

Timber Resources of the Puget Sound Area



Washington

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PREFACE

This report summarizes the findings of the latest inventory of the forests in Island, King, Kitsap, Pierce, San Juan, Skagit, Snohomish, and Whatcom Counties, Washington. Fieldwork on lands outside the National Forests was started in 1966 and completed in 1967. Data from the 1960 inventory were used for San Juan County in this report. Fieldwork on

the north half of the Mount Baker National Forest was done in 1965; the south half was done in 1966. The portion of the Snoqualmie National Forest in the Puget Sound area was inventoried in 1964 and 1965, with the exception of the Cedar River Block which was inventoried in 1961. Inventories previous to the above were completed as follows:

County	First inventory	Second inventory	Third inventory
Island	1932	1959	—
King	1932-33	1941	1960
Kitsap	1933	1940	1959
Pierce	1932-33	1938	1959
San Juan	1932	1960	—
Skagit	1931-32	1957	—
Snohomish	1932	1955	—
Whatcom	1931-32	1957	—

This inventory was conducted by the Forest Survey, a nationwide project of the Forest Service authorized by the McSweeney-McNary Forest Research Act of 1928 and subsequent amendments. The purposes of the Forest Survey are (1) to obtain comprehensive information on timber resources, including the extent and condition of forest lands, the amount and kind of timber growing on these lands, the rate of forest growth and depletion, the amount of timber cut, and probable future trends in timber requirements, and

(2) to analyze and make available survey information needed to formulate forest policies and programs. Resurveys are made periodically to update basic information.

The Forest Survey is conducted in all nine forest regions of the United States by the USDA Forest Service Experiment Stations. The Pacific Northwest Forest and Range Experiment Station at Portland, Oregon, is responsible for the States of Washington, Oregon, California, Alaska, and Hawaii.

SUMMARY

The latest inventory of the forest resources in the Puget Sound area shows a total of 3,300,000 acres of commercial forest land and 74,859 million board feet (International 1/4-inch scale) of sawtimber volume. Since 1953, about 221,000 acres of commercial forest land have been converted to roads, powerlines, reservoirs, agriculture, and urban and industrial developments, and about 65,000 acres have been set aside in parks and other reserved areas. Total sawtimber volume has decreased about 8 percent; softwoods have decreased 11 percent, while hardwoods have increased 71 percent.

About 41 percent of the commercial forest land is in public ownership; 59 percent is private, with forest industries holding 28 percent and farmers and miscellaneous private owners, 31 percent. About 20 percent of the commercial forest land is in old-growth timber, and over half of this is in National Forest ownership. Other public owners have 13 percent of the old growth; forest industries, 28 percent; farmers and miscellaneous private owners, 8 percent.

Douglas-fir is the most extensive forest type* but is estimated to cover only half as much area as it covered in the 1800's before settlement of the Puget Sound area. Over 600,000 acres of logged and burned country now stocked with hardwoods, and many agricultural areas, roads, reservoirs, and town and industrial sites were once Douglas-fir forest. Almost 60 percent of the Douglas-fir type is in private ownership. Western hemlock is the second most extensive forest type and the major type on National Forest lands.

Less than 2 percent of the forest land is nonstocked, a contrast with conditions in 1933 when about 20 percent was nonstocked. This improvement reflects the success of fire control and forestry efforts since the 1930's but is probably more a testimony to the recuperative ability of the forest land in the Puget Sound area. In spite of this improvement in stocking, large areas are occupied by low quality trees. Hardwood types are predominantly in private ownership and cover a greater area than the total commercial forest land on the National Forests; hundreds of thousands of acres now stocked with hard-

woods formerly supported more valuable conifers.

Sixty percent of the commercial forest land is capable of growing 120 or more cubic feet per acre per year. In general, the best tree-growing lands are in the mid-elevations, which are predominantly in State and forest-industry ownership. National Forests and farmer and miscellaneous private owners hold much of the lower quality forest land.

Though Douglas-fir is the most extensive forest type, there is more western hemlock volume — 24 billion board feet of hemlock compared with 21 billion Douglas-fir. This is because much more of the Douglas-fir type is young growth with less volume per acre.

Net annual growth is about 1.4 million board feet, somewhat less than current annual timber harvest. Over the years, the timber cut has shifted from private to public lands and from Douglas-fir to hemlock. Annual mortality averages 130 board feet per acre and is highest on National Forest and forest-industry lands, which include about 80 percent of the old-growth timber. Hemlock accounts for one-third of the mortality and true firs for one-fifth. About 15 percent of the mortality is Douglas-fir.

The low country between the foothills of the Cascades and Puget Sound is rapidly being urbanized and industrialized. The Washington State Department of Natural Resources has classified State-owned lands into resource zones for the present, for 1980, and for 2000. Though applicable only to State lands, the projections were based on expected uses of all lands, using past trends as a guide. Within the Department's Year 2000 Urban Zone in the Puget Sound area are an estimated 1,154,000 acres of commercial forest land, about 35 percent of the total in the eight counties, and 11 percent of the total in western Washington. Included are nearly half on the Douglas-fir acreage and 43 percent of all young-growth stands in the Puget Sound area. If these lands are converted to nonforest uses, total potential production of timber may be reduced by 30 percent.

**Definitions of technical terms are found beginning on page 67.*

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Figure 1. — The Puget Sound country has been called “The Charmed Land.”

INTRODUCTION

This report is concerned with the timber resources of eight counties in western Washington — Island, King, Kitsap, Pierce, San Juan, Skagit, Snohomish, and Whatcom. Island and San Juan Counties consist of several islands in Puget Sound. Kitsap County is basically a peninsula connected to the larger Olympic Peninsula west of the Sound. The remaining five counties are on the mainland. Their western limits form the east shore of Puget Sound; their eastern limits follow the crest of the Cascade Mountains. Mount Rainier, in Pierce County, marks the south end of the area; Mount Baker, in Whatcom County near the Canadian line, marks the north end (fig. 1).

The eight counties make up about 16 percent of the total land area in the State but have 62 percent of the State's population. Several of the State's larger cities are in this area, including Seattle, Tacoma, Bremerton, Everett, and Bellingham. The average population density is about 190 persons per square mile, but even in the most populous counties there are extensive areas of sparsely populated land. In general the population is concentrated along the Sound and in the river valleys. Many mountain areas are completely without permanent residents.

Forests form the dominant natural vegetative cover over most of this area, extending from sea level to timberline which ranges from

about 5,000 to 6,000 feet in elevation. The forests have been and still are one of the area's most important resources.

The forest resource data presented in this report and the discussions of forest area, volume, growth, and cut relate to the supply of wood available to meet regional and national needs. The information in this report is presented for the use of legislators, local and regional planners, investors, forest industry managers, and others interested in the timber situation.¹ Some of the information in this report — the discussion of forest land losses and the supporting data, for example — may be useful to people who are not interested in timber production but are concerned about the changes taking place in the Puget Sound landscape.

¹*Besides timber, several other products are harvested from commercial forest lands in the Puget Sound area and sold on the market. The floral greenery industry provides full- and part-time work for hundreds of people. In 1969, about \$540,000 worth of evergreen huckleberry, salal, swordfern, Oregongrape, and Scotch broom were gathered and sold in the eight counties. Other products include cascara bark, fuelwood, small roundwood for posts, cabin logs, flatcar stakes, mine props and hop poles, and forest seed cones (Douglass 1970).*

Information on recreation, watershed, and other uses of forest land is available from the Pacific Northwest Forest and Range Experiment Station.

BACKGROUND

About 125 years ago, a few settlers established homes at Fort Nisqually, a Hudson's Bay Company trading post near the south end of Puget Sound. These early settlers found tall, dense evergreen forests reaching from salt water to the mountains. The only natural openings were lakes, bogs, stream beds, and a few gravelly prairies. The settlers started to clear the land for farming and to obtain material for building their homes. Though much of the land near Puget Sound was flat enough to farm, the soils in most areas were gravelly and did not prove suitable for agriculture, despite the lush forest vegetation they supported. Only the river valleys produced a return for the farmers' efforts. Many pioneers who came to the Puget Sound country to farm became loggers.

In 1847, the year before Oregon (which then included what is now Washington State) was admitted by Congress as a territory, a sawmill was built at Tumwater, near present-day Olympia. In 1850-51, a settlement was established at Alki Point, the beginning of Seattle. The 1849 gold rush created lumber needs in California, and, in response to this and local needs, Henry Yesler built a steam sawmill in Seattle in 1852 which cut about 15,000 board feet a day. In 1853, Captain Andrew Talbot, originally from Maine, built a sawmill at Port Gamble near the confluence of Hood Canal and Puget Sound in what is now Kitsap County. This was the beginning of the Pope and Talbot Company in the Pacific Northwest, which still exists today with a mill operating at its original location in Port Gamble. A sawmill was also established in 1853 by Captain Henry Roeder on Bellingham Bay in what is now Whatcom County. By 1854, about three dozen sawmills

on the Sound were producing lumber and loggers were felling trees — Douglas-fir, western redcedar, and some Sitka spruce — near tide-water and yarding the enormous logs by ox team. Lumbering became the principal industry, though the market was limited to the west coast and Sandwich Islands (Hawaii) until the transcontinental railroads reached Seattle (1889 to 1909) and the Panama Canal was opened in 1914.

Three major railroads tapped the Puget Sound area, and they were important to the timber industry in that they expanded lumber markets and one of them was granted vast tracts of forest land, some of which later became large timber company holdings. Some of these early grant lands are still in railroad company ownership and are intermingled with National Forest lands in a broad checkerboard pattern.

Lumbering increased and the forests were logged off in the lowlands near the Sound, up the fingerlike river valleys, and on the foothills west of the high mountains. Thousands of acres of timber were claimed by fires during this same period, and many cutover areas burned two, three, or more times. More settlers tried to farm the cutovers, and "stump ranches" appeared throughout the low hills near the Sound. In time, most of the hillside farms in the low country were abandoned, and the cutover and burned-over lands slowly began to reforest, helped along by tree planting programs begun in the 1930's. Many of the timber stands now found in the low country of the Puget Sound area began this way.

Lumbering was Puget Sound's major industry during the first quarter of the 20th century. In 1925, lumber production totaled 3.6 billion

board feet, then declined steadily to a little over 1 billion board feet in 1945. Though the pulp and paper industry had already gotten its start with the Puget Sound Pulp and Paper Company (now Simpson-Lee) at Everett in 1891, significant expansion of this industry came in the 1920's (Hall 1969). A kraft mill was built at Tacoma and sulfite mills at Anacortes, Bellingham, and Everett. Sawmill wastes made up a large portion of the resource used by the pulp industry in these early years (Andrews and Cowlin 1940). As the pulp and paper and plywood industries grew in the Puget Sound area, the lumber industry moved southward in search of a cheaper, more dependable supply of Douglas-fir logs. The pulp industry turned increasingly to logs and pulpwood for raw material — hemlock and spruce were the principal species.

In 1916, labor unions were fighting a vigorous and ultimately successful battle to upgrade working conditions in the logging camps and mills in the Puget Sound area. During the same year, an event occurred which would change the industrial climate of the Puget Sound area and possibly do more to influence development than any other single factor. William Boeing, who had been making private planes in a small Seattle plant, was asked by the Government to build aircraft for use in World War I. This was the beginning of the Puget Sound aerospace industry, which, though subject to economic and employment fluctuations, is now the area's number one industry.²

The forest products industry, though far from number one now, is still one of the more important economic factors in the Puget Sound area.³ Forest products are shipped from Puget Sound mills to worldwide ports, and the industry is the main supporting payroll of many communities. There are now about 148 forest products mills in the eight-county area, including about 65 sawmills, 45 shake and shingle mills, a dozen veneer and plywood mills, 8 pulpmills, and a number of pole and piling yards and log export centers. Although several mills have been in operation 60 years or longer, some new mills have been established within the past 5 years. Some of the older mills have recently been remodeled to increase efficiency and handle smaller logs from the second-growth forests.

The Puget Sound area has had all the elements needed for industry. Its assets include abundant fresh water, deep water ocean ports, a relatively inexpensive source of power, a well-developed transportation system, favorable access to oriental markets, a variety of local resources, and access to resources from the Inland Empire and the Columbia Basin, as well as Alaska and Canada. Much of the Alaska fish industry is headquartered in Seattle, and oil from the recently discovered North Slope oil fields is expected to augment the flow of crude oil to the four existing Puget Sound refineries. (Another refinery is being built in Whatcom County.) Other industries have moved into the Puget Sound area recently, including an aluminum plant in Whatcom County, which has attracted many people to the north end of the Sound. Shipbuilding has been important on the Sound since 1874 when ships were built for the west coast lumber trade. The naval shipyard at Bremerton and a number of private shipyards have been important to the local economy for decades, particularly during war times. The building of small pleasure craft is a growing industry and will probably grow even more in the future if leisure time and affluence increase.

While the Puget Sound area has many industry-drawing factors, it is attractive in other ways. Few areas in the world can match the Puget Sound country for natural beauty, variety of scenery, and diversity of outdoor recreation opportunity (fig. 1) — from mountain climbing, hiking, and skiing thousands of feet above sea level to canoeing in the many lakes and streams, clamming on the beaches, and diving for octopus in the Straits of Juan de Fuca.⁴ The outdoor equipment industry has flourished; outdoor clubs number their members in the hundreds and thousands. Tourism and

² In 1969, the aircraft and parts manufacturing industry employed about 91,000 people, 16 percent of total reported employment in the Puget Sound area (State of Washington 1968).

³ In 1969, the forest industries in the Puget Sound area employed about 22,000 people, roughly 4 percent of total employment and 35 percent of total employment by forest industries in the State.

