fuel wood, fence posts, poles, and piling. The portion of the tree left in the forest by cutting operations was not included since the saw-timber inventory statistics and growth calculations included only the usable portion of the tree.

The annual output of sawlogs was classified by species, State, and forest-survey unit, and that of the minor products by item, species, State, forest-survey unit, and size class of the trees from which the material was cut, whether of saw-timber size (11.1 inches d. b. h. or more) or of less than saw-timber size.

Sawlog Drain

The 1.1 billion board feet of sawlogs produced annually during 1925–36 (table 14) amounted to about 87 percent of the total cutting depletion. The cut was large during the first half of the 12-year period; in only one year, 1927, did the volume fall below 1 billion board feet and in 1929 1.4 billion was cut. A decrease in the second half of the period reached a low of 565 million board feet in 1932, but subsequently a rapid rise carried the total to 1.5 billion board feet in 1936, the high point for the period. During 1937 production reached 1.6 billion board feet, dropped to 1.3 in 1938, but advanced to an all-time high of 1.8 billion in 1939.

Approximately 77 percent of the average annual sawlog cut was in Oregon. The trend in this State followed very closely that for the region, the peak being reached in 1936 and the low point in 1932. In eastern Washington the peak was reached in 1929, at an 18 percent increase over the 1936 cut. Figure 20 shows the average annual sawlog production in the region during 1925–36 by forest-survey unit.

The Klamath Plateau unit led during the period in the volume of sawlogs produced, reaching to nearly half of the average annual output in Oregon. The unit contains two of the most active lumbering centers in the region, Klamath Falls and Lakeview. Large-scale lumbering began in the Klamath Falls district about 1924 and in the Lakeview district in 1929. By 1936, the end of the period studied, production exceeded 600 million board feet and was still increasing. Because of the large supply of accessible ponderosa pine timber in the unit the output of logs will probably average over half a billion board feet annually for the next two decades, unless restrictions in the sale of Federal-owned and Indian-owned timber and the adoption

TABLE 14.—*Average annual sawlog production (M board feet Scribner log scale), ponderosa pine region, by species, 1925–36*

Forest-survey unit	Ponderosa pine	Douglas-fir	Western white pine [1]	Western larch	Balsam firs [2]	Sugar pine	Engelmann spruce	Western red-cedar [3]	Western hemlock	Total
Eastern Washington:										
Chelan-Colville	108,757	10,943	10	2,641	630	-------	31	286	-------	123,298
Yakima River	83,049	37,871	416	46	1,410	-------	-------	482	808	124,082
North Blue Mountain	2,836	333	-------	464	169	-------	9	-------	-------	3,811
Total	194,642	49,147	426	3,151	2,209	-------	40	768	808	251,191
Eastern Oregon:										
North Blue Mountain	70,877	5,241	10	4,822	786	-------	46	-------	-------	81,782
Deschutes River	231,298	324	12	-------	3	-------	-------	-------	-------	231,637
South Blue Mountain	105,405	1,998	7	1,317	267	-------	6	-------	-------	109,000
Klamath Plateau	399,695	9,955	130	-------	1,318	4,877	-------	504	-------	416,479
Total	807,275	17,518	159	6,139	2,374	4,877	52	504	-------	838,898
Region total	1,001,917	66,665	585	9,290	4,583	4,877	92	1,272	808	1,090,089

[1] Includes 2 M board feet of lodgepole pine in Chelan-Colville unit. [2] Includes all species of *Abies*.
[3] Includes 504 M board feet of California incense-cedar in Klamath Plateau unit.

FIGURE 20.—*Average annual sawlog production in the ponderosa pine region in 1925–36, by forest-survey unit.*

of a sustained-yield plan by some of the larger private operators reduce the cut appreciably.

In 1939 annual sawlog drain in this unit totaled nearly 750 million board feet, practically all ponderosa pine.

In the Deschutes River unit, the second in volume of sawlogs produced, large-scale operations began about 1916 in the Bend district and reached a peak in 1925 when approximately 345 million board feet was cut. Although this record was closely approached in 1929, production remained fairly stable during the period 1925–36. It is doubtful whether the cut will ever again reach the 1925 figure, but it will probably average about a quarter billion annually for a considerable time. As in the Klamath Plateau unit, the cut may be considerably reduced through adoption of sustained-yield management by the larger operators and limitation in the sale of Federal-owned timber. Production in the South Blue Mountain unit showed a large increase during the latter part of the period, owing to the beginning of a large operation in Grant County in 1929.

In general the cut in the three Washington units varied little from the regional trend except that in none was recovery from the 1932 low as rapid as in the Oregon units and in none was the 1929 volume again reached.

Ponderosa pine constituted 92 percent of the average sawlog output during the period and Douglas-fir made up the bulk of the remainder. In Oregon an even greater portion, 96 percent, of the cut was of ponderosa pine. In Washington, however, 77 percent was of ponderosa pine, a considerable quantity of Douglas-fir being cut in the Yakima River unit.

Of the region's total output during the period, approximately 72 percent was cut on lands in private ownership, 15 percent on Indian-owned lands, 11 percent on national-forest lands, and the remainder principally on State lands and Federal-owned revested grant lands.

Fuel Wood

Live timber cut for fuel was the second largest item of cutting depletion from 1925–36 and comprised about 13 percent of the total volume. Table 15 shows the production of fuel wood by State, forest-survey unit, and species. Since fuel wood was cut both from trees of saw-timber size and smaller trees, these two classes are shown separately. Average annual production for the period was based on a study of minor forest products made in 1930 by H. M. Johnson and an estimated annual per capita consumption of live forest fuel wood for both urban and rural areas. Per capita consumption was higher in the rural districts than in urban districts, since large quantities of slabs, edgings, mill waste, and sawdust were consumed for fuel in the cities. In Washington a considerable amount of coal was used in both urban and rural localities. Data on the amount of dead timber utilized for fuel were not compiled, since this use does not constitute depletion of the timber inventory. However, in some localities much of the fuel wood is cut from timber killed by insects, fire, or drought. Practically all of this dead material is of lodgepole pine and ponderosa pine; both species are considered excellent fuel. Another source of fuel wood not constituting a drain on the timber supply is ponderosa pine limbwood resulting from logging operations.

Of the total annual production of fuel wood of 155 million board feet from trees of saw-timber size, and 1.3 million cubic feet from smaller trees, 56 percent was produced in Oregon and 44 percent in Washington. Practically all of the wood was used in the locality in which it was cut. Ponderosa pine, as the leading species, constituted 69 percent of the total volume. Douglas-fir and western larch were cut extensively throughout

TABLE 15.—*Production of forest fuel wood in the ponderosa pine region by State, forest-survey unit, and species* [1]

Forest-survey unit	From trees of saw-timber size [2]					From smaller trees			
	Ponderosa pine	Douglas-fir	Western larch	Other species	Total	Western juniper	Oak	Other species	Total
	M board feet	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M cubic feet*	*M cubic feet*	*M cubic feet*	*M cubic feet*
Eastern Washington:									
Chelan-Colville	16,909	9,355	5,818	1,904	33,986	-	-	343	343
Yakima River	13,941	5,200	25	13	19,179	-	108	2	110
North Blue Mountain	9,631	2,517	1,897	483	14,528	-	-	87	87
Total	40,481	17,072	7,740	2,400	67,693	-	108	432	540
Eastern Oregon:									
North Blue Mountain	19,287	5,702	4,088	8	29,085	-	-	-	-
Deschutes River	20,308	3,643	-	-	23,951	406	101	-	507
South Blue Mountain	20,543	994	696	-	22,233	227	-	20	247
Klamath Plateau	10,755	1,370	-	-	12,125	18	-	-	18
Total	70,893	11,709	4,784	8	87,394	651	101	20	772
Region total	111,374	28,781	12,524	2,408	155,087	651	209	452	1,312

[1] In addition to the volume shown here, considerable quantities of slabs, edgings, mill waste, and sawdust were used for fuel.

[2] Figures given are log scale, based on Scribner rule; 1,000 board feet is approximately equivalent to 130 cubic feet.

TABLE 16.—*Production of round and split fence posts in the ponderosa pine region by State, forest-survey unit, and species*

Forest-survey unit	From trees of saw-timber size [1]							From smaller trees		
	Western redcedar	Western larch	Douglas-fir	Ponderosa pine	California incense-cedar	Others	Total	Lodgepole pine	Sierra juniper	Total
	M board feet	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M cubic feet*	*M cubic feet*	*M cubic feet*
Eastern Washington:										
Chelan-Colville	1, 503	1, 170	334	100	----------	67	3, 174	36	----------	36
Yakima River	954	700	255	64	----------	21	1, 994	27	----------	27
North Blue Mountain	----------	1, 221	610	610	----------	61	2, 502	119	----------	119
Total	2, 457	3, 091	1, 199	774	----------	149	7, 670	182	----------	182
Eastern Oregon:										
North Blue Mountain	----------	996	569	569	----------	142	2, 276	92	31	123
Deschutes River	131	164	164	246	----------	33	738	35	159	194
South Blue Mountain	----------	1, 037	314	314	----------	63	1, 728	68	238	306
Klamath Plateau	----------	----------	81	115	404	35	635	37	75	112
Total	131	2, 197	1, 128	1, 244	404	273	5, 377	232	503	735
Region total	2, 588	5, 288	2, 327	2, 018	404	422	13, 047	414	503	917

[1] Figures given are log scale, based on Scribner rule.

most of the region. Of the other species, considerable quantities of Sierra juniper were used in parts of the Oregon units, where it is often the only supply of wood readily accessible to ranchers. Small quantities of oak were cut in the Deschutes and Yakima River units.

Fence Posts

Since a large percentage of the fence posts are cut by ranchers for their own use, it is difficult to determine accurately the average annual production, but in the period 1925–36 fence posts are estimated to have made up about 1.5 percent of the total volume of cutting depletion. Data on production of round and split posts (table 16) were obtained from the 1930 study of minor forest products and the yearly number of post replacements was compiled on the basis of a fencing-acreage ratio for the farms of the region and an average post life expectancy of 12 years. Allowance was made for posts imported into the region, an estimate of which was obtained in the 1930 study. Most of the posts imported were utilized in the large agricultural districts not readily accessible to forested areas.

The species and size of timber from which the posts were cut depended almost entirely on what was available, since in each unit there is one or more species suitable for post production. Western redcedar, one of the most desirable species for post material because of its durability, was cut extensively in the Chelan-Colville and Yakima River units and somewhat less in the Deschutes River unit. Large quantities of split posts were cut from western larch in all of the units except the Klamath Plateau. The use of California incense-cedar, another desirable species, was limited to the Klamath Plateau unit. The greatest number of round posts were made from Sierra juniper, a very durable wood, although its use is limited to the Oregon units. Lodgepole pine, because of size and ease with which it can be worked into posts, was utilized in all units.

Fifty-five percent of the average annual volume of posts produced was cut in eastern Oregon and 45 percent in eastern Washington. Sixty-five percent was cut from trees of saw-timber size and 35 percent from smaller trees.

Other Minor Products

Small quantities of poles and piling were produced during the period 1925–36, principally in the Chelan-Colville and Yakima River units. The bulk of the poles produced were of western redcedar; a small quantity of California incense-cedar poles was cut in the Klamath Plateau unit. The piling was of western redcedar, Douglas-fir, and western larch.

Other minor products, such as railroad ties, mine timbers, cross arms, and shingles, were cut for local use, but the volume of each of these products was negligible. Recently a small volume of ponderosa pine peeler logs has been exported from eastern Oregon to a veneer plant in Portland.

Insect Depletion

Natural causes of depletion include forest insects, disease, and wind throw. Of these, forest insects is the only agency for which dependable records of loss are available and these records are limited to ponderosa pine. However, in the past, forest insects have been by far the most destructive of the natural-depletion agencies, and ponderosa pine, because of its commercial value, is the only species in which losses due to insects are of serious economic concern.

In Oregon and Washington ponderosa pine is the host of two of the bark beetles—western pine beetle (*Dendroctonus brevicomis* Lec.) and mountain pine beetle (*D. monticolae* Hopk.); several pine engraver beetles—species of Ips; and two defoliators—the pandora moth (*Coloradia pandora* Blake) and the pine butterfly (*Neophasia menapia* Felder). The western pine beetle has been by far the most active and destructive.

Although entomologists are practically certain that the western pine beetle has always been present in the pine forests of the region, continuous records of infestations prior to 1911 are lacking. Since that year there have been three epidemic periods, each followed by declines in activity resulting from the action of natural agencies of control. Peaks of the epidemics were reached in 1917, 1927, and 1932.

Since 1921, the Bureau of Entomology and Plant Quarantine has kept a continuous check of bark beetle losses on a series of sample plots in the Klamath Plateau unit. Beginning in 1931, these annual surveys were extended to other parts of the region and conducted cooperatively by the Bureau of Entomology and Plant Quarantine, Forest Service, Office of Indian Affairs, and private timber protective agencies. The estimates of depletion by forest insects are based upon the surveys for 1931 to 1937, inclusive. Although covering only 7 years, this period is fairly representative of the trend of beetle activity during the past two decades, since it included a severe epidemic followed by several years of declining severity of attack. However, losses that occurred during 1932 were the greatest within the knowledge of entomologists and they may not be equaled for many years.

Increased activity of the western pine beetle began in 1931, when climatic and host-resistance conditions were especially favorable to it, and resulted in a loss of over 5.7 billion board feet of ponderosa pine during 1931 to 1937, inclusive. The gross depletion during this period, as estimated by the Bureau of Entomology and Plant Quarantine, is shown by years in figure 21. The peak of infestation was reached in 1932, when the year's loss totaled nearly 1.7 billion board feet, a record for the region and greater than the peak volume of sawlog production during the period 1925–36. Although the epidemic was regionwide, the loss was heaviest in parts of the region which had been practically free of infestations for many years. This was especially true in the South Blue Mountain and Yakima River units. In parts of the former unit a loss of the entire stand occurred on tracts up to 10 acres and losses of 15 percent of the stand over large areas were common. Extremely low temperatures during the winter of 1932–33 destroyed a large percentage of the overwintering broods and brought about a

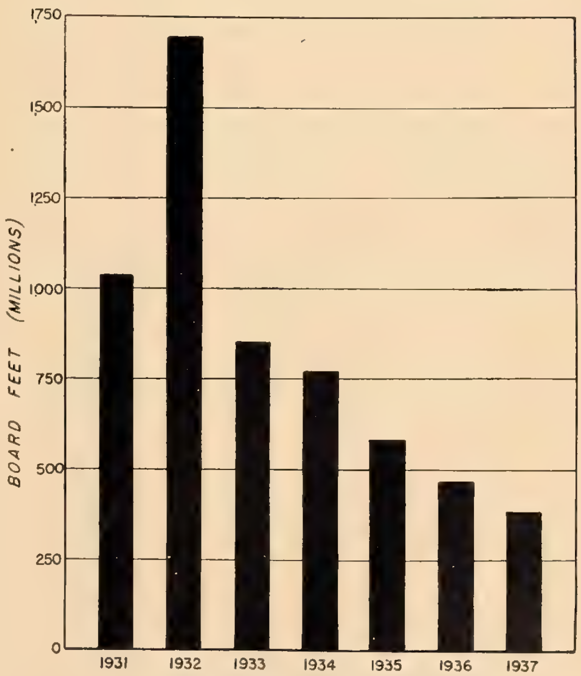

FIGURE 21.—*Estimated depletion of ponderosa pine by forest insects in the ponderosa pine region during 1931–37, inclusive.*

50 percent reduction of loss in 1933. This decline in activity continued in subsequent years, principally because more moisture resulted in increased tree vigor. The low for the period was 377 million board feet in 1937. However, in 1938 and 1939 there were increases in the beetle losses in portions of the region that presage an upward trend considerably above the 1937 low.

Recently the mountain pine beetle has been active both in virgin and dense second-growth stands of ponderosa pine, although volume of timber killed has been small.

Damage caused by Ips beetles has been confined principally to sapling and pole stands of ponderosa pine and cannot be readily measured. However, a considerable acreage of small second-growth pine has been killed in recent years, particularly in 1934.

Table 17.—*Estimated annual gross depletion, log scale, of ponderosa pine by forest insects in the ponderosa pine region in 1931–37, inclusive, by forest-survey unit*

[In million board feet—i. e. 000,000 omitted]

Year	Region total	Eastern Washington			
		Chelan-Colville	Yakima River	North Blue Mountain	Total
1931	1,025	47	76	2	125
1932	1,688	93	164	3	260
1933	844	58	148	2	208
1934	759	23	89	3	115
1935	574	32	21	2	55
1936	457	36	20	1	57
1937	377	32	27	1	60
Total	5,724	321	545	14	880
Annual average	818	46	78	2	126

Year	Eastern Oregon				
	North Blue Mountain	Deschutes River	South Blue Mountain	Klamath Plateau	Total
1931	45	200	225	430	900
1932	63	360	480	525	1,428
1933	26	187	175	248	636
1934	46	164	114	320	644
1935	26	128	107	258	519
1936	18	101	111	170	400
1937	21	80	99	117	317
Total	245	1,220	1,311	2,068	4,844
Annual average	35	174	187	296	692

Of the two defoliators present that attack ponderosa pine, the pine butterfly has been the most destructive and is potentially one of the worst insect enemies in the region. No outbreaks have occurred in recent years, but during the period 1893–95 the larvae of this butterfly killed from 20 to 80 percent of stands on 150,000 acres in the Yakima Indian Reservation.

The pandora moth, the other defoliator, has been active in parts of Oregon in recent years, but the last epidemic occurred during 1920–25 in Klamath County. Although the trees defoliated by this insect are not always killed, their rate of growth is so greatly retarded as to reduce volume production seriously.

Practically all the 818 million board feet of ponderosa pine lost annually through insect activity (table 17) is attributed to the western pine beetle. This is approximately 82 percent of the average annual ponderosa pine sawlog production from 1925 to 1936. Nearly 85 percent of this depletion occurred in Oregon, and the greatest loss was in the Klamath Plateau unit where annual depletion averaged 296 million board feet. In Washington, where the beetles were much less active, the greatest loss occurred in the Yakima River unit.

Although nearly all other species in the region have been subjected at one time or another to insect attacks, these attacks have seldom reached an epidemic stage and the volume of any one species killed annually has not been great. In recent years the mountain pine beetle has infested lodgepole pine stands in several parts of the region but reached an epidemic stage only in Crater Lake National Park and adjoining national-forest areas. Control work and low temperatures of the winter of 1932–33 brought about the cessation of the epidemic. Western white pine is also the host of the mountain pine beetle.

The Douglas-fir beetle (*Dendroctonus pseudotsuga* Hopk.) has been active in parts of the region recently and killed a comparatively small amount of Douglas-fir in the Chelan-Colville unit. Some western larch in this unit has been killed by the fir flatheaded borer (*Melanophila drummondi* Kby.) and western larch roundheaded borer (*Tetropium oclutinum* Lec.).

The annual loss of volume due to insects in species other than ponderosa pine was grouped with the losses caused by disease and wind throw and an annual loss rate of 0.75 percent of the total stand of these species was estimated, or 342 million board feet.

Fire Depletion

Although fire causes a much smaller loss of saw timber than does cutting or insects, it is nevertheless an important agency. Unlike cutting depletion, the total loss from fire cannot be measured in board or cubic feet. The outright killing of trees of saw-timber size is only a portion of the loss; often the greater part is in timber defective because of fire scars, the destruction of immature stands or reduction in their stocking, and material losses in the productivity of the forest soils.

The study of fire depletion was based on fires that occurred during the 12-year period, 1924–35. From data obtained from these fires were computed average annual gross area covered by fire, the area deforested, the net loss of saw-timber volume in board feet (table 18), and loss in trees 5.1 inches d. b. h. and larger in cubic feet (table 19). Detailed fire-depletion data by type and unit are given in supplemental tables in the appendix.

National Forests

The average of 36,000 acres of national-forest land covered by fire annually during the 12-year period amounted to 0.33 percent of the total, but considerably less than half of this was deforested. Of the area deforested, approximately 40 percent was occupied by noncommercial types, 35 percent by saw-timber stands, and 25 percent by second-growth conifer stands. Less than a third of the burned area of saw timber was classed as deforested, in contrast to more than half of the area of other types in this class. The noncommercial group of types includes the lodgepole pine types which are highly inflammable (fig. 22), usually inaccessible, and in the lightning zone. Forty percent of the total area deforested was occupied by immature lodgepole pine (type 26). Of the saw-timber stands, the upper-slope mixture (type 27½) was the most inflammable; the ratio of area deforested to the total area of the type on the national forests was approximately two and a half times that of pure ponderosa pine stands (type 20½).

TABLE 18.—*Estimated annual average gross forest-land area covered by fire, area deforested, and saw-timber volume (log scale) lost, ponderosa pine region, 1924-35*

Ownership and forest-type groups	Area of burns	Deforested area	Saw-timber volume loss
National forest:			
Conifer saw timber (5½, 20, 20½, 20A, 20B, 21, 27, 6, 7, 8, 9A, 23, 27½, and 29)	*Acres* 16, 676	*Acres* 5, 334	*M board feet* 46, 002
Conifer second growth (22, 28, 10, 9B, 24, 28½, and 30)	5, 307	3, 859	31
Noncommercial (4, 5, 25, 26, 33, and 38)	13, 654	6, 111	402
Old cut-over areas, nonrestocked, and previously deforested burns (35A and 37)	77		
Hardwood timber (31½ and 31)	6		
Total	35, 720	15, 304	46, 435
Other ownerships:			
Conifer saw timber (5½, 20, 20½, 20A, 20B, 21, 27, 6, 7, 8, 9A, 23, 27½, and 29)	31, 876	14, 955	39, 528
Conifer second growth (22, 28, 10, 9B, 24, 28½, and 30)	11, 737	5, 634	627
Noncommercial (4, 5, 25, 26, 33, and 38)	5, 144	1, 140	99
Old cut-over areas, nonrestocked, and previously deforested burns (35A and 37)	981		
Hardwood timber (31½ and 31)	13		
Total	49, 751	21, 729	40, 254
All ownerships:			
Conifer saw timber (5½, 20, 20½, 20A, 20B, 21, 27, 6, 7, 8, 9A, 23, 27½, and 29)	48, 552	20, 289	85, 530
Conifer second growth (22, 28, 10, 9B, 24, 28½, and 30)	17, 044	9, 493	658
Noncommercial (4, 5, 25, 26, 33, and 38)	18, 798	7, 251	501
Old cut-over areas, nonrestocked, and previously deforested burns (35A and 37)	1, 058		
Hardwood timber (31½ and 31)	19		
Total	85, 471	37, 033	86, 689

The 46 million board feet of saw timber killed by fire and not salvaged was only 0.07 percent of the total volume of the national-forest saw timber. Approximately 45 percent was ponderosa pine. Timber salvaged annually averaged only 370 M board feet, practically all ponderosa pine.

Other Lands

On lands other than national forest the area burned over annually averaged 0.45 percent of the total area of such forest land and the area deforested 0.19 percent, or approximately the same ratio as on national-forest land. Approximately 69 percent of the area deforested was occupied by saw-timber types, 26 percent by second-growth stands, and the remainder by noncommercial

TABLE 19.—*Summary of total average annual depletion, in saw timber and in all stands by State and forest-survey unit, depletion agency, and species group*

State and unit	Cutting			Fire			Other [1]			Total		
	Ponderosa pine	Other species	Total	Ponderosa pine	Other species	Total	Ponderosa pine [2]	Other species [3]	Total	Ponderosa pine	Other species	Total
STANDS OF SAW-TIMBER SIZE (IN MILLION BOARD FEET)												
Eastern Washington:												
Chelan-Colville	125.8	35.2	161.0	14.7	34.6	49.3	54.2	83.1	137.3	194.7	152.9	347.6
Yakima River	97.1	48.6	145.7	.9	5.1	6.0	85.5	87.2	172.7	183.5	140.9	324.4
North Blue Mountain	13.1	7.7	20.8	.1		.1	2.4	4.9	7.3	15.6	12.6	28.2
Total	236.0	91.5	327.5	15.7	39.7	55.4	142.1	175.2	317.3	393.8	306.4	700.2
Eastern Oregon:												
North Blue Mountain	90.7	22.5	113.2	.5	.3	.8	41.0	43.8	84.8	132.2	66.6	198.8
Deschutes River	251.8	4.5	256.3	9.2	1.7	10.9	188.7	40.6	229.3	449.7	46.8	496.5
South Blue Mountain	126.3	6.7	133.0	5.8	.8	6.6	203.8	32.8	236.6	335.9	40.3	376.2
Klamath Plateau	410.5	18.8	429.3	10.3	2.7	13.0	322.4	49.6	372.0	743.2	71.1	814.3
Total	879.3	52.5	931.8	25.8	5.5	31.3	755.9	166.8	922.7	1,661.0	224.8	1,885.8
Region total	1,115.3	144.0	1,259.3	41.5	45.2	86.7	898.0	342.0	1,240.0	2,054.8	531.2	2,586.0
ALL STANDS [4] (IN MILLION CUBIC FEET)												
Eastern Washington:												
Chelan-Colville	22.5	7.1	29.6	3.0	22.9	25.9	10.2	24.3	34.5	35.7	54.3	90.0
Yakima River	17.3	9.3	26.6	.2	1.7	1.9	15.9	20.5	36.4	33.4	31.5	64.9
North Blue Mountain	2.3	1.7	4.0				.5	1.7	2.2	2.8	3.4	6.2
Total	42.1	18.1	60.2	3.2	24.6	27.8	26.6	46.5	73.1	71.9	89.2	161.1
Eastern Oregon:												
North Blue Mountain	16.2	4.5	20.7	.2	.2	.4	7.8	15.1	22.9	24.2	19.8	44.0
Deschutes River	45.0	1.5	46.5	1.7	.7	2.4	34.6	11.4	46.0	81.3	13.6	94.9
South Blue Mountain	22.5	1.9	24.4	1.1	.3	1.4	37.4	9.0	46.4	61.0	11.2	72.2
Klamath Plateau	73.3	3.6	76.9	2.0	.9	2.9	59.0	15.6	74.6	134.3	20.1	154.4
Total	157.0	11.5	168.5	5.0	2.1	7.1	138.8	51.1	189.9	300.8	64.7	365.5
Region total	199.1	29.6	228.7	8.2	26.7	34.9	165.4	97.6	263.0	372.7	153.9	526.6

[1] Includes insects, disease, and wind throw.

[2] Insect loss in ponderosa pine based on records covering period 1931 to 1937, by Bureau of Entomology and Plant Quarantine. Losses from other causes based on estimates.

[3] Losses from all causes based on estimates.

[4] Trees 5.1 inches d. b. h. and larger.

types. Ponderosa pine stands occupied about two-fifths of the area of saw-timber types deforested.

Volume of saw timber killed annually on these lands averaged 47 million board feet, of which 7 million board feet was salvaged. Volume lost per acre of saw-timber area burned over was 1.24 M board feet, whereas on national-forest land the corresponding loss was 2.76 M board feet. Sixty percent of the volume killed on other lands, however, was ponderosa pine. Practically all of the volume salvaged was also ponderosa pine.

Summary of Depletion

The average annual loss of ponderosa pine caused by the other two considerable depletion agencies, disease, and wind throw, is much more difficult to calculate. Some of the loss attributed to the western pine beetle is the indirect result of disease, which has so weakened the vitality of the trees that they are highly susceptible to beetle attack. Also, the estimates obtained in the beetle-loss surveys are of gross volume and usually include 5 to 15 percent defective as the result of disease. On the other hand, much of the timber felled by wind is defective.