⁴ Within the eight-county area are two National Parks, two National Forests, and many State and county parks.

tourist-catering businesses are growing. The new highway across the North Cascades — expected to open in 1972 or 1973 — and the new North Cascades National Park and Ross Lake National Recreation Area will increase the tourist traffic on both sides of the mountains and no doubt will affect businesses and land managers in the area. The many “amenity resources” of the Puget Sound area also draw industries that are not dependent upon proximity to either markets or raw materials simply because the area is a nice place for people to live.

Industrial expansion, population growth, and the outdoor recreation boom are rapidly changing the character of the Puget Sound area. As in many other areas in the country, thousands of acres of open country are annually being converted to housing developments, highways, and industrial sites. Industries may

find further expansion difficult because of limited land, water, power and raw material resources, increasing pollution problems, and perhaps in some cases simply because people do not want the industries to expand for fear of losing other values. Of the many industries caught up in the conflict over allocation of resources, the timber industry is probably the outstanding example. Thousands of acres of forest land are being taken out of timber production each year for residential, commercial, and industrial development. Recreational pressure on remaining forest lands is increasing, and the public is demanding that more forest area be reserved from timber cutting. Our need for timber, our need for places to build houses for people, and our need for open space and natural beauty — all very real — are growing, yet the resources for supplying these needs are declining.

FOREST LAND

Almost 49 Percent of Area, or 3.3 Million Acres, Is Commercial Forest Land

The eight counties of Island, King, Kitsap, Pierce, San Juan, Skagit, Snohomish, and Whatcom have a total land area of 6,753,000 acres. Of this, 4,863,000 acres or 72 percent is forest land, and 3,300,000 or 49 percent is commercial forest land.

Over 1 million acres of forest land are classified as noncommercial because of low productivity, rugged terrain, and adverse location. Over 500,000 acres of physically productive forest land are reserved from cutting and are also classified as noncommercial. Included in this reserved category are the forests in Mount Rainier and North Cascades National Parks, Ross Lake National Recreation Area, National Forest wilderness and natural areas, and numerous State and county parks. Also included as productive-reserved are 13,000 acres of Christmas tree lands in Kitsap and Pierce Counties.⁵ For the purpose of this report all lands in San Juan County outside the parks are also considered productive-reserved. Forest land in the San Juan Islands is of low productivity, and an increasing acreage is being developed for residential and recreational purposes; the timber potential of the islands is considered negligible. In 1960, there were an estimated 76,000 acres of commercial forest land in San Juan County.

The commercial forest acreage for King County shown in the tables in this report does not include 49,000 acres of suburban forest tracts in the Seattle area west of a line running north and south through Lake Sammamish and extending the full width of the county. This area is rapidly being urbanized and is classified as nonforest in this report.

Commercial Forest Area Is Decreasing

The total commercial forest area shown in the previous county inventories for the Puget Sound area cannot be compared directly with the current estimate because of changing standards and definitions. In order to ascertain what has been happening, we compared given areas on current photographs with the same areas on photographs used in early inventory work, noting both losses and gains of forest area, and gathered what information was available on acreages of new roads, powerlines, reservoirs, and other forest clearings, as well as records of recently created reserved areas. The results indicated that since 1953 about 165,000 acres of commercial forest land outside the Seattle urban zone have been converted to roads, powerlines, reservoirs, agricultural use, and urban and industrial developments (fig. 2). About 56,000 acres within the Seattle urban zone have been converted to nonforest. Over 300,000 acres of National Forest land (mostly on the Mount Baker National Forest) that had been classified as commercial in the previous inventory have been reclassified as noncommercial. These areas are steep, rocky, unstable, and include isolated pockets of timber on mountain benches and other inaccessible sites (fig. 3). About 65,000 acres of commercial forest land outside San Juan County were set aside in parks and other reserved areas.⁶

⁵In 1969, about 567,000 Christmas trees were produced in Kitsap and Pierce Counties, mostly Kitsap. Douglas-fir was the major species (Douglass 1970).

⁶Creation of the North Cascades National Park and Ross Lake National Recreation Area had relatively little effect on the commercial forest land area, because most of the park lands had been National Forest wilderness areas and were already classified as noncommercial.



Figure 2. — Since 1953, about 221,000 acres of commercial forest land in the Puget Sound area have been converted to other uses such as powerlines and agriculture. The powerline right-of-way is in Snohomish County near Granite Falls. Powerline clearings are being used increasingly for Christmas tree production, especially on poorer, gravelly soils where tree growth is slow enough to produce desirable trees. More lands under powerlines could be used for low crops such as blackberries, filberts, fenceposts, and floral greenery. The cleared field is in Whatcom County near Acme.



Figure 3. — Private land bordering public land in the Stillaguamish River Valley, near Darrington in Snohomish County. The farmer-owned “stump ranch” and the bordering hardwood stands occupy old cutover lands in the low country. The front of tall fir timber on the slope marks the boundary of the Mount Baker National Forest. Productive conifer lands grade into steep noncommercial lands sliced by avalanche trails. On the lower slope young conifer timber is encroaching on the hardwoods near the tall timber.



Figure 4. — Looking east over the town of Mount Vernon and the Skagit River Valley, Skagit County — farmer and miscellaneous private lands are in the low country near transportation routes and urban areas, forest industry and State-owned lands in the foothills, National Forest lands in the higher mountains. (Photo courtesy of Washington State Department of Natural Resources.)

About 40 Percent of the Commercial Forest Land Is in Public Ownership

The Mount Baker and Snoqualmie National Forests have 748,000 acres of commercial forest land in the Puget Sound area. Commercial forest area on other public lands, which include Fort Lewis and other military holdings, several Indian reservations, many county- and city-owned tracts, and State of Washington lands (Forest Board, County Trust, school lands, etc.), totals 613,000 acres.

Forest industry owners have 910,000 acres of commercial forest land, or about 28 percent of the total in the Puget Sound area. Farmers and miscellaneous private owners have 1,029,000 acres or 31 percent of the total.

The National Forests are in the higher elevations in the eastern portion of Pierce, King, Snohomish, Skagit, and Whatcom Counties. With a few exceptions, forest industry lands and most of the larger blocks of State lands

are in the intermediate elevations just west of the National Forests (fig. 4). There is a checkerboard pattern of ownership throughout much of the Snoqualmie National Forest in King County, with alternate sections owned by Weyerhaeuser Timber Company or the Burlington Northern Railroad. In the Cedar River drainage, the city of Seattle owns several thousand acres of land within the general boundaries of the National Forest.

The U. S. Forest Service and the owners of lands within the National Forest boundaries have been consolidating their lands through an exchange plan. In 1968, for example, several parcels of Forest Service land near Chester Morse Lake were transferred to the city of Seattle in exchange for city of Seattle land in other counties.

In general, the farmer and miscellaneous private lands are located in the lower elevations near the Sound,⁷ on islands in the

⁷The "Sound" as used here includes all salt-water straits, inlets, passages, and bays from the mouth of the Nisqually River in the south to the Strait of Georgia in the north.

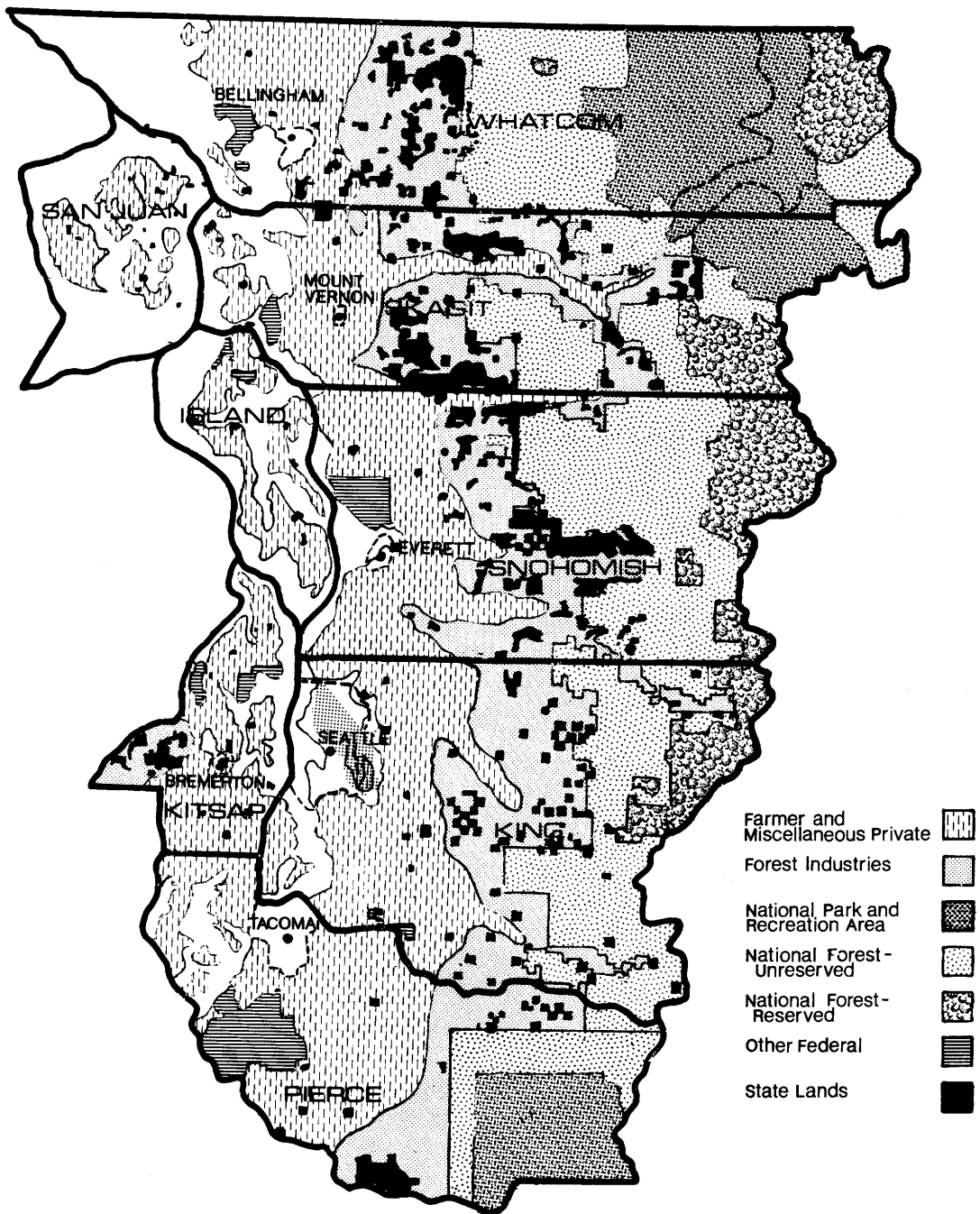


Figure 5. — Map of Puget Sound area showing generalized ownership boundaries.

Sound, and in the east-reaching valleys of the major rivers (figs. 3 and 4). Military lands are mostly in the low elevations, and Indian lands are adjacent to the Sound or major rivers (fig. 5).

About 20 Percent of the Commercial Forest Land Is in Old-growth Timber

Sawtimber stands 140 years or older occupy 628,000 acres, over half of which are on the National Forests (fig. 6). Other public owners have 13 percent of the old growth, forest industries 28 percent, and farmer and miscellaneous private owners 8 percent.

Over 40 Percent of the Commercial Forest Land Is Stocked With Small Young Growth

Over 40 percent of the commercial forest land is stocked with even-aged stands under 40 years old. Some of the young stands in the low country near the Sound represent the third crop of trees since the first lumber mill was established in 1847.

A considerable area of forest land near Tacoma, Seattle, and Everett was cut over prior to 1920 and burned several times after logging. Much of this land became tax delinquent and reverted to the counties, then was later purchased by individuals and timber companies. Some of these cutover and burned-over tracts are now residential areas; those still rural are generally well stocked with trees because of forest fire control over the past three decades and the ability of the land to restock when fire is kept out. A large area, however, is stocked with poor quality trees (fig. 7). Some of the cutover and burned-over lands in the low country have been planted to trees since the 1930's, when many reforestation projects were initiated.

The State of Washington has also acquired large areas of tax-delinquent cutover and burned-over lands, mostly in the foothills and midslopes of the Cascades. The Department of Natural Resources now has an active tree planting program for restocking State lands.

The National Forests have not had the long history of logging that has characterized the private and State lands in the low country and



Figure 6. — Old-growth sawtimber stands occupy 628,000 acres in the Puget Sound area. This old-growth Douglas-fir stand is on the Mount Baker National Forest. National Forests own over half of the old-growth timberland.



Figure 7. — Extensive areas of forest land are producing far below their potential. This area in Snohomish County was apparently logged in the 1920's. It once grew very large Douglas-fir timber but for decades has been poorly stocked with low quality hardwoods, a few scraggly cedars, brush, and bracken fern.

much of the midslopes. However, they do have a considerable area of young growth — 108,000 acres of even-aged stands less than 40 years old and 192,000 acres less than 100 years old. Some logging on both the Mount Baker and Snoqualmie National Forests was done before 1920, though not until World War II did timber harvest reach 100 million board feet a year on either forest. (In 1968, the combined harvest on both forests in this area was 390 million board feet.) Extensive areas of large second-growth timber occupy the old “railroad burns,” which occurred during the 1890's and early 1900's when the railroads were being built through the mountains. The National Forests have acquired some cut-over land in the past through exchange — and have been planting trees on burned and cut-over areas since the 1930's.

**Douglas-fir Is the Most
Extensive Forest Type,
Covering About 30 Percent of the
Commercial Forest Area**

In the eight-county area, there are 1,018,000 acres of Douglas-fir type. This for-

est type occurs from sea level to the middle slopes in the Cascades, but it is most extensive on the gravelly glacial deposits near the Sound and in the foothills (figs. 8 and 17). The higher elevations are forested predominantly with hemlock and true firs.

**About 60 Percent of the
Douglas-fir Type Is in
Private Ownership**

Private owners have 598,000 acres or 59 percent of the Douglas-fir type; 236,000 acres or 23 percent is on timber company land, and 362,000 acres or 36 percent is on farmer and miscellaneous private land. National Forests have 163,000 acres or 16 percent, and other public owners have 257,000 acres or 25 percent.

Much of the land cleared for agriculture and town sites was originally forested with Douglas-fir, and over 600,000 acres of logged and burned-over country now stocked with hardwoods supported Douglas-fir in the 1800's (fig. 7). It is reasonable to say that Douglas-fir type once covered twice as much land in the Puget Sound area as it does today.

Figure 8. — Young-growth Douglas-fir on glacial till, low country in King County near Auburn. Soils on glacial material in the Puget Sound area are not the best for tree growth, though in general support well-stocked conifer stands. The better residual and alluvial soils in the low country often support hardwoods.



Figure 9. — Western hemlock type covers 882,000 acres in the Puget Sound area and is the most extensive forest type on National Forest lands.

Western Hemlock Is the Second Most Extensive Forest Type, Covering 27 Percent of Commercial Forest Area

Western hemlock type occurs on 882,000 acres of commercial forest land (fig. 9). It is found mostly in the middle and upper elevations of the Cascade Mountains and for this reason is the predominant type on the National Forests, occupying 40 percent of their total commercial forest area. About 20 percent of other public and 24 percent of private commercial forest land are stocked with western hemlock. Over 70 percent of the privately owned hemlock type is on forest industry land.

Upper Slope Types Cover 11 Percent of Commercial Forest Area

Mountain hemlock, true fir (Pacific silver, noble, and subalpine firs), Alaska-cedar, and Engelmann spruce types cover 362,000 acres. These types cover the higher forested slopes of the mountains, grading into western hem-





Figure 10. — Stands of tall, well-formed black cottonwood grown in narrow belts and small groves along streams in the Puget Sound area, on lands that are often too wet for farming or development. Properly managed, the areas could produce a considerable volume of wood fiber and at the same time protect the streamside environment. This stand is in Pierce County near Orting.



Figure 11. — Thousands of acres of commercial forest land are occupied by low quality trees, such as this bigleaf maple sprout clump near Rockport in Skagit County.

lock at the lower end of their range and straggling out into alpine meadows in the high mountains. The forests near timberline on Mount Baker, Mount Rainier, and Glacier Peak are examples of these upper slope types.

Pacific silver fir is by far the most extensive type in this group, covering 275,000 acres and ranging the length of the Cascade Mountains in the Puget Sound unit. Noble fir is rarely found as a forest type in this area but rather as an individual tree or in pockets of trees in stands of other true firs or hemlock. Noble fir apparently does not occur north of Snohomish County. Subalpine fir type is generally confined to the highest forested areas and Engelmann spruce and Alaska-cedar to moist basins in the high mountains. Mountain hemlock type is more widely distributed and often grades subtly into western hemlock on cool, moist mountain slopes. It appears to occur at lower elevations in the north end of the area than in the south.

The upper slope types have been relatively unimportant from a timber standpoint but are of inestimable value for watershed protection and for their beauty. During recent years, some logging of upper slope types has been done, and it is possible that increasing demands for timber and loss of forest land in the lower elevations will necessitate more intensive use of these forests. The sites on which these types occur are relatively low in productivity, the growing season short, and the land often steep and rocky. Considerably more than an acre of upper slope land is required to produce what an acre in the lower elevations can produce.

Hardwood Types Cover 765,000 Acres or 23 Percent of Commercial Forest Land

Hardwood stands occupy 765,000 acres, more than the total commercial forest land in the National Forests in this area. Hardwood types occur almost exclusively in the low elevations in the western part of the Puget Sound area. Nearly 90 percent of the hardwood area is in private ownership. National Forests have 15,000 acres or only 2 percent of the hardwood area, and these are in river valleys such as the Skagit, Suiattle, and Sauk.



Figure 12. — About 650,000 acres of commercial forest land in the Puget Sound area, that once supported conifer timber, are now stocked with hardwoods. This farmer-owned red alder stand has an unusually well-stocked understory of western hemlock and western redcedar that will eventually take over as the alder dies out. Snohomish County near Oso.

Other public owners have 82,000 acres of hardwoods or 11 percent of the hardwood area.

The principal hardwood type is red alder, which occupies 542,000 acres. Bigleaf maple is the second most extensive hardwood type, occupying 120,000 acres. Other hardwood types found in the Puget Sound area include black cottonwood, Oregon ash, Oregon white oak, Pacific madrone, and, from Snohomish County northward, paper birch. Red alder and black cottonwood stands currently have the greatest value. Red alder stands in general do not produce large volumes per acre. Some stands may yield as much as 30,000 board feet, but 10,000 or less is more common in this area. Red alder trees rarely exceed 90 feet in height and 20 to 25 inches in diameter.

Black cottonwood, though limited in occurrence, often grows to large sizes. Forty- to seventy-year-old stands of black cottonwood, with trees up to 140 feet tall and 30 to 50 inches in diameter, grow in many of the river

valleys, often in narrow belts and small groves in lowlands too wet for farming or subject to annual flooding (fig. 10). These areas, if not developed for other uses, could possibly produce a substantial amount of wood annually.

Ash, oak, and maple, though having some commercial value, are of little importance in the Puget Sound area. Stands of these species in this area are often poor in quality with cull trees predominating (fig. 11).

About 650,000 Acres Now Stocked With Hardwoods Have Grown Conifers in the Past

Early logging and forest fires removed conifers — mostly Douglas-fir — from extensive areas in the low country of the Puget Sound area, leaving few conifer seed trees. Light seeded red alder, willow, paper birch (in the northern part of the area), and other hardwoods became established in these areas, grew rapidly, and completely dominated the sites (fig. 12). Some logged or burned areas re-



Figure 13.—Most logged areas on public and forest industry lands are restocked promptly. Aerial seeding of Douglas-fir. (Photo courtesy of Washington State Department of Natural Resources.)

stocked with a mixture of hardwoods and conifers. In many such stands, especially on farmer and miscellaneous private lands, the conifers were cut when they reached merchantable size, but the hardwood trees were left. This type of cutting in the second-growth stands has resulted in forests of crooked, broken, low-value hardwoods on private land in the low country. Now that red alder has commercial value, alder trees are being cut in some areas, but the bigleaf maple and other

low value hardwoods are often left to control the site and prevent establishment of conifers or a new crop of red alder, both of which require full overhead light for seedling development.

Timber companies and some public land-owners have been replacing hardwood stands with conifers, but most of the hardwood area is in farmer and miscellaneous private ownership. These owners of small forested tracts are often not interested in investing in timber stand improvement, and a very large number are planning to sell their land or develop it for residential, commercial, or other nonforest uses.

Less Than 2 Percent of the Forest Land Is Nonstocked

The survey found 53,000 acres of commercial forest land that were less than 16 percent stocked with growing-stock trees. This is not a great deal more than the 30,000 to 40,000 acres that are being clearcut annually, indicating relatively successful reforestation on most lands (figs. 13 and 14). The present low acreage of nonstocked lands contrasts sharply with the situation that existed in 1933, when about 850,000 acres or nearly 20 percent of the forest land was nonstocked. Now less than 2 percent of the area is nonstocked, a comment on the success of forest fire control and forest management since the 1930's, but probably more, a testimony to the recuperative ability of the forest land in the Puget Sound area.

Sixty Percent of the Commercial Forest Land Is Capable of Growing 120 Cubic Feet or More Per Acre

About 2 million acres, or 60 percent, of the 3.3 million acres of commercial forest land in the Puget Sound area is capable of growing 120 cubic feet or more per acre per year (see table 7).⁸ Of these 2 million acres, about 58 percent is in private ownership and 42 percent in public ownership.

In general, the low elevation forest lands between the foothills of the Cascade Mountains and the Sound are not the best tree-growing sites in the area, though comparatively few areas in the world outside the Northwest can match them. Much of the low coun-

try outside the river valleys is covered by a mantle of glacial till (fig. 8) especially in the south portion of the area and on the Kitsap Peninsula and Whidbey Island. The soils are gravelly and tend to become droughty in the summer. Much of the fertile river bottom land is now used for agriculture or urban and industrial sites. Though farmer and miscellaneous private lands — predominantly low country between the foothills and the Sound — include 555,000 acres or 28 percent of the land capable of growing 120 or more cubic feet per acre, they have only 128,000 acres or 16 percent of the land capable of growing 165 or more cubic feet per acre. Forest industry lands — concentrated in the mid-elevations — include 265,000 acres or 34 percent of the land capable of growing 165 or more cubic feet per acre, and 66,000 acres or 40 percent of the land capable of growing 225 or more cubic feet per acre. Forest industry and other public lands⁹ combined — in other words, most of the foothill and midslope country — contain 431,000 acres, or 55 percent of the land capable of growing 165 or more cubic feet per acre. National Forests have 227,000 acres or about 29 percent.

The poorer sites are mostly in National Forest and farmer and miscellaneous private ownership, these two ownerships combined holding 354,000 acres or about 65 percent of the land incapable of producing 85 or more cubic feet per acre per year. The low site National Forest lands are in the higher mountains.

The average productive capacity for all owners combined in all counties is about 131 cubic feet per acre per year, or roughly 650 board feet. Public lands have a slightly greater average productive capacity than private lands — 132 cubic feet per acre for public owners, 130 cubic feet per acre for private owners.

⁸In terms of McArdle's Douglas-fir yield tables, this is about site index 130 and higher. The cubic-foot classification makes possible comparison of different site classes for different species, providing a basis for rating relative potential of all forest land.

⁹Although some of the other public lands are in the lower elevations (military and Indian reservations in particular), State lands comprise nearly three-fourths of the total other public acreage and are located mainly in the mid-elevations.



Figure 14. — Young men from a State youth camp plant tree seedlings on State-owned land. (Photo courtesy of Washington State Department of Natural Resources.)

TIMBER VOLUME

Live Sawtimber Volume Totals 75 Billion Board Feet

For all ownerships, the total sawtimber volume in trees 11.0-inch d.b.h. and larger is about 75 billion board feet, International ¼-inch scale. Softwood volume is 70 billion; hardwood volume, 5 billion. Total growing-stock volume in trees 5.0-inch d.b.h. and larger is about 15 billion cubic feet, with 13 billion in softwoods and 2 billion in hardwoods.

Timber Volume Is Decreasing

Since 1953, total volume of timber in the Puget Sound area has decreased, though hardwood volume has been increasing. Softwood sawtimber volume has decreased an estimated 11 percent. Table 1 shows estimated volumes for 1953, 1963, and 1967. The figures for 1953 and 1963 were developed from the 1967 inventory data using a stand projection technique which allowed backdating using historical growth, cut, and mortality rates, and changes in

forest area. These figures provide a better estimate of real change over time than can be obtained from the previous inventory statistics, because of different standards and definitions used in the previous inventories.

There are three primary causes for the decrease in softwood volume: (1) annual cut exceeding growth, (2) the shift of commercial forest land to reserved status, and (3) the conversion of low elevation commercial forest land to nonforest uses. The causes for the increase in hardwood volume are: (1) stocking since 1953 of many old burns and cutovers with hardwoods, and growth in hardwood stands already established in 1953, (2) removal of conifers from mixed conifer-hardwood stands, thus releasing the hardwoods from competition and accelerating their growth, and (3) low annual cut of hardwoods because of limited demand.

Though total softwood volume over the entire eight-county area has decreased since 1953, there has been a slight increase in softwood volume in Island and Kitsap Counties. This has come about because most of the old-growth

Table 1. — Comparison of net volume of growing stock and sawtimber on commercial forest land by softwoods and hardwoods, Puget Sound area, Washington, 1953, 1963, and 1967

Year	Growing stock			Sawtimber		
	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods
----- Million cubic feet -----			----- Million board feet ----- (International ¼-inch scale)			
1953	14,919	13,689	1,230	81,507	78,520	2,987
1963	15,294	13,608	1,686	80,050	75,510	4,540
1967	14,715	12,914	1,801	74,859	69,751	5,108

timber had already been logged from these low-land counties by 1953, and much of the forest land restocked with Douglas-fir. Growth in these two counties has been greater than the loss of volume by logging on commercial forest land and clearing of forest land for other uses.

Sixty-three Percent of the Sawtimber Volume Is on Public Lands

National Forests have 36.3 billion board feet (International ¼-inch scale) or 49 percent of the sawtimber volume, and other public owners have 10.6 billion board feet, or 14 percent. Timber companies hold 16.2 billion board feet of sawtimber or 22 percent, and farmer and miscellaneous private owners hold 11.7 billion or 15 percent. Over 14 percent of the private sawtimber is hardwoods — three-fourths of this is held by farmers and miscellaneous private owners; only about 2 percent of the public sawtimber is hardwoods.

National Forests Have 70 Percent of the Old-growth Sawtimber Volume

The total volume in stands 140 years and older is about 47 billion board feet (International ¼-inch scale). This is about 63 percent of the total volume in all stands. National Forests have about 33 billion board feet in stands 140 years and older, or 70 percent of the total old growth. The old-growth stands on National Forest lands are predominantly western hemlock and Pacific silver fir, these two species contributing 58 percent of the total volume in softwood trees, 21-inch d.b.h. and larger. In spite of this, National Forests hold about 54 percent (6.6 billion board feet) of the total Douglas-fir volume in trees, 21.0 inches and larger.