Annual loss caused by wind throw was estimated at 80 million board feet, approximately 0.1 percent of the total stand of ponderosa pine.

The annual drain on stands of saw-timber size from all causes totals nearly 2.6 billion board feet, log scale, Scribner rule, and on all stands in which the timber is 5.1 inches d. b. h. or more, approximately 527 million cubic feet (table 19).

Assumed Future Depletion

In estimating potential growth rates and future forest inventories the most uncertain and also one of the most important factors is drain. Although current drain can be closely approximated from available records of sawlog cutting, fire records, and insect damage surveys estimates of future drain must be based on assumptions. In the survey these assumptions were made after careful analysis of past and current rates of drain, present inventory and ownership of timber resources, capacity of the wood-utilizing industry, and regional and Nation-wide lumber production trends.

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FIGURE 22.—*A stand of lodgepole pine, type 26, killed by fire. The present condition of this area creates a critical fire hazard.*

Assumptions of depletion by cutting and fire were made for each of three decades, 1936–45, 1946–55, and 1956–65. These are shown in table 20 by survey unit. Depletion resulting from the natural agencies of forest insects, disease, and wind throw were not included, on the assumption that losses attributed to these agencies are offset by growth in old-growth stands and allowed for in computing yield in second-growth stands.

The estimate of annual cutting depletion for the decade 1936–45 of 1,745 million board feet is approximately 39 percent higher than the average annual cut during the 12-year period 1925–36, but the trend of sawlog production, which is about 87 percent of total production, was sharply upward during the last 4 years of the period. Production continued to increase in 1937, and the drop in 1938 was still well above the average for the period 1925–36 and more than balanced by the all-time high in 1939.

Approximately three-fourths of the cutting depletion during the period 1925–36 was of privately owned timber. It is assumed that this ratio will probably hold for 1936–45, but that by the beginning of the second decade many of the operations in privately owned ponderosa pine will be cut out. The cut of publicly owned and Indian timber will probably increase during the second decade, but since such timber is not available for unrestricted cutting the increase will not offset the decrease in cut of private timber. It is therefore estimated that the cutting depletion during the period 1946–55 will average 1,435 million board feet.

By the third decade, 1956–65, the bulk of the privately owned ponderosa pine will probably have been logged and most of the cut will come from national-forest and Indian-owned timber. Likewise, by this date probably most of the timber regardless of ownership will be under sustained-yield management and the cut will be governed chiefly by the productive capacity of the forests. Considering the ownership of the remaining timber and its sustained-yield capacity, and other factors, it was assumed that cutting depletion in the third decade would average 1,220 million board feet.

In estimating future losses due to fire, records of fires that occurred during the period 1924–35 were analyzed and a rate of area deforested annually was computed for each type. The types were then combined into 11 groups and a net annual rate for each group assigned. Based on the group rates, the average annual area to be deforested in the future was estimated at 30,000 acres. The volume of timber killed annually, determined through application of average stand-per-acre figures to the areas of merchantable types deforested, is estimated to be approximately 80 million board feet.

TABLE 20.—*Assumed future average annual forest depletion in the ponderosa pine region, log scale, Scribner rule*

[In million board feet, i. e., 000,000 omitted]

Form of depletion and survey unit	1936–45	1946–55	1956–65
Cutting depletion:			
Eastern Washington:			
Chelan-Colville	185	155	140
Yakima River	175	150	135
North Blue Mountain	20	20	20
Total	380	325	295
Eastern Oregon:			
North Blue Mountain	125	105	100
Deschutes River	325	290	225
South Blue Mountain	250	200	185
Klamath Plateau	665	515	415
Total	1,365	1,110	925
Region total	1,745	1,435	1,220
Fire depletion:			
Eastern Washington:			
Chelan-Colville	17	17	17
Yakima River	17	17	17
North Blue Mountain	1	1	1
Total	35	35	35
Eastern Oregon:			
North Blue Mountain	8	8	8
Deschutes River	11	11	11
South Blue Mountain	11	11	11
Klamath Plateau	15	15	15
Total	45	45	45
Region total	80	80	80
Total depletion:			
Eastern Washington:			
Chelan-Colville	202	172	157
Yakima River	192	167	152
North Blue Mountain	21	21	21
Total	415	360	330
Eastern Oregon:			
North Blue Mountain	133	113	108
Deschutes River	336	301	236
South Blue Mountain	261	211	196
Klamath Plateau	680	530	430
Total	1,410	1,155	970
Region total	1,825	1,515	1,300

Forest Growth

IN a region such as this with extensive areas of unmanaged, mature forests, the forest capital is constantly being depleted by human and natural agencies, at the same time that it is replenished to an extent by growth. Growth and depletion are characteristically out of balance during the early period of rapid timber harvest. Some sort of a balance, however, must eventually be attained. If depletion is abruptly curtailed to equal growth, the production of marketable products, recovery of wealth, and the contribution to community support from the forest will fall short of the sustainable amounts. On the other hand, if depletion exceeds growth too long, forest capital will be so reduced that the subsequent rate of possible timber harvest will be very low. One aim of forest management is to bring the two opposing forces of growth and depletion into balance at the optimum level. Hence, a current excess of depletion over growth is justified by the region's substantial old-growth timber supply, to the extent it is harvested under forestry practices that will insure continuing yields at this level.

Although varying widely in character, the commercial forest stands may be classified with respect to condition of growth into two broad categories—immature stands and mature or virgin stands. Estimates of gross growth were computed for all commercial stands, but detailed net growth estimates were restricted to the immature stands—those not more than 160 years of age—on the assumption that in older stands, on the whole, growth is offset by losses through mortality and decay.

Growth estimates were made only for the commercial forest sites. Rates applied to the immature ponderosa pine stands were derived from two sources—those for even-aged stands from the normal yield tables,[5] those for uneven-aged stands from the growth charts for selectively cut forests (*11*). For the virgin saw-timber types growth rates were derived from 323 samples taken throughout the region and analyzed especially for this study, as detailed in the appendix, p. 91. Rates for the immature stands of other species were derived from the Douglas-fir yield tables (*10*).

Three kinds of volume growth were calculated in both cubic feet and board feet. Each kind is useful in describing in part the forest growth situation, but none alone adequately portrays the entire situation. These are current annual growth, or the current annual increment of stands in their present condition; periodic growth, or the estimated increment within three periods of 10 years each; and potential annual growth, or the average annual increment that could be obtained from all commercial forest land through reasonably intensive forestry practice as judged by current local standards.

Current Annual Growth

Estimates of current annual growth are based on forest conditions as of date of survey inventory, which averages about January 1936. This expression of growth should not be used as a basis for estimates of volume at a future time, as changing conditions quickly invalidate it. It shows neither the potential productivity of the land nor the relation between character of forest practice and forest productivity. Current growth is directly comparable with current depletion, but conclu-

[5] Yield table adjustment factors were applied to the rates derived from the published tables (*12*) in order to allow for approach of understocked stands to normal. These factors were based on findings of J. W. Girard and L. J. Cummings in connection with the growth phase of the forest survey in northeastern Washington.

sions drawn from this simple comparison are likely to be misleading unless they are modified by analysis of existing growing stock and prevailing forest practices.

Sites occupied by commercial forest stands total 15,771,000 acres, of which 11,654,000 acres bear mature stands, i. e., more than 160 years old, and 4,117,000 acres immature.

Mature Stands

On the 74 percent of the region's commercial-forest area that is in mature timber, a gross annual growth is being achieved that in 1936 was 183 million cubic feet or 893 million board feet (table 21). But in spite of this, mature timber as a class suffered a loss in volume from 1917 to 1936, owing principally to insect epidemic and severe drought. For the next several decades, however, a net increment may be anticipated in such stands owing to the release that losses from insect attack have afforded the remaining trees and to the greater rainfall following the earlier abnormal drought. Although some stands have continued to lose volume despite such release, it is believed that for larger areas such periods of loss are followed by periods of gain. It is impossible as yet, however, to predict mortality of unmanaged mature stands with more detail than is involved in the general assumption that it will in the long run equal gross growth over large areas.

Thus it is that three-quarters and more of the total gross saw-timber growth in the region is at present being nullified by mortality caused principally by insects. Unlike that in many forest regions, this mortality is chiefly in high-quality trees. Records of the Bureau of Entomology and Plant Quarantine show that the average ponderosa pine tree killed by insects is about 32 inches in diameter and that 90 percent of the loss is in trees 22 inches in diameter, or more. Reduction of this wide discrepancy between gross and net growth is one of the region's most urgent forest-management problems.

Forest managers believe that by substituting light, thrifty-maturity selection cutting at frequent intervals for clear cutting or heavy selection, the mortality now occurring in the virgin stands can be reduced much more rapidly. Under this system only the least thrifty, most mature trees, of high

TABLE 21.—*Current annual growth* [1] *ponderosa pine region, 1936*

State and unit	Area	Cubic-foot growth		Board-foot growth	
		Gross	Net	Gross	Net
	Thousand acres	*Million cubic feet*	*Million cubic feet*	*Million board feet*	*Million board feet*
MATURE STANDS [2]					
Eastern Washington:					
Chelan-Colville	2, 285	34		154	
Yakima River	1, 422	29		144	
North Blue Mountain	124	2		7	
Total	3, 831	65		305	
Eastern Oregon:					
North Blue Mountain	1, 387	21		89	
Deschutes River	1, 582	27		144	
South Blue Mountain	2, 428	29		136	
Klamath Plateau	2, 426	41		219	
Total	7, 823	118		588	
Region total	11, 654	183		893	
IMMATURE STANDS [3]					
Eastern Washington:					
Chelan-Colville	1, 103	37	32	74	64
Yakima River	713	30	26	58	50
North Blue Mountain	162	7	6	8	7
Total	1, 978	74	64	140	121
Eastern Oregon:					
North Blue Mountain	799	33	29	44	39
Deschutes River	401	19	16	18	16
South Blue Mountain	457	18	16	21	18
Klamath Plateau	482	14	13	29	25
Total	2, 139	84	74	112	98
Region total	4, 117	158	138	252	219
ALL STANDS					
Eastern Washington:					
Chelan-Colville	3, 388	71	32	228	64
Yakima River	2, 135	59	26	202	50
North Blue Mountain	286	9	6	15	7
Total	5, 809	139	64	445	121
Eastern Oregon:					
North Blue Mountain	2, 186	54	29	133	39
Deschutes River	1, 983	46	16	162	16
South Blue Mountain	2, 885	47	16	157	18
Klamath Plateau	2, 908	55	13	248	25
Total	9, 962	202	74	700	98
Region total	15, 771	341	138	1, 145	219

[1] Cubic-foot growth is for that portion of the stem of trees 5.1 inches d. b. h., or more, between stump and top 4 inches in diameter inside bark, exclusive of bark and limbwood. Board-foot growth is for trees 11.1 inches, d. b. h., or more, in 16-foot logs to an 8-inch top, Scribner rule.
[2] Stands more than 160 years old, on commercial conifer forest land.
[3] Stands 160 years or less in age, on commercial conifer forest land.

insect susceptibility and low growth rate, are harvested at each cut. If the same total volume is thus removed in lighter cuts per acre, more acres will be cut over annually and conversion of virgin forest to net-growth condition may be accomplished in a relatively short cutting cycle.

Current gross growth provides a measure of the maximum effective increment during the first cycle following application of this method of cutting. The portion of this maximum that will actually be achieved is, of course, unknown, but there is a realistic opportunity of speeding the recovery of a substantial part of total gross growth by such alteration of cutting practice.

Immature Stands

Stands not more than 160 years old cover 26 percent of the region's area of commercial forests, consisting of young forests that have followed clear cutting or burning and residual stands left in condition of net growth by selective cutting. Their current annual gross growth totals 158 million cubic feet or 252 million board feet. After allowing for the low normal mortality characteristic of these thrifty stands, net annual increase in volume is 138 million cubic feet or 219 million board feet.

Location, species, and quality influence the economic availability of this increment. Approximately one-half is in ponderosa pine types (table 22) and there is little doubt of its potential availability, not only because ponderosa pine is commercially desirable but also because these stands are as a whole favorably located. Of the other half of the net growth, probably a large part will also be economically loggable at a time and in amounts dependent upon market values and production costs. Quality of net growth in both type groups is far lower than that of timber now being logged. It is estimated that only one-fifth of the total net growth is being put on trees 22 inches d. b. h. or more. In contrast, more than four-fifths of current timber drain is in trees of this size class.

TABLE 22.—*Annual increment in stands of the ponderosa pine types in terms of total saw-timber growth in all stands, by survey units, 1936*

State and unit	Gross growth	Net growth
Eastern Washington:	*Percent*	*Percent*
Chelan-Colville	39	33
Yakima River	37	40
North Blue Mountain	35	25
Average (weighted)	38	35
Eastern Oregon:		
North Blue Mountain	43	37
Deschutes River	70	77
South Blue Mountain	75	75
Klamath Plateau	77	59
Average (weighted)	69	59
Region average (weighted)	58	48

All Commercial Stands

If no reduction is made for losses by mortality and decay, the total gross growth in the region is 341 million cubic feet or 1,145 million board feet annually. This growth in cubic feet amounts to 1.1 percent of the region's total timber stand; in board feet, to 0.9 percent. Two-thirds of it is in ponderosa pine types but only 58 percent on ponderosa pine trees, largely because the volume of other species in the pine types is greater than the ponderosa pine volume in the nonpine types (table 22). In contrast ponderosa pine suffers 87 percent of the total cutting depletion.

Total regional net growth is identical with that occurring in the immature stands. Net increment in cubic measure is 40 percent, that in board measure is only 19 percent of total gross growth, the remainder being at present offset by mortality.

Periodic Growth

In this region, where extensive virgin forests are being rapidly cut over, the change in growth rate is so rapid that the trend of growth is of far greater significance than is its current level. As here computed, periodic growth is the net increment that will occur concurrent with probable cutting, fire, and mortality depletion [6] during three decades under three classes of cutting practice in ponderosa pine stands: (1) Light selection cutting (the most mature, least thrifty 50 percent of the virgin stand per acre) on lands of all ownerships; (2) heavy selection cutting (75 percent removal per acre) on private lands and light selection cutting (50 per-

[6] Allowance was made for insect, windfall, and disease mortality in immature stands at estimated normal rates. Allowance was made for these factors in virgin stands by assuming that, on the whole, growth balances mortality therein.

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cent) on lands of other ownerships; (3) virtual clear cutting (95 percent of virgin stand per acre) on private lands and heavy selection cutting (75 percent) on lands of other ownerships. The third class of cutting practice approximates that which has prevailed prior to the date of the survey; the current trend is toward lighter cutting. In each instance it was assumed that the portion of the stand removed would be the slowest growing of the total. These percentages of cut are employed to illustrate the effect on growth of leaving various densities of reserve stand; none is necessarily recommended as most suitable for any specific forest.

Relatively little logging is anticipated in the nonpine types during the next 30 years; hence, only one class of practice, clear cutting, was assumed for them. This does not imply, however, that there may not be advantages in selective cutting in these types.

Owing to the expected conversion of additional areas to growing condition as cutting continues, the estimated net annual increment increases substantially in the three decades following 1936 (table 23, fig. 23). If the cutting practice that has prevailed in the past continues, it is estimated that the annual net growth for the region will increase from about 220 million board feet in 1936 to about 615 million board feet in 1966. Under a relatively light selection cutting of the same total volume in the pine stands, the estimated net growth for the region as of 1966 would reach 900 million board feet, an increase in growth 72 percent greater than that anticipated under continuation of past practice. Under heavy selection on private lands and light selection on all other, a net annual growth of 815 million board feet could be attained by the year 1966.

Light selection cutting not only converts the static or decadent virgin stands more rapidly to a condition of net growth, but also improves the quality of the growth. Also, owing to the greater reserve stand left and the greater volume and quality of growth obtained, a second cut may be taken after a much shorter interval following light selection.

At present ponderosa pine types contribute only one-half of the net growth, but suffer nearly 90 percent of regional depletion. By 1966, however, they will be making from 71 to 80 percent (depending on cutting practice) of the net growth and a relatively high percent of it will be occurring in accessible stands of the most desirable species.

The effect of cutting practice on future growth is obscured somewhat because the growth shown above includes that of existing immature stands, the increment of which could of course be affected

TABLE 23.—*Periodic saw-timber growth*[1] *in the ponderosa pine region, 1936–65, by decade and class of cutting practice*

[In million board feet—i. e., 000,000 omitted]

State and unit	1936–45			1946–55			1956–65		
	50–50	75–50	95–75	50–50	75–50	95–75	50–50	75–50	95–75
Eastern Washington:									
Chelan-Colville	769	730	665	1,284	1,178	962	1,694	1,567	1,240
Yakima River	552	523	486	888	812	701	1,131	1,046	883
North Blue Mountain	77	74	69	156	146	132	223	208	188
Total	1,398	1,327	1,220	2,328	2,136	1,795	3,048	2,821	2,311
Eastern Oregon:									
Northern Blue Mountain	400	380	355	815	736	649	1,109	992	858
Deschutes River	355	306	235	769	657	446	1,105	968	676
South Blue Mountain	271	246	200	657	570	410	1,003	874	629
Klamath Plateau	652	560	397	1,377	1,167	722	1,799	1,590	1,015
Total	1,678	1,492	1,187	3,618	3,130	2,227	5,016	4,424	3,178
Region total	3,076	2,819	2,407	5,946	5,266	4,022	8,064	7,245	5,489

[1] Growth is shown for all trees 11.1 inches d. b. h., or more, estimated in 16-foot logs to an 8-inch top, Scribner rule. Under each decade is shown results from three cutting methods: (50–50) light selection, removal averaging 50 percent of virgin stand volume per acre on both private and other areas where cutting occurs; (75–50) heavy selection, averaging 75 percent of virgin stand volume per acre on private lands and light selection, averaging 50 percent, on other lands; (95–75) virtual clear cutting on private lands and heavy selection on other.

in no way by the cutting practice employed on other areas. By 1966, it is estimated, the net growth of stands assumed to be converted to immature status subsequent to 1936 will be about 215 million board feet annually if past cutting practice continues. Cutting on a light selection basis, however, would raise the net growth of such stands in 1966 to 520 million board feet, or more than 2.4 times that which would be obtained by continuation of past practice (fig. 24.)

Over a rotation, the spread between the volume growth following light and that following heavy cutting would be smaller than for the initial 30-year period, but the difference in quality of growth would still be great. If the anticipated demand for privately owned timber is completely met, a critical period will arrive in the heavily producing units within one to two decades. The quality and quantity of growth available in the reserve stands will then decide how drastic the curtailment must be. Both amount and value of growth as of this period can be greatly increased, and consequently the necessary curtailment considerably reduced, by shifting cutting practice to a light selection basis now.

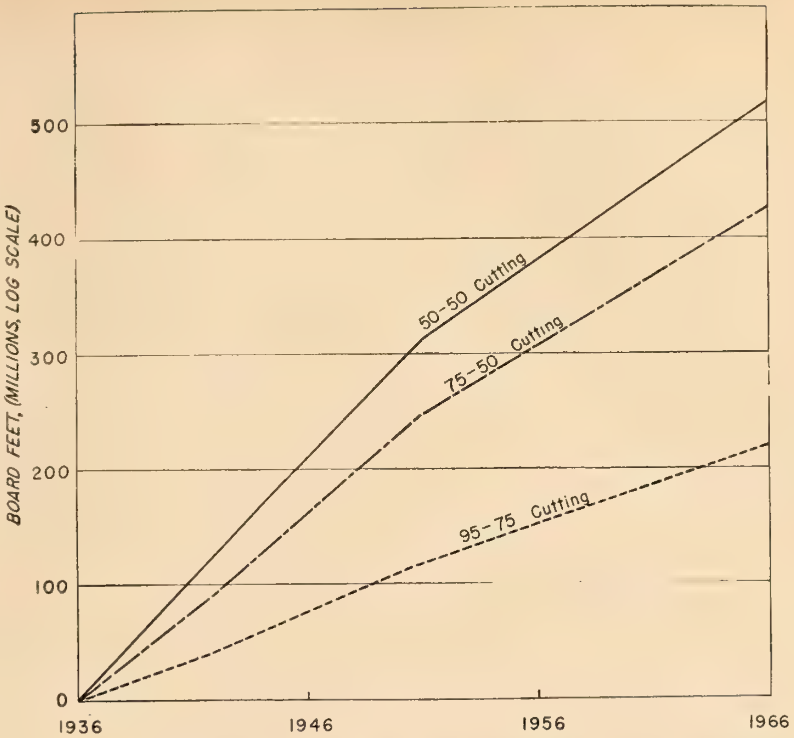

FIGURE 24.—*Annual growth of stands that would be converted to net growth status subsequent to 1936, by cutting practice.*

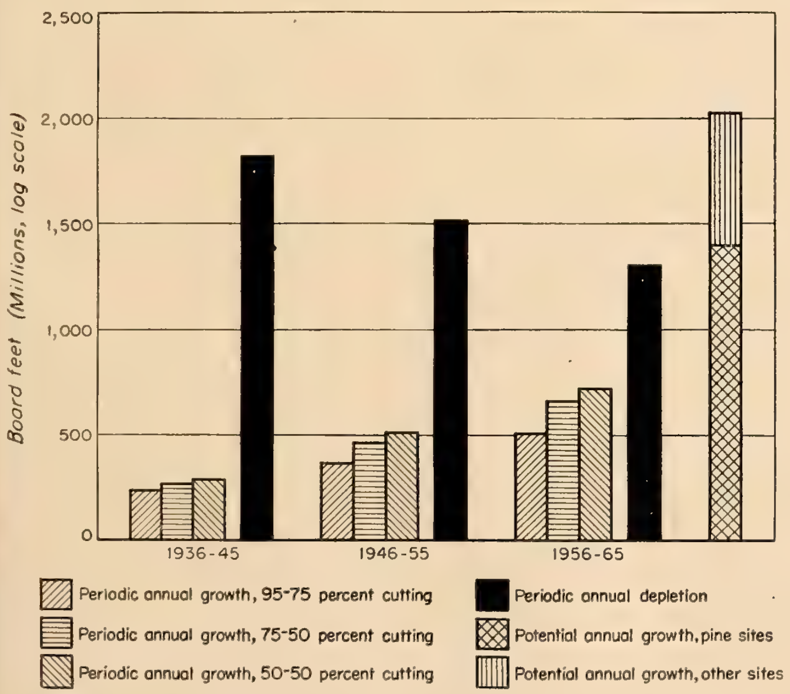

FIGURE 23.—*Regional periodic annual growth under three degrees of cutting, periodic annual depletion, and potential annual growth.*

Potential Annual Growth

Potential annual growth, as already defined, is the average annual increment obtainable through reasonably intensive forestry as judged by current local standards. It does not represent maximum increment; the theoretical ultimate value has been substantially reduced to allow for an amount of understocking and nonuse of forest land believed inevitable. Even so, this obtainable growth could be achieved on the whole of the region's commercial forest land only after years of careful and effective forest-land management.

It was anticipated that, under reasonably intensive management, timberland sites rated according to the ponderosa pine classification would produce 60 percent of normal yield-table increment and woodland sites 20 percent. For sites rated by the Douglas-fir classification, an average increment of 75 percent of the full yield-table value was assumed. Growth equal to or in excess of these adjusted standards is now found in many parts of the region's natural forests, uniformly over areas of several thousand acres. The adjusted mean annual growth rate for each site-quality class was multiplied by the corresponding acreage, and the sum of the resulting products is the estimated potential growth (table 24 and fig. 20; also, for rates used in making these calculations, table 42 in the appendix).

Of the 658 million cubic feet of wood, or 2 billion board feet of trees 11.1 inches d. b. h. or more that sustained-yield forest management can produce annually on the 16.2 million acres of commercial conifer land, the four Oregon units, comprising 63 percent of this area, have about 61 percent.

Approximately three-quarters of the commercial forest land, including about 69 percent of the potential growth, is in ponderosa pine sites, and these represent 81 percent of the growth capacity of eastern Oregon, but only 51 percent of that for the Washington units of the region. Seven percent of the ponderosa pine lands is in woodland sites, but these include less than 2 percent of the pine-site growth capacity.

One-half of the region's commercial forest land and of its productive capacity is in the national forests, one-third is privately owned, and the remainder is principally in Indian ownership. Forest lands legally reserved from cutting have about 2 percent of the timber-growth capacity.

The extent to which yield can be increased when opportunity is afforded for marketing thinnings varies with utilization standard or type of product, as well as with site quality, age, and density

Table 24.—*Potential annual growth*[1] *on commercial forest sites in the ponderosa pine region*

State and unit	Area	Growth on all trees	Growth on saw-timber trees: Total	Growth on saw-timber trees: Ponderosa pine
	Thousand acres	*Million cubic feet*	*Million board feet*	*Percent*
Eastern Washington:				
Chelan-Colville	3, 525	140	408	55
Yakima River	2, 177	104	342	45
North Blue Mountain	288	12	36	49
Total	5, 990	256	786	51
Eastern Oregon:				
North Blue Mountain	2, 244	90	260	64
Deschutes River	2, 016	79	252	84
South Blue Mountain	2, 925	110	337	86
Klamath Plateau	2, 993	123	402	86
Total	10, 178	402	1, 251	81
Region total	16, 168	658	2, 037	69

[1] Growth in cubic feet is shown for that portion of the stem of all trees 5.1 inches or more in d. b. h. between stump and a top 4 inches in diameter inside bark, exclusive of bark and limbwood. Growth in board feet is shown for all trees 11.1 inches d. b. h. or more estimated in 16-foot logs to an 8-inch top, Scribner rule.

of stands. No allowance was made for this factor in computing potential growth, but analysis of the normal yield-table mortality rates reveals that the maximum increase in yield derivable from this source may approximate one-third of the cubic measure yields shown in the published tables (*10, 12*).

Comparison of Current, Probable Future, and Potential Growth

Growth status as of 1936, summarized in table 25 in comparison with probable future and potential growth, shows that stands that are making net growth are contributing cubic-foot growth nearly proportionate to the area they occupy, but less than half the board-measure increment of which the sites are capable. This is due chiefly to the fact that the clear cutting and heavy selection cutting prevailing in the past have so depleted the residual stands of sawlog-size growing stock that many of the stands are below saw-timber size. Board-foot growth rates on these areas may be

TABLE 25.—*Comparison of current, probable as of 1966, and potential annual conifer increment in the ponderosa pine region*

ACTUAL VALUES

Kind of annual growth calculation	Area involved	Increment on all trees 5.1+ inches d. b. h.	Increment on all trees 11.1+ inches d. b. h.
	Thousand acres	*Million cubic feet*	*Million board feet*
Current, 1936	4,117	138	219
Probable, 1966:			
50–50 [1]	10,282	355	900
75–50 [2]	9,499	325	815
95–75 [3]	8,139	255	615
Potential	16,168	658	2,037
RATIO TO POTENTIAL VALUES			
	Percent	*Percent*	*Percent*
Current, 1936	25	21	11
Probable, 1966:			
50–50 [1]	64	54	44
75–50 [2]	59	49	40
95–75 [3]	50	39	30

[1] Assuming 50 percent volume removal on all lands during first cutting cycle.

[2] Assuming 75 percent volume removal on private lands, 50 percent on other lands.

[3] Assuming 95 percent volume removal on private lands, 75 percent on other lands.

expected in time to increase materially, but such growth will for many years be low in quantity and even more so in quality. Differences in site-quality class of the areas shown in table 25 are negligible; average site quality of the areas in growing stands approximates that for the region's total area of commercial forest land.

The probable annual growth estimates as of 1966 are derived from the periodic growth calculations. If past cutting practice continues, about 8.1 million acres will be occupied by growing stands by 1966 and their estimated net annual growth as of that date is 255 million cubic feet or 615 million board feet. Light thrifty maturity selection cutting applied to ponderosa pine stands of all ownerships could increase saw-timber growth to 900 million board feet by 1966.