Hemlock Is the Most Plentiful Sawtimber Species; Douglas-fir Second

Though Douglas-fir is the most extensive forest type in the Puget Sound area, there is slightly more western hemlock sawtimber volume — 24 billion board feet of hemlock, compared with 21 billion board feet of Douglas-fir. This is because much more of the

Douglas-fir type is young growth with less volume per acre.

Douglas-fir is, and for decades has been, one of the most important commercial woods in the world, used for structural timbers, dimension and shop lumber, flooring, doors, veneer, plywood, piling, and railroad ties. Douglas-fir has been the prime factor in the economic development of much of Oregon and Washington west of the Cascade Mountains. In the Puget Sound area, Douglas-fir is used proportionately less now than in the 1930's (Andrews and Cowlin 1940), mainly because much of the old-growth Douglas-fir has been cut. Even so, about 55 percent of the sound log consumption by sawmills in the Puget Sound area in 1968 was Douglas-fir — about 29 percent was hemlock; and about 50 percent of the sound log consumption by veneer and plywood mills was Douglas-fir — 37 percent was hemlock.

Western hemlock is now second in importance to Douglas-fir in western Oregon and Washington. Prior to 1930, western hemlock was not readily accepted by lumber users. Seasoning techniques had not been perfected; and the prejudice against eastern hemlock wood, which is harsh and splintery under tools, splits easily, and has low nail-holding capacity, was extended to western hemlock, which is generally superior. Western hemlock is now used in a variety of products, including general construction lumber, siding, flooring, boxes, and crates. Its greatest use in the Puget Sound area is for pulp. In 1968, 285 million board feet of hemlock logs were used by pulpmills in the Puget Sound area. This is about 53 percent of total consumption of all species by the pulp and board industry¹⁰ and nearly a third of total hemlock consumption.

Pacific silver fir is the third most plentiful species, and 65 percent of it — 8.4 billion board feet out of 13 billion — is on the National Forests. This species and the other true firs (noble fir, grand fir, and subalpine fir) that occur in the Puget Sound area were used very little by the forest industries before World War II, and most of what was used went into pulp (a small amount of noble fir lumber was sawn). The

¹⁰ Included are manufacturers of chipboard, particleboard, hardboard, and similar products.

main reason true firs were not used very much is that they were generally inaccessible. With the exception of scattered grand fir trees in the valleys (grand fir is also called lowland white fir), the true firs grow on the upper slopes of the mountains. In most areas these mountain forests had not been opened to logging until fairly recently.

In 1968, the total consumption of true fir logs in the Puget Sound area was 212 million board feet, about 9 percent of total consumption of all species. About 52 percent of true fir consumption went into pulp, and about 35 percent was exported. About 7 percent went into lumber, and 6 percent went into veneer and plywood.

Redcedar Volume Totals Over 6.7 Billion Board Feet, Most of Which Is Old Growth

Western redcedar sawtimber volume totals 6.7 billion, and 76 percent of this is in trees, 21.0-inch d.b.h. and larger. About 58 percent of the redcedar volume is on National Forest land, and 77 percent is in the northern counties of Skagit, Snohomish, and Whatcom.

Pure stands of redcedar are relatively rare in the Puget Sound area; only 204,000 acres, or 6 percent, of the total commercial forest land qualifies as redcedar type by Forest Survey standards. More commonly, redcedar occurs as an associated species with most of the conifer or hardwood types, favoring the cool, wetter places such as north slopes and canyon bottoms.

Western redcedar has been an important timber species since the early lumbering days in Puget Sound and has been used extensively for sills, siding, shakes, and shingles. In 1968, there were about 50 shake and shingle mills in the Puget Sound area, and 10 of them had been in operation for 5 years or less. The total log consumption by shingle and shake mills was over 68 million board feet. About 90 percent of their log supply — nearly all of which was western redcedar — came from the Puget Sound area. The demand for cedar shakes and shingles has increased during the past few years with a corresponding increase in the annual cut of redcedar. The reported volume of cedar harvested in the woods in the Puget Sound area in

1968 was 114 million board feet, compared with about 90 million in 1957. About 91 percent of the total 1968 cedar harvest was old growth, and over 1 percent was salvage, leaving less than 8 percent of the cedar harvest in young growth. Presently young-growth cedar is being used very little in the shingle and shake industry, primarily because it is considered unsuitable. It has a high percentage of sapwood, is knotty, and tends to have worm holes in it.

Currently, little effort is being made to grow western redcedar on a sustained yield basis. Douglas-fir, hemlock, and, on some higher elevation sites, true firs are being planted after old-growth stands are cut. Some volunteer redcedar seedlings are becoming established on cutovers, and to a certain extent redcedar is being left after selective logging on private timberlands in the low elevations. Often the cedars left growing are highly defective. The low elevation forest tracts may not remain in forest use in the future.

For these reasons, it seems that redcedar volume will decline in the future.

Hardwood Sawtimber Totals 5 Billion Board Feet

The volume of all hardwood species totals 5.1 billion board feet (International ¼-inch scale), 3.1 billion or 61 percent of which is red alder. Hardwood trees in the Puget Sound area are generally of small diameter, are shorter than conifer trees of the same diameter, and have less volume. There is a greater proportion of low quality and cull hardwood trees than conifers. The cubic-foot volume of cull hardwood trees is about 6 percent of the volume of growing-stock hardwood trees; volume of cull softwoods is only 1 percent of softwood growing-stock volume.

In the early logging days in the Puget Sound area, hardwoods were considered worthless for timber. By the 1930's, some use was being made of red alder for furniture, turnery products, and fuel; some bigleaf maple was used for furniture, veneer, and fuel; and black cottonwood was used in small quantities for pulp, excelsior, and cooperage. Hardwoods are being used much more now than in the 1930's. From 1925 to 1933, the average annual harvest of hardwoods in the Puget Sound area was about 7

million board feet. In 1968, about 65 million board feet of hardwoods were harvested; 145 million board feet were consumed by mills in the Puget Sound area. Alder and cottonwood are the primary species being used now, though other hardwoods do occasionally enter the market. Pulp, veneer, and lumber are made from alder and cottonwood. Over 100 furniture manufacturers in southern California use red alder from the Pacific Northwest. A small amount of wall paneling has been made from red alder. In the Puget Sound area in 1968, about 39 million board feet of hardwood logs were sawn into lumber, 4 million were used in veneer and plywood, and about 102 million went into pulp.

Though hardwood volume has been increasing in the Puget Sound area, it will probably decrease in the future for these reasons: (1) hardwoods grow almost exclusively in the low country near the Sound, the major rivers, the transportation routes, and the heavily populated areas where land is being converted to nonforest uses, (2) many forest managers are replacing hardwood stands with conifers on lands committed to timber production, and (3) hardwoods — especially red alder — are relatively short-lived; many stands are already de-

teriorating and slowly being replaced by understory conifers (fig. 12).

Salvable Dead Timber Volume Totals About 2.8 Billion Board Feet

In the eight-county area on all ownerships, there were about 2.8 billion board feet, International 1/4-inch scale, of salvable dead sawtimber at the time of inventory. About one-third of this was western hemlock, and one-fourth was true firs, mostly Pacific silver fir. (The wood of western hemlock and true fir trees tends to deteriorate rapidly after death.) Cedar made up 16 percent of the salvable dead volume and Douglas-fir, 15 percent. About 762 million board feet of hemlock and 596 million board feet of true fir, approximately 80 percent of the salvable dead volume in these two species, were in trees that had 500 or more board feet of sound wood.

For all species combined, about 1,613 million board feet, or 57 percent, was in concentrations of 5,000 or more board feet per acre.¹¹

¹¹ *This information comes from 1/5-acre and 1-acre plots. No information is available on size of areas in which concentrated volumes of salvable dead timber were found.*

GROWTH, CUT, AND MORTALITY

Current Net Annual Growth Averages 412 Board Feet Per Acre

Current net annual growth of sawtimber on commercial forest land is 1,359 million board feet, International ¼-inch scale, about 1.8 percent of current inventory volume. Average net annual growth for all ownerships is 412 board feet per acre. Forty-two percent of the growth is Douglas-fir, and 26 percent is western hemlock. About 13 percent of the growth is in hardwood species, mostly red alder.

Net annual growth of growing-stock trees is 298 million cubic feet, about 2.0 percent of inventory volume; 79 percent is in conifer species, and 21 percent is in hardwoods.

Two-thirds of Cubic-foot Growth Occurs on Private Lands

Net annual growth of growing stock on National Forest and other public lands is 94 million cubic feet, or about 32 percent of total growth; and growth on private lands is 204 million, or 68 percent of the total.

Net annual growth on National Forest and other public lands averages 69 cubic feet per acre; on private lands growth averages 105 cubic feet per acre. The difference in growth rates between public and private owners is primarily due to the greater acreage in young-growth stands on private lands. On National Forest and other public lands, about 69 per-

cent of the stands are less than 140 years old, compared with 87 percent on private lands. For all owners combined, 82 percent of total net annual growth is in stands under 100 years old, and 90 percent in stands under 140 years old.

Farmer and miscellaneous private owners have the highest cubic-foot growth (table 25) because they have virtually no old-growth timber and a larger acreage than any other owner group in 20- to 50-year-old stands — the age span of greatest periodic growth on most Douglas-fir sites (McArdle, Meyer, and Bruce 1961).

To a certain extent, total annual growth for farmer and miscellaneous private lands is misleading. About 30 percent of the growth in these lands is on hardwood trees, which are generally of poorer form, have less usable volume for a given diameter, and are currently less valuable than conifer trees.

Cut Exceeds Growth by 4.1 Percent

From 1963 to 1967, the annual cut of live trees in the eight-county area averaged 1,415 million board feet, International ¼-inch scale. This is 56 million feet, or 4.1 percent greater than net annual growth. The following tabulation shows growth, average annual cut from 1963 to 1967, and net effect on inventory by ownership classes.

<u>Ownership</u>	<u>Live cut</u> (M bd. ft., Int. ¼-inch)	<u>Net annual growth</u>	<u>Annual change in inventory</u> (Percent)
National Forest	390,000	115,400	-0.76
Other public	153,000	336,900	+1.74
Private	872,000	906,400	+ .12
All ownerships	1,415,000	1,358,700	- .08

It is difficult to make a meaningful analysis of cut and growth in an area such as Puget Sound. There are still extensive areas of wild, old-growth stands that are growing very slowly or declining because of high mortality rates. On the other hand, there are extensive areas of fast-growing young timber, some of which will never be managed for continuous timber production. A considerable area of well-stocked young conifer timber north of Seattle is being converted to industrial, commercial, and residential sites. Throughout the Kitsap Peninsula and on much of Whidbey Island, lands that are well stocked with young-growth Douglas-fir are being sold in 3- to 10-acre tracts for homesites. The same sort of thing is happening in a rather random manner throughout the lower elevations on the mainland from Olympia to the Canadian line. These developments could well end timber production entirely on hundreds of thousands of acres (a more detailed discussion, "Prospective Loss of Timberland," follows this chapter).

Following is a discussion of some other factors bearing upon the cut-growth relationship for the various ownerships in the Puget Sound area.

National Forests are currently decreasing their inventory volume on lands committed to timber production, as they steadily convert wild, old-growth stands to managed young growth.¹² The long-term goal is a regulated forest with a relatively even distribution of stand age classes to provide continuous timber production and at the same time preserve or enhance other resources, such as wildlife, water quality, soils, and scenery. Though cut is currently more than growth on National Forest timberlands, growth will increase in the future — as more old-growth timber is cut and lands are restocked with young stands and as the 89,000 acres of seedling and sapling stands become large enough to start putting on measurable cubic- and board-foot growth.

Other public owners as a group are cutting considerably less timber than is growing on their lands. These lands are in many small and a few large parcels, scattered throughout the Puget Sound area, in the low country between the foothills and the Sound as well as the foothills and the midslopes of the Cascades. They are managed by many different agencies. Included are the Department of Natural Resources, Bureau of Indian Affairs, various military posts (Fort Lewis and Whidbey Island Naval Air Station are two examples), counties,

and cities (Seattle's Cedar River Watershed, for example). Some tracts of land in this other public owner group are being intensively managed for timber production; others are being managed primarily for different purposes (city watersheds, for example), though some timber harvesting is being done. Some tracts of land are not being managed for timber production at all, because they are being considered for sale, future conversion to parks or institutional sites, or other purposes.

Cut and growth for all private lands combined are nearly in balance, yet on an individual owner basis some lands are being heavily cut and others not at all. Included in the private ownership group are several timber companies, many of which are managing their lands for continuous timber production; some large non-timber industry corporate owners who may plan to manage for timber production but may also have other objectives; and a great number of farmers and miscellaneous noncorporate owners with various objectives.

Timber Cut Is Shifting From Private Lands to Public, From Douglas-fir to Hemlock

The volume of timber harvested in the Puget Sound area in 1968 was only 20 percent less than the average volume harvested annually between 1925 and 1933.¹³ The 1925-33 harvest, however, came almost exclusively from private lands, whereas about 37 percent of the 1968 harvest came from public lands, mostly National Forest and State of Washington. Another im-

¹² *This discussion applies only to lands classified as commercial forest land on the National Forests. Hundreds of thousands of acres of National Forest land are classified noncommercial; these include areas where timber cutting would be unwise because of physical factors and areas set aside by statute to be preserved in their natural state. Timber harvest is prohibited on these areas. Growth of timber on these lands is not included here.*

¹³ *The year 1925 marks the peak of lumber production, which dropped steadily from 3.6 billion board feet that year to about 1.2 billion in 1945. Log harvest declined from 2.4 billion in 1925 to about 1.0 in 1945. The 1920's and 1930's also saw many forest protection and regeneration programs started and, generally speaking, the beginning of sustained yield forestry in the Northwest.*



Figure 15. — In the Puget Sound area, most logging operations are now in steep, mountainous terrain. This logging operation near Darrington on the Mount Baker National Forest is in hemlock and Pacific silver fir which, combined, make up nearly 50 percent of the current timber harvest on all ownerships.

portant difference is the distribution of the annual cut by species: over two-thirds of the 1925-33 cut was Douglas-fir, which now makes up less than one-third. Hemlock comprised about 19 percent of the cut in the 1925-33 period, compared with 45 percent now. True firs and hardwoods made up less than 1 percent in 1925-33, compared with 16 percent now (fig. 15).