Effectiveness of Past Forest Practice

Since nearly three-quarters of the commercial forest land is occupied by mature stands that are making no current net growth, a regional comparison of current growth with total potential growth is of little value as an index of the effectiveness of past forest practice. It is more appropriate to compare current and potential growth on the 4½ million acres of commercial forest land that is not occupied by virgin timber, of which 94 percent is now supporting growing stands of some sort and the remaining 6 percent is deforested. Here current growth in cubic feet is 73 percent but in board feet only 37 percent of the potential (table 26). Current growth in both cubic measure and board measure is less than the potential in

TABLE 26.—*Current and potential growth on commercial forest land in the ponderosa pine region, exclusive of land occupied by mature timber*

State and unit	Area	Current annual growth		Potential annual growth		Ratio of current to potential growth	
						Cubic feet	Board feet
	Thousand acres	*Million cubic feet*	*Million board feet*	*Million cubic feet*	*Million board feet*	*Percent*	*Percent*
Eastern Washington:							
Chelan-Colville	1,239	32	64	53	155	60	41
Yakima River	755	26	50	37	126	70	40
North Blue Mountain	164	6	7	7	21	86	33
Total	2,158	64	121	97	302	66	40
Eastern Oregon:							
North Blue Mountain	857	29	39	34	97	85	40
Deschutes River	435	16	16	17	57	94	28
South Blue Mountain	497	16	18	19	60	84	30
Klamath Plateau	567	13	25	23	75	57	33
Total	2,356	74	98	93	289	80	34
Region total	4,514	138	219	190	591	73	37

every unit, but the discrepancy in cubic-foot growth is relatively small. Cubic-foot increment is progressing at a comparatively satisfactory rate in the existing immature stands, particularly in the Deschutes River and in the three Blue Mountain units. The deficiency of board-measure growth so pronounced in every unit is additional evidence of the low quality of current increment. The situation is due largely to the dearth of saw-timber-size growing stock in the immature stands.

As cutting continues to convert virgin to growing stands, and as the existing immature stands increase in age, board measure growth will increase substantially without change in forestry practice, but the quality of such growth will be low for many decades. Growth can be further increased in volume, and also materially in value, only by improved cutting practices.

Comparison of Growth and Drain

The Current Situation

Normal regional mortality depletion [7]—principally from insect, windfall, and disease loss—added to the average depletion from cutting and fire during the recent past (table 27)—1,259 million board feet for cutting and 87 million board feet for fire—gives a total depletion figure of 2,272 million board feet, or twice the gross annual growth. The region's saw-timber stand is thus being reduced by 1,127 million board feet annually. If, however, comparison is made directly between that portion of the total growth which is currently effective, i. e., between net growth and cutting depletion plus fire loss, the ratio of saw-timber drain to growth is about 6 to 1.

On the same basis but in terms of cubic feet, current gross growth is 73 percent of gross depletion. Current net cubic-foot growth is 52 percent of net cubic-foot depletion, and (table 27) the regional cubic-foot volume of wood is being currently reduced by approximately 126 million cubic feet annually.

The annual net reduction in timber volume in the region amounts to 0.9 percent of the saw-timber stand, but to only 0.4 percent of total cubic volume. The disparity between these percentages is further evidence that net growth is occurring principally on small trees of low quality while larger, more valuable trees are being harvested in logging and killed by insects. Net saw-timber growth is exceeded by depletion from cutting and fire in every unit in the region and net cubic-volume growth in all but the North Blue Mountain units. Growth in these units also is substantially exceeded by depletion on a value basis.

Fortunately, as already implied, the region's timber budget is not out of balance to the extent indicated by these direct comparisons of growth and depletion. The large excess of depletion over growth is partly explained by the fact that three-quarters of the region's commercial forest land is still covered with virgin stands that are considered as making no net growth, although they contain a large saw-timber supply and the land they occupy possesses a substantial growth capacity. Because of this, the regional cut may exceed growth for several decades without damage; in fact, if such cut is confined to the most mature or decadent trees, the eventuality of greatly increasing net growth can be highly favorable; the extent and rate of increase and the quality are all directly dependent upon the character of forestry practice that will prevail. In the region's principal sawmill centers, however, even the best of forestry measures cannot increase net growth to equal the current overcutting.

Comparison of Potential Growth and Depletion

Total potential saw-timber growth exceeds recent regional depletion from cutting and fire by about 51 percent. The productive capacity of the ponderosa pine sites alone is about 5 percent greater than recent saw-timber depletion. In terms of cubic volume, however, the growth capacity of the ponderosa pine sites is only 83 percent of total drain from cutting and fire. Potential cubic-volume growth of all sites exceeds depletion by 25 percent. As shown in the last two columns of table 27, physical opportunity for net saw-timber growth eventually exceeding current drain exists in all but Deschutes River and

[7] Estimated normal mortality for immature stands plus loss allowance for virgin stands equal to total gross growth therein.

Table 27.—*Comparison of current annual growth and drain*

SAW TIMBER (MILLION BOARD FEET)

State and unit	Current gross growth [1]	Normal mortality depletion [2]	Current net growth [3]	Average fire loss 1924–1935	Average cutting depletion 1925–1936	Annual reduction in saw-timber volume	Potential increase in net growth
Eastern Washington:							
Chelan-Colville	228	164	64	49	161	146	344
Yakima River	202	152	50	6	145	101	292
North Blue Mountain	15	8	7		21	14	29
Total	445	324	121	55	327	261	665
Eastern Oregon:							
North Blue Mountain	133	94	39	1	113	75	221
Deschutes River	162	146	16	11	257	252	236
South Blue Mountain	157	139	18	7	133	122	319
Klamath Plateau	248	223	25	13	429	417	377
Total	700	602	98	32	932	866	1, 153
Region total	1, 145	926	219	87	1, 259	1, 127	1, 818

ALL STANDS (MILLION CUBIC FEET)

State and unit	Current gross growth [1]	Normal mortality depletion [2]	Current net growth [3]	Average fire loss 1924–1935	Average cutting depletion 1925–1936	Annual reduction in saw-timber volume	Potential increase in net growth
Eastern Washington:							
Chelan-Colville	71	39	32	26	30	−24	108
Yakima River	59	33	26	2	26	−2	78
North Blue Mountain	9	3	6		4	+2	6
Total	139	75	64	28	60	−24	192
Eastern Oregon:							
North Blue Mountain	54	25	29		21	+8	61
Deschutes River	46	30	16	3	47	−34	63
South Blue Mountain	47	31	16	1	24	−9	94
Klamath Plateau	55	42	13	3	77	−67	110
Total	202	128	74	7	169	−102	328
Region total	341	203	138	35	229	−126	520

[1] On commercial forest land, 1936.
[2] Insects, disease, wind throw, etc.
[3] On commercial stands not more than 160 years in age, 1936.

Klamath Plateau, the principal lumber-producing units, and potential growth in cubic volume exceeds recent depletion by a substantial margin in every unit.

Despite the favorable spread between recent cut and physical growth capacity of the region as a whole, it is conceivable that that portion of the potential growth that proves to be economically accessible may fall short of future needs because much of the remote forest land is unsuitable for ntensive management.

Local Trends in Saw-Timber Growth and Depletion

Cutting of saw timber assumed for the decade 1936–45 exceeds the 1925–36 average rate by about 39 percent, in general conformity with the increase in timber cut since 1934. As supplies of privately owned timber diminish, a larger proportion of the timber cut will come from public and Indian lands. For the bulk of such lands the cut is limited to volume that can be sustained without serious interruption. Hence a reduction in cut is assumed for the 20-year period following 1945.

As cutting continues, growth will increase, the rate depending largely upon the prevailng cutting practice. If no significant change is made, it is estimated that by 1966 depletion will exceed net growth, not by the current ratio of 6 to 1 but by about 2 to 1, owing to anticipated increase in increment following conversion of mature stands to net growth condition by cutting. If cutting took the form of 50 percent selection of the most mature trees in the stands logged, it is estimated that by 1966 depletion would exceed growth by only about 44 percent.

Growth-depletion relationships vary widely for the several units of the region (table 27 and fig. 25). In the Chelan-Colville and North Blue Mountain units, total net growth will either about equal or slightly exceed estimated depletion by 1966, depending on the quality of forestry practice. In the Yakima River unit growth will be approaching depletion. A substantial part of the net growth in these three units, however, will be in nonpine types of average low value and accessibility. In the Yakima River unit more than half the forest productive capacity is in these types. Even if all possible improvement is made in cutting practice there will still be a wide discrepancy between ponderosa pine depletion and ponderosa pine growth in 1966. But since total potential growth exceeds assumed depletion by a wide margin in each of these units, it would be possible, through reasonably intensive forestry practice, eventually to sustain an increased production if opportunity to market species other than ponderosa pine is developed.

The average depletion assumed to occur in the Deschutes River unit during the 30-year period exceeds total potential growth by 15 percent—on the pine sites alone by 37 percent. Potential growth cannot be attained here by the time the existing mature timber will be gone, and hence a material reduction in cut is inevitable. However, prompt and effective forest management can mitigate the severity of the curtailment. The excess of cut over permanent productive capacity is even greater in the Bend area, the unit's principal industrial center, than it is for the unit as a whole. The area tributary to Bend has been so badly overcut for several decades that drastic reduction in output will be unavoidable in less than two decades.

In the South Blue Mountain unit, assumed average depletion for the period 1936–65 is 76 percent of the potential growth of the ponderosa pine sites. Properly managed, the timber resources are sufficient to prevent serious interruption of production for the unit as a whole, if the cut does not advance beyond that assumed. Local shortages, however, already exist in this unit and may be expected to increase in severity.

The Klamath Plateau unit includes the principal lumber-producing center in the region, Klamath Falls, and is assumed to yield more than 36 percent of the region's cut for the next three decades. If this heavy cutting actually occurs, a drastic future reduction is inevitable. Necessary curtailment will be less severe if cutting is made under good forestry practice, but even so there will be a large deficit between anticipated growth and depletion as of 1966 (fig. 22). Since assumed average depletion for the period 1936–65 exceeds total potential growth by 36 percent, it is evident that production could not be maintained at that level, even though all the unit's timberlands had been under reasonably intensive forestry management for many years. The longer the inevitable curtailment is postponed the more severe it will eventually be.

These assumptions of heavy depletion for the period 1936–65, although justified by present trends, most decidedly are not recommendations. In the Deschutes River and Klamath Plateau units particularly, every constructive effort should be made to alter current depletion trends.

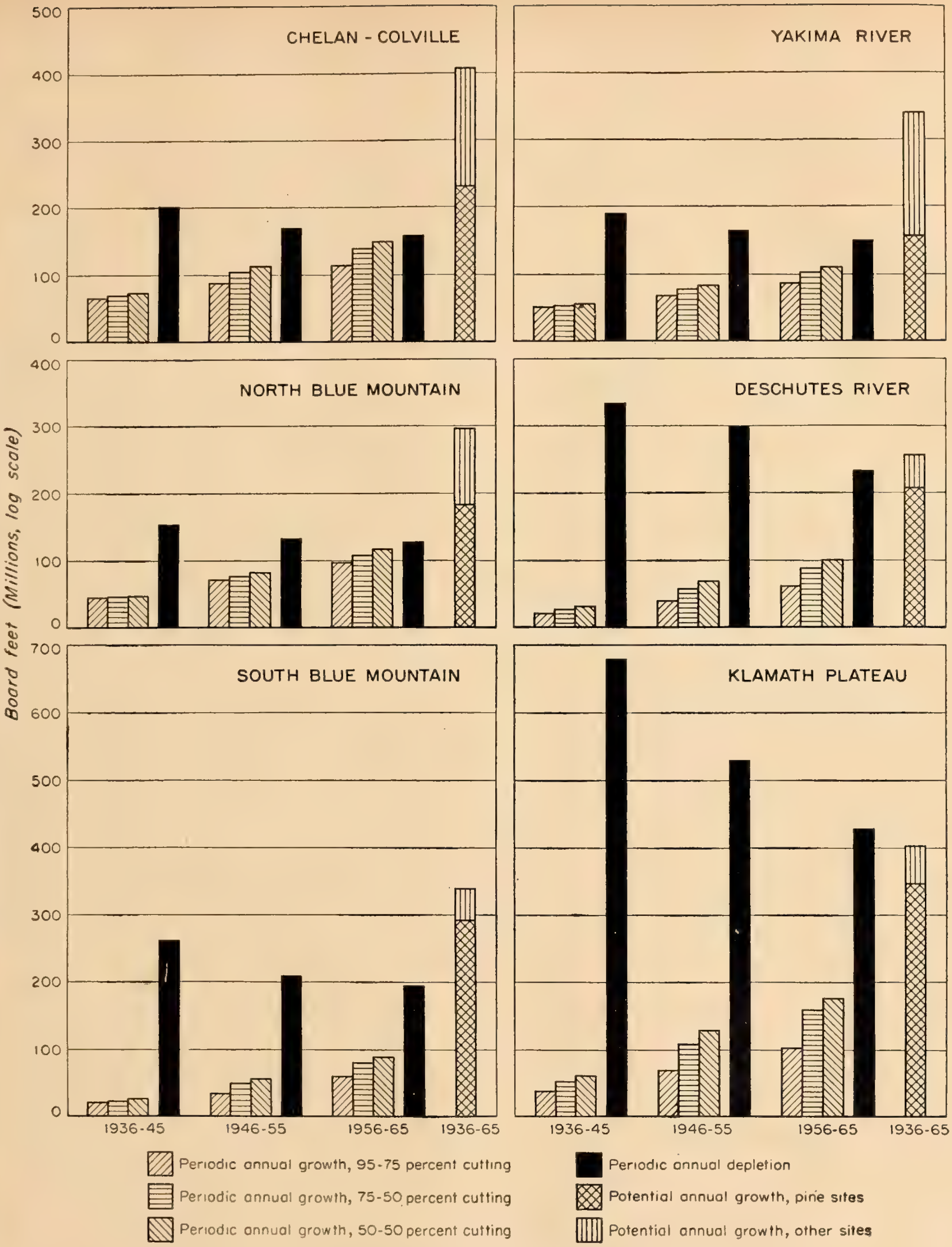

FIGURE 25.—*Periodic annual growth, depletion, and potential annual growth by survey unit.*

Land Use

Nonforest Land Use

THE total area of the ponderosa pine region is 65.5 million acres, of which 22.1 million acres was classified as forest land by the survey, including 2.0 million acres classified as woodland pasture and 0.15 million acres as woodland not pastured, by the 1935 census of agriculture. The 1935 census designates 21.5 million acres as nonforest land in farms. The remaining 21.9 million acres of nonforest, nonagricultural land consists of mountain barrens, alpine meadows, and desert land. Not all is waste land, however, as the mountain meadows and much of the desert land are grazed in some degree. This type of land is usually publicly owned and is used by neighboring stockmen on a fee-permit basis.

Approximately 8.5 million acres of the total land in farms is available for crops and about 15 percent of this area is under irrigation. The total area of pasture land in farm ownership is 14.4 million acres, composed of 12.4 million acres of nonwoodland pasture and 2.0 million acres of woodland pasture. In addition a very large percent of public and private forest land is used for forage production.

Water is the key element in the agricultural economy. Irrigation is necessary where intensive farming is practiced; elsewhere stock raising and dry-land wheat growing are the principal agricultural occupations.

Forest Land Use

There is no indication of any appreciable reduction in the forest-land area through conversion to agriculture, and for all practical purposes the forest-land area can be considered as stationary at 22 million acres.

There has been little conversion of forest land to cropland, and agriculture and forestry are in harmony in practically all parts of the region. The forests are largely confined to the mountains and high plateaus where topography is too rough and climate too rigorous for successful agriculture. The broad valleys, plains, and deserts are treeless mostly because precipitation is inadequate for tree growth.

A significant feature of the forest situation is the extent of multiple forest land use. Timber production, forage production, watershed protection, recreation, and wildlife support are all important uses of forest land and all or nearly all are practiced simultaneously over large areas. Seldom is it necessary to restrict any extensive area to only one of these uses.

Timber Production

Approximately 16.2 million acres or 73.2 percent of the region's forest land was classified as potentially productive of conifers on a commercial basis. An additional 40,000 acres of hardwood land has some slight value for timber production. Two million acres of lodgepole pine land classified as noncommercial yields occasional timber products.

The withdrawal of public forest land for recreation and other uses has made little reduction in the area available for commercial timber production. Most of the reserved lands are at the higher elevations where the forest cover is either noncommercial or low in merchantable value. Cutting of timber is prohibited on about 900,000 acres. There is little likelihood of extensive future withdrawals as the land preeminently suitable for recreation or protection is almost invariably noncommercial.

Grazing

Next to timber production the most important use of forest land in the region is the production of forage. Under the open ponderosa pine forests many grasses, shrubs, and herbaceous species grow. Most of these are high in forage value.

The range livestock industry is important. It is estimated that nearly 2 million sheep (figure 26) and a third of a million cattle valued, at more than $100,000,000, graze the ranges of this region. Practically all of the summer range available to the industry is in the forested area and over 20 million acres of forest land is grazed. The limiting factor in the livestock industry is the volume of summer range; there is sufficient spring-fall range and winter range or hay production to support a greater livestock population. One possible remedy is to increase forage production on summer range through improved management. The protection of forest ranges and correlation of this use with other forest land use is an important problem not only to the livestock industry but also to timber owners, who derive secondary income from rental of forest land for forage. It has been repeatedly demonstrated that through proper land management the same forest area can be used successfully for timber and forage production.

Soil and Watershed Protection

With but few exceptions the streams of this region rise in forested country. The dependence of agriculture upon irrigation and adequate watering places for stock makes it imperative that the flow of streams be regulated and the water supply be conserved. This is best accomplished through protection of the forested watersheds. Heavy investments in engineering works for irrigation and hydroelectric power must be protected against abnormal silt deposits which reduce water storage capacity and cause other damage. Studies of the exact effect of removal of vegetative cover upon streamflow and erosion have not been made here.

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FIGURE 26.—*Sheep on summer range in a national forest in eastern Oregon.*

The open nature of the forests, the slowness with which they are reestablished, and the failure of shrubby vegetation to hold the soil on deforested slopes are evidence that a permanent forest cover must be maintained to protect the watershed values. This can usually be done without conflict with other important uses if proper forest management is followed.

Water for domestic use in the larger cities and towns is usually obtained from forested watersheds. To protect the purity as well as the quantity of the supply it may be necessary to prohibit or restrict other uses, including timber production. The area involved is not large.

Recreation

The forested areas are rich in recreational and scenic values. The open, parklike ponderosa pine and alpine forests are easily accessible, and the mountain lakes and streams, alpine meadows, and rugged mountain peaks attract vacationists, hunters, fishermen, nature lovers, and alpinists. Although the local population is sparse, the forests of the region are extensively used, many visitors coming from the coast. Outstanding scenic attractions, such as Crater Lake, Lake Chelan, the North Cascade Primitive Area, and the Wallowa Mountains, draw visitors from all parts of the country. Crater Lake National Park is visited annually by 200,000 people. Approximately 856,000 acres of the national forests have been set aside as primitive areas and recreational areas. In addition the Forest Service has developed many campgrounds and recreational facilities, so that the innumerable forested beauty spots can be enjoyed. Approximately 450,000 people use the five national forests for recreation each year.

Wildlife

An outstanding attraction of the forested districts is the abundant supply of fish and game. The principal game animal is the mule deer and in season hunters from the entire Pacific Coast pursue this animal. Intelligent game management has resulted in large increases in the mule deer population. In fact the population on certain protected and managed areas has increased beyond the capacity of the winter range and in 1938 and 1939 it was necessary to open the season on does in certain localities.

In addition to furnishing summer range for deer, the forests also furnish food and shelter for elk and many fur-bearing animals. Like the deer the elk population is increasing, and each year hunting of these animals which were once considered vanishing is permitted under close supervision. Mountain goats and big-horn sheep still inhabit the more remote sections and are protected. Antelope in limited numbers are found in the desertlike southern part of the region.

The lakes and streams are noted for their trout. The forests are an important element in maintaining optimum conditions for fish through their protective influence on streamflow.

Forest Protection

THE swift catastrophes, often involving wholesale destruction, by which forests are constantly threatened make heavy demands for more adequate protective measures. The entire timber supply supporting a substantial community may be wiped out in a few hours by fire. A forest industry may be seriously crippled through destruction of its timber holdings by an insect epidemic. The unavailability of insurance against such loss and the long time required to replace a merchantable forest further emphasize the need for systematic protection. It is believed that adequate protection is possible in this region without unreasonable cost. Ranked in order of damage, insects precede fire.

Insect Control

Insect depredators and the damage involved have already been discussed. The amounts spent in control operations in areas of heavy infestation are considerable. Expenditures for western pine beetle control work during the fiscal years 1931 to 1938 were $160,000 by the Forest Service, $461,000 by the Indian Service, and $118,000 by private owners, according to the Bureau of Entomology and Plant Quarantine.

In Oregon, control of insects on private lands is required by statute. The law declares pine beetles and other insect pests and infestations injurious to timber and forest growth to be a public nuisance and authorizes public eradication measures if the owner fails to control pests on his land. Upon notice of an infestation the State forester is charged with the duty of declaring and establishing the boundaries of a district or zone of infestation. Upon application of owners of 60 percent or more of the timber or timbered lands within an infestation district, the State forester notifies all owners of land therein to proceed with control measures. If any owner fails to comply, the State forester undertakes the eradication work, the expense thereof constituting a legal lien against the property. This law has seldom been invoked. No similar law exists in Washington. The Klamath Forest Protective Association, which conducts fire-protection work on private forest lands in the Klamath Plateau unit, also does insect-control work on the lands of its members. Several private owners have voluntarily carried on control measures individually on their own lands.

The Bureau of Entomology and Plant Quarantine gives technical advice on insect control and conducts a program of forest-insect research.

Two methods of controlling epidemics of bark beetles are (1) the burning method, which consists of felling infested trees, peeling the bark from the top half of the trunk, and burning the tree; (2) the sun-curing method, which consists of exposing the bark of the felled trees to the sun's rays. The latter method is now used only in the control of mountain pine beetle attacks on lodgepole pine. Salvage operations are also used to control infestations. Recent research by the Bureau of Entomology and Plant Quarantine has demonstrated possibilities of averting or minimizing future epidemics through silvicultural management. Keen (*8*) has evolved a system of classifying ponderosa pine on the basis of susceptibility to insect attack. The use of the Keen system in marking trees for selective cutting should reduce future losses from western pine beetle.

The only epidemic fungus disease attacking forest trees in this region is the white pine blister rust which attacks the five-needle pines. Control activities consist of eradicating ribes plants, the alternate host. Ribes eradication work has been carried on in northeastern Washington under the supervision of the Bureau of Entomology and Plant Quarantine.

Fire Control

Even though losses from insect epidemics are much greater, fire loss is an important factor in saw-timber stands. The forests are dry for a large part of the year, resinous trees predominate, and lightning storms are common during the driest time of the year. Yet, in spite of these adverse conditions, fire losses are relatively smaller than in the Douglas-fir region. This is accounted for by the open nature of the ponderosa pine forests and the scarcity of the undergrowth, which retard the rate of spread and make fires less likely to crown. Also, the easy topography and open stands make possible a high degree of mechanization and effectiveness in fire suppression, at least in the ponderosa pine forests.

The most critical fire problem area in the region is in northern Washington, where lodgepole pine and upper-slope types predominate. This district is comparatively inaccessible and the topography is rough, making fire protection more difficult than in the areas where the ponderosa pine types predominate. Climatic conditions are unfavorable and lightning is common.

The entire forest area is under organized fire protection, varying in degree, however, with forest-cover type, accessibility, timber values involved, and ownership. Naturally the areas of valuable saw timber have received the most intensive protection. In the past few years, help received from the Civilian Conservation Corps has made it possible to strengthen protection on all forest lands.

National Forests

The national forests with 10.9 million acres of forest land are protected by the Forest Service, which also protects alienated lands within the exterior boundaries through agreement with the State foresters. Isolated parcels of national-forest land intermingled with private land are usually protected by the State foresters and private associations through agreement with the Forest Service.

Protection standards have improved steadily in recent years as a result of increased facilities, more scientific planning, training of personnel in organization and technique, and cooperation of the Civilian Conservation Corps and other emergency work programs. Fire detection has benefited through the construction and betterment of guard stations, lookouts, and telephone lines. Attack on fires has been made more effective through construction of new roads and trails and airplane landing fields. Reduction of hazards along roads and in especially inflammable areas has prevented many fires from starting. Moreover, C. C. C. units have constituted a mobile fire-fighting force which can be organized and trained, held in readiness, and its organized units quickly transported to fires, with the result that fires have been attacked more intensively and effectively than by pick-up labor.

Other Federal Lands

On most national parks and monuments, protected by the National Park Service, protection is not an acute problem. Many of these areas are at high elevations where the fire season is short or are covered with types that are not unusually hazardous.

The Indian-owned lands compare with the national forests in fire danger and are protected by a system generally similar to that used on national forests.

The public domain lands are usually scattered and are protected by the agency protecting the adjoining lands. No separate organization is provided.

State, County, and Private Lands

State and county lands are protected by the State foresters except where such lands fall in national-forest protective units, in which case the State forester contracts with the Forest Service to furnish protection.

The fire-protective system is practically the same in both States, and close cooperation among Federal, State, and private agencies is the key to its success. Public land other than Federal-owned land is protected by the State foresters, and private land by the owner either independently or in association with other owners or by the State foresters. Where there is a commingling of lands differing in ownership, cooperative agreements provide for division of the area and assumption of responsibility for protection of each division by a single agency.

Both States have progressive forest-fire codes requiring every owner of forest land to provide protection therefor. If an owner fails to protect his land, the State forester does so and the cost is assessed against the property on the county tax rolls. Both States have compulsory slash-disposal laws. Oregon has a law enabling the Governor to close forest areas to entry during critical fire weather; an operator's permit law that gives the State forester authority to shut down logging operations during periods of high fire hazard; and a law requiring snag falling. In Washington hazardous areas may be closed or other restrictions applied thereon by the State Director of Conservation and Development, and the Supervisor of Forestry is authorized to suspend logging, land clearing, or other industrial operations during periods of extreme fire hazard.

The private timberland owner has the privilege of protecting his own holdings or of paying the State to do it. In only a few instances have timberland owners exercised this option and formed protective associations. All private forest lands in eastern Washington are protected by the State forester. Eastern Oregon has three forest-fire protective associations, the strongest being the Klamath Forest Fire Association covering a large acreage in Klamath and Lake Counties, and the other two, the Walker Range and the Black Butte, both comparatively small. The work of the associations is inspected by representatives of the State forester to see that adequate protection is given. The State may contract with an association for the protection of tax-roll land within the association's territory.

The States receive fire-protection funds from three sources; from private owners through county tax rolls, through direct appropriation by their legislatures, and from the Federal Government under the Clarke-McNary Act. Federal contributions have been of valuable assistance to the development and maintenance of fire protection on private lands, not only through the Clarke-McNary Act, but also in recent years through Federal emergency work programs, notably the Civilian Conservation Corps.

Forest Industries

MANUFACTURING in this region is limited chiefly to forest industries. Processing and canning of agricultural products is the only other manufacturing industry of any consequence. Even this industry is small and by far the greater part of the agricultural production is shipped in the raw condition.

The regional population was 528,000 in 1939. The population density of 5.2 persons per square mile indicates the rural character of this region and absence of populous metropolitan centers. Approximately 40 percent of the population was engaged in gainful occupations. The fact that forest industries accounted for only 7.6 percent of the gainfully employed in 1930, whereas agriculture employed 39.5 percent, fails as an indicator of the importance of the forest industries as a source of basic income. For one thing, these industries furnish relatively more secondary employment within the region than does agriculture. Even here where agriculture is chiefly of a large-scale, single-crop type—wheat growing, stock raising, and orcharding—farmers are much more self-sufficient than forest-industry workers and make less demand upon service industries and generate comparatively less retail buying. It is a safe estimate that at least 20 percent of the population is dependent either directly or indirectly upon the forest industries.

It is estimated (1939 Census of Manufactures) that the forest industries produced goods valued at approximately $50,000,000 during 1939. During the same year it is estimated that about $16,500,000 was paid in salaries and wages and that the total value of sawlogs, fuel wood, poles, fence posts, and other forest products was approximately $14,000,000 to $16,000,000.

As already noted, lumber manufacture is the only primary wood-using industry of any magnitude and this has been a large-scale industry only since the beginning of this century. The development of the industry has been greatly retarded by lack of water transportation which normally costs less than rail shipment. Being dependent almost entirely on rail transportation to markets, the industry has had to ship products dry to reduce freight costs and hence has made heavy investments in dry kilns, extensive air drying yards, and large inventories. Kiln drying and remanufacture are much more prevalent here than in the Douglas-fir region where much of the lumber is shipped by boat. The typical large lumber manufacturing plant (fig. 27) consists of sawmill, dry kiln, planing mill, sash and door factory, and box factory.

This region has no open log market, another result of the lack of water transportation, and this has forced lumber manufacturers to acquire sufficient timber to last the entire operating life of a mill or to depend partly upon public-owned timber. This condition has tended to preclude independent logging operations.

Few lumber operations have been started with the expectation of obtaining all raw material from public forests. A number of operations have counted on public forests for part of their supply, assuming that by virtue of the location of their plants, or through the intermingling of their own holdings with public timber, they would be assured eventually of the opportunity to purchase the public stumpage within their sphere of operation.

The investment of private money in the forest industries, including standing timber, logging improvements and equipment, manufacturing plants, and working capital, is estimated roughly at $125,000,000 under current conditions.

Principal problems that contribute to impermanence of forest industries are: (1) Distance from markets, (2) lack of markets for species other than

FIGURE 27.—*Large sawmill plant located in eastern Oregon.*

ponderosa pine, and (3) concentration of manufacturing capacity in Klamath Falls and Bend.

Logging

Since logging is controlled by the manufacturer and all the large concerns own their logging operations, there are no large-scale independent logging operations that own timber and sell their output either on contract to manufacturers or in an open market. A few large manufacturers contract part of their logging, but in these cases they usually own the timber. A few small manufacturers obtain all or most of their sawlogs through contract logging of their own timber or through purchase from small independent logging operators. Or a single phase of the logging operation may be commonly contracted, such as felling and bucking. Logging is seasonal on nearly all operations, although the shut-down period on account of climatic conditions seldom exceeds 2 or 3 months.

Geographic, silvicultural, and economic conditions are particularly favorable to partial cutting in the ponderosa pine forests, and nearly all operations, even those on private lands exclusively, leave some trees standing after logging. In some cases the first cut is so heavy as to approximate clear cutting and in other instances the residual stand is practically worthless. Constant improvement is evident, however, and better methods of management are becoming the rule.

Logs have been almost universally ground skidded, until recently with horses, chains, tongs, carts, wagons, or big wheels. The earliest use of tractors for logging was in ponderosa pine forests, and tractors are now in common use, chiefly with an arch and cable; big wheels have just about passed out of use. Horses are still used in some operations for bunching logs at a landing and with the cross haul for loading trucks and even in some cases railroad cars. Loading, on the large operations using railroads for transportation, is done with power loaders or "jammers" (fig. 28). Flexibility in selection of logging equipment has been facilitated by the easy topography and open type of forest.

The light stands of the ponderosa pine forests necessitate that large mills have extensive tributary territory and exceptionally long rail hauls. In spite of this apparently adverse factor a number of

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the large mills have located on the edge of the forest zone or in some cases many miles from the nearest timber. Such locations have sometimes been necessary to obtain main-line rail facilities but sometimes are the result of more obscure reasons. Fortunately logging railroads can be constructed cheaply owing to the easy grades and rare need for bridges. Little excavation and rock work is necessary in railroad construction.

Logs are usually moved from the woods to the mill either by railroad or truck. Water transportation is used in only a few isolated instances. Flumes are unknown and log chutes are seldom used any more. In the 1931–40 decade, both large and small operators steadily increased their use of trucks for hauling logs (fig. 29), owing to the construction of many miles of new highways. Dirt roads can be constructed relatively inexpensively and there is only a short period in the year when rain or snow makes them impassable. While the advent of truck transportation has meant much to small operations and independent loggers, there is little likelihood that motor trucks will completely displace railroad transportation on large operations, owing to the fact that beyond a certain maximum distance the use of trucks appears to be unprofitable.

Lumber Manufacture

Sawmills

The region had 230 sawmills in 1937, of which 203 were active at least part of that year and 27 were completely idle but not dismantled or abandoned. The largest city in eastern Oregon, Klamath Falls, is dependent for its economic existence mainly upon sawmill pay rolls. Other good-sized communities, such as Bend, Oreg., are vitally dependent upon the lumber industry. Spokane, a short distance outside the region, is an important lumber-manufacturing center, but only small quantities of logs from this region reach the Spokane sawmills.

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FIGURE 28.—*Loading ponderosa pine logs on flat cars with gas "jammer." Tractors with arches are used to bring logs to the landing.*

Sawmills range in size from small portable mills (fig. 30) operated by a few men and having an installed daily capacity of some 20 M board feet to large plants employing hundreds of people and turning out as much as 500 M feet (table 28). Roughly one mill in every nine was idle during 1937; but it is significant that more than three-quarters of the idle mills were of the smallest size class. No mill with a daily installed capacity greater than 100 M feet was idle; the aggregate capacity of the idle mills was but 6 percent of the

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FIGURE 29.—*Loading ponderosa pine logs on truck with a Diesel converted shovel loader.*

total sawmill capacity; and these idle mills were well scattered throughout the region (table 28).

Of both idle and active mills, the Chelan-Colville unit has the largest number, but many are small and the Klamath Plateau unit with half as many mills has a much larger capacity. The greatest concentration of mills, both by number and capacity, is in the vicinity of Klamath Falls (fig. 31). Eastern Oregon, with its greater area of forest land and timber volume, has a score more mills than eastern Washington and more than double the sawmill capacity.

Lumber Production and Its Relation to Installed Sawmill Capacity

The total installed capacity of all sawmills in 1937, computed for a year of 300 8-hour working days, was approximately 2.4 billion board feet

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FIGURE 30.—*Portable tie mill which cuts approximately 300 ties a day. Three men operate it—a sawyer, offbearer, and stacker. Four horses, used singly, yard logs from the woods.*

(lumber tally), and the annual capacity of the mills active in 1937 was 2.3 billion board feet. The lumber production in 1937 (table 29) was 1.8 billion board feet, or approximately three-fourths of the total installed capacity. Many of the large mills operate two shifts daily even during periods of low regional production and the mills of the region can actually exceed by a large measure the installed capacity rating computed on the basis of one daily 8-hour shift. In spite of this apparent maladjustment of installed capacity to production, several new mills have recently been constructed and others proposed for early construction. Of course, some of the older mills are nearing the end of their operating life owing to exhaustion of available raw material. In the Klamath Plateau unit installed capacity does not so greatly exceed lumber production as in most of the other units. As a general rule the large mills maintain production more evenly and at a higher comparative rate than do the small mills. The excess of installed sawmill capacity over normal production is much less in this region than in some other forest regions—the Douglas-fir, for example—indicative of the more stable conditions.

TABLE 28.—*Number and daily installed capacity*[1] *of sawmills in forest-survey units of ponderosa pine region, 1937*

Forest-survey unit and capacity group	Active mills	Idle mills	Total mills	Active mills	Idle mills	All mills
	Number	*Number*	*Number*	*M board feet*	*M board feet*	*M board feet*
Eastern Washington:						
Chelan-Colville	54	6	60	1, 319	114	1, 433
Yakima River	34	3	37	882	65	947
North Blue Mountain	7		7	120		120
Total	95	9	104	2, 321	179	2, 500
Eastern Oregon:						
North Blue Mountain	20	5	25	823	55	878
Deschutes River	27	4	31	1, 203	47	1, 250
South Blue Mountain	31	7	38	962	65	1, 027
Klamath Plateau	30	2	32	2, 292	110	2, 402
Total	108	18	126	5, 280	277	5, 557
Daily capacity (M board feet):						
1–20	114	21	135	973	151	1, 124
21–50	46	4	50	1, 549	150	1, 699
51–100	29	2	31	2, 204	155	2, 359
101–200	11		11	1, 915		1, 915
201–500	3		3	960		960
Regional total	203	27	230	7, 601	456	8, 057

[1] Per 8-hour shift.

TABLE 29.—*Annual lumber production in the ponderosa pine region, by survey unit and species, 1925–38*[1]

[In million board feet—i. e., 000,000 omitted]

Forest-survey unit and species	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Chelan-Colville	135	124	116	113	142	119	115	85	115	107	128	137	171	139	189
Yakima River	155	173	145	166	196	156	132	101	110	104	143	166	174	137	162
North Blue Mountain	199	181	116	82	145	97	59	31	53	44	94	117	134	105	137
Deschutes River	363	320	270	306	334	242	159	92	147	162	237	281	301	281	379
South Blue Mountain	94	97	70	73	88	138	117	83	105	96	171	208	234	182	230
Klamath Plateau	397	448	389	506	537	466	377	220	355	373	524	690	759	602	772
Region total	1, 343	1, 343	1, 106	1, 246	1, 442	1, 218	959	612	885	886	1, 297	1, 599	1, 773	1, 446	1, 869
Ponderosa pine	1, 204	1, 205	1, 016	1, 129	1, 300	1, 118	892	582	824	818	1, 192	1, 444	1, 619	1, 324	1, 728
Douglas-fir	105	107	69	89	95	81	55	26	50	50	77	109	116	78	100
Sugar pine	1	1	(2)	6	3	1	1	1	2	6	15	30	16	29	19
Western larch	20	20	13	11	18	12	1	1	3	4	5	10	7	5	6
Western white pine	1	2	1	1		1	6	(2)	(2)	4	(2)	1	2	3	4
White firs[3]	3	6	6	7	23	4	2	1	4	1	5	3	8	3	7
Western hemlock	8	1	(2)	2	2	(2)	(2)	(2)	1	1	2	1	1	1	1
Other conifers	1	1	1	1	1	1	2	1	1	2	1	1	4	3	4
Hardwoods		(2)			(2)										
Total	1, 343	1, 343	1, 106	1, 246	1, 442	1, 218	959	612	885	886	1, 297	1, 599	1, 773	1, 446	1, 869

[1] Compiled from original data obtained by Forest Service under cooperative agreement with the Bureau of Census.
[2] Less than 500 M board feet.
[3] Includes Pacific white fir and grand fir.

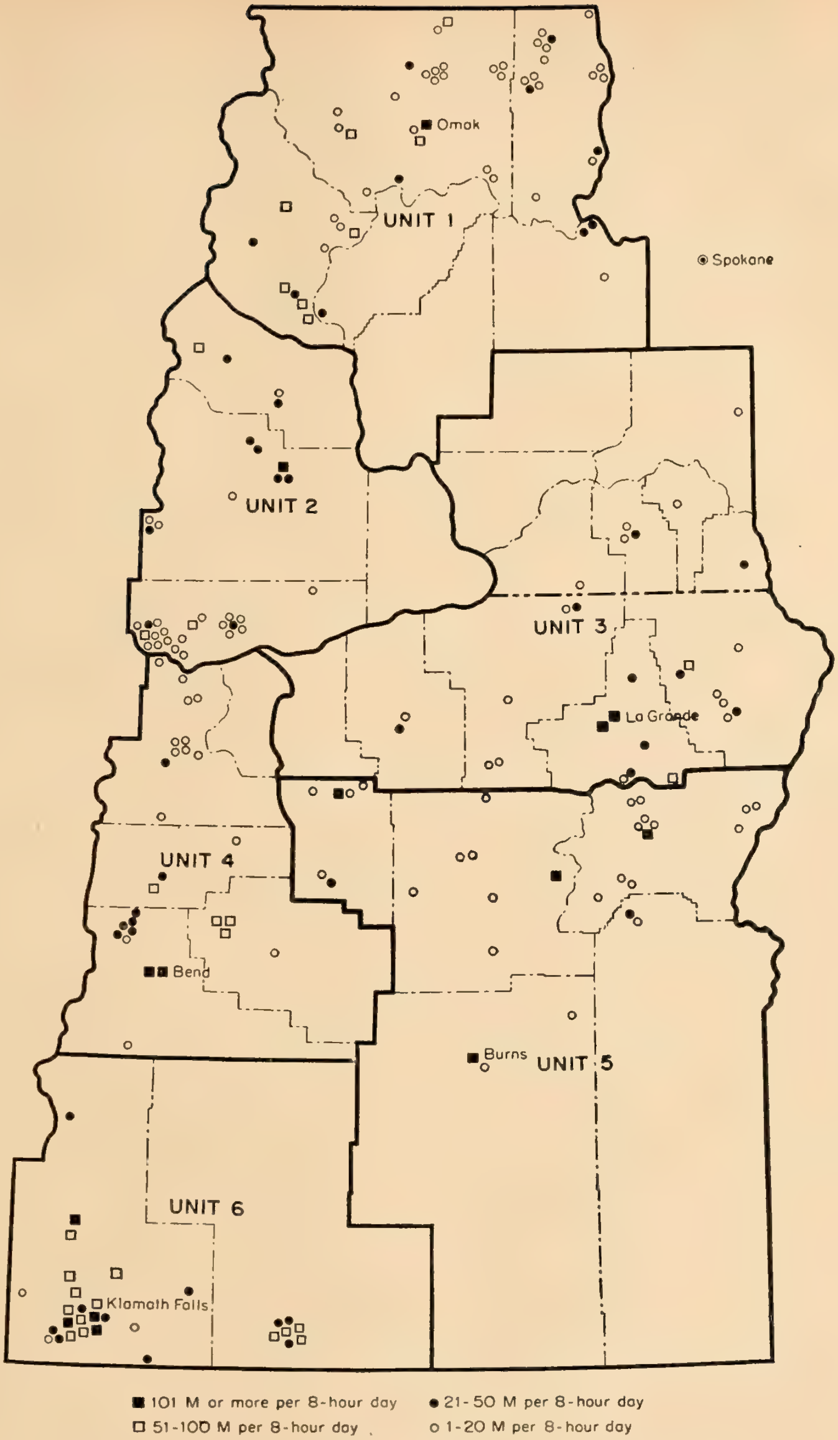

FIGURE 31.—*Location of sawmills in the ponderosa pine region, by capacity class.*

Lumber production here deviated from trends in other regions and for the country as a whole in not receding proportionately as much during the depression period 1931 to 1934 and in recovering thereafter more rapidly (table 29). Oregon sawmills produced more than three-quarters of the average annual regional production during the period 1925–38, inclusive.

Ponderosa pine amounted to 96 percent of the total lumber production in the pine region of Oregon, 77 percent in Washington, and 91 percent in the entire region. This region produces about two-fifths of the entire cut of ponderosa pine lumber in the country (fig. 32).

Lumber transportation and markets

Transportation of lumber to primary consuming markets is almost entirely by rail. It is estimated that less than 1 percent of the regional lumber production is exported to foreign countries, and about 40 percent is sold in Oregon and Washington. It is doubtful, however, that more than 10 percent of the lumber sold locally is finally consumed within the region; the remainder is remanufactured and shipped to other parts of the country in such forms as sash and doors and box shook. The principal outside markets for lumber are California, New York, Illinois, Iowa, Wisconsin, and Minnesota. A large part of these shipments consists of factory or shop lumber destined for further finishing. Freight amounts to a large part of the delivered price of lumber shipped to middle western and eastern points. The rail rate from Bend or Klamath Falls to Des Moines is 69½ cents per hundredweight, to Chicago 73½ cents, and to points eastward to the Atlantic Coast 82 cents. Assuming an average shipping weight of 2,000 pounds per M board feet, these rates amount to $13.90, $14.70, and $16.40, respectively, per M board feet. Partly, at least, because of the heavy burden of freight charges which ponderosa pine must bear, this species is marketed in a more orderly fashion and with better control by the manufacturers than many other woods.

Because of the high freight cost, the shipment of the lower grades to distant markets is not justified, but a large part goes to local box factories.

Manufacture of cedar shingles is the only other primary wood-using industry and it is of little importance. There are only a few small mills producing cedar shingles.

Other Manufactures

The chief sawmill byproducts are lath, fuel wood, hogged fuel, and sawdust. The use of hogged fuel and sawdust for industrial fuel is limited almost entirely to the wood-using industries. Sawdust, slabs, and edgings are used as fuel in homes, schools, and office buildings in the forest-industry communities, but this use is limited by the sparseness of population in these localities.

The leading secondary wood-using industry is manufacture of box shooks. It is estimated that in the Klamath Falls district two-thirds of the lumber cut is manufactured into box shooks. In other parts of the region the amount going to box factories is much less but still a substantial part of the total cut. Most of the large sawmills and many of the small mills operate box factories. In addition there are a number of small independent box factories that either buy lumber or more commonly operate a small sawmill to supply their box factories, disposing of the better quality boards for lumber. In all, there are about 50 box factories with a total

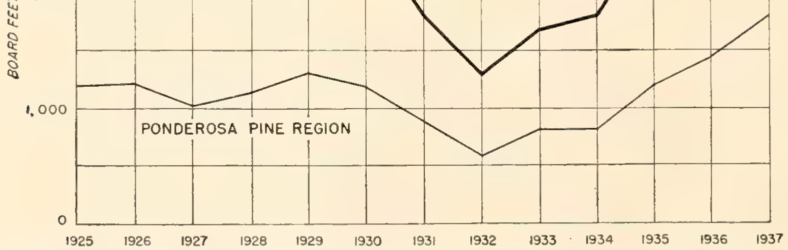

FIGURE 32.—*Comparison of production of ponderosa pine lumber in the United States and in the ponderosa pine region of eastern Oregon and eastern Washington.*

installed capacity of 2.5 million board feet of shooks per 8-hour shift. These plants range from small factories with 1 cut-off saw and a daily capacity of 8 to 10 M board feet per day to large factories with 10 to 15 cut-offs and daily capacities of 100 to 150 M feet or more. The excellent qualities of ponderosa pine box shooks give them a commanding position in consuming markets. Among many kinds of shooks manufactured, the principal types are designed for apple and pear boxes for local markets, orange boxes, lug boxes for grapes, tomatoes, etc., vegetable crates, and cannery cases chiefly for the salmon canneries.

Sash and door factories and planing mills are also operated by most of the large lumber manufacturers. Sash, doors, cut stock, casket shooks, mouldings, paneling, and various other specialty items are manufactured. In addition there are a few plants located in Klamath Falls manufacturing moulding and other planing-mill products exclusively. The region has one veneer plant also located at Klamath Falls, but the use of ponderosa pine for veneers and plywood is still new here. Small quantities of ponderosa pine logs have been shipped from central Oregon to a Portland basket and veneer plant.

Forest Management

AS already intimated, success in establishing a permanent forest economy in this region depends on the solution of two major problems in forest management in the ponderosa pine types. First, and most important, the large area of stagnated old-growth forests must be converted to growing condition. Second, growth of the immature forests, which on the whole is much less than half capacity, must be increased. Except in a few instances it is doubtful if other forest types are suitable for even fairly intensive management.

Approximately 12 million acres, amounting to 74 percent of the region's commercial forest land, is classified as ponderosa pine land. And about 75 percent of this is occupied by old-growth saw-timber stands (fig. 33), most of which contain more than 80 percent ponderosa pine. Some 10 percent supports second-growth saw-timber stands (type 21), and 12 percent small second-growth stands. The remainder is deforested.

Selective Timber Management

Selective cutting apparently offers the most effective method of vitalizing stagnant old-growth stands. The great importance of advance reproduction in ponderosa pine management has been conclusively demonstrated. If not destroyed during logging or slash-hazard abatement, the young growth already established under cover of the virgin forest will perpetuate the forest without interruption. On the other hand, if the advance reproduction is destroyed, vagaries of climate and seed crop may delay establishment of a satisfactory second crop 30 or 40 years or even longer.

The uneven-aged character of the virgin ponderosa pine forest favors selective cutting of some form or other. The growth characteristics of individual trees range from those of young rapid-growing trees to those of overmature slow growing. The range in immediate conversion value is as great; some trees are high in value, others are of low or negative value.

Partial cutting, loosely called selective cutting, has been practiced for many years, not only on the publicly owned national forests and Indian reservations, but also on private lands. The degree of cutting has varied, but generally it has been heavy, with 80 percent or more of the original stand removed in the first cut (fig. 34). Marking of trees for cutting on national forests and Indian lands has been based on silvicultural characteristics. On private lands the general rule is to remove all trees of positive conversion value.

Basic Principles

Fundamental rules for management of ponderosa pine stands are clearly evident. Briefly stated the objectives of management are, other things being equal:

A. To cut heavy enough to:
   1. Reduce insect loss to inconsequential levels.
   2. Provide an economic operation.
   3. Stimulate growth of reserve sawlog trees, poles, and reproduction.

B. To cut light enough to:
   1. Harvest rapidly the high-value trees over the entire operating tract.
   2. Reduce subsequent windfall losses to a minimum.
   3. Leave an adequate reserve stand for an early second cut.
   4. Provide a seed supply where needed.

To accomplish these objectives the following cutting rules are proposed.

A. Cut high-quality trees of:
   1. High-mortality probability.
   2. Low-value increment.

B. Leave low-quality trees of:
   1. Low-mortality probability.
   2. High-value increment.

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FIGURE 33.—*Virgin stand of ponderosa pine on the Malheur National Forest showing groupwise occurrence.*

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FIGURE 34.—*Reserve stand after removal of 80 percent of the volume, Malheur National Forest.*

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FIGURE 35.—*Reserve stand after 40 percent cutting. Trees felled were high in quality and large in size.*

In actually applying these rules to specific stands many trees fall into one or another of these categories without question, but conflicts also occur. For example, what shall be done with low-quality trees of low-value increment, high-quality trees of high-value increment, and low-quality trees of high-mortality probability? Many other conflicts occur in practice. It is not always possible to eliminate all highly insect-susceptible trees through logging and still cut lightly enough to avoid accelerated windfall losses.

The Maturity-Selection System

Recent studies by Brandstrom (*2*) on the economics of ponderosa pine management have demonstrated the advantages of a light initial cut on areas being managed for sustained yield. These studies resulted in the development of the so-called maturity-selection system based on the removal of the high-value overripe trees that are generally the least productive in the stand both economically and silviculturally. This system results in a first cut far below past practice, in one instance as low as 40 percent (fig. 35). Exceptions from the basic rule allow cutting of certain low-value trees of poor vigor and leaving high-value trees of above-average vigor. Generally there is close correlation between silvicultural and economic objectives under this system, and removal of the high-value trees converts the stagnant forest to a growing condition. Under this light cut it is unnecessary to dispose of slash except in certain vulnerable locations, thereby so improving soil conditions as eventually to increase the productive capacity of the forest site.

Region-wide application of such a system would greatly facilitate and hasten sustained-yield management, thus stabilizing industries and communities. As already demonstrated in the chapter on forest growth, light selection will increase regional growth at a faster rate than heavy selection. The more rapid spread of logging over the entire region will result in the development of an extensive network of roads which will assist in fire control and make more feasible salvage of insect-killed, fire-killed, and wind-thrown timber. Furthermore, universal application of the maturity-selection system should assist in control of insect epidemics by establishing healthy growing conditions and ridding the forest of many insect-susceptible trees.

Even on public forest lands the maturity-selection system has been used only in recent years. Its development, of comparatively recent origin, has been fostered to a great extent by increased mobility of logging equipment. Tractors, trucks, motorized log loaders, and improved road-building machinery permit greater flexibility in logging. The exchange policy of the Forest Service, whereby Government stumpage is exchanged for selectively cut pine land in good condition, has stimulated light selection cutting on some private land, but as yet not widely. It is generally agreed among foresters that a lighter cut than has been practiced on private or even on most public lands is desirable. Under the impetus and leadership of Federal forest agencies, it is safe to predict that the maturity-selection system will spread more widely to private lands.

Disadvantages in the System

It is obvious that the maturity-selection system cannot be universally applied even in this region. Some forest stands are not suitable; for example, those more nearly even-aged with a large part of the stand in the same size, value, and maturity classes. In this case a heavier first cut would be advantageous. In other logging units in this region, particularly in northern Washington where the mature stand is not more than 5 to 10 M board feet per acre, the volume taken under a light selection system would be too small to make a profitable operation under present conditions. Such stands will probably continue to be cut heavily. (Fig. 36).

Removal of too few trees from heavy mature stands, in order to harvest quickly the highest value trees on the entire tract, may leave an adequate reserve for an early return cut, but growth will be little stimulated if at all. It is frequently impossible to cut stands on rough ground lightly enough to cover the tract quickly, avoid excessive windfall loss, leave an adequate reserve stand, and still maintain an economic operation. Cutting to eliminate all insect-susceptible trees in overmature stands may result in not leaving sufficient volume for an early return cut or not providing adequate seed sources for restocking the area. It is not often that all desirable silvicultural and economic objectives can be achieved during the initial cut. Compromise is inevitable, and obviously a

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Figure 36.—*Results of clear cutting on private land. Liquidation dictates this type of cutting on many operations.*

rational plan must rest upon analysis and weighing of the relative physical and economic factors which may differ widely tract by tract.

The most serious obstacle to general adoption of this system has its roots in the concentration of manufacturing capacity in a few localities. Such uneven distribution of sawmills with respect to raw material creates a pressure to cut that makes it seemingly impossible to ration supplies unless ownership is concentrated in a few hands. The outstanding example of this condition is Klamath Falls. It is not likely that mill owners in such localities will drop out of the competitive race for raw material as long as stumpage can be purchased. Mills that have been fully depreciated from an accounting standpoint are able to bid higher, other factors being equal, than mills still charging off annual depreciation. As a general rule most mills in the areas of industrial concentration fall in the first category. Sharp competition for stumpage between such mills forces timber on the market and makes sustained-yield operations difficult to establish. Manufacturers holding stumpage reserves, who might operate on a sustained-yield basis if they could be assured of obtaining additional stumpage at reasonable prices to supplement their own stumpage, are forced into liquidating by the abnormal stumpage price. This results in maintaining high production in the concentrated industrial areas until the available stumpage is virtually exhausted and a sharp and drastic curtailment is unavoidable—a process repeated time and time again in various other forest regions. Fortunately, in this region the substantial backlog of operable public-owned timber insures a minimum continuous production that will at least maintain forest industries on a reduced scale. The chances of a liquidating operation adopting selective timber-management practices are small. There is no great advantage in this system if liquidation is the objective of an enterprise.

The size of the manufacturing unit may have some influence on the application of sustained-yield management and selective timber management. Superficial reasoning would indicate that the mammoth industrial plant with heavy capital investments implies permanency. Actually the reverse may be true. Such plants have large overhead costs and often must maintain high production during adverse market conditions. Geared to high continuous production during their operating life as determined by the period of depreciation, they draw raw material from a wide area. General adoption of a light-cutting practice can extend the territory of operations beyond the limits of economical transportation. For these reasons small- and medium-sized manufacturing units would seem to fit better into selective timber-management plans for private operations.