Annual Mortality Exceeds 400 Million Board Feet

Average annual mortality in all stands across all ownerships is about 430 million board feet (International ¼-inch scale), or about 130 board feet per acre. This is about 0.6 of 1 percent of the total inventory volume. Total and per-acre mortality are heaviest in those ownership classes with the greatest proportion of their holdings in old-growth stands.

Ownership	Percent of area in old-growth timber	Board-foot mortality per acre (Int. ¼-inch)
National Forest	44	290
Other public	13	96
Forest industry	28	124
Farmer and miscellaneous private	<u>5</u>	<u>40</u>
All ownerships	19	130

The immediate cause of over 50 percent of the mortality of all species on all ownerships was weather — mostly windthrow and snow-break. About 12 percent of the mortality was attributed directly to disease and only 3 percent directly to insects, though both could have contributed to the death of trees from other causes. About one-fourth of the dead trees tal-

lied on plots were assigned an unknown cause of death. Insects or diseases could have contributed to the death of many of these trees.

Currently there are no devastating insect or disease epidemics in the Puget Sound forests, though a number of potential troublemakers exists. The balsam wooly aphid, which has killed over a billion board feet of true fir timber (mostly Pacific silver fir) in southwestern Washington (Mitchell 1966), has caused mortality in subalpine fir as far north as the headwaters of the Skykomish River in Snohomish County. So far, the impact has been in noncommercial areas and the damage primarily to scenic values.

The hemlock looper, a native insect that has killed millions of board feet of timber in Oregon and Washington since 1900, has caused some damage in the Skagit River drainage on the Mount Baker National Forest. Mortality, however, has been light.

There have been some minor outbreaks of Douglas-fir beetle in the past 2 or 3 years in the Baker River area of the Mount Baker National Forest. The mountain pine beetle has killed a large number of western white pine trees on both the Snoqualmie and Mount Baker National Forests. In many cases, the white pine trees were weakened by the white pine blister rust before the beetles attacked. White pine is a minor species in the Puget Sound area, making up less than 0.2 percent of total sawtimber volume. The negative annual growth shown for other softwoods on National Forest lands in table 27 is due primarily to mortality of white pine exceeding white pine growth.

Childs and Shea (1967) have estimated that forest diseases cause annual losses of 3,133 million board feet in the Pacific Northwest. Growth loss and cull together far exceed losses due to mortality. In the Puget Sound area, heart rots cause considerable loss of usable wood volume due to cull in old-growth stands but generally do not kill trees. Root rots, the most important of which is *Poria weirii*, are found in the Puget Sound area, primarily in young-growth stands. Losses from root rots are mainly in mortality and growth impact. Dwarf-mistletoe in hemlock is one of the major disease problems in the Puget Sound area, causing cull and reducing growth. It generally does not cause mortality except in very old stands where

it weakens trees and makes them susceptible to insect attack or unable to survive periods of drought.

One-third of Mortality Is Hemlock

About one-third of the mortality is hemlock, and much of this, again, comes from the old-growth stands in National Forest land. Western hemlock dieback has been a singularly serious problem on the Mount Baker National Forest for over a decade.¹⁴ Until recently the cause was unknown.

Apparently the tops of old western hemlock trees (350 years or older) begin to die in periods of warm, dry weather possibly because the tips farthest from the roots lose moisture faster than it can be replaced when humidity is low. A heart-rotting "coral fungus" then enters the dead branches in the top. In many cases, dwarf-mistletoe also becomes a factor (dwarf-mistletoe often develops prodigiously in hemlock stands that are opened up to light by selective logging, storm damage, or other causes).¹⁵ For several years the Mount Baker National Forest has been concentrating its timber sales in areas of heavy hemlock dieback.

True firs account for about 21 percent of the mortality, western redcedar 17 percent, and Douglas-fir 15 percent.

Though mortality constitutes a loss of timber production, not all of the mortality volume is lost. In 1968, the reported harvest of dead trees in the eight-county area was 57.2 million board feet. This harvest of dead trees offsets about 13 percent of the total annual mortality. Over 95 percent of this came from National Forest lands. The salvage of dead material on National Forest lands is equal to more than 25 percent of annual mortality on the National Forests, though some of the material being salvaged is from trees that have been dead many years.

¹⁴ Mountain hemlock trees in the same area do not seem to be affected by these "dieback" agents.

¹⁵ Personal communication with Kenelm Russell, forest pathologist, Washington State Department of Natural Resources.

PROSPECTIVE LOSS OF TIMBERLAND

Forest Area Is Decreasing With Increasing Population and Industrial Expansion

In 1950, the population of the Puget Sound area was about 1.3 million. A preliminary summary of the 1970 census shows about 2.1 million. The increase in population in the eight-county area from 1950 to 1970 was over 75 percent of the increase for the entire State of Washington for the same period and about 38 percent greater than the population increase for the entire State of Oregon (U. S. Department of Commerce 1969).

Along with the increase in population has come an increase in industrialization. Past trends and current activity indicate that the Puget Sound area will become even more urbanized and industrialized in the next two or three decades. The population for 1990 in King, Kitsap, Pierce, and Snohomish Counties has been projected at about 2.9 million (Pethick 1969), and the population of the eight-county area is projected at over 4 million for 2000. The increase in population will probably be accompanied by shorter workweeks; increasing disposable income, some of which people will spend on boats, campers, back-country vehicles, and second homes in the forests; and an ever-increasing technology demanding more land for factories, warehouses, offices, roads, landing strips, parking lots, and electric power generating plants and powerlines. The effect of all these factors will be to increase the pressure to convert timber-growing land to other uses.

Some timberland will be physically converted to other uses such as residential areas,

industrial sites, roads, powerlines, garbage dumps, etc. (fig. 16). Some areas that may continue to support trees may not be used for timber production. Included might be buffer strips of trees to screen blight and noise, wooded institutional grounds, and areas restricted from timber harvesting because higher priorities have been given to recreational and scenic purposes. A substantial acreage of forest land may become so valuable that taxes and incentives to convert to nonforest use will make timber production economically unattractive. In many areas privately owned timberland is being subdivided into small parcels, making timber management activities impractical.

No one is able to say how much commercial forest will be lost with a gain of a million persons in the area, or exactly what pattern future development will take. Many planning organizations, including the Puget Sound Governmental Conference, various county planning groups, and the Washington State Department of Natural Resources, have been studying these problems and developing land use plans. Land use plans and even zoning laws have often proved to be effective only for short terms but nevertheless provide a basis for planning and making projections.

The Washington State Department of Natural Resources has adopted a multiple use resource zoning plan for State-owned lands. The plan provides a framework in which land and other resources will be managed to meet the Department's objectives, which are to: "(1) obtain maximum sustained economic benefits to the trusts to which the land is dedicated while fulfilling the basic social obligations common to all large forest and range land ownerships;

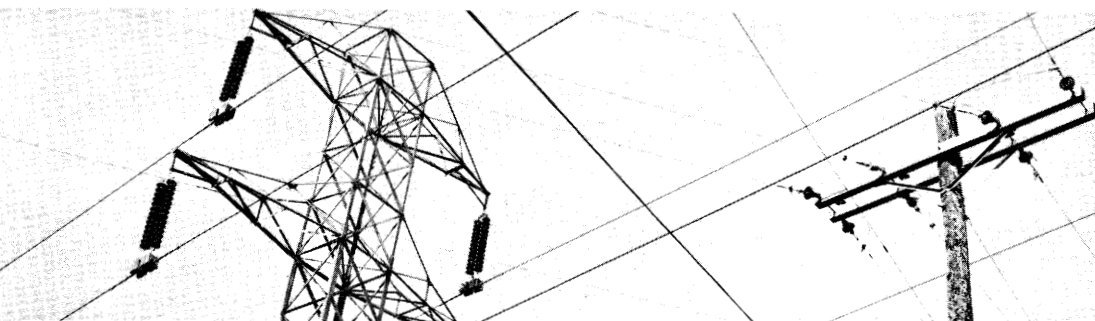
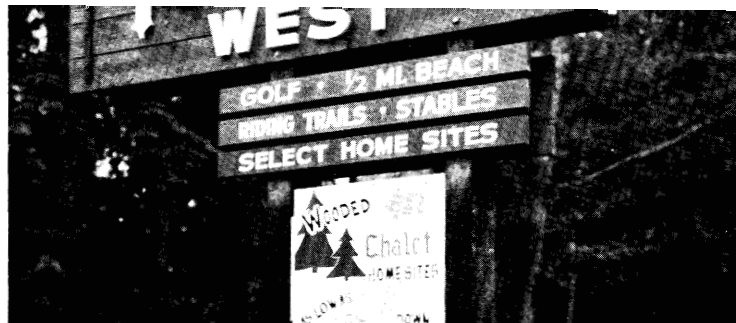


Figure 16. — Over 1 million acres of forest land in the Puget Sound low country may be converted to other uses by the year 2000.

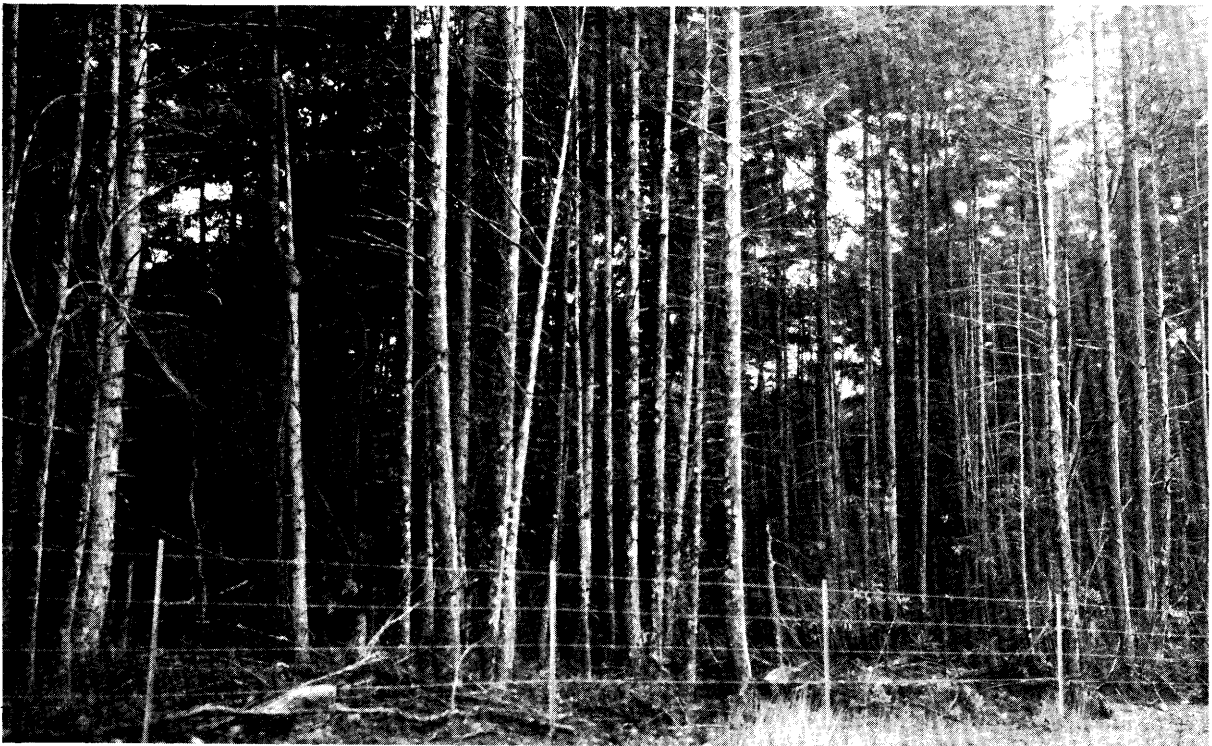


Figure 17. — Thousands of acres of young-growth Douglas-fir stands in the Puget Sound low country could be thinned. Thinning would increase yields and often result in more esthetically appealing forests. Present land use trends are discouraging land owners from engaging in forest management activities in the low country. This 45-year-old Douglas-fir stand is on Whidbey Island near Freeland, Island County.

and (2) when not in conflict with the first objective, to maximize social benefits to the people of the State” (State of Washington 1969).

The Department has classified all State-owned lands into “resource zones” and has drawn boundaries around all lands in these zones for the present, for 1980, and for 2000. Though the State’s classification does not apply to private lands within a given “resource zone,” the zone classification was based to a large extent on the present and expected future use of all lands in that zone. The Department’s projections are based on past trends and development patterns and rates during a period when there was essentially no control over land development. Already, many organizations are trying to change the direction of development. Current and proposed legislation is geared to check urban spread and favor preservation of open space. For these reasons, estimates of future forest land conversion based on the De-

partment’s resource zoning might be considered outside limits or maximums.

The Department’s Year 2000 Urban Zone is defined as “anticipated growth area on fringes along urban zone, 1980, geographically suited for development; characterized by high land values, usually timber-covered and may be interspersed with widely scattered housing developments only on choice sites.” Developments on private land are dispersed throughout much of this area and are increasing.

The Department’s Year 2000 Urban Zone line generally follows the base of the Cascade foothills and conforms in many places with the generalized boundary between the farmer and miscellaneous private lands and the forest industry and State of Washington timberland shown in figure 5.