The most logical means of checking too rapid liquidation is through stabilizing ownership of standing timber. Various methods have been proposed to accomplish this end, but the most likely appears to be public acquisition of key properties and organization of cooperative sustained-yield units composed of Federal and private timber. There are a few instances of prospective adoption of sustained-yield policies by private owners whose holdings will make a feasible operating unit. Undoubtedly stabilization of ownership will promote selective timber management.

Slash Disposal

Under the forest practice of the immediate past, involving approximately an 80 to 90 percent cut, slash disposal has been a serious problem and one that has been the subject of intensive study (*13*). Neither in Oregon nor in Washington have the compulsory slash-disposal laws been enforced as long and as consistently as in the Douglas-fir region. For a number of years they were interpreted by private operators as requiring burning; and as broadcast burning was cheapest, this method was used. Other methods were considered too costly, although piling and burning was and still is practiced on public lands. Broadcast burning is exceedingly destructive to advanced reproduction and usually delays forest regeneration several decades or in many instances longer.

Revision and recent liberal interpretation of the laws permit partial burning and other methods of hazard abatement than burning. Intensive protection of slash as a substitute for burning is now practiced. In spite of this progress, the slash-disposal problem is not satisfactorily solved on all land, and broadcast burning is still practiced on some operations. Widespread adoption of the maturity-selection system or any type of lighter cutting would automatically ease this situation and, if comparatively inexpensive protection were provided, the slash could be left to enrich the soil.

The Timber Supply

VITALLY important to forest industries and communities is the timber supply upon which both depend. Appraisals of the adequacy of this primary resource for maintaining flow of timber have in many instances resulted in conflicting conclusions. Discrepancies have arisen both from variation in method of analysis and from differences in statistics employed. The forest survey eliminated inconsistencies in basic data, but considerable variation in interpretation of these data persists.

Relation of Timber Cut to Timber Supply

In the past, forest industry has generally been migratory, the life of the principal operation in each locality being determined largely by the available stand of virgin timber. Based on a system of liquidation, the duration of forest industry has frequently been estimated simply by dividing total timber stand by annual production. For example, it would be computed that this region's present timber supply, subjected to an annual depletion equal to the average cut of saw timber for the period 1925–36, would endure for about 101 years. Such crude calculation disregards entirely the effect on timber supply of depletion by agencies other than cutting on one hand and effect of growth on the other. It ignores the fact that a portion of the timber supply is economically inaccessible owing to remote location, undesirable composition, or poor quality, and also that approximately two-thirds of the timber resource is in Federal and Indian ownership and not available for unrestricted cutting. Furthermore, such a calculation fails to reveal the maldistribution of timber with respect to established communities.

An average figure such as 101 years for the life of the timber supply is grossly misleading and fails to emphasize the urgency of the forest problem. For example, similar calculations made by unit and by species groups show an indicated life of ponderosa pine supply for the region of only 73 years, while, for example, in the heavy-producing Deschutes River and Klamath Plateau units the hypothetical life of ponderosa pine is but 60 and 65 years, respectively, and for communities such as Bend and Klamath Falls the time must be halved or quartered.

Privately owned timberlands, however, are being cut over much more rapidly than the average. The one-third of the region's ponderosa pine saw timber that is in private ownership is suffering about 70 percent of the pine depletion. In addition the rate of depletion has accelerated rapidly since 1936. For example, if cutting continued at the 1937 rate, the region's privately owned pine would be completely exhausted in 21 years.

Sustained-Yield Capacity

The Region as a Whole

A far more rational analysis of the forest resource, anticipating timber harvest under a forward-looking plan of management, involves computation of sustained-yield capacity, i. e., the volume of timber that could be cut annually without interruption or substantial future reduction.

If future curtailment is to be avoided, the current regional cut from ponderosa pine types should be limited to 930 million board feet annually. This is the estimated cut that these types can sustain over an initial cutting cycle (based on 95 percent volume removal per acre on privately owned lands and 75 percent on lands of other ownerships) without reducing their future productivity. This sustained-yield cut for the pine types is 74 percent of the average saw-timber cut of all species in the region for the period 1925–36, inclusive, and only 53 percent of the rate for the period 1937–39, inclusive. Virtually all cutting has been in the pine types.

The allowable cut under sustained yield can be materially increased by two means—first, by changing cutting practice to a light selection system; second, by cutting in the nonpine saw-timber stands. By cutting on a maturity-selection basis, removing in each cycle only 50 percent of total volume per acre, the allowable annual sustained-yield cut for the pine types is increased 21 percent, totaling 1,126 million board feet. This increase is justified by the increased speed with which virgin forest is converted to a condition of net growth under a system of lighter volume removal per acre, and the consequent saving in mortality. Within the limits assumed for volume removal per acre, it is obvious that the less volume removed from any one acret he greater is the sustainable cut for the entire area, provided that cut is confined to the most mature and the least thrifty trees in the stand. Assuming a volume per acre removal of 75 percent of the virgin stand on privately owned pine lands and 50 percent on those in other ownerships, the allowable cut from this type group is 1,069 million board feet.

The sustainable annual cut from the nonpine saw-timber types is 387 million board feet, but until there is greater assurance of their ultimate economic availability and utilization, they can be given little weight in balancing the timber budget. The ponderosa pine types contain 16 percent by volume of so-called inferior species. An eventual increase in the use of nonpine species is anticipated; in fact, unless use of them is increased, the sustained-yield capacity of the type group will be reduced. Only a negligible amount of ponderosa pine occurs in the nonpine types.

Under reasonably intensive silvicultural practices and protection from fire and insects, the region's ponderosa pine types could in theory maintain an ultimate annual production of 1,404 million board feet; the nonpine types, 589 million. However, it is doubtful if this level of productivity could be attained in less than a century, even if the entire forest area were put under sustained-yield management immediately.

The Situation Within the Units

The advantages of sustained-yield management are many but they may be generalized into two: (1) Assurance of a continuous supply of forest products to the consuming public, and (2) assurance of the permanence of the communities and economic institutions that are built around and are dependent upon the wood-using industries. Although an analysis on a regional basis is adequate from the standpoint of the consuming public, it gives a grossly inadequate portrayal of the community problems. For this purpose individual and coordinated case studies by production units are indispensable. Such studies are beyond the province of the present report, but analysis of sustained-yield capacities by forest-survey units materially localizes the problems involved and adds to the practical usefulness of the calculations.

From table 30, comparing allowable cut by three classes of cutting practice and by type group with recent rates of saw-timber cut and ultimate sustained-yield capacity, it is apparent that in no unit can the 1937–39 rate of saw-timber production be maintained in the ponderosa pine types, regardless of the intensiveness of forestry that is practiced.

Although future curtailment can be materially reduced by adopting improved cutting methods now, a lapse in production is unavoidable. In the Deschutes River and the Klamath Plateau units, the 1937–39 rate of cut from ponderosa pine stands exceeded their ultimate sustained-yield capacity, attainable only after years of intensive forestry, by substantial amounts. The 1937–39 cut was 63 percent greater than the ultimate in the Deschutes River unit, 94 percent in the Klamath Plateau unit. In other words in the latter unit, the most important pine producer in the region, the cut during these 3 years was nearly twice the permanent productive capacity.

Under a light selection system, the present allowable cut of ponderosa pine types in the Deschutes River unit is only 2 percent lower than the ultimate sustained-yield capacity; in the Klamath Plateau unit it is 13 percent greater. This is due to the fact that both units still contain a larger timber volume than would be required (in younger trees) to yield the total potential growth.

Although the Klamath Plateau unit has a greater volume than any other unit of the region, the

TABLE 30.—*Average annual cut of trees of saw-timber size 1925–36, 1937–39, theoretical allowable cut under sustained yield 1936, and ultimate sustained-yield capacity on available lands*

[In million board feet—i. e., 000,000 omitted]

Unit	Annual cut 1925–36	Annual cut 1937–39	Allowable under sustained yield, 1936				Ultimate sustained-yield capacity [2]	
			Ponderosa pine types [1]			Other types	Ponderosa pine sites	Other sites
			50–50	75–50	95–75			
Eastern Washington:								
Chelan-Colville	161	190	126	123	106	114	224	171
Yakima River	145	161	108	103	88	119	152	181
North Blue Mountain	21	23	8	8	7	13	18	18
Total	327	374	242	234	201	246	394	370
Eastern Oregon:								
North Blue Mountain	113	131	94	88	77	57	166	91
Deschutes River	256	343	205	195	170	36	210	39
South Blue Mountain	133	232	195	187	168	27	290	47
Klamath Plateau	430	667	390	365	314	21	344	42
Total	932	1,373	884	835	729	141	1,010	219
Region total	1,259	1,747	1,126	1,069	930	387	1,404	589

[1] Allowable cut under sustained yield if cutting in the ponderosa pine types during the period 1936–65 takes the form (50–50) of light maturity-thrift selection on both private and public lands; and (75–50) of heavy maturity-thrift selection on private, and light maturity-thrift selection on other lands; and (95–75) of virtual clear cutting on private, and heavy maturity-thrift selection on other lands.

[2] Potential annual growth.

timber-supply problem is most acute here, owing to the heavy concentration of sawmill capacity and the extremely high cut in the Klamath Basin. In fact if the relation of cut to timber supply is analyzed for Klamath County alone, or for the so-called Klamath production area,[8] the situation appears even more critical. Some of the timber in eastern Jackson County (in the Douglas-fir region) may move to the Klamath Basin, but the volume available from this source would not support production at the present rate in the Klamath Plateau unit for more than 2 years. On the other hand, a substantial timber volume in northern Klamath County will be milled in the Deschutes River unit. Some students of the situation have predicted that timber in northern California will move to Klamath Basin mills. The maximum supply that could be derived from this source would furnish not more than a 5-year cut at the present rate. The amount that will actually be derived from this source will likely be much less, owing to competition for stumpage from northern California mills.

[8] Includes the territory from the northern boundary of the Klamath Indian Reservation, south to the Oregon-California line, and from the divide in Lake County between the Klamath Basin and the Goose Lake and Summer Lake drainages west to the summit of the Cascade Range.

Saw-timber cut at the average rate for 1925–36 could be sustained from the ponderosa pine types without change of forestry practice only in the South Blue Mountain unit. Since that period, production in this unit has increased considerably beyond the sustainable volume.

The timber budget could be balanced at the 1937–39 level of cutting in the Washington units and the North Blue Mountain Oregon unit if the volume in the nonpine types were economically available. However, the production capacity of these types in the Deschutes River, South Blue Mountain, and Klamath Plateau units, the large producers of the region, is of minor importance.

Immediate adoption of a sustained-yield policy would mean reducing the present cut drastically in the principal producing centers and considerably elsewhere. In spite of the difficulties now involved in reducing the cut, the longer such reduction is postponed the more severe will be the eventual curtailment enforced by lack of merchantable raw material.

Adequacy of the Forest Resource in Relation to Production Trend

The desirability of sustained-yield management is widely appreciated, but the obstacles involved are so formidable that its wide-scale adoption, if achieved on private lands, will unquestionably be gradual rather than instantaneous. Thus the questions arise—What of the timber supply in the absence of sustained-yield management? What will be the opportunities of maintaining timber production in the future if apparent trends continue?

The Situation Predicted for 1966

It should be borne in mind that future depletion figures used in these calculations are not presented as estimates and by no means as recommendations. They are purely assumptions based on analysis of depletion trend and associated factors, made in order to direct attention to consequences of a continuation of present trend.

Assumptions of forest drain from cutting and fire for the period 1936–65 (table 20) were based upon a detailed analysis of depletion records and lumber-production trends, of timber volume, and ownership and location of existing timber supplies, making allowance for the fact that roughly two-thirds of the region's timber resource is in public and Indian ownership and now being managed with the objective of sustaining production. By applying these depletion assumptions to the 1936 saw-timber inventory and making allowance for the growth that would occur, estimates of saw-timber volume as of 1966 (table 31) are obtained.

It is estimated that by 1966, if future cutting is largely a continuation of past practice (95–75), the saw-timber volume in ponderosa pine types, which totaled 96.8 billion board feet in 1936, will be reduced to 63.1 billion board feet. If, however, an equal volume of timber were removed in lighter cuts (50–50), it is estimated that in 1966 the ponderosa pine types would contain 68.2 billion board feet. The favorable effect of lighter cutting on growth has been emphasized previously. It is apparent again here. Thus spreading an equal volume cut over a greater area and concentrating it in the most mature trees, the anticipated saving in mortality and increase in growth over the 30-year period is 5.1 billion board feet. This volume, at the 1937 regional average price of ponderosa pine in stumpage sales, would be valued at approximately $15,000,000. Since the trees lost by mortality are of better than the average quality

TABLE 31.—*Saw-timber volume as of 1936 and estimated volume as of 1966, by type group, class of cutting practice, and forest-survey unit*

[In million board feet—i. e. 000,000 omitted]

Unit	Volume 1936			Estimated volume as of 1966						
	Ponderosa pine types	Other types	Total	Ponderosa pine types[1] 50–50	Ponderosa pine types[1] 75–50	Ponderosa pine types[1] 95–75	Other types	Total[1] 50–50	Total[1] 75–50	Total[1] 95–75
Eastern Washington:										
Chelan-Colville	10, 970	8, 317	19, 287	8, 677	8, 406	7, 804	9, 043	17, 720	17, 449	16, 847
Yakima River	9, 512	9, 568	19, 080	7, 660	7, 473	7, 167	8, 855	16, 515	16, 328	16, 022
North Blue Mountain	552	494	1, 046	474	446	407	408	882	854	815
Total	21, 034	18, 379	39, 413	16, 811	16, 325	15, 378	18, 306	35, 117	34, 631	33, 684
Eastern Oregon:										
North Blue Mountain	8, 269	3, 576	11, 845	6, 583	6, 368	6, 124	4, 022	10, 605	10, 390	10, 146
Deschutes River	17, 463	3, 182	20, 645	11, 012	10, 719	10, 151	3, 120	14, 132	13, 839	13, 271
South Blue Mountain	19, 396	2, 295	21, 691	14, 752	14, 515	14, 068	2, 187	16, 939	16, 702	16, 255
Klamath Plateau	30, 654	2, 845	33, 499	19, 018	18, 515	17, 348	1, 890	20, 908	20, 405	19, 238
Total	75, 782	11, 898	87, 680	51, 365	50, 117	47, 691	11, 219	62, 584	61, 336	58, 910
Region total	96, 816	30, 277	127, 093	68, 176	66, 442	63, 069	29, 525	97, 701	95, 967	92, 594

[1] Estimated volume under three forms of cutting in the ponderosa pine types during 1936–65: (50–50) light selection on all areas; (75–50) heavy selection on private, light selection on other lands; (95–75) virtual clear cutting on private lands, heavy selection on other lands.

Table 32.—*Average annual cut of trees of saw-timber size 1925–36, 1937–39, assumed cut 1936–65, and allowable cut on available lands 1966, by type group, class of cutting practice, and forest-survey unit*

[In million board feet—i. e., 000,000 omitted]

Unit	1925–36	1937–39	Assumed, 1936–65		Allowable under sustained yield, 1966			
			Ponderosa pine types	Other types	Ponderosa pine types [1]			Other types
					50–50	75–50	95–75	
Eastern Washington:								
Chelan-Colville	161	190	147	13	113	107	75	120
Yakima River	145	161	108	45	108	100	84	123
North Blue Mountain	21	23	9	11	7	6	5	14
Total	327	374	264	69	228	213	164	257
Eastern Oregon:								
North Blue Mountain	113	131	102	8	87	77	61	67
Deschutes River	256	343	275	5	150	141	116	38
South Blue Mountain	133	232	207	5	188	175	152	28
Klamath Plateau	430	667	500	32	256	231	184	15
Total	932	1, 373	1, 084	50	681	624	513	148
Region total	1, 259	1, 747	1, 348	119	909	837	677	405

[1] Allowable cut under sustained yield if cutting in the ponderosa pine types during the period 1936–65 takes the form (50–50) of light selection on all lands; (75–50) heavy selection on private, light selection on other lands; and (95–75) virtual clear cutting on private, heavy selection on other lands.

and value of the whole stand, the actual saving should be considerably more. Assuming that cutting takes a middle course (75–50), the estimated volume in the ponderosa pine types as of 1966 would represent a saving of 3.1 billion board feet.

In the types other than ponderosa pine [9] a small net volume reduction, from 30.3 billion board feet to 29.5 billion board feet, is shown for the period 1936 to 1965.

Thus it appears that a materially reduced but still substantial supply of saw timber will remain in the region in 1966 if, from 1936 on, forest practice is at least as effective in maintaining a growing stock as it was previously.

Allowable Cut, 1966

If the rate of saw-timber cut from 1936 to 1965 approximates that assumed for this period (1,467 million board feet annually), and there is meanwhile no material change in method of cutting, the sustainable annual cut from the ponderosa pine types for the succeeding cycle will drop from 1,348 to 677 million board feet (table 32), or about 50 percent. If a heavier cut is made under these circumstances even greater future reduction will be necessary. If accessible, the upper-slope, Douglas-fir, and other nonpine types could build up a total annual cut of 1,082 million board feet, or 74 percent of the assumed annual cut for 1936–65.

The sustainable cut as of 1966 from the ponderosa pine types could be increased more than one-third, or to 67 percent of the 1936–65 cut, if maturity-selection cutting (50–50) were immediately put into practice and applied uniformly (table 31).

The prospect of an enforced 50 percent reduction in sawlog production, or even a 33 percent reduction, for the region as a whole, although unpleasant, fails to emphasize the gravity of the local situation with respect to the ponderosa pine saw-timber supply. The outlook in the Klamath Plateau and the Deschutes River units is most unfavorable. For example, if the current trend continues, the cut from pine types in the Klamath Plateau unit may average 500 million board feet annually for the period 1936–65. If it does, the remaining saw timber would support production at only 37 percent of this level for the following cycle. In the Deschutes River unit the trend indicates that the pine types

[9] Owing to the small amount of exploitation anticipated in this type group within the next 30 years, clear cutting only was assumed for this group. This assumption does not imply that there may not be real advantages in selective cutting for these as well as for the ponderosa pine types.

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may yield an average annual cut of 275 million board feet from 1936 to 1965, but if so, the residual forest resource would not be sufficient to maintain output at more than 42 percent of this volume during the succeeding cycle.

The relation of cut to supply of ponderosa pine is more rational in the Yakima River and South Blue Mountain units than elsewhere in the region, but even here extensive curtailment is anticipated unless cutting methods are improved. In spite of all that can be done in the latter unit, maintenance of cut in its principal lumber centers, Baker and Burns, will present serious problems.

As shown in table 32, the sustainable annual production following 1965 can be increased materially by the adoption now of a light cutting practice of the maturity-selection type. In addition, the economic advantages of this method of making the initial cut in virgin ponderosa pine stands may be even greater than is apparent in the favorable effect on volume growth, mortality, and sustained-yield capacity (*2*). As already pointed out, not only may the volume of saw timber available for future harvest be increased, but also the quality of such volume averages higher under light cutting.

Conclusions

For the region as a whole, the ponderosa pine types will be badly overcut during the next few decades, owing to the large volume of privately owned timber, the cutting of which is restricted by little else than market demand, unless radical changes in ownership or private operating practice take place. During the cutting cycle following the 1936–65 period, a 54 percent reduction in the region's average annual ponderosa pine production will be necessary to avoid serious depletion of the forest resource, necessitating even more drastic curtailment later. Approximately one-third of the anticipated deficit in the pine types could be avoided, without reducing the total volume removal, by an immediate and wide-scale application of light maturity-selection cutting.

During the next few decades nonpine types will probably support less than one-third of the cut they could permanently sustain. Owing to their relatively low quality and accessibility they cannot be given equal weight with the pine types in balancing the region's timber budget, but a substantial increase in their utilization is anticipated.

Although establishment of sustained-yield management on privately owned lands is highly desirable, it is equally urgent that current cutting practice on all lands not so handled be rapidly shifted to a light maturity-selection basis. To reduce effectively the severity of the inevitable future curtailment of cut these measures must be adopted without delay.

A Summary of Regional Forest Problems

BECAUSE recognition and definition of problems constitute the first essential step in the proper handling of forest lands, major attention is directed to this phase. Effort is made to point out critical situations, both current and prospective, so as to focus attention on the necessity of formulating rather promptly a detailed program of action aimed at permanent forest management as a second step. Solutions are touched on only to bring out and emphasize the problems.

Problems of Supply and Utilization

The regional inventory showed 11.6 million acres of mature stands and only 3.8 million acres of immature stands. As a partial consequence of this excess of mature stands, current annual growth is but 11 percent of total potential annual growth. Excluding land occupied by virgin forests, current annual board-foot growth is 37 percent of the potential. Current annual depletion from all causes is 6 times current annual net growth.

The chief natural forest enemies, fire and insects, are responsible for 35 percent of the current drain. Such depletion is uneconomic and practically a total loss whereas depletion from cutting is serving an economic purpose. The control of fire damage and insect epidemics and the utilization of fire- and bug-killed trees would result in the conversion of such losses to economic use. The transformation of inert old-growth stands to growing condition would increase the productivity of the region's forests. The accomplishment of these two objects would increase growth considerably beyond current depletion but this will require many years.

Ponderosa pine forms 64 percent of the standing saw-timber volume, 87 percent of the average annual timber cut, 79 percent of the average annual total saw-timber depletion, and 69 percent of the potential growth. It is estimated that, given adequate protection against fire and insects and reasonably intensive forest management, the ponderosa pine forests can maintain permanently a forest industry of approximately the same magnitude as now exists. This would necessitate, however, rearrangement of forest industries throughout the region. The existing heavy concentration of forest industries in certain localities, a system which in the past has led to tremendous economic losses in other forest empires, is rapidly heading this region toward the same history of rise and decline.

The most critical situation with respect to future timber supply exists in the heaviest producing centers, the Klamath Plateau and the Deschutes River units in Oregon, which include the industrial towns of Klamath Falls and Bend. These two units, which together contribute approximately three-fifths of the region's lumber production, must anticipate reduction of cut to about 28 and 34 percent of their present respective levels within three decades if the apparent trend continues.

In eastern Washington the situation is somewhat better, but not satisfactory. Present cut is about twice that allowable under sustained yield and about three times the current annual growth. The Yakima unit, including the industrial center of Yakima, deserves first attention.

Even though only about one-third of the ponderosa pine is privately owned, it is this strategic one-third that is being seriously overcut. There is doubt that this situation will be corrected voluntarily. Public acquisition of key tracts or some form of control may be needed.

Forest Protection

Unless adequate protection against fire, insects, and disease can be assured, opportunity for private forestry will be narrowly limited. Fire is usually the greatest forest enemy, but in this region forest insects have in some years caused destruction equal to the volume of cut. The individual private owner is helpless and cooperative action on the part of public and private agencies is essential to meet this problem. In the main the Federal Government will have to assume the greatest burden. Added expenditures for research and annual surveys to discover impending epidemics are needed. When epidemics threaten, provision must be made for control by concerted action on the part of private, State, and Federal agencies.

A fire-protection system is in force that with some additional expenditure should keep losses to a reasonable minimum. It is increasingly evident that additional funds needed to provide satisfactory fire control must come from the Federal Government. The Clarke-McNary Act provides the machinery for giving aid and the maximum additional appropriations for which it provides should be made. This would still fall short of funds needed, however; the authorization must be increased before adequate aid can be given.

Forest Management

Unsolved problems in the actual physical management of the resource are no serious impediment to public or private forestry. Known methods and tools of forest management are far in advance of their application. Employment of recently developed tools and methods of fire control is limited by the inability of the forest owner to pay higher protection costs. Critical examination shows that many so-called management problems really stem from economic maladjustments, which frequently prohibit use of the best method of cutting to obtain regeneration and improved slash disposal methods that research and trial have developed. Research may show, however, as in the case of the maturity-selection system, that adoption of improved silvicultural practice results in immediate pecuniary rewards.

A fundamental measure has been proposed by Keen (*8*), namely, consideration of insect susceptibility in selecting trees to be cut. Foresters generally agree that light selection cutting is best in managing ponderosa pine forest. However, the silvicultural, economic, and entomological factors cannot always be harmonized perfectly in selecting trees to be cut. When conflicts occur, decision must be made on the basis of the economically feasible procedure that will benefit the forest most in the long run. Continued studies of growth and mortality following various types of selective cutting are needed to furnish information to guide the selection of the trees that will best serve this objective.

Achievement of full productive capacity rests on utilization of species other than pine, which make up one-third of the region's growing stock and potential growth. Research in utilization of these species, now little used, is urgently needed.

Studies in thinning and pruning ponderosa pine stands are now being conducted. Possibly results of these studies may not be applied for many years but it is desirable that research be well in advance of application.

Economic Problems

Obviously, stability of forest-land ownership is fundamental to stability of forest management during transition from liquidation to sustained yield. Once sustained-yield management is firmly established, interruption in continuity of tenure will be less important. Partial removal of certain economic obstacles to stable private ownership would probably result in immediate adoption of sustained-yield management on the part of certain private timber owners who have sufficient timber to form an operating unit. Others, who have only sufficient timber to make the nucleus of an operation, would have to negotiate cooperative agreements with Federal or State governments or purchase additional timber from other private owners. Owners possessing only a small volume of timber would probably continue the same general course followed in the past. Some manufacturers would find their plants entirely too large to be operated continuously; in such cases adjustments in plant capacity would have to be made.

Chief among the economic problems, in some respects interrelated, are taxation, difficulty of financing long-time operations, unavailability of insurance protection of standing timber, unstable and inadequate markets for forest products, fluctuating and unpredictable price levels, and rising costs of operation.

Forest Taxation

Taxation of forest properties has been the subject of more discussion and study in recent years than any other forest economic problem (*6*, *7*). It is generally designated as one of the serious obstacles to private forestry not only in this region but also in practically all forest regions in the country. Although scientific investigations are revealing that the influence of taxation has been exaggerated in many cases, it still deserves first mention in our list of economic problems.

The property tax is the chief factor in the taxation problem. Owing to the nonliquidity of forest investments, the necessity of paying taxes imposed on property transfers upon the owner's death may interrupt continuity of ownership to the detriment of good forest management. Since no study has been made here of the specific influence of inheritance and estate taxes on forestry, and since income and other taxes create no problem peculiar to the practice of forestry, further discussion of forest taxation will be restricted to the property tax.

A study made in 1936–37 (*14*) showed the average assessed value per acre of eastern Oregon timberland to be $10.10, the full value per acre $19.15, and the average tax levy 2.8 cents per $1 of assessed valuation. It gave the estimated annual carrying charges on 2,125,173 acres of private timberland in eastern Oregon as: Taxes $604,908, fire patrol $41,689, and interest (3 percent on full value) $1,220,991, making a total of $1,867,588. The area involved in this calculation was roughly three-quarters of the privately owned area of saw timber in eastern Oregon. The average annual tax per acre on the basis of the figures given was 28 cents, which is considerably less than comparable figures for a decade previous.

Analysis of reports of the State Tax Commission (*15*) shows that in Oregon the annual taxes levied on all real property reached a peak of about $51,000,000 in 1928, but by 1937 had receded to about $40,000,000. In Washington there has been a marked decrease in annual property tax levies on all real property from a peak of $81,000,000 in 1929 to $42,000,000 in 1937 (*18*). In Washington this recession was brought about by enactment of over-all limitations of 37 mills on urban and 25 mills on rural property (Iniat. Meas. 64, 1932) accompanied by a tremendous increase in the sales tax and various business and occupational taxes, from $13,000,000 in 1930 to $44,000,000 in 1937. In Oregon the increase in other taxes was not as great.

In both States practically all property tax revenue goes to local government and the State depends upon other forms of taxation. In 1939 the Washington State Government received only 5 percent of its total income from the property tax. Although the States have been assuming many of the functions formerly performed by the counties and are turning over to local governmental bodies an increasingly large proportion of their receipts from all sources, the property tax is still the mainstay of local government. Consequently, the forest-land owner has a definite interest in the functioning of local government.

The annual tax charges, taken alone, are evidently not high enough to precipitate widespread liquidation of old-growth timber. It has been found (*6*) that interest on invested capital far exceeded taxes as a factor contributing to premature and excessive cutting. But taxation has contributed to that undesirable practice; the property tax favors old-growth timber that is being liquidated and thus tends to accelerate cutting of such timber.

The only special tax legislation that has been enacted to date are laws (Oregon in 1929, Washington in 1931) removing from the ordinary operation of the property tax certain cut-over and burned-over lands suitable for reforestation and not containing timber in merchantable quantities. Lands classified under these laws pay a small annual land tax and a yield tax on timber products cut. In eastern Oregon the land tax is 4 cents per acre and the yield tax is 12½ percent of the value of forest crops harvested. Under the Washington law, classified properties in counties east of the Cascade Range are assessed at a fixed valuation of 50 cents an acre. A yield tax is also imposed on the market value of timber or other forest crop cut, the rate being 1 percent for each year that has expired from date of classification for the first 12 years and thereafter 12½ percent.

Cut-over lands have been classified under this legislation in only two eastern Oregon counties, Deschutes and Klamath. From 1930 to 1939, inclusive, 208,269 acres were classified, of which 39,467 acres were later declassified and 51,497 acres acquired by the Federal Government were withdrawn, leaving a net total of 117,305 as of 1939. This and approximately 13,000 acres classified in Klickitat County, Wash., in 1932 constitute the entire area classified in both States.

The most urgently needed action towards more equitable forest taxation includes: (1) More accurate assessment of forest properties, placing increased emphasis on their income possibilities and their treatment in natural operating units; (2) revision of local government organization and operation to fit the needs of scattered rural populations in areas predominantly forest; and (3) enactment and effective administration of a special forest tax law which would equalize the tax burden on deferred-income forest properties with that imposed on properties yielding a regular annual income. The last is urgently needed because of the preponderance of virgin forests not covered by laws mentioned in the preceding paragraph.

Solution of the forest tax problem must come as a part of a general reform in local government and taxation, but adoption of one of the three forest taxation plans developed in the Forest Service publications already cited (*6*, *7*) would produce substantial benefits.

The problem, being chiefly concerned with the property tax, is primarily a State responsibility, but its solution vitally affects the economic status of forestry on privately-owned land and therefore is of national concern.

Financing Long-Time Enterprises

The liquidation method of exploiting forest resources is encouraged and in some cases forced by private banking policies which demand rapid repayment of credit advances. Private forestry needs an available supply of long-term credit at low interest rates. Conversion of a private operation from liquidation management to sustained-yield management often means that not only must the present financial structure based on short-term liquidation financing be replaced by a stable financial structure, but also additional properties may have to be acquired to build up growing stocks and consolidate holdings, and logging and milling facilities must be modernized or shaped to fit the new management policy.

Forestry is the only major use of land for which adequate credit facilities are not available. Farming and stock raising, the major uses of land unoccupied by forests, are more generously provided with credit facilities chiefly because of action by the Federal Government. The Farm Credit Administration, the Home Owners Loan Corporation, the Federal Housing Administration, and the Reconstruction Finance Corporation provide credit for all forms of rural and urban land use except forestry. Private credit quite reasonably is not available at rates and terms that will encourage conservative forest management. The public concern in this objective is great enough to justify making Federal credit available at low interest rates, as with other objectives deemed in the public interest.

Insurance for Standing Timber

The fear of disastrous loss of capital investment through destruction of timber by fire and insect epidemics is a real obstacle to private forestry and encourages rapid liquidation. Insurance against this loss at reasonable premium rates would effectively remove this obstacle. In a study of the feasibility of commercial fire insurance in the Pacific Northwest recently published (*16*), commercial fire insurance at rates within the reach of the private operator is judged feasible under certain reasonable conditions. Establishment of favorable conditions rests upon at least the partial solution of the other economic and physical problems discussed here. No systematic studies have been made of the feasibility of insect epidemic insurance, but the need for it is as urgent as forest-fire insurance or more so.

The threat of major fire catastrophes such as the Tillamook Fire of 1933 in the Douglas-fir region probably accounts for the reluctance of insurance companies to enter this field actively. In order to break the deadlock that exists, participation by the Federal Government may be necessary.

Several possible avenues for such action exist; it might be done through a federally sponsored corporation, or through a federally owned corporation. If Federal aid becomes necessary, its extension should be predicated upon observance of satisfactory forest practice on the part of the private owners benefited.

Instability of Markets for Forest Products

Lumber from this region is almost entirely distributed in domestic markets, most of which are distant: exports are a negligible factor. Compared to some other forest regions, the element of instability represented by a fluctuating foreign market is absent or at least of little importance. Ponderosa pine lumber prices are less sensitive than Douglas-fir, but are much more sensitive than many other commodities. The general feeling of uncertainty of future markets is current among lumber manufacturers in this region, as in other forest regions. A large part of the lumber produced in this region is used in the manufacture of box shooks. Competition of paper box containers and other substitutes for wooden boxes is a constant threat. The bulk of the remaining production is used in building construction where the threat of wood substitutes is also present. Owing to excessive cost of transportation, marketing of lower grades of ponderosa pine is restricted. Dependence upon the box-shook market for disposition of the low-grade material is unsafe. Other uses and wider markets for this material must be found. Continued research is needed on reduction of manufacturing waste, development of new products, and general diversification of products. This should be coupled with expansion of utilization extension. These activities should be undertaken jointly by public and private agencies.

Conclusions

The ponderosa pine region offers encouragement to private forestry in many respects, in spite of the obstacles previously discussed in this report. Its products enjoy a comparatively stable market. Grazing under proper management offers a stable secondary revenue. Fire-protection costs and fire losses are relatively low. Satisfactory growth rates can be obtained through methods of cutting that also have many economic advantages. Existing private holdings are fairly well consolidated. Public timber is so located and of such character that it can be used to stimulate private forestry in many cases.

A serious problem in this region is maldistribution of forest industries in relation to forest-land productive capacity. There are no geographic obstacles which prevent correction of this situation or give one part of the region great advantage over another with respect to transportation. Difference in quality of timber stands, however, has been an important factor in the concentration of forest industries.

It is improbable that private initiative alone will correct the liquidation process and coordinate the industrial capacity of the forest land so as to produce raw materials permanently in this region. The program presented by the Forest Service to the Joint Congressional Committee on Forestry established by the Seventy-fifth Congress (S. Con. Res. 31) contains measures of Nation-wide application designed to correct critical situations such as obtain in this region. Measures of special significance to this region are those relating to (1) cooperative protection against forest insects and disease, (2) public credits to owners of forest land, (3) utilization research and extension, (4) cooperative sustained-yield units, (5) public regulation, and (6) extension of public ownership.

A program for specific action in this region, to be of highest value, should be based on analyses of local situations, such as it is now planned to present in a series of reports analyzing in considerable detail forest problems of smaller units and recommending specific remedial measures.

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Appendix

Methods in Inventory Phase

Existence of considerable information, particularly on the saw-timber areas which comprise 60 percent of the 22 million acres of forest land in the region, permitted use of the so-called compilation method in making the inventory. This method consisted of obtaining information on forest-type areas and timber volumes through compilation and checking of existing records—such as forest-type maps, timber cruises, land-exchange examinations, aerial and panoramic photos, cut-over land surveys, extensive reconnaissances, fire reports, and similar records—from private timberland owners, or their agents, and various public agencies. Areas for which no reliable records were available were covered by intensive field reconnaissance. Field work was commenced in the summer of 1934 and completed in the winter of 1936.

In the compilation method all forest-type area and timber-volume information was obtained in place, which made possible the preparation of a forest-type map and timber-volume estimate for a specific area. The same procedure was employed on all the forest lands in the region, regardless of ownership.

The inventory phase was conducted in four steps; first, collection of existing information; second, checking usable timber estimates and adjusting them to a common standard; third, field examination of areas not covered by usable information; and fourth, compilation of data collected.

Collection of Existing Information

The first step in the collection of existing information was to compile all available timber cruises from various sources. The majority of the acreage of privately owned forest land in the region was found to be covered by intensive cruises, either in the possession of the owner or his agent or county cruises made for taxation purposes. In the counties in which the county cruise gave a complete coverage of privately owned timber and was known to be sufficiently consistent and reliable, no private cruises were collected. Each owner who furnished timber cruises was guaranteed that information obtained from the cruises would be held strictly confidential and released only in conjunction with other cruise data.

Intensive cruises were available for the bulk of the ponderosa pine timber and for a considerable acreage of other types in national-forest ownership. The Klamath, Warm Springs, Yakima, and Colville Indian Reservations, and Oregon & California Railroad revested grant lands in Klamath County were covered by intensive surveys.

Detailed forest-type maps of all national-forest land covered by intensive surveys were available, as well as generalized type maps made at the time of the 1922 extensive reconnaissance of the region's national forests. Although these maps were not exactly in accordance with the type scheme adopted by the Forest Survey and had to be checked in the field and transposed to the standard scheme, they very materially lessened the amount of field typing.

Vertical aerial photos covering a considerable acreage in Union and Umatilla Counties were obtained from a private owner and proved a very valuable aid in the mapping. Also, during the survey, oblique aerial photos were taken of between 4 and 5 million acres of rough and inaccessible mountainous country in Chelan and Okanogan Counties, Wash., and Wallowa, Baker, Union, Umatilla, and Grant Counties, Oreg.

Locations and year of cut of logged areas were obtained from records in the offices of the county assessors and private timber owners. Locations of areas deforested by fire were obtained from the

Forest Service Office of Fire Control, State Foresters of Oregon and Washington, Indian Service, and private fire-patrol associations.

Checking and Adjusting Timber Estimates

After all available private and public timber cruises had been collected, the next step was to bring each individual cruise to the specifications set up by the Forest Survey. This step, known as check cruising consisted in cruising sample areas covered by the original cruise according to survey standards and computing an adjustment factor from a comparison of the original and check cruises. The sample areas, usually 320 acres in extent, were so distributed throughout the area covered by the original cruise as to give a representative check on 2 to 5 percent of the total acreage.

In cruising, quarter-acre circular plots were taken at 2½-chain intervals along compass lines run twice through each 40-acre tract, making a total of 16 such plots and giving a 10-percent cruise. All cruise lines were carefully referenced to section and quarter-section corners, assuring the same coverage as the original cruise. Volume was recorded for all trees 11.1 inches d. b. h. and larger on the plot and the locations of all doubtful-line trees were determined with a tape. All large trees were measured for diameter with a tape and sufficient smaller trees were measured to check the cruiser's estimate of diameter. Tree heights to a utilizable top were obtained with the Abney level and by taping an occasional windfall. Deduction for breakage and defect in each species was made for each 40-acre tract. All beetle-killed ponderosa pine trees were recorded by diameter class, and the number of poles—trees 5.1 to 11.1 inches d. b. h.—was also recorded by species for each 40-acre tract.

The check cruises were compiled currently in the field and were compared with the original cruise. Through this comparison the check cruiser was able to determine when sufficient samples had been obtained to give a reliable adjustment factor.

Whenever records were available, a comparison of actual cut and original cruise was made. The results of this comparison provided a good check on the adjustment factors set up for that particular cruise.

Type Mapping

The accuracy of the resultant type map was very largely dependent upon the detail and accuracy of the base data. In most counties in the region, the land survey was from 50 to 70 years old and section corners and lines were usually difficult to locate. Although the mappers checked on corners whenever these could be readily found, they depended greatly on the base-map location of roads, trails, streams, and triangulation points for orientation.

The volume per acre and composition of all previously uncruised saw-timber stands were estimated ocularly by mappers, who frequently checked their judgment by taking a series of equally spaced ¼-acre sample plots along a compass line. The mapping of a county was assigned to a party chief with from one to five or more assistants. Usually a township was entirely mapped by one man. Daily coverage varied widely depending upon accessibility, topography, and density and character of the timber.

Mapping procedure consisted of working in cars along roads, on foot along trails, ridges, and random compass lines, and of using all lookout stations and points. In mature and selectively cut stands much of the mapping was done by running random strips. All mapping was done on 1-inch-to-the-mile township forms of transparent vellum. These vellums were overlaid on a base map of the township prepared through the enlargement of the most recently revised ½-inch-to-the-mile lithographed national-forest base map. These national-forest maps were found to be the most accurate and covered the bulk of the forested portion of the region. In two of the Indian reservations, not completely covered by national-forest base maps, maps prepared by the Indian Service were used. For regular townships standard township forms of vellum were used for the mapping overlay sheet; for irregular townships the section lines and quarter lines were drafted on a blank sheet of vellum.

Type boundaries as determined were placed directly on the vellum overlay by the use of symbols indicating the type, composition, and volume per acre of saw-timber stands, and the type, composition, age, and degree of stocking of immature stands.

Stocking was determined by the stocked-quadrat method, which consisted of examining four contiguous squares at regular intervals along a compass line. For trees less than 3.1 inches d. b. h. a 13.2-foot square was used and for trees 3.1 to 11.1 inches d. b. h. a 20.9-foot square was used. The 13.2-foot square was considered stocked if it contained one well-established seedling and the 20.9-foot square if it contained one tree of pole size. Clear-cut areas and burns were also examined by the stocked-quadrat method to determine if they were restocking.

Before considering a township type vellum completed, the mapper carefully matched the type boundaries along the four sides with the vellums of adjoining townships.

Determination of the site quality of the forest land and the preparation of township site maps were carried on in the field concurrently with the type mapping and check cruising. Although height at any given age is the precise measuring stick of site, it was necessary to use methods that did not involve a large number of age and height determinations. In general, the procedure followed in the field was for the type mapper to make frequent age and height determinations in a large number of stands until he was able to estimate the site accurately through comparison, after which an occasional measurement kept his eye in practice. Age was determined by the use of the increment borer and by counting rings on nearby stumps, and heights were measured with an Abney level or by taping windfalls. Usually a minimum of 9 or 10 measured determinations were made to a township. The minimum site unit was about 640 acres.

In recording site-quality classes, the area of surveyed townships, by sections and rounded off to the nearest 5 acres, was obtained from the original General Land Office plats. The area of unsurveyed townships was determined by carefully planimetering ½-inch-to-the-mile lithographed base maps of the national forests. Total national-forest, Indian-reservation, and national-park areas were determined by combining township area data. This method was also used for several of the counties, which were principally forested, and for which complete area statistics were compiled. The total area of the counties in which there was a large acreage of nonforest land was obtained from statistics of the Bureau of the Census.

The location of site determinations was platted on a vellum township form (Form 974) and the boundaries of site classes were shown in pencil on the same form. These township maps were later used in the office in the preparation of the county site map.

Two kinds of forest-type maps resulted from the forest survey. Type maps, on a scale of 1 inch to the mile and showing all of the type detail mapped in the field, were prepared for each forested county in the region. In the preparation of these maps, the type data shown on the township field vellum were traced on a brown-line print of the base map of the county. A vandyke negative of the tracing was then made, from which blue-line prints are obtainable. The prints can be used uncolored but are much more easily read if hand colored with pencils or inks. The vandyke negative of a county type map is lent to anyone desiring the map who has a blueprint machine at his disposal, or is lent to a Portland blueprinting firm from which the interested person can purchase the prints.

The other kind of map is a generalized forest-type map, on a scale of ¼ inch to the mile, lithographed in colors to show the principal forest types, and issued in four parts, covering the States of Oregon and Washington. These are for sale by the Pacific Northwest Forest Experiment Station at a nominal price for each quarter.

Compilation and Release of Data

AREA COMPILATIONS

The exact land area of each forested township in the region and of each township within the boundaries of all national forests, Indian reservations, and national parks, whether forested or not, was determined. The land area of nonforested townships outside any of the public forest units was not determined except in a few counties where complete area statistics were compiled. Complete area statistics were compiled for all public forest units.

Timber volume and forest-type acreages were compiled by ownership classes, and determined from the most reliable sources. The ownership of county and municipal lands was obtained from the county offices; State lands from State offices; Indian, O. & C. revested grant, unappropriated public domain, and national-park lands from various offices of the Department of the Interior; and national-forest land from Forest Service records.

The area of the various types and subtypes—segregation by age class and degree of stocking—in each section was computed for each ownership class from the original township field vellums. Type areas in surveyed townships were computed by a method known as square counting in which a celluloid scale divided into ⅛-inch squares was used as an overlay on the field vellum. Type areas in unsurveyed townships were determined by use of a polar planimeter. A summary of the type areas, by ownership class, was made, first, for each township and, finally, for each county.

The area of the site classes in each township was computed by planimetering and the percentage of the total area of the township occupied by each site class was then determined. From these computations site statistics by county, survey unit, and region were summarized.

VOLUME COMPILATIONS

In order to obtain satisfactory estimates of volume of standing timber it was necessary to have for each of the commercial saw-timber species an accurate volume table that could be applied throughout the region. Investigation and check of the existing tables showed that some of them could be used as they were and others could be made usable by adjustment and extension to include larger trees, but that for some species new tables would have to be made.

The ponderosa pine table, made by James W. Girard in 1932, was based on a diameter factor of 67 percent, which assumes that the diameter inside the bark at small end of the average 16-foot log is 67 percent of diameter at breast height. The table was based on a top-diameter utilization ranging from 40 to 60 percent of diameter breast height, with an average of approximately 50 percent, which corresponded to actual top utilization in the region at the time the table was made. In checking the table against actual scale in several parts of the region 428 felled trees were measured. The variation of the volume-table scale on average areas ranged from +1.9 percent to −4.5 percent, but for all trees averaged −0.29 percent.

The sugar pine table was also constructed by Girard in 1932 in the same way as the ponderosa pine table and was based on a diameter factor of 60 percent. The top diameter varied from 8 inches for small trees to 20 inches for large trees.

For western white pine, a species of limited occurrence in the region, the Girard-Bowman table made in 1932 for the Inland Empire of northern Idaho and northeastern Washington was used. This table was based on a diameter factor of 65 percent for 20-inch trees and 57 percent for 60-inch trees; the factor for other d. b. h. classes was read from a curve. Top diameter varied from 6 to 12 inches. This table was thoroughly checked in the Inland Empire and found to be satisfactory.

The Ochoco National Forest table made by E. J. Hanzlik in 1913 was used for lodgepole pine and whitebark pine.

For Douglas-fir along the Cascade Divide, Girard's table made in 1932 for the Douglas-fir region was used. In making this table the formula, $\frac{\text{D. b. h.}+4}{2}$ equals the diameter of the average 16-foot log, was used for trees 32 inches d. b. h. or more, and below this diameter the average estimated form and taper was used. For the remaining Douglas-fir and for western larch, Girard's diameter-factor table for western larch and Douglas-fir was used. In making this table the diameter factor varied from 60 percent for 20-inch trees to 54 percent for 50-inch trees and top diameter varied from 8 to 14 inches.

Girard's western hemlock table, based on the formula $\frac{\text{D. b. h.}+8}{2}$ equals the diameter of the average 16-foot log, made for the Douglas-fir region, was selected for western hemlock and mountain hemlock, and H. B. Steer's table was used for western redcedar after being adjusted to 16-foot logs. Table 79 of Volume Tables for the Important Timber Trees of the United States: Part I, Western Species, was used for Pacific silver fir, white fir, alpine fir, noble fir, Shasta red fir, and Engelmann spruce after being adjusted to 12-inch top and extended to 70 inches d. b. h. Table 91 of the same publication was selected for California incense-cedar and table 11 for second-growth cottonwood was extended and used for all hardwoods.

Timber-volume data were computed in three units of measure: In board feet, log scale, Scribner rule; in board feet, lumber tally; and cubic feet.

In determining the board-foot volume in log scale, Scribner rule, all live conifers 11.1 inches d. b. h. and larger that would make at least one 16-foot log to an 8-inch top diameter and all live hardwood trees 11.1 inches d. b. h. and larger that would make at least one 8-foot log to a 10-inch top were included. Utilization of all conifers to a top diameter about 40 to 60 percent of the breast-high diameter was assumed. Decay and other defects were subtracted from the gross estimate. Ponderosa pine, western white pine, and sugar pine trees were totally culled for defect only when over two-thirds of their gross scale was unmerchantable. All other species were totally culled only when over one-half of their gross volume was unmerchantable. Timber-volume data in board feet, log scale, were computed by species and ownership class for each section in surveyed townships and for each merchantable-timber type area in unsurveyed townships. Compilation of the volume on areas covered by reliable preexisting cruises consisted of adjusting the cruise by factors previously determined through check cruising. Volume on areas not covered by preexisting cruises was computed by the application of stand-per-acre values, determined in the field, to the acreages of merchantable-timber types. Volumes resulting from these computations were then posted by section, species, and ownership class on township summary sheets and finally combined into a county total.

Volume of merchantable saw timber in board feet, lumber tally, was determined by applying a conversion factor of 1.10 to the log scale, board-foot volumes.

Cubic-foot volume of solid wood in all living and standing dead trees 5.0 inches d. b. h. and larger from stump to a 4-inch tip inside bark, excluding bark and limbwood, was computed, by species and ownership class, for each county. Cubic-foot volume of trees of saw-timber size was determined by applying a conversion factor to the merchantable board-foot volume. This conversion factor varied by species; for ponderosa pine and sugar pine the board-foot-cubic-foot ratio was 5.5, and varied from 3.8 to 5.8 for other species. The cubic-foot volume of trees less than saw-timber size was computed by several methods. The volume in understory trees in saw-timber stands was determined from data obtained in field samples taken in the growth phase of the survey. The volume of even-aged pole stands other than ponderosa pine was determined from partial yield tables, and in ponderosa pine pole stands by multiplying the number of poles per acre by the volume of the average pole, as determined from growth-study samples. The latter method was also used for lodgepole pine pole stands. Some of the cubic-foot volume was derived from cordwood estimates of such species as Sierra juniper, mountain mahogany, and aspen. A converting factor of 65 cubic feet of solid wood per cord was used for Sierra juniper and mountain mahogany and 72 cubic feet for aspen.

Methods in Depletion Phase

The immediate purpose of the depletion phase was to determine the quantity and kind of timber annually removed by cutting or killed by insects, fire, wind throw, disease, and other causes, and the area deforested by all causes; in short, the extent and character of the drain on the forest capital. The ultimate object was to determine the trends of depletion and growth, present and potential, and the net result of the two trends. To estimate the quantities of wood material in the future it was necessary to project the depletion figures into the future.

Cutting Depletion

The estimate of the average volume of material removed annually during the 12-year period, 1925–36, from the forests of the region as sawlogs was determined from statistics on sawlog production compiled annually by species and counties by the Forest Service in cooperation with the Bureau of the Census. Unavailable, however, was any similar statistical record of the volume of material removed annually as minor products, such as fuel wood and fence posts.

In estimating the production of fuel wood from live timber, a per capita consumption for each county was set up for both urban and rural districts. This assumed consumption, based chiefly on a study by H. M. Johnson of the production of minor products in Oregon and Washington in 1930, varied widely between counties and urban and rural districts, depending upon the availability of other kinds of fuel, such as dead timber, limb wood from logging operations, slabs, edgings, planer ends, sawdust from mills, coal, or gas. After the average total fuel-wood consumption had been determined for each county in the region, the average fuel-wood production in the county was computed, due regard being given the importation and exportation of fuel wood and the species available for such use.

The estimate of the annual drain on saw-timber stands due to production of round and split fence posts was determined by computing the number of post replacements needed on the farms annually. In computing this figure the number and total acreage of the farms in each of six size classes were obtained from statistics of the Bureau of the Census. A varying fencing-acreage ratio was used to determine the total number of posts in use, and this figure divided by a life expectancy of 12 years gave the number of posts replaced annually. A converting factor of 1.08 cubic feet per post was used. Since most of the posts are produced locally, the species utilized depended largely upon availability. Data on the quantities of other minor products produced annually, such as poles, piling, ties, mine timbers, cross arms, and shingles, were obtained from the 1930 minor-products study.

Fire Depletion

The average annual rate of fire depletion in the region was derived from an analysis of fires that occurred during the 12-year period 1924–35 This analysis consisted of translating the data obtained from the individual reports for fires 40 acres and larger, obtained from the Forest Service, Indian Service, State Foresters of Oregon and Washington, and private fire-patrol associations, in forest-survey types and species and adjusting the derived figures to agree with the total area burned and timber volume killed during the period. The adjustment of the derived figures was based on an extensive examination in the field of approximately 80 percent of the total area burned. Modification of the individual reports was made primarily on the judgment of the field examiner.

Two broad ownership classes were recognized—national-forest land and all other land. The former includes only net national-forest land; the latter includes all private, State, county, municipal, and Indian-owned lands, both inside and outside the national forests, and unappropriated Federal lands.

There were practically no area adjustments of individual reports for net national-forest land. The total area of net national-forest land burned was obtained by summarizing the individual reports of fires 40 acres and larger for the period and adding the acreage of smaller fires reported by each national forest. For practically all national forests this summary was considerably lower than the acreages reported in the annual national-forest fire reports owing to incomplete coverage of large fires or loss of reports. The annual summary reports were apportioned by counties on the basis of fires of which record was available and used as the total net national-forest land burned for the period.

It was assumed at the outset that the records of the State Foresters of Washington and Oregon would cover all lands other than national forest, but it was found that they did not include the fires that occurred on the Colville and Yakima Indian Reservations in Washington and only partially included those on the Warm Springs and Klamath Indian Reservations in Oregon. It was also found that not all of the acreage of burned-over alienated lands inside the national forests was included in the State reports. Addition of the Indian-reservation fires and unreported fires on alienated lands in the national forests and adjustments made by the men in the field increased the total area of other lands burned over in the 12-year period about 57 percent over the area indicated in the State reports for the same period.

The volume loss as compiled by the Forest Survey was considerably greater than that shown by the national-forest reports. Although there was some downward adjustment in individual reports, this was more than offset by upward adjustments, and there was also additional loss of volume on areas reported as protection forests for which no loss was indicated.

Since the State reports on fires on other lands did not include the Indian reservations, no direct comparison of timber volume lost as shown by the reports and that compiled by the survey can be made.

After all adjustments of the data derived from the individual fire reports had been made, estimated annual averages of area deforested and timber volume lost were compiled by forest type and county. These averages were then summarized by Forest Survey units.

Methods in Growth Phase

General procedure followed in the Forest Survey growth study and detail of the results obtained have been previously presented in the station's Forest Survey Report No. 78, "Forest Growth in the Ponderosa Pine Region of Oregon and Washington." Nevertheless several significant details of methodology are included here in the belief that they may contribute to facility in interpretation of results given in the text of the present report.

Gross Growth Study in Virgin Stands

This study was undertaken primarily to appraise the prospects of net growth, under management, from the region's extensive virgin timberland areas. In so doing 323 growth samples were taken during the summers of 1935 and 1936 throughout the virgin saw-timber types. Plots were so located on type maps in the office as to sample with reasonable uniformity the principal virgin stands in the region. Number of samples taken within a type was determined roughly by the type's extent and economic importance.