Following is a discussion of the estimated forest resources within the Year 2000 Urban Zone.

Commercial Forest Land Area May Decrease by Over 1 Million Acres by 2000

Within the Department's Year 2000 Urban Zone in the Puget Sound area there are currently an estimated 1,154,000 acres of commercial forest land. This is about 35 percent of the total commercial forest land in the eight-county area, about 11 percent of the total in western Washington, and slightly less than 5 percent of the Douglas-fir region. Farmer and miscellaneous private owners hold 785,000 acres or 68 percent of this area. Forest industry owners have 203,000 acres or 18 percent, and other public owners have 165,000 acres or 14 percent. Practically all of this land is stocked with young timber stands under 90 years old, and 54 percent is stocked with stands under 50 years old (fig. 17). About 43 percent of all young-growth stands in the Puget Sound area is in this prospective urban zone.

Nearly Half of the Douglas- fir Lands May be Converted to Nonforest Uses

About 482,000 acres of the commercial forest land in the prospective urban zone are currently in Douglas-fir type. This is about 47 percent of the total Douglas-fir type acreage in the Puget Sound area. In addition, about 410,000 acres, or over 60 percent of the hardwood stands on conifer sites (mostly Douglas-fir), is in this prospective urban zone. Thus, the total loss of land capable of growing Douglas-fir may exceed 890,000 acres.

Sawtimber Volume in the Prospective Urban Zone Totals 12 Billion Board Feet

In the Year 2000 Urban Zone, there are currently an estimated 12 billion board feet (International 1/4-inch scale) of sawtimber. This is about 16 percent of the total volume in the eight-county area for all ownerships and 31 percent of the volume outside the National Forests. About 9 billion board feet is softwoods and 3 billion, hardwoods. Growing-stock volume in the prospective urban zone totals 3.2 billion cubic feet or about 22 percent of the total volume for all ownerships in the eight-

county area and 36 percent of the volume outside the National Forests.

Annual Growth in Prospective Urban Area Exceeds One-half Billion Board Feet

Current net annual growth of sawtimber in the prospective urban zone is 502 million board feet (International 1/4-inch scale), about 37 percent of total growth in the eight-county area. About 20 percent of the growth is hardwoods. On many sites in the prospective urban area, current growth is far below the full capacity of the land. The potential loss in terms of timber production is therefore even greater than these figures indicate.

Potential Production of Timber May Be Reduced by 30 Percent

If all the commercial forest land within the Year 2000 Urban Zone is converted to nontimber uses, the estimated loss in potential yield capacity would be about 130 million cubic feet or 30 percent of the potential for the entire Puget Sound area. The present potential yield capacity of all lands in the Puget Sound area is 432 cubic feet per year.¹⁶ These estimates are based on normal yield tables (McArdle, Meyer, and Bruce 1961; Barnes 1962; Worthington, Johnson, Staebler, and Lloyd 1960) and site classification of lands in the area.

In general, the area within the Year 2000 Urban Zone is below the average productivity for the entire Puget Sound area, being predominantly Douglas-fir site 160 and lower and having but 16 percent of the site 170 and better lands. For this reason the potential reduction in productivity is somewhat less than the commercial forest acreage within the Year 2000 Urban Zone — 35 percent of the entire area — might indicate.

Intensive management may possibly change the relative yields from forest lands. Some tim-

¹⁶ *The total potential yield from National Forest lands, as from most lands, will probably never be realized. National Forests now cut considerably less than annual yield from roadside areas, tracts near streams, campgrounds, and other landscape-management areas. Reductions in yield realization due to such harvest restraints could amount to 20 or 30 percent, or more in the future.*

ber companies expect considerably greater yields from future forests than shown in normal yield tables. Data in this report show that growth on forest industry lands is still less than three-fourths of the potential as shown in normal yield tables developed for unmanaged stands. For all owners combined, present growth is only 69 percent of potential as shown in these normal yield tables. Foresters still have not achieved production equal to that from fully stocked **unmanaged** stands. Several timber companies and Government agencies are currently engaged in activities to increase future production: in many areas hardwood stands on conifer sites are being replaced with conifers; some timber companies and the Department of Natural Resources are fertilizing young timber stands; thinning is becoming a standard practice; restocking after logging is done promptly on most lands (figs. 13 and 14);

tree genetics projects are underway; foresters are using more sophisticated methods to appraise site quality, select planting stock, and develop management plans; and new methods of animal, insect, and disease control are being tried. These activities may help offset some of the loss of timber production due to forest land conversions.

Whether or not the growing Puget Sound megalopolis ever completely covers the Department's projected Year 2000 Urban Zone, it is probably safe to say that a large portion of the 1,154,000 acres of commercial forest land in it will be converted to nonforest use. Although some of the 12 billion board feet of timber on these lands will undoubtedly be logged and processed in mills and some of the growth on present stands will be utilized, the future forest resource base will be considerably different from today's.

Table 2.— Area by land class and county, Puget Sound area, Washington, January 1, 1967
(In thousand acres)

Land class	All counties	Island	King	Kitsap	Pierce	San Juan	Skagit	Snohomish	Whatcom
Forest:									
Commercial	3,300	80	747	177	575	—	581	693	447
Productive-reserved ¹	504	2	37	10	94	81	56	69	155
Unproductive	1,059	⁴	142	1	89	—	220	253	354
Total	4,863	82	926	188	758	81	857	1,015	956
Nonforest ²	1,890	54	437	63	315	34	254	328	405
Total area ³	6,753	136	1,363	251	1,073	115	1,111	1,343	1,361

¹ Includes 13,000 acres of forest land managed for Christmas tree production. Forest land outside the parks in San Juan County is also included.

² Includes cropland, pasture and range, swampland, industrial and urban areas, powerline clearings, railroads, and all improved roads and highways, and 58,041 acres classified as water by Forest Survey standards but defined by the Bureau of the Census as land. Also includes 49,000 acres of suburban forest tracts near Seattle.

³ Source: U. S. Bureau of the Census, Land and Water Area of the United States, 1960, revised 1965.

⁴ Less than 500 acres.

Table 3. — Area of commercial forest land, by ownership class and county, Puget Sound area, Washington, January 1, 1967
(In thousand acres)

Ownership class	All counties	Island	King	Kitsap	Pierce	Skagit	Snohomish	Whatcom
Public:								
National Forest	748	---	156	---	114	145	222	111
Other Federal	70	---	---	4	45	3	9	9
State	440	3	61	17	40	116	121	82
County and municipal	103	2	71	15	---	4	9	2
Total public	1,361	5	288	36	199	268	361	204
Private:								
Forest industry	910	5	250	28	207	199	118	103
Farmer-owned	277	34	13	---	43	64	57	66
Miscellaneous private — corporate	231	7	104	---	45	18	33	24
Miscellaneous private — noncorporate	521	29	92	113	81	32	124	50
Total private	1,939	75	459	141	376	313	332	243
All ownerships	3,300	80	747	177	575	581	693	447

Table 4. — Area of commercial forest land, by stand-size and ownership class, Puget Sound area, Washington, January 1, 1967

(In thousand acres)

Stand-size class	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Sawtimber stands:					
Old growth ¹	628	327	79	174	48
Young growth ²	1,483	272	309	314	588
Total	2,111	599	388	488	636
Poletimber stands	599	53	117	174	255
Sapling and seedling stands	537	89	93	227	128
Nonstocked areas	53	7	15	21	10
All classes	3,300	748	613	910	1,029

¹ Stands 140 years and older.

² Stands less than 140 years old.

Table 5. — Area of commercial forest land, by stand volume and ownership class, Puget Sound area, Washington, January 1, 1967

(In thousand acres)

Stand volume (board feet per acre ¹)	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Less than 1,500	663	102	118	239	204
1,500 to 4,999	398	18	58	147	175
5,000 to 9,999	425	30	77	131	187
10,000 to 19,999	670	46	175	153	296
20,000 to 29,999	280	55	74	37	114
30,000 to 39,999	183	59	43	50	31
40,000 to 49,999	134	66	22	45	1
50,000 or more	547	372	46	108	21
All classes	3,300	748	613	910	1,029

¹ Net volume, International 1/4-inch scale.

Table 6. — Area of commercial forest land by stocking class of all growing-stock trees and ownership class, Puget Sound area, Washington, January 1, 1967

(In thousand acres)

Stocking percent ¹	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Less than 10	37	7	7	18	5
10-39	151	43	19	56	33
40-69	479	51	95	142	191
70 and over	2,633	647	492	694	800
Total	3,300	748	613	910	1,029

¹ See "Definition of Terms."

Table 7. — Area of commercial forest land, by cubic-foot site and ownership classes, Puget Sound area, Washington, January 1, 1967

(In thousand acres)

Site class ¹ (cubic feet)	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
225 or more	167	52	21	66	28
165 to 224	619	175	145	199	100
120 to 164	1,196	207	236	326	427
85 to 119	761	149	117	210	285
50 to 84	515	146	76	104	189
20 to 49	42	19	18	5	---
All classes	3,300	748	613	910	1,029

¹ A classification in terms of capacity for cubic-foot annual growth per acre at culmination of mean annual growth. In general, the cubic-foot site classes can be equated with the Douglas-fir site indexes shown in Technical Bulletin No. 201 (McArdle, Meyer, and Bruce 1961) as follows:

Cubic-foot site class	Douglas-fir site index value
225 or more	210 and better
165 to 224	170 to 200
120 to 164	130 to 160
85 to 119	110 to 120
50 to 84	80 to 100
20 to 49	below 80

Table 8. — Area of commercial forest land, by forest type and ownership class, Puget Sound area, Washington, January 1, 1967

(In thousand acres)

Forest type	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Douglas-fir	1,018	163	257	236	362
Western hemlock	882	301	125	322	134
Mountain hemlock	54	25	16	13	---
Western redcedar	204	56	48	26	74
Alaska-cedar	15	8	---	7	---
Pacific silver fir	275	152	59	57	7
Noble fir	7	7	---	---	---
Subalpine fir	10	10	---	---	---
Sitka spruce	11	1	10	---	---
Engelmann spruce	1	1	---	---	---
Red alder	542	13	71	173	285
Bigleaf maple	120	2	3	17	98
Black cottonwood	32	---	2	---	30
Other commercial hardwoods ¹	30	---	4	---	26
Noncommercial conifers	5	2	---	3	---
Noncommercial hardwoods	41	---	2	35	4
Nonstocked	53	7	16	21	9
All types	3,300	748	613	910	1,029

¹Includes Oregon ash, Oregon white oak, Pacific madrone, and western paper birch.

Table 9. — Area of noncommercial forest land, by forest type, Puget Sound area, Washington, January 1, 1967

(In thousand acres)

Forest type	All areas	Productive-reserved areas ¹	Unproductive areas
Douglas-fir	177	177 ²	---
Hemlock	97	97	---
Fir-spruce	211	211	---
Lodgepole pine	2	2	---
Cedars	6	6	---
Hardwoods	33	11	22
Unclassified:			
Rocky ³	803	---	803
Low site ⁴	214	---	214
Other ⁵	20	---	20
All types	1,563	504	1,059

¹Includes forest land capable of growing 20 cubic feet or more per acre per year in the North Cascades and Mount Rainier National Parks; Ross Lake National Recreation Area; Glacier Peak, Pasayten, and Alpine Lakes Wilderness areas; several natural areas; several State and county parks, and forest land outside the parks in San Juan County.

²Includes 13,000 acres of forest land managed for Christmas tree production.

³Includes areas that are capable of growing merchantable trees but are too steep and rocky for timber management.

⁴Areas stocked with commercial tree species but incapable of growing 20 cubic feet per acre because of soil and climatic factors. In the Puget Sound area low site forest lands are found mostly in the mountains at the upper limits of tree growth (timberline).

⁵Includes unstable areas that cannot be logged without seriously affecting the watershed and small isolated patches of commercial forest land on steep mountainsides.