The samples, taken in strip form, consisted of stand tallies by tree class, growth rates by tree class being determined from increment cores of sample trees. The sample unit consisted of 1 day's work for the crew of three—usually 16 acres but varying from 8 to 32. Average annual growth rate was based upon the period 1900 to 1935 or 1936, depending on date of sampling. Growth rate of ponderosa pine is characteristically cyclic. On the basis of Keen's tree-ring analysis (*9*) supplemented by additional region-wide investigation as a part of the survey growth phase, these periods were selected as ones during which actual growth approximated the normal rate. The growth rates employed were the gross rates made by trees that survived to the date of measurement. Growth of trees that grew for part of the increment period, but succumbed before measurement, could not be included. On the other hand it is believed that the average increment of the trees that survived was superior to that made by those that did not. Biases involved by these two factors tend to be compensating. Average annual increment of poles that grew into saw-timber size during the growth period was of course included.

Sample stand tallies were converted to stock tables by use of height curves, prepared for each sample, and regional volume tables. For the sample trees grouped into broad classes [10] ratios of volume as of 1900 to volume as of 1935 or 1936 were computed for each sample. These ratios were applied to the appropriate portion of the stock table to compute estimated stand volume as of 1900. This value was subtracted from volume found at time of survey; the remainder divided by years in the growth period and acres in the sample gave a measure of the average annual growth per acre made by the sample stand.

Methods of Analysis

Preliminary study of the samples indicated significant differences in growth rate by forest type and by the various stand variables shown below by type. Alinement charts were constructed for each type as a means of quickly estimating growth corresponding to any combination of stand variables encountered. The charts for the pine woodland type were constructed by the empirical alinement chart method (*4*), those for all other types were made by the mathematical-graphical method of successive approximation (*3*).

Making Mortality Estimates

As employed in the growth estimates, mortality in virgin stands was dismissed by assuming loss

[10] The grouping into Dunning tree classes (*5*) approximated that employed by Meyer (*11*). The Keen tree-classification system (*8*) widely adopted in the region recently was not devised until after completion of the growth-phase field work.

equal to gross growth. Normal mortality rates for even-aged immature stands were automatically allowed for by use of the normal yield tables. Loss in the uneven-aged immature stands, however, was computed as a separate step. For such stands estimated loss (as percent of volume in reserve stand at start of growth period) varied considerably, depending on estimated gross growth, but averaged about 0.55 percent annually. The relation between annual loss as percent of volume and gross growth was based on the measurements of mortality (from all causes) made by Meyer (*11*) on 169 of the 179 sample plots upon which his growth study was based.

Methods in Requirements Phase

The requirements phase of the forest survey consisted in a determination of present and prospective requirements for wood products. Estimates of the quantities of these products needed in the future cannot be made solely on the basis of needs within the region. Interchange of products between regions necessitates determination of future requirements on a national basis, followed by allocation of the quantity determined among the several timber-producing regions. Nevertheless requirements for certain classes of wood materials must be computed separately for each region. Estimates of future requirements were based upon studies of (1) urban construction needs, (2) rural construction needs, and (3) the requirements of the secondary wood-using industries. In the Pacific Northwest studies were made of the first two subjects named.

The complete results of the requirements studies made in this region are not presented in this report. They will be integrated and correlated with data from other regions and published in a report on national requirements.

It is manifest that the Pacific Northwest with its extensive and varied forest resources and sparse population can supply its requirements for practically all kinds of forest products indefinitely. The only wood products consumed in this region that must be imported are small amounts of hardwood material such as flooring and interior finish, and articles manufactured of woods not grown in this region, such as certain kinds of furniture and implement handles. The principal sources of these items are eastern and southern United States, the Philippine Islands, and South and Central America.

Supplemental Tables

In this report all saw-timber volume data have been expressed in log scale, Scribner rule. However, in some of the other regions in the United States similar data are expressed in lumber tally. For the purpose of comparison, tables showing saw-timber volume data in lumber tally for this region have been prepared. These are included in this section as supplemental tables.

Table 33 shows the volume of timber in millions of board feet, lumber tally, in the region by species and forest-survey unit, and table 34 by species and ownership class.

A comparison of annual saw-timber growth and depletion, in millions of board feet, lumber tally, is shown by unit in table 35. Also shown in lumber tally is the current annual gross growth in the region by unit and broad age class in table 36, current and potential annual net growth in the region by unit in table 37, and periodic net saw-timber growth in the region, 1936–65, by unit, decade, and class of cutting practice in table 38.

Detailed fire-depletion data are given in supplemental tables as follows: Table 39 shows the area deforested on national forests and lands other than national forests in the region in 1924–35, inclusive, by type and forest-survey unit; table 40 shows the loss of timber volume in log scale on the same areas; and table 41 is a regional summary of estimated annual average of area deforested and timber volume lost.

Rates used in calculating potential growth of conifer timber in the region are shown in table 42.

TABLE 33.—*Volume of timber, lumber tally, in the ponderosa pine region, by species and forest-survey unit, 1936*

[In million board feet—i. e., 000,000 omitted]

Species	Eastern Washington				Eastern Oregon					Region total
	Chelan-Colville	Yakima River	North Blue Mountain	Total	North Blue Mountain	Deschutes River	South Blue Mountain	Klamath Plateau	Total	
Ponderosa pine	9,028.6	8,198.3	434.2	17,661.1	6,604.1	16,748.7	19,053.1	29,572.6	71,978.5	89,639.6
Sugar pine						15.2		795.0	810.2	810.2
Western white pine	182.9	296.3	.4	479.6	4.6	141.6	2.7	246.9	395.8	875.4
Lodgepole pine	190.1	261.6	14.9	466.6	83.9	163.5	71.4	441.5	760.3	1,226.9
Douglas-fir	5,870.5	5,756.4	198.7	11,825.6	2,593.4	2,499.4	2,144.6	1,307.1	8,544.5	20,370.1
Western redcedar	140.3	105.3		245.6		5.9			5.9	251.5
Alaska yellow-cedar	.6	31.8		32.4		.5			.5	32.9
California incense-cedar						58.7		185.1	243.8	243.8
Western hemlock	398.6	722.4		1,121.0		197.1		50.6	247.7	1,368.7
Mountain hemlock	248.7	875.7		1,124.4	3.5	1,329.7		553.6	1,886.8	3,011.2
White fir	107.5	835.1	212.6	1,155.2	1,388.4	884.6	1,060.6	2,504.5	5,838.1	6,993.3
Noble fir		39.2		39.2		233.4		1,142.4	1,375.8	1,415.0
Pacific silver fir	966.9	1,756.5		2,723.4		34.0			34.0	2,757.4
Alpine fir	218.0	329.3	34.8	582.1	106.5	30.9	37.2	11.3	185.9	768.0
Western larch	2,331.0	1,344.6	182.6	3,858.2	1,854.3	284.2	1,359.6		3,498.1	7,356.3
Engelmann spruce	1,494.3	403.1	72.2	1,969.6	379.0	79.9	126.4	36.1	621.4	2,591.0
Red alder		.1		.1						.1
Bigleaf maple	(1)			(1)						(1)
Northern black cottonwood	36.8	32.2	.7	69.7	11.6	2.5	4.5	.1	18.7	88.4
Aspen	.6	.2		.8				1.9	1.9	2.7
Total	21,215.4	20,988.1	1,151.1	43,354.6	13,029.3	22,709.8	23,860.1	36,848.7	96,447.9	139,802.5

[1] Less than 50 M board feet.

TABLE 34.—*Volume of timber, lumber tally, in the ponderosa pine region, by species and ownership class, 1936*

[In million board feet, i. e., 000,000 omitted]

Species	Private	State		County	Municipal	Federally owned or managed							Total
						Indian	Revested land grants	Public domain			National forest		
		Available for cutting	Reserved from cutting					Available for cutting	Railroad selection pending	Reserved from cutting[1]	Available for cutting	Reserved from cutting	
Ponderosa pine	29,935.8	1,777.3	0.3	416.4	8.6	16,442.8	157.7	847.6	379.8	185.1	39,180.4	307.8	89,639.6
Sugar pine	424.6	6.4				197.8	38.3	.3		.5	141.6	.7	810.2
Western white pine	77.0	5.6		(2)		52.4	7.8	.2	35.2	7.3	625.1	64.8	875.4
Lodgepole pine	149.4	24.1		2.1	(2)	36.3	.4	3.7	12.0	33.9	850.0	115.0	1,226.9
Douglas-fir	5,129.1	784.0		177.6	8.1	2,199.1	67.1	139.5	288.2	4.6	11,132.6	440.2	20,370.1
Western redcedar	42.9	1.6		.3		14.6		.4	19.9		158.6	13.2	251.5
Alaska yellow-cedar	.2	.1				.9			2.1		26.0	3.6	32.9
California incense-cedar	132.3	1.2		.3		52.1	1.1	.8		.6	54.6	.8	243.8
Western hemlock	318.3	7.0		.1		8.2		.8	73.0	5.6	861.9	93.8	1,368.7
Mountain hemlock	94.0	2.6		2.1		228.7			112.4	183.4	2,142.9	245.1	3,011.2
White fir	2,041.9	59.0		22.3	4.3	677.7	49.5	16.9	28.9	24.3	3,967.1	101.4	6,993.3
Noble fir	93.4	1.0				52.5	75.9	3.6	6.7	218.5	828.0	135.4	1,415.0
Pacific silver fir	411.4	10.0		.1		.7		(2)	239.4		1,792.1	303.7	2,757.4
Alpine fir	42.3	6.4		.1	.8	126.7		(2)	22.9		442.1	126.7	768.0
Western larch	1,245.2	281.8		68.8	1.6	752.0		69.0	51.4		4,760.2	126.3	7,356.3
Engelmann spruce	140.4	46.1		4.3	.9	105.6		2.8	42.9	.1	1,477.6	770.3	2,591.0
Red alder	.1							(2)					.1
Bigleaf maple	(2)										(2)		(2)
Northern black cottonwood	47.9	.8		.1	(2)	15.7		.5	.8		20.0	2.6	88.4
Aspen	2.6										.1		2.7
Total	40,328.8	3,015.0	.3	694.6	24.3	20,963.8	397.8	1,086.1	1,315.6	663.9	68,460.9	2,851.4	139,802.5

[1] Crater Lake National Park. [2] Less than 50 M board feet.

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TABLE 35.—*Comparison of annual saw-timber growth and depletion, lumber tally, by unit, 1936*

[In million board feet—i. e., 000,000 omitted]

State and unit	Current gross growth [1]	Normal mortality depletion [2]	Current net growth [3]	Average fire loss 1924–35	Average cutting depletion 1925–36	Reduction or increase in saw-timber volume	Potential increase in net growth
Eastern Washington:							
Chelan-Colville	250.8	180.4	70.4	53.9	135.3	−118.8	378.4
Yakima River	222.2	167.2	55.0	6.6	136.4	−88.0	321.2
North Blue Mountain	16.5	8.8	7.7		4.4	+3.3	31.9
Total	489.5	356.4	133.1	60.5	276.1	−203.5	731.5
Eastern Oregon:							
North Blue Mountain	146.3	103.4	42.9	1.1	90.2	−48.4	243.1
Deschutes River	178.2	160.6	17.6	12.1	255.2	−249.7	259.6
South Blue Mountain	172.7	152.9	19.8	7.7	119.9	−107.8	350.9
Klamath Plateau	272.8	245.3	27.5	14.3	457.6	−444.4	414.7
Total	770.0	662.2	107.8	35.2	922.9	−850.3	1,268.3
Region total	1,259.5	1,018.6	240.9	95.7	1,199.0	−1,053.8	1,999.8

[1] On commercial forest land, 1935.
[2] Exclusive of fire loss.
[3] On commercial stands not more than 160 years in age, 1935.

TABLE 36.—*Current annual gross growth, lumber tally, in the ponderosa pine region, by unit and broad age class, 1936*

State and unit	Mature stands [1]		Immature stands [2]		Total		
	Area	Current annual gross growth	Area	Current annual gross growth	Area	Current annual gross growth	Growth of ponderosa pine as portion of total growth
	Thousand acres	*Million board feet*	*Thousand acres*	*Million board feet*	*Thousand acres*	*Million board feet*	*Percent*
Eastern Washington:							
Chelan-Colville	2,285	169.4	1,103	81.4	3,388	250.8	39
Yakima River	1,422	158.4	713	63.8	2,135	222.2	37
North Blue Mountain	124	7.7	162	8.8	286	16.5	35
Total	3,831	335.5	1,978	154.0	5,809	489.5	38
Eastern Oregon:							
North Blue Mountain	1,387	97.9	799	48.4	2,186	146.3	43
Deschutes River	1,582	158.4	401	19.8	1,983	178.2	70
South Blue Mountain	2,428	149.6	457	23.1	2,885	172.7	75
Klamath Plateau	2,426	240.9	482	31.9	2,908	272.8	77
Total	7,823	646.8	2,139	123.2	9,962	770.0	69
Region total	11,654	982.3	4,117	277.2	15,771	1,259.5	58

[1] Stands more than 160 years old, on commercial conifer forest land.
[2] Stands 160 years or less in age, on commercial conifer forest land.

TABLE 37.—*Current and potential net annual growth,*[1] *lumber tally, in the ponderosa pine region, by unit*

State and unit	Current annual net growth: Area immature stands	Current annual net growth: Total net growth	Current annual net growth: Growth of ponderosa pine as portion of total	Potential annual net growth: Area commercial forest sites	Potential annual net growth: Total net growth	Potential annual net growth: Growth of ponderosa pine as portion of total
	Thousand acres	*Million board feet*	*Percent*	*Thousand acres*	*Million board feet*	*Percent*
Eastern Washington:						
Chelan-Colville	1,103	70.4	33	3,525	448.8	55
Yakima River	713	55.0	40	2,177	376.2	45
North Blue Mountain	162	7.7	25	288	39.6	49
Total	1,978	133.1	35	5,990	864.6	51
Eastern Oregon:						
North Blue Mountain	799	42.9	37	2,244	286.0	64
Deschutes River	401	17.6	77	2,016	277.2	84
South Blue Mountain	457	19.8	75	2,925	370.7	86
Klamath Plateau	482	27.5	69	2,993	442.2	86
Total	2,139	107.8	59	10,178	1,376.1	81
Region total	4,117	240.9	48	16,168	2,240.7	69

[1] Growth in board feet is shown for all trees 11.1 inches d. b. h. or more, estimated in 16-foot logs to 8-inch top, Scribner rule.

TABLE 38.—*Periodic net saw-timber growth,*[1] *lumber tally, in the ponderosa pine region, 1936–65, by unit, decade, and class of cutting practice*

[In million board feet—i. e., 000,000 omitted]

State and unit	1936–45: 50–50 [2]	1936–45: 75–50 [3]	1936–45: 95–75 [4]	1946–55: 50–50 [2]	1946–55: 75–50 [3]	1946–55: 95–75 [4]	1956–65: 50–50 [2]	1956–65: 75–50 [3]	1956–65: 95–75 [4]
Eastern Washington:									
Chelan-Colville	846	803	731	1,412	1,296	1,058	1,864	1,724	1,364
Yakima River	607	575	535	977	893	771	1,244	1,150	971
North Blue Mountain	85	82	76	172	161	145	245	229	207
Total	1,538	1,460	1,342	2,561	2,350	1,974	3,353	3,103	2,542
Eastern Oregon:									
North Blue Mountain	440	418	390	896	809	714	1,220	1,091	944
Deschutes River	390	337	259	846	723	491	1,215	1,065	744
South Blue Mountain	298	270	220	723	627	451	1,103	961	692
Klamath Plateau	717	616	437	1,515	1,284	794	1,979	1,749	1,116
Total	1,845	1,641	1,306	3,980	3,443	2,450	5,517	4,866	3,496
Region total	3,383	3,101	2,648	6,541	5,793	4,424	8,870	7,969	6,038

[1] Growth is shown for all trees 11.1 inches d. b. h. or more, estimated in 16-foot logs to an 8-inch top, Scribner rule.

[2] This is the estimated periodic growth if the anticipated timber cut in ponderosa pine types takes the form of light selection, removal averaging 50 percent of virgin stand volume per acre on all areas where cutting occurs.

[3] Estimated periodic growth if the anticipated timber cut in ponderosa pine types takes the form of heavy selection on privately owned lands, removal averaging 75 percent of virgin stand volume per acre; light selection averaging 50 percent on other lands.

[4] Estimated periodic growth if the anticipated cut in ponderosa pine types takes the form of virtual clear cutting on privately owned lands, removal averaging 95 percent of virgin stand volume per acre; heavy selection averaging 75 percent on other lands.

TABLE 39.—*Estimated annual average of area deforested by fire in the ponderosa pine region in 1924–35, by types and forest-survey unit*

ON NATIONAL FORESTS

Type No.	Type	Eastern Washington				Eastern Oregon					Grand total
		Chelan-Colville	Yakima River	North Blue Mountain	Total	North Blue Mountain	Des-chutes River	South Blue Mountain	Klamath Plateau	Total	
		Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
5½	Ponderosa pine woodland	125	----	----	125	2	----	16	----	18	143
20	Ponderosa pine, large	480	----	----	480	12	21	44	20	97	577
20½	Pure ponderosa pine, large	889	16	----	905	14	161	549	549	1,273	2,178
21	Ponderosa pine, small	172	----	----	172	4	6	11	55	76	248
27	Ponderosa pine mixture, large	229	6	1	236	26	3	35	90	154	390
7	Douglas-fir, small old growth	148	5	----	153	----	5	----	----	5	158
8	Douglas fir, large second growth	70	31	----	101	----	----	----	----	----	101
9 A	Douglas fir, large poles	62	----	----	62	----	----	----	----	----	62
23	Fir-mountain hemlock, large	27	----	----	27	----	4	----	12	16	43
27½	Upper-slope mixture, large	1,386	----	----	1,386	14	17	17	----	48	1,434
22	Ponderosa pine seedlings and saplings	70	----	----	70	4	64	124	12	204	274
28	Ponderosa pine mixture, small	11	----	----	11	3	8	6	26	43	54
9 B	Douglas-fir, small poles	27	----	----	27	----	4	----	----	4	31
10	Douglas-fir seedlings and saplings	10	1	----	11	----	----	----	----	----	11
24	Fir-mountain hemlock, small	6	----	----	6	----	4	----	45	49	55
28½	Upper-slope mixture, small	3,398	----	3	3,401	10	22	1	----	33	3,434
25	Lodgepole pine, large	34	----	----	34	----	39	----	4	43	77
26	Lodgepole pine, small	5,601	----	----	5,601	45	134	43	205	427	6,028
5 B	Juniper or mountain mahogany woodland	----	----	----	----	----	----	6	----	6	6
	Total	12,745	59	4	12,808	134	492	852	1,018	2,496	15,304

ON LANDS OTHER THAN NATIONAL FORESTS

Type No.	Type	Chelan-Colville	Yakima River	North Blue Mountain	Total	North Blue Mountain	Des-chutes River	South Blue Mountain	Klamath Plateau	Total	Grand total
5½	Ponderosa pine woodland	601	31	----	632	----	26	8	271	305	937
20	Ponderosa pine, large	606	37	----	643	9	318	19	224	570	1,213
20½	Pure ponderosa pine, large	515	74	7	596	37	532	205	781	1,555	2,151
20 A	Ponderosa pine-sugar pine, large	----	----	----	----	----	2	----	19	21	21
20 B	Sugar pine mixture, large	----	----	----	----	----	----	----	10	10	10
21	Ponderosa pine, small	417	328	----	745	106	1	42	130	279	1,024
27	Ponderosa pine mixture, large	199	50	----	249	17	12	2	6	37	286
6	Douglas-fir, large old growth	----	----	----	----	----	----	----	1	1	1
7	Douglas-fir, small old growth	47	7	----	54	----	----	----	1	1	55
8	Douglas-fir, large second growth	114	316	----	430	----	----	----	----	----	430
9 A	Douglas-fir, large poles	384	89	----	473	----	3	----	----	3	476
23	Fir-mountain hemlock, large	----	147	----	147	----	----	----	1	1	148
27½	Upper-slope mixture, large	8,143	51	----	8,194	7	----	2	----	9	8,203
22	Ponderosa pine seedlings and saplings	1,127	423	11	1,561	389	556	144	905	1,994	3,555
28	Ponderosa pine mixture, small	401	40	110	551	225	----	6	----	231	782
9 B	Douglas-fir, small poles	22	36	----	58	----	10	----	----	10	68
10	Douglas-fir seedlings and saplings	4	60	----	64	----	----	----	----	----	64
24	Fir-mountain hemlock, small	----	10	----	10	----	----	----	----	----	10
28½	Upper-slope mixture, small	929	200	3	1,132	19	----	4	----	23	1,155
25	Lodgepole pine, large	----	44	----	44	----	----	----	1	1	45
26	Lodgepole pine, small	892	30	----	922	----	91	----	67	158	1,080
4	Oak woodland	----	----	----	----	----	15	----	----	15	15
	Total	14,401	1,973	131	16,505	809	1,566	432	2,417	5,224	21,729

TABLE 40.—*Estimated annual average of timber volume* [1] *lost by fire in the ponderosa pine region in 1924–35, by type and forest-survey uni*

ON NATIONAL FORESTS

Type no.	Type	Eastern Washington: Chelan-Colville	Eastern Washington: Yakima River	Eastern Washington: North Blue Mountain	Eastern Washington: Total	Eastern Oregon: North Blue Mountain	Eastern Oregon: Deschutes River	Eastern Oregon: South Blue Mountain	Eastern Oregon: Klamath Plateau	Eastern Oregon: Total	Grand total
		M board feet	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*
5½	Ponderosa pine woodland	122			122	1		25		26	148
20	Ponderosa pine, large	3, 496			3, 496	23	242	412	324	1, 001	4, 497
20½	Pure ponderosa pine, large	5, 130	158		5, 288	81	2, 401	3, 877	4, 426	10, 785	16, 073
20A	Ponderosa pine-sugar pine, large								9	9	9
21	Ponderosa pine, small	363			363	5	7	61	350	423	786
27	Ponderosa pine mixture, large	2, 315	40	3	2, 358	57	33	251	481	822	3, 180
7	Douglas-fir, small old growth	1, 443	38		1, 481		50			50	1, 531
8	Douglas-fir, large second growth	372	256		628						628
9A	Douglas-fir, large poles	442			442						442
23	Fir-mountain hemlock, large	584			584		56		188	244	828
27½	Upper-slope mixture, large	17, 377			17, 377	56	329	118		503	17, 880
22	Ponderosa pine seedlings and saplings					1	1	25		27	27
28	Ponderosa pine mixture, small							1		1	1
28½	Upper-slope mixture, small	3			3						3
25	Lodgepole pine, large	67			67						67
26	Lodgepole pine, small	328			328			6	1	7	335
	Total	32, 042	492	3	32, 537	224	3, 119	4, 776	5, 779	13, 898	46, 435

ON LANDS OTHER THAN NATIONAL FORESTS

Type no.	Type	Eastern Washington: Chelan-Colville	Eastern Washington: Yakima River	Eastern Washington: North Blue Mountain	Eastern Washington: Total	Eastern Oregon: North Blue Mountain	Eastern Oregon: Deschutes River	Eastern Oregon: South Blue Mountain	Eastern Oregon: Klamath Plateau	Eastern Oregon: Total	Grand total
5½	Ponderosa pine woodland	529	4		533		54	74	325	453	986
20	Ponderosa pine, large	3, 680	143		3, 823	54	3, 505	141	2, 259	5, 959	9, 782
20½	Pure ponderosa pine, large	2, 236	455	68	2, 759	209	3, 808	1, 512	3, 910	9, 439	12, 198
20A	Ponderosa pine-sugar pine, large						17		279	296	296
20B	Sugar pine mixture, large								179	179	179
21	Ponderosa pine, small	605	171		776	121	2	92	235	450	1, 226
27	Ponderosa pine mixture, large	1, 339	202		1, 541	60	112	5	12	189	1, 730
6	Douglas-fir, large old growth								4	4	4
7	Douglas-fir, small old growth	196	54		250		3		3	6	256
8	Douglas-fir, large second growth	670	2, 792		3, 462						3, 462
9A	Douglas-fir, large poles	1, 572	36		1, 608		1			1	1, 609
23	Fir-mountain hemlock, large	528	1, 309		1, 837				6	6	1, 843
27½	Upper-slope mixture, large	5, 690	218	3	5, 911	33		13		46	5, 957
22	Ponderosa pine seedlings and saplings	175	1		176	46	259	51	12	368	544
28	Ponderosa pine mixture, small	2			2	18		1		19	21
9B	Douglas-fir, small poles	3			3						3
28½	Upper-slope mixture, small	38			38	21				21	59
25	Lodgepole pine, large		83		83				1	1	84
26	Lodgepole pine, small		15		15						15
	Total	17, 263	5, 483	71	22, 817	562	7, 761	1, 889	7, 225	17, 437	40, 254

[1] Log-scale basis.