Table 10. — Volume of growing stock and sawtimber on commercial forest land, by ownership class and by softwoods and hardwoods, Puget Sound area, Washington, January 1, 1967

Ownership class	Average volume per acre	Total volume		
		All species	Softwoods	Hardwoods
	<i>Cubic feet</i>	<i>----- Million cubic feet -----</i>		
All growing stock:				
National Forest	7,778	5,818	5,764	54
Other public	4,026	2,468	2,147	321
Forest industry	3,812	3,469	3,000	469
Farmer and miscellaneous private	2,877	2,960	2,003	957
All ownerships	4,459	14,715	12,914	1,801
	<i>Board feet</i>	<i>----- Million board feet -----</i>		
Sawtimber (International ¼-inch scale):				
National Forest	48,580	36,338	36,107	231
Other public	17,287	10,597	9,696	901
Forest industry	17,811	16,208	15,158	1,050
Farmer and miscellaneous private	11,386	11,716	8,790	2,926
All ownerships	22,685	74,859	69,751	5,108
Sawtimber (Scribner scale):				
National Forest	38,848	29,058	28,864	194
Other public	12,677	7,771	6,898	873
Forest industry	13,348	12,147	11,131	1,016
Farmer and miscellaneous private	8,588	8,837	5,993	2,844
All ownerships	17,519	57,813	52,886	4,927

Table 11. — Volume of growing stock and sawtimber on commercial forest land by county and ownership class, Puget Sound area, Washington, January 1, 1967

County	Total	National Forest	Other public	Forest industry	Farmer and miscellaneous private
----- Million cubic feet -----					
Growing stock:					
Island	236	---	23	14	199
King	3,541	1,096	522	1,247	676
Kitsap	520	---	113	73	334
Pierce	2,306	913	297	738	358
Skagit	2,586	1,140	463	678	305
Snohomish	3,532	1,874	657	334	667
Whatcom	1,994	795	393	385	421
Total	14,715	5,818	2,468	3,469	2,960
----- Million board feet -----					
Sawtimber (International ¼-inch scale):					
Island	731	---	64	21	646
King	18,443	6,831	2,379	6,302	2,931
Kitsap	2,170	---	407	185	1,578
Pierce	11,706	5,759	1,277	3,438	1,232
Skagit	13,235	7,103	1,685	3,185	1,262
Snohomish	18,508	11,652	3,104	1,250	2,502
Whatcom	10,066	4,993	1,681	1,827	1,565
Total	74,859	36,338	10,597	16,208	11,716
Sawtimber (Scribner scale):					
Island	499	---	41	14	444
King	14,078	5,387	1,748	4,722	2,221
Kitsap	1,553	---	278	135	1,140
Pierce	8,888	4,486	932	2,550	920
Skagit	10,364	5,775	1,179	2,416	994
Snohomish	14,614	9,383	2,334	963	1,934
Whatcom	7,817	4,027	1,259	1,347	1,184
Total	57,813	29,058	7,771	12,147	8,837

Table 12. — Number of growing-stock trees on commercial forest land, by diameter class and by softwoods and hardwoods, Puget Sound area, Washington, January 1, 1967

(Thousands of trees)

Diameter class (inches at breast height)	All species	Softwoods	Hardwoods
5.0-6.9	180,803	132,832	47,971
7.0-8.9	118,673	83,503	35,170
9.0-10.9	79,472	54,483	24,989
11.0-12.9	51,729	37,614	14,115
13.0-14.9	33,977	25,762	8,215
15.0-16.9	23,997	19,294	4,703
17.0-18.9	15,886	13,811	2,075
19.0-20.9	10,058	9,294	764
21.0-28.9	21,312	20,383	929
29.0-38.9	9,215	9,029	186
39.0 and larger	4,093	4,044	49
All classes	549,215	410,049	139,166

Table 13. — Average number of growing-stock trees per acre on commercial forest land, by diameter and ownership class, Puget Sound area, Washington, January 1, 1967

Diameter class (inches at breast height)	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
5.0-6.9	55	37	74	52	58
7.0-8.9	36	25	47	40	35
9.0-10.9	24	16	32	24	25
11.0-12.9	16	12	20	14	17
13.0-14.9	10	10	12	10	10
15.0-16.9	7	8	9	6	7
17.0-18.9	5	6	5	3	5
19.0-20.9	3	5	3	3	2
21.0-28.9	6	13	5	5	4
29.0-38.9	3	7	1	2	1
39.0 and larger	1	4	---	1	---
All classes	166	143	208	160	164

Table 14. — Number of growing-stock trees on commercial forest land, by species and diameter class, Puget Sound area, Washington,
January 1, 1967

(Thousands of trees)

Species	Diameter class (inches at breast height)											
	All classes	5.0- 6.9	7.0- 8.9	9.0- 10.9	11.0- 12.9	13.0- 14.9	15.0- 16.9	17.0- 18.9	19.0- 20.9	21.0- 28.9	29.0- 38.9	39.0 and larger
Softwoods:												
Douglas-fir	145,665	42,344	31,002	21,036	15,145	10,685	7,991	5,381	3,331	6,078	1,800	872
Western hemlock	143,913	50,488	28,894	20,594	12,157	7,840	5,583	3,758	2,843	6,663	3,328	1,765
Mountain hemlock	6,825	1,258	823	594	644	679	542	688	375	742	414	66
Western redcedar	55,210	20,569	12,045	6,380	5,363	2,865	1,954	1,514	863	1,967	950	740
Alaska-cedar	2,259	208	256	197	272	180	281	118	218	335	147	47
Pacific silver fir	50,147	16,076	9,628	5,283	3,472	2,996	2,631	2,141	1,420	3,989	2,070	441
Grand fir	837	49	278	---	179	214	53	15	15	15	15	4
Noble fir	1,709	440	253	77	54	63	61	48	111	307	204	91
Subalpine fir	1,294	265	248	123	88	123	128	114	80	110	15	---
Sitka spruce	1,274	762	---	---	127	71	50	16	24	142	65	17
Engelmann spruce	37	---	11	---	---	6	8	3	---	3	6	---
Lodgepole pine	153	11	---	139	3	---	---	---	---	---	---	---
Western white pine	712	348	65	60	110	40	12	15	14	32	15	1
Whitebark pine	14	14	---	---	---	---	---	---	---	---	---	---
Total	410,049	132,832	83,503	54,483	37,614	25,762	19,294	13,811	9,294	20,383	9,029	4,044
Hardwoods:												
Red alder	105,418	35,501	27,978	19,938	10,802	6,389	3,109	1,036	264	401	---	---
Bigleaf maple	23,962	8,935	4,660	3,910	2,587	1,364	1,139	565	332	331	111	28
Black cottonwood	3,394	403	670	310	466	411	394	364	136	147	72	21
Other hardwoods ¹	6,392	3,132	1,862	831	260	51	61	110	32	50	3	---
Total	139,166	47,971	35,170	24,989	14,115	8,215	4,703	2,075	764	929	186	49
All species	549,215	180,803	118,673	79,472	51,729	33,977	23,997	15,886	10,058	21,312	9,215	4,093

¹Included are Oregon ash, Oregon white oak, Pacific madrone, and western paper birch.

Table 15. — Volume of timber on commercial forest land, by class of timber and by softwoods and hardwoods, Puget Sound area, Washington, January 1, 1967

(In million cubic feet)

Class of timber	All species	Softwoods	Hardwoods
Sawtimber trees:			
Saw-log portion	11,449	10,696	753
Upper-stem portion	622	404	218
Total	12,071	11,100	971
Poletimber trees	2,644	1,814	830
All growing-stock trees	14,715	12,914	1,801
Sound cull trees	128	36	92
Rotten cull trees	141	132	9
Salvable dead trees, sawtimber-size	447	430	17
Total, all timber	15,431	13,512	1,919

Table 16. — Volume of growing stock and sawtimber on commercial forest land, by stand-size class and by softwoods and hardwoods, Puget Sound area, Washington, January 1, 1967

Stand-size class	Average volume per acre	All species	Softwoods	Hardwoods
	<i>Cubic feet</i>	<i>----- Million cubic feet -----</i>		
All growing stock :				
Sawtimber stands	3,984	13,147	11,874	1,273
Poletimber stands	400	1,320	833	487
Sapling and seedling stands and nonstocked areas	75	248	207	41
Total	4,459	14,715	12,914	1,801
	<i>Board feet</i>	<i>----- Million board feet -----</i>		
Sawtimber (International ¼-inch scale):				
Sawtimber stands	21,849	72,101	67,610	4,491
Poletimber stands	670	2,209	1,634	575
Sapling and seedling stands and nonstocked areas	166	549	507	42
Total	22,685	74,859	69,751	5,108
Sawtimber (Scribner scale):				
Sawtimber stands	16,927	55,860	51,529	4,331
Poletimber stands	480	1,585	1,030	555
Sapling and seedling stands and nonstocked areas	112	368	327	41
Total	17,519	57,813	52,886	4,927

Table 17. — Volume of growing stock on commercial forest land, by species and county, Puget Sound area, Washington, January 1, 1967
(In million cubic feet)

Species	Total	Island	King	Kitsap	Pierce	Skagit	Snohomish	Whatcom
Softwoods:								
Douglas-fir	4,126	145	932	344	902	594	743	466
Western hemlock	4,537	34	1,199	46	793	843	1,080	542
Mountain hemlock	345	---	90	---	10	67	147	31
Western redcedar	1,311	4	195	28	95	326	412	251
Alaska-cedar	118	---	17	---	4	8	31	58
Pacific silver fir	2,156	---	575	---	226	401	577	377
Grand fir	25	2	¹	---	1	19	3	---
Noble fir	177	---	120	---	53	---	4	---
Subalpine fir	36	---	8	---	22	2	---	4
Sitka spruce	60	2	36	---	¹	1	15	6
Engelmann spruce	3	---	---	---	1	2	---	---
Lodgepole pine	2	---	---	2	¹	---	---	---
Western white pine	18	¹	4	4	3	1	4	2
Total	12,914	187	3,176	424	2,110	2,264	3,016	1,737
Hardwoods:								
Red alder	1,289	47	258	85	156	184	395	164
Bigleaf maple	349	2	87	11	23	100	76	50
Black cottonwood	114	---	18	---	8	36	40	12
Other hardwoods ²	49	---	2	---	9	2	5	31
Total	1,801	49	365	96	196	322	516	257
All species	14,715	236	3,541	520	2,306	2,586	3,532	1,994

¹ Less than 500,000 cubic feet.

² Includes Oregon ash, Oregon white oak, Pacific madrone, and western paper birch.

Table 18. — Volume of sawtimber on commercial forest land, by species and county, Puget Sound area, Washington, January 1, 1967 (International ¼-inch scale)

(In million board feet)

Species	Total	Island	King	Kitsap	Pierce	Skagit	Snohomish	Whatcom
Softwoods:								
Douglas-fir	21,013	495	4,776	1,616	4,364	3,374	4,154	2,234
Western hemlock	24,305	75	6,457	192	4,542	4,494	5,594	2,951
Mountain hemlock	2,070	---	534	---	60	389	905	182
Western redcedar	6,736	16	1,002	85	438	1,621	2,220	1,354
Alaska-cedar	656	---	95	---	18	40	184	319
Pacific silver fir	12,991	---	3,575	---	1,344	2,214	3,585	2,273
Grand fir	132	12	---	---	4	90	26	---
Noble fir	1,175	---	790	---	361	---	24	---
Subalpine fir	185	---	37	---	107	13	---	28
Sitka spruce	369	11	235	---	---	5	82	36
Engelmann spruce	19	---	---	---	7	12	---	---
Lodgepole pine	¹	---	---	---	¹	---	---	---
Western white pine	100	1	22	11	18	9	27	12
Total	69,751	610	17,523	1,904	11,263	12,261	16,801	9,389
Hardwoods:								
Red alder	3,111	112	501	217	295	432	1,176	378
Bigleaf maple	1,259	9	293	49	62	335	307	204
Black cottonwood	655	---	126	---	55	204	225	45
Other hardwoods ²	83	---	---	---	31	3	---	49
Total	5,108	121	920	266	443	974	1,708	676
All species	74,859	731	18,443	2,170	11,706	13,235	18,509	10,065

¹ Less than 500,000 board feet.

² Includes Oregon ash, Pacific madrone, and western paper birch.

Table 19. — Volume of growing stock on commercial forest land, by species and ownership class, Puget Sound area, Washington, January 1, 1967
(In million cubic feet)

Species	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Softwoods:					
Douglas-fir	4,126	1,253	901	820	1,152
Western hemlock	4,537	2,148	559	1,347	483
Mountain hemlock	345	185	68	92	---
Western redcedar	1,311	610	251	205	245
Alaska-cedar	118	54	8	56	---
Pacific silver fir	2,156	1,359	311	406	80
Grand fir	25	3	8	3	11
Noble fir	177	97	22	58	---
Subalpine fir	36	36	---	---	---
Sitka spruce	60	4	17	13	26
Engelmann spruce	3	3	---	---	---
Lodgepole pine	2	¹	---	---	2
Western white pine	18	12	2	---	4
Total	12,914	5,764	2,147	3,000	2,003
Hardwoods:					
Red alder	1,289	38	245	356	650
Bigleaf maple	349	14	48	85	202
Black cottonwood	114	2	22	26	64
Other hardwoods ²	49	---	6	2	41
Total	1,801	54	321	469	957
All species	14,715	5,818	2,468	3,469	2,960

¹ Less than 500,000 cubic feet.

² Includes Oregon ash, Oregon white oak, Pacific madrone, and western paper birch.

Table 20. — Volume of sawtimber on commercial forest land by species and ownership class, Puget Sound area, Washington, January 1, 1967 (International 1/4-inch scale)
(In million board feet)

Species	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Softwoods:					
Douglas-fir	21,013	8,008	4,012	3,894	5,099
Western hemlock	24,305	13,295	2,246	6,747	2,017
Mountain hemlock	2,070	1,175	383	512	---
Western redcedar	6,736	3,888	925	893	1,030
Alaska-cedar	656	314	35	307	---
Pacific silver fir	12,991	8,421	1,807	2,326	437
Grand fir	132	26	40	16	50
Noble fir	1,175	659	137	379	---
Subalpine fir	185	185	---	---	---
Sitka spruce	369	33	106	84	146
Engelmann spruce	19	19	---	---	---
Lodgepole pine	¹	¹	---	---	---
Western white pine	100	84	5	---	11
Total	69,751	36,107	9,696	15,158	8,790
Hardwoods:					
Red alder	3,111	142	642	705	1,622
Bigleaf maple	1,259	69	143	215	832
Black cottonwood	655	20	101	130	404
Other hardwoods ²	83	---	15	---	68
Total	5,108	231	901	1,050	2,926
All species	74,859	36,338	10,597	16,208	11,716

¹ Less than 500,000 board feet.

² Includes Oregon ash, Pacific madrone, and western paper birch.