TABLE 41.—*Summary of estimated annual average of losses by fire in the ponderosa pine region in 1924–35, by type and forest-survey unit*

AREA DEFORESTED (ACRES)

Type No.	Type	Eastern Washington				Eastern Oregon					Grand total
		Chelan-Colville	Yakima River	North Blue Mountain	Total	North Blue Mountain	Des-chutes River	South Blue Mountain	Klamath Plateau	Total	
5½	Ponderosa pine woodland	726	31		757	2	26	24	271	323	1,080
20	Ponderosa pine, large	1,086	37		1,123	21	339	63	244	667	1,790
20½	Pure ponderosa pine, large	1,404	90	7	1,501	51	693	754	1,330	2,828	4,329
20A	Ponderosa pine-sugar pine, large						2		19	21	21
20B	Sugar pine mixture, large								10	10	10
21	Ponderosa pine, small	589	328		917	110	7	53	185	355	1,272
27	Ponderosa pine mixture, large	428	56	1	485	43	15	37	96	191	676
6	Douglas-fir, large old growth								1	1	1
7	Douglas-fir, small old growth	195	12		207		5		1	6	213
8	Douglas-fir, large second growth	184	347		531						531
9A	Douglas-fir, large poles	446	89		535		3			3	538
23	Fir-mountain hemlock, large	27	147		174		4		13	17	191
27½	Upper-slope mixture, large	9,529	51		9,580	21	17	19		57	9,637
22	Ponderosa pine seedlings and saplings	1,197	423	11	1,631	393	620	268	917	2,198	3,829
28	Ponderosa pine mixture, small	412	40	110	562	228	8	12	26	274	836
9B	Douglas-fir, small poles	49	36		85		14			14	99
10	Douglas-fir seedlings and saplings	14	61		75						75
24	Fir-mountain hemlock, small	6	10		16		4		45	49	65
28½	Upper-slope mixture, small	4,327	200	6	4,533	29	22	5		56	4,589
25	Lodgepole pine, large	34	44		78		39		5	44	122
26	Lodgepole pine, small	6,493	30		6,523	45	225	43	272	585	7,108
4	Oak woodland						15			15	15
5B	Juniper or mountain mahogany woodland							6		6	6
	Total	27,146	2,032	135	29,313	943	2,058	1,284	3,435	7,720	37,033

TIMBER VOLUME LOST, LOG-SCALE BASIS (M BOARD FEET)

Type No.	Type	Chelan-Colville	Yakima River	North Blue Mountain	Total	North Blue Mountain	Des-chutes River	South Blue Mountain	Klamath Plateau	Total	Grand total
5½	Ponderosa pine woodland	651	4		655	1	54	99	325	479	1,134
20	Ponderosa pine, large	7,176	143		7,319	77	3,747	553	2,583	6,960	14,279
20½	Pure ponderosa pine, large	7,366	613	68	8,047	290	6,209	5,389	8,336	20,224	28,271
20A	Ponderosa pine-sugar pine, large						17		288	305	305
20B	Sugar pine mixture, large								179	179	179
21	Ponderosa pine, small	968	171		1,139	126	9	153	585	873	2,012
27	Ponderosa pine mixture, large	3,654	242	3	3,899	117	145	256	493	1,011	4,910
6	Douglas-fir, large old growth								4	4	4
7	Douglas-fir, small old growth	1,639	92		1,731		53		3	56	1,787
8	Douglas-fir, large second growth	1,042	3,048		4,090						4,090
9A	Douglas-fir, large poles	2,014	36		2,050		1			1	2,051
23	Fir-mountain hemlock, large	1,112	1,309		2,421		56		194	250	2,671
27½	Upper-slope mixture, large	23,067	218	3	23,288	89	329	131		549	23,837
22	Ponderosa pine seedlings and saplings	175	1		176	47	260	76	12	395	571
28	Ponderosa pine mixture, small	2			2	18		2		20	22
9B	Douglas-fir, small poles	3			3						3
28½	Upper-slope mixture, small	41			41	21				21	62
25	Lodgepole pine, large	67	83		150				1	1	151
26	Lodgepole pine, small	328	15		343			6	1	7	350
	Total	49,305	5,975	74	55,354	786	10,880	6,665	13,004	31,335	86,689

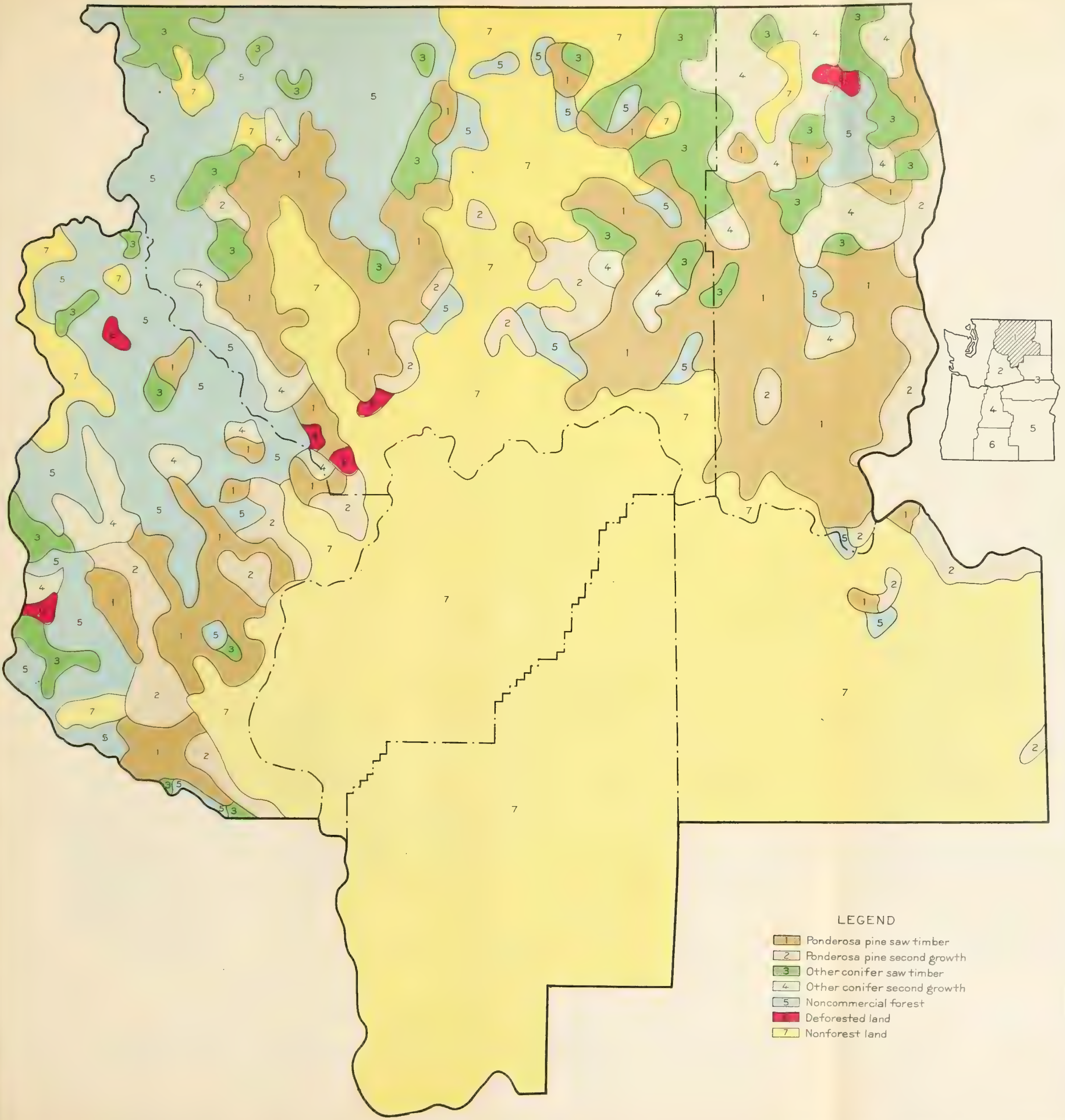
TABLE 42.—*Rates used in calculating potential annual growth of conifer timber in the ponderosa pine region of eastern Oregon and eastern Washington*

Site-quality class	Mean annual growth per acre					
	Ponderosa pine sites				Other commercial conifer sites [3]	
	Timberland [1]		Woodland [2]			
	Total growth	Saw-timber growth	Total growth	Saw-timber growth	Total growth	Saw-timber growth
	Cubic feet	*Board feet*	*Cubic feet*	*Board feet*	*Cubic feet*	*Board feet*
I	85	345			155	875
II	65	255			135	675
III	50	185	17	60	105	475
IV	40	130	13	45	75	275
V	30	90	10	30	45	100
VI	25	55	7	20		

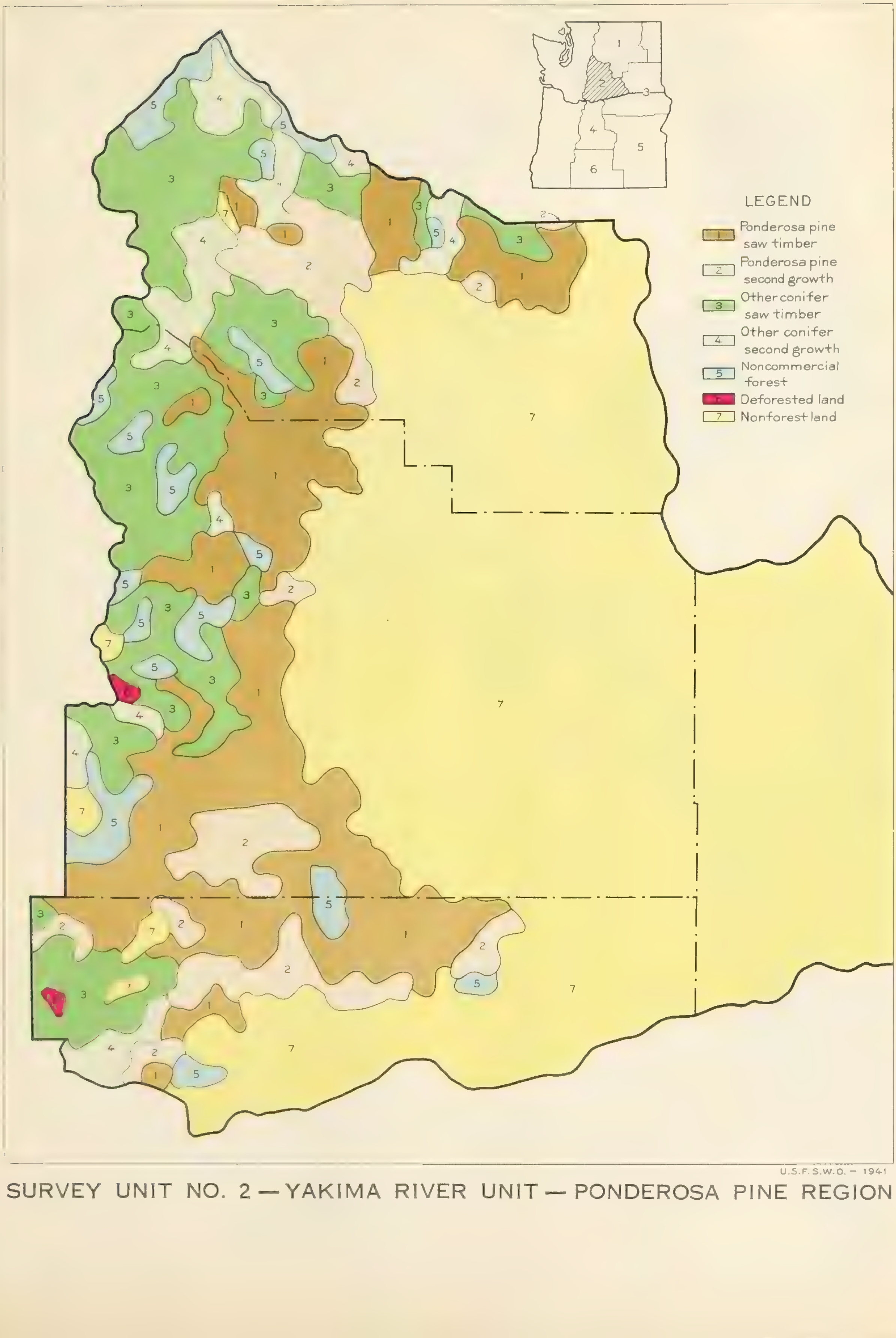
[1] Sixty percent of normal yield-table growth rates to technical rotation age.

[2] Twenty percent of normal yield-table growth rates to technical rotation age.

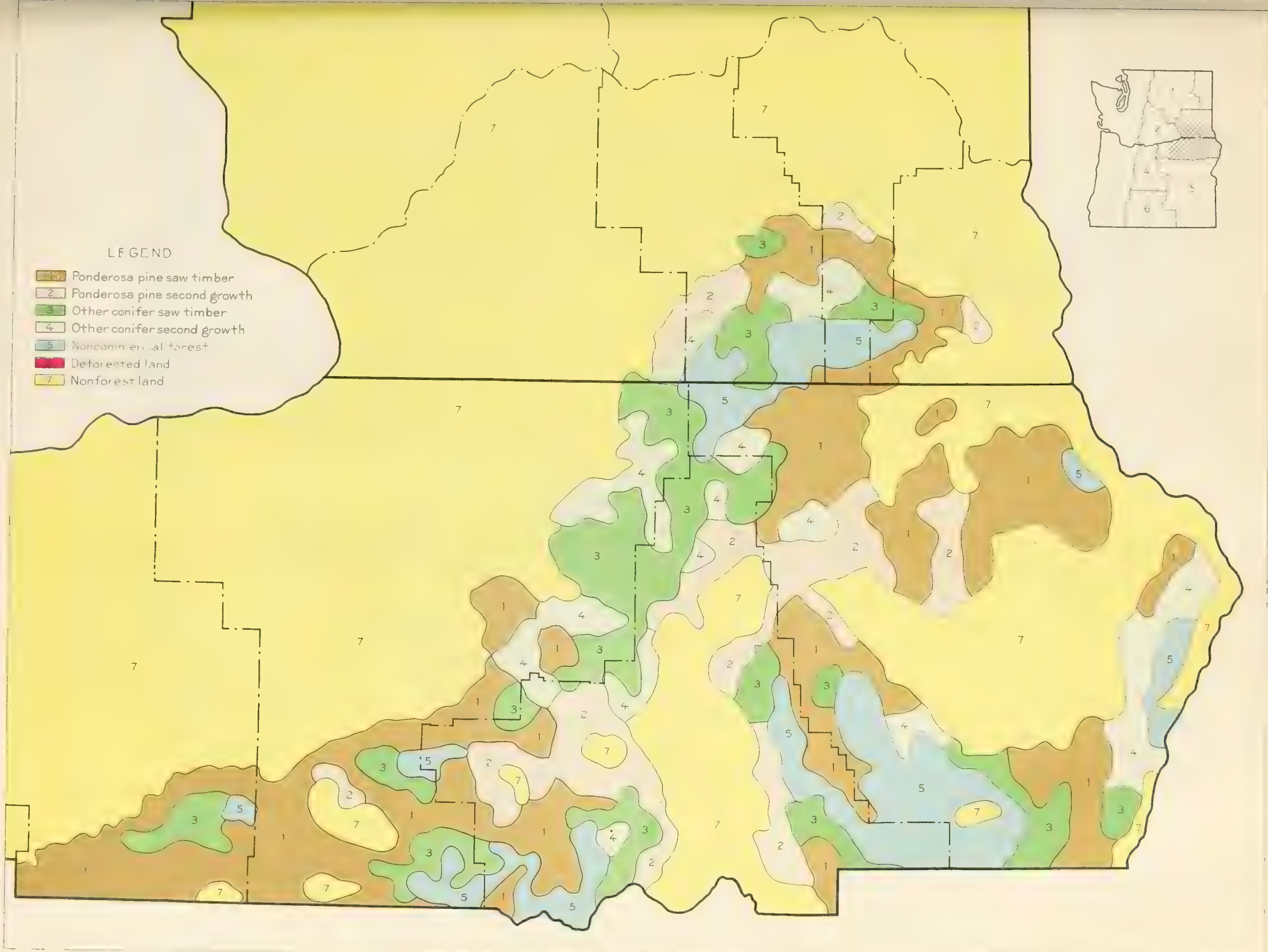
[3] Seventy-five percent of normal yield-table growth rates for Douglas-fir to technical rotation age.



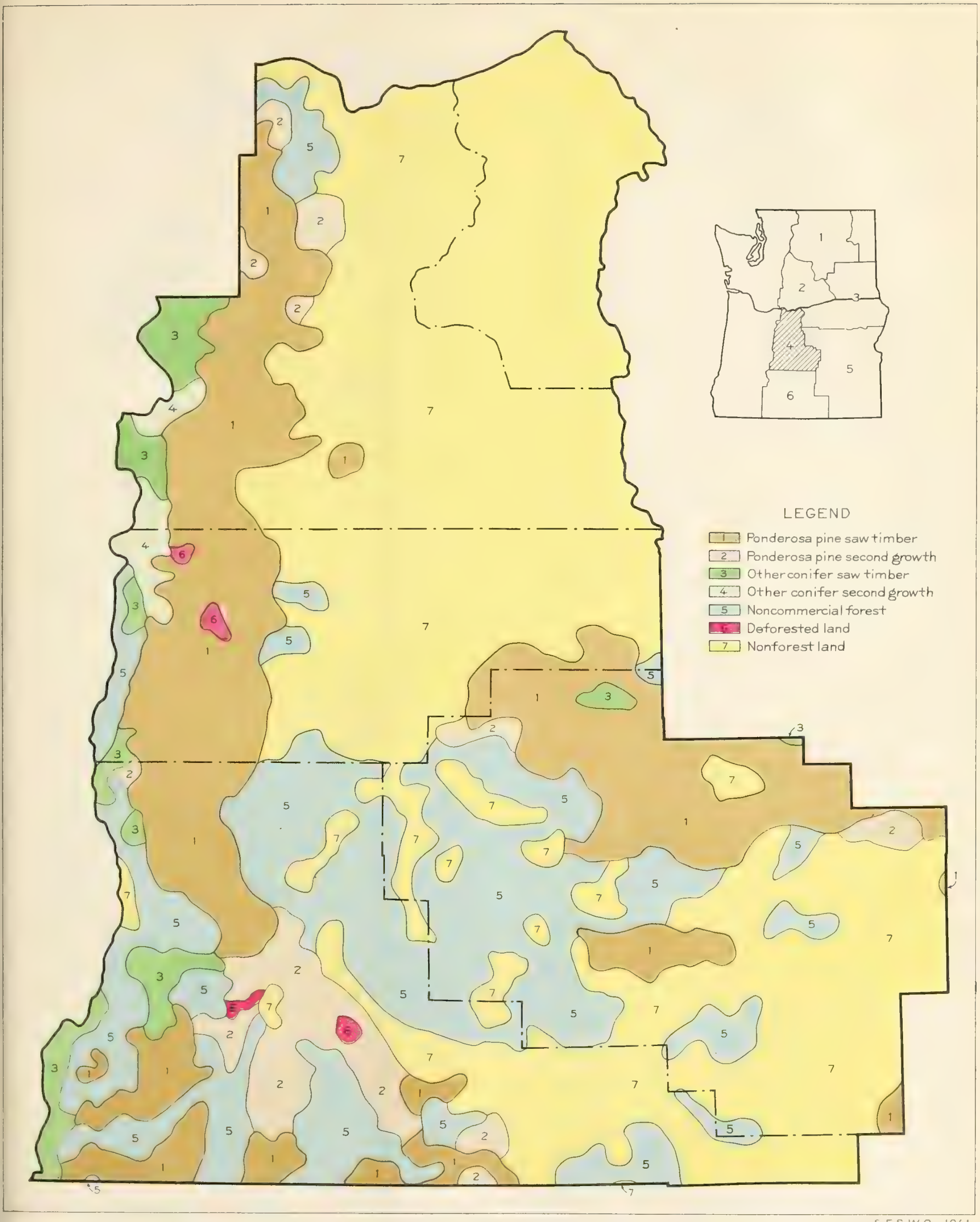
SURVEY UNIT NO. 1 — CHELAN-COLVILLE UNIT — PONDEROSA PINE REGION



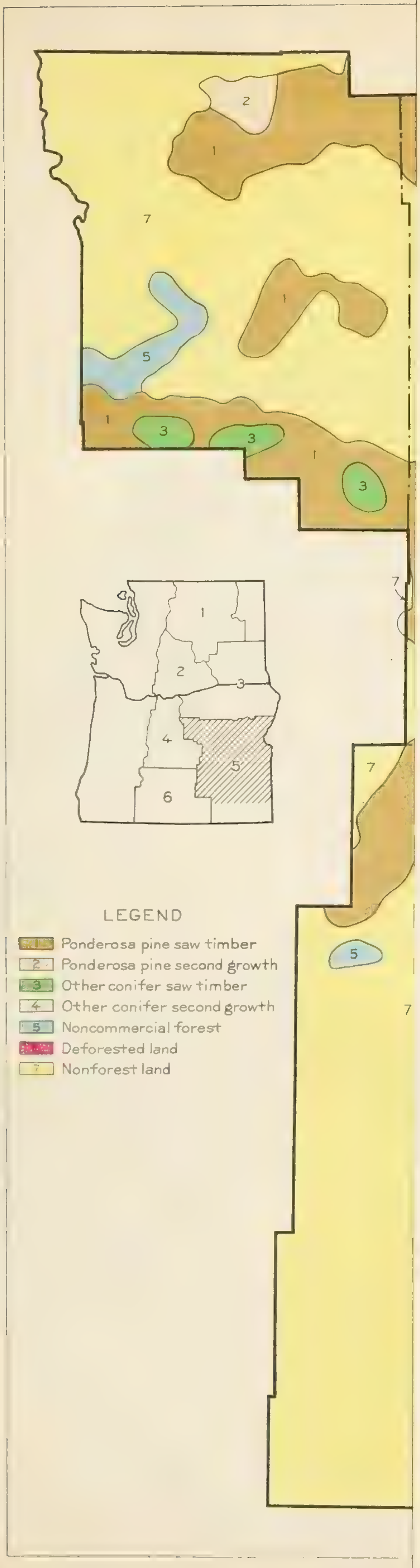
SURVEY UNIT NO. 2 — YAKIMA RIVER UNIT — PONDEROSA PINE REGION



SURVEY UNIT NO. 3 — NORTH BLUE MOUNTAIN UNIT — PONDEROSA PINE REGION

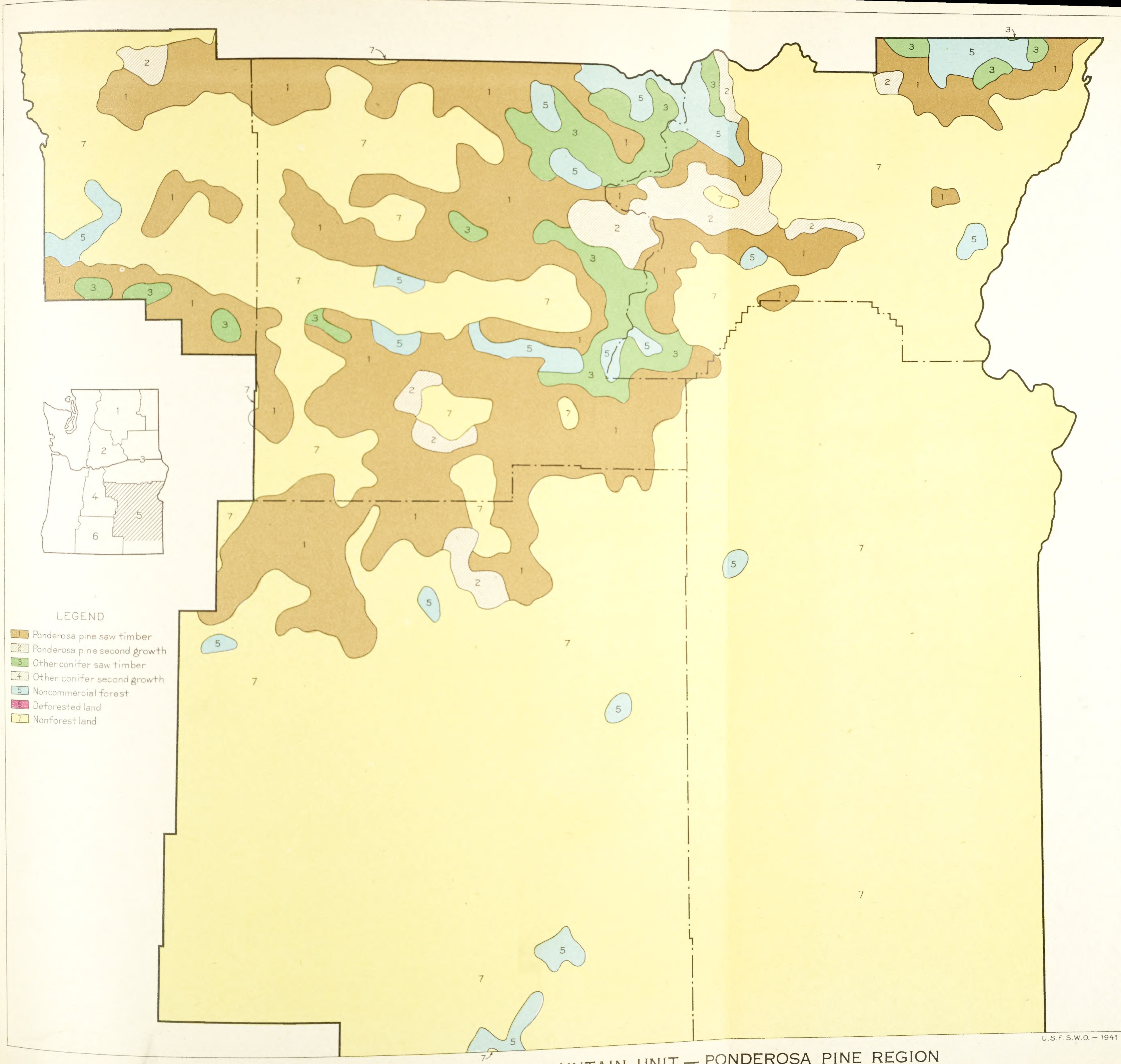


SURVEY UNIT NO. 4 — DESCHUTES RIVER UNIT — PONDEROSA PINE REGION

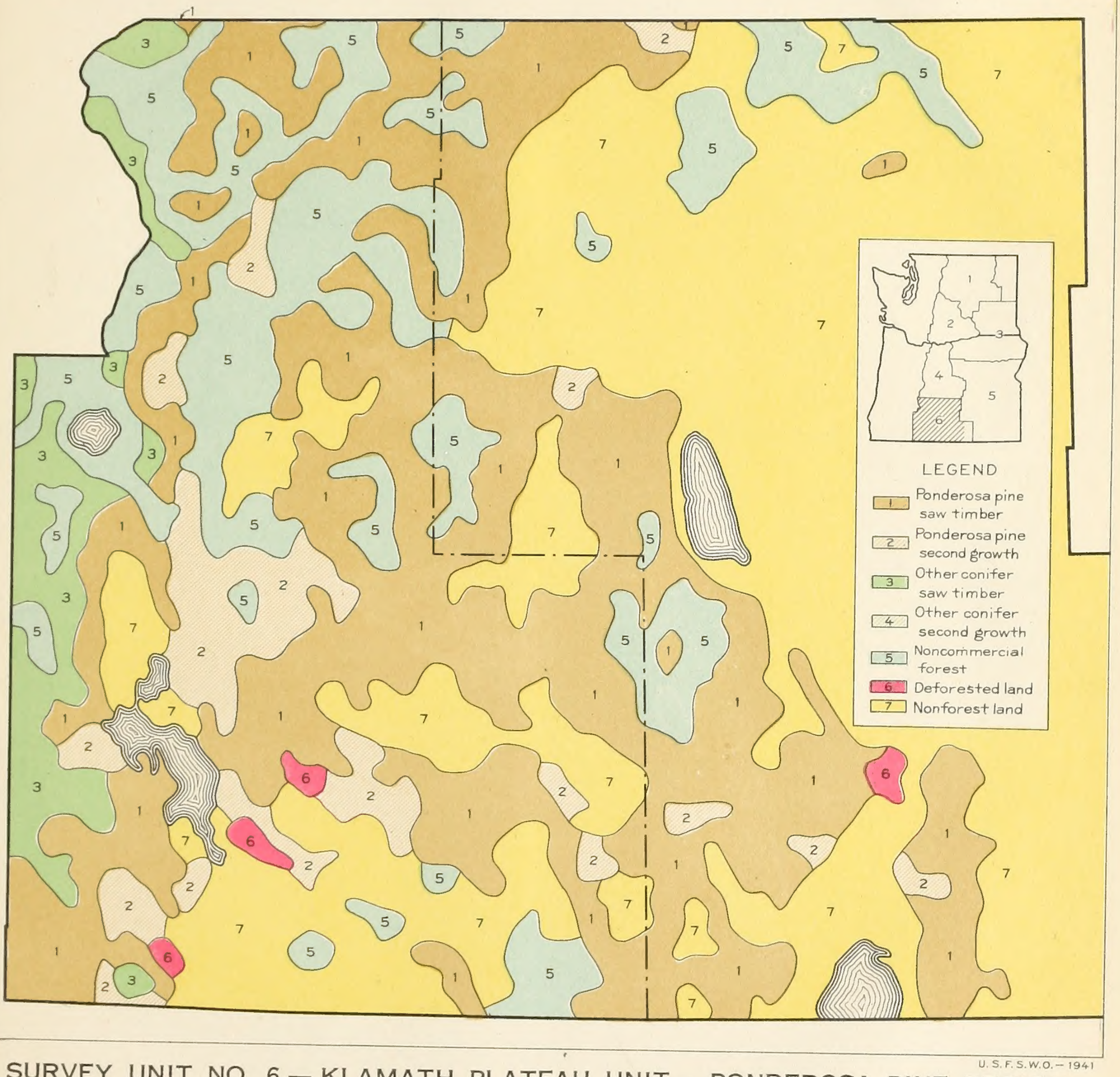


LEGEND
1 Ponderosa pine saw timber
2 Ponderosa pine second growth
3 Other conifer saw timber
4 Other conifer second growth
5 Noncommercial forest
6 Deforested land
7 Nonforest land

SURVEY



SURVEY UNIT NO. 5 — SOUTH BLUE MOUNTAIN UNIT — PONDEROSA PINE REGION



SURVEY UNIT NO. 6 — KLAMATH PLATEAU UNIT — PONDEROSA PINE REGION