Table 21. — Volume of growing stock on commercial forest land, by species and diameter class, Puget Sound area, Washington, January 1, 1967
(In million cubic feet)

Species	Diameter class (inches at breast height)											
	All classes	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0-38.9	39.0 & larger
Softwoods:												
Douglas-fir	4,126	164	244	292	337	345	359	326	261	751	481	566
Western hemlock	4,537	191	222	284	268	258	259	232	225	856	878	864
Mountain hemlock	345	4	6	5	11	22	21	40	27	83	83	43
Western redcedar	1,311	64	72	64	86	65	63	66	47	180	177	427
Alaska-cedar	118	1	3	2	3	3	9	4	12	34	31	16
Pacific silver fir	2,156	51	63	69	78	105	130	144	123	566	592	235
Grand fir	25	¹	2	---	4	7	3	1	1	1	4	2
Noble fir	177	¹	2	1	1	2	3	4	10	45	59	50
Subalpine fir	36	¹	2	1	1	4	5	5	5	10	3	---
Sitka spruce	60	3	---	---	3	2	3	1	2	18	18	10
Engelmann spruce	3	---	¹	---	¹	¹	¹	¹	---	1	2	---
Lodgepole pine	2	¹	---	2	---	---	---	---	---	---	---	---
Western white pine	18	1	¹	1	3	1	¹	1	2	4	4	1
Total	12,914	479	616	721	795	814	855	824	715	2,549	2,332	2,214
Hardwoods:												
Red alder	1,289	151	233	276	224	189	119	53	16	28	---	---
Bigleaf maple	349	38	39	48	50	37	38	25	19	31	18	6
Black cottonwood	114	1	6	4	9	13	17	19	9	16	12	8
Other hardwoods ²	49	11	12	10	4	1	2	5	1	3	---	---
Total	1,801	201	290	338	287	240	176	102	45	78	30	14
All species	14,715	680	906	1,059	1,082	1,054	1,031	926	760	2,627	2,362	2,228

¹ Less than 500,000 cubic feet.

² Includes Pacific madrone, western paper birch, Oregon white oak, and Oregon ash.

Table 22. — Volume of sawtimber on commercial forest land, by species and diameter class, Puget Sound area, Washington, January 1, 1967 (International 1/4-inch scale)

(In million board feet)

Species	Diameter class (inches at breast height)								
	All classes	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0-38.9	39.0 and larger
Softwoods:									
Douglas-fir	21,013	1,512	1,755	1,976	1,912	1,603	4,923	3,327	4,005
Western hemlock	24,305	1,292	1,373	1,473	1,377	1,410	5,566	5,953	5,861
Mountain hemlock	2,070	55	107	131	229	153	533	564	298
Western redcedar	6,736	361	310	324	346	268	1,058	1,192	2,877
Alaska-cedar	656	20	19	48	30	67	195	177	100
Pacific silver fir	12,991	378	569	756	878	784	3,833	4,116	1,677
Grand fir	132	16	37	16	7	7	11	21	17
Noble fir	1,175	5	10	17	18	60	302	409	354
Subalpine fir	185	6	14	23	30	28	67	17	---
Sitka spruce	369	15	12	16	7	11	115	122	71
Engelmann spruce	19	---	1	3	1	---	---	8	6
Lodgepole pine	¹	1	---	---	---	---	---	---	---
Western white pine	100	14	7	4	6	7	31	25	6
Total	69,751	3,674	4,214	4,787	4,841	4,398	16,634	15,931	15,272
Hardwoods:									
Red alder	3,111	986	910	632	303	95	185	---	---
Bigleaf maple	1,259	214	174	192	143	105	228	140	63
Black cottonwood	655	39	65	92	106	61	108	105	79
Other hardwoods ²	83	20	2	8	28	6	19	---	---
Total	5,108	1,259	1,151	924	580	267	540	245	142
All species	74,859	4,933	5,365	5,711	5,421	4,665	17,174	16,176	15,414

¹ Less than 500,000 board feet.

² Includes Pacific madrone, western paper birch, and Oregon ash.

Table 23. — Volume of sawtimber on commercial forest land, by species and diameter class, Puget Sound area, Washington, January 1, 1967 (Scribner scale)

(In million board feet)

Species	Diameter class (inches at breast height)								
	All classes	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0-38.9	39.0 and larger
Softwoods:									
Douglas-fir	15,559	858	1,072	1,283	1,303	1,137	3,724	2,731	3,451
Western hemlock	18,563	741	846	961	945	1,006	4,248	4,856	4,960
Mountain hemlock	1,542	30	64	83	153	108	397	455	252
Western redcedar	5,129	198	175	199	218	177	743	938	2,481
Alaska-cedar	472	10	11	29	21	43	138	137	83
Pacific silver fir	10,091	222	359	505	616	573	2,990	3,409	1,417
Grand fir	91	9	22	10	5	6	9	16	14
Noble fir	941	3	6	11	12	43	232	334	300
Subalpine fir	135	4	11	17	21	20	49	13	—
Sitka spruce	275	8	6	11	5	7	85	98	55
Engelmann spruce	14	—	¹	1	1	—	2	10	—
Lodgepole pine	¹	¹	—	—	—	—	—	—	—
Western white pine	74	8	5	2	5	5	22	22	5
Total	52,886	2,091	2,577	3,112	3,305	3,125	12,639	13,019	13,018
Hardwoods:									
Red alder	2,993	944	875	610	292	92	180	—	—
Bigleaf maple	1,214	203	167	183	133	103	223	139	63
Black cottonwood	638	36	63	88	102	58	107	105	79
Other hardwoods ²	82	19	2	8	28	7	18	—	—
Total	4,927	1,202	1,107	889	555	260	528	244	142
All species	57,813	3,293	3,684	4,001	3,860	3,385	13,167	13,263	13,160

¹ Less than 500,000 board feet.

² Includes Pacific madrone, western paper birch, and Oregon ash.

Table 24. — Area of commercial forest land and volume of growing stock and sawtimber, by stand age and ownership classes, Puget Sound area, Washington, January 1, 1967

Stand age (years)	All ownerships			National Forest			Other public			Forest industry			Farmer and miscellaneous private		
	Thousand acres	Growing stock	Sawtimber	Thousand acres	Growing stock	Sawtimber	Thousand acres	Growing stock	Sawtimber	Thousand acres	Growing stock	Sawtimber	Thousand acres	Growing stock	Sawtimber
		Million cubic feet	Million board feet ¹		Million cubic feet	Million board feet ¹		Million cubic feet	Million board feet ¹		Million cubic feet	Million board feet ¹		Million cubic feet	Million board feet ¹
Nonstocked ²	53	5	—	7	3	—	15	3	—	21	2	—	10	—	—
0 - 9	299	98	244	42	11	60	34	5	27	139	44	95	84	38	62
10 - 19	239	188	317	38	8	10	41	18	14	92	77	172	68	85	121
20 - 29	343	633	1,396	13	12	37	71	133	241	125	236	595	134	252	523
30 - 39	523	1,789	5,592	15	25	56	151	542	1,755	166	618	1,766	191	604	2,015
40 - 49	403	1,603	5,900	30	86	255	121	542	1,851	78	334	1,222	174	641	2,572
50 - 59	133	574	2,599	15	67	256	14	104	486	27	148	692	77	255	1,165
60 - 69	84	381	1,752	15	79	382	18	99	464	9	9	29	42	194	877
70 - 79	60	200	933	6	38	183	7	40	203	6	7	6	41	115	541
80 - 89	40	276	1,346	14	78	378	3	19	95	15	114	515	8	65	358
90 - 99	10	60	346	4	19	95	4	12	69	2	29	182	—	—	—
100 - 109	19	153	857	14	106	590	4	34	210	—	—	—	1	13	57
110 - 119	19	144	833	12	85	483	—	—	—	5	51	311	2	8	39
120 - 129	14	97	545	11	67	351	2	15	95	—	—	—	1	15	99
130 - 159	32	270	1,679	27	229	1,429	3	14	85	2	27	165	—	—	—
160 - 199	48	430	2,665	43	385	2,406	—	—	—	—	—	—	5	45	259
200 and over	508	5,308	34,141	358	3,795	24,943	42	377	2,250	97	1,020	6,206	11	116	742
Uneven-aged under 100 years	269	1,004	4,452	22	142	404	49	228	1,128	50	242	1,305	148	392	1,615
Uneven-aged over 100 years	204	1,502	9,262	62	586	4,020	34	283	1,624	76	511	2,947	32	122	671
All ages	3,300	14,715	74,859	748	5,818	36,338	613	2,468	10,597	910	3,469	16,208	1,029	2,960	11,716

¹ International 1/4-inch scale.

² See "Definition of Terms."

³ Less than 500,000 cubic feet.

Table 25. — Net annual growth of growing stock on commercial forest land, by species and ownership class, Puget Sound area, Washington, 1966¹
(In thousand cubic feet)

Species	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Softwoods:					
Douglas-fir	108,800	8,200	28,800	24,200	47,600
Western hemlock	76,700	6,800	20,000	31,900	18,000
Western redcedar	25,900	3,400	13,400	² -2,800	11,900
True firs	10,500	2,200	3,300	4,100	900
Other softwoods ³	13,500	² -2,600	² -1,300	17,400	⁴
Total	235,400	18,000	64,200	74,800	78,400
Hardwoods:					
Red alder	42,600	900	7,700	12,500	21,500
Other hardwoods ⁵	20,500	300	3,100	5,700	11,400
Total	63,100	1,200	10,800	18,200	32,900
All species	298,500	19,200	75,000	93,000	111,300

¹ See "Inventory Procedures" for an explanation of growth estimates and the actual periods over which growth was measured.

² Negative growth is the result of mortality exceeding gross annual growth.

³ Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

⁴ Less than 50,000 cubic feet.

⁵ Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, Oregon white oak, and Oregon ash.

*Table 26. — Net annual growth of sawtimber on commercial forest land, by species and ownership class, Puget Sound area, Washington, 1966¹ (International 1/4-inch scale)
(In thousand board feet)*

Species	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Softwoods:					
Douglas-fir	566,400	52,200	164,400	101,900	247,900
Western hemlock	356,700	28,200	69,300	168,400	90,800
Western redcedar	106,000	25,000	59,600	² -35,100	56,500
True firs	57,200	10,500	17,000	24,500	5,200
Other softwoods ³	90,500	² -14,700	² -2,500	107,100	600
Total	1,176,800	101,200	307,800	366,800	401,000
Hardwoods:					
Red alder	104,200	10,700	19,400	25,400	48,700
Other hardwoods ⁴	77,700	3,500	9,700	16,200	48,300
Total	181,900	14,200	29,100	41,600	97,000
All species	1,358,700	115,400	336,900	408,400	498,000

¹ See "Inventory Procedures" for an explanation of growth estimates and the actual periods over which growth was measured.

² Negative growth is the result of mortality exceeding gross annual growth.

³ Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

⁴ Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, and Oregon ash.

Table 27.— *Net annual growth of sawtimber on commercial forest land, by species and ownership class, Puget Sound area, Washington, 1966¹ (Scribner scale)*
(In thousand board feet)

Species	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Softwoods:					
Douglas-fir	401,400	41,400	115,100	72,000	172,900
Western hemlock	234,300	21,600	41,100	111,100	60,500
Western redcedar	52,900	18,800	34,000	² -37,400	37,500
True firs	46,100	7,700	13,900	20,300	4,200
Other softwoods ³	73,000	² -10,800	² -1,000	83,900	900
Total	807,700	78,700	203,100	249,900	276,000
Hardwoods:					
Red alder	98,200	7,100	18,900	24,800	47,400
Other hardwoods ⁴	75,500	2,300	9,700	15,900	47,600
Total	173,700	9,400	28,600	40,700	95,000
All species	981,400	88,100	231,700	290,600	371,000

¹ See "Inventory Procedures" for an explanation of growth estimates and the actual periods over which growth was measured.

² Negative growth is the result of mortality exceeding gross annual growth.

³ Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

⁴ Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, and Oregon ash.

Table 28. — Net annual growth of growing stock on commercial forest land, by species and county, Puget Sound area, Washington, 1966¹
(In thousand cubic feet)

Species	County							
	All counties	Island	King	Kitsap	Pierce	Skagit	Snohomish	Whatcom
Softwoods:								
Douglas-fir	108,800	7,000	22,000	13,100	22,900	14,100	17,600	12,100
Western hemlock	76,700	1,600	19,800	1,600	10,100	15,700	20,300	7,600
Western redcedar	25,900	700	3,800	1,100	² -4,100	10,300	9,900	4,200
True fir	10,500	100	4,300	---	500	3,000	3,700	² -1,100
Other softwoods ³	13,500	⁴	5,100	100	⁴	300	² -1,600	9,600
Total	235,400	9,400	55,000	15,900	29,400	43,400	49,900	32,400
Hardwoods:								
Red alder	42,600	1,600	10,300	1,200	5,400	6,100	11,700	6,300
Other hardwoods ⁵	20,500	100	4,800	⁴	1,500	6,300	4,200	3,600
Total	63,100	1,700	15,100	1,200	6,900	12,400	15,900	9,900
All species	298,500	11,100	70,100	17,100	36,300	55,800	65,800	42,300

¹See "Inventory Procedures" for an explanation of growth estimates and the actual periods over which growth was measured.

²Negative growth is the result of mortality exceeding gross annual growth.

³Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

⁴Less than 50,000 cubic feet.

⁵Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, Oregon white oak, and Oregon ash.

Table 29. — Net annual growth of sawtimber on commercial forest land, by species and county, Puget Sound area, Washington, 1966¹ (International ¼-inch scale)
(In thousand board feet)

Species	County							
	All counties	Island	King	Kitsap	Pierce	Skagit	Snohomish	Whatcom
Softwoods:								
Douglas-fir	566,400	37,300	93,700	72,800	95,900	90,000	97,100	79,600
Western hemlock	356,700	3,400	85,000	7,200	65,600	69,100	112,300	14,100
Western redcedar	106,000	200	22,800	14,800	² -31,800	44,800	40,000	15,200
True firs	57,200	400	29,500	---	1,100	11,200	23,600	² -8,600
Other softwoods ³	90,500	500	29,800	² -100	² -1,200	4,500	² -5,000	62,000
Total	1,176,800	41,800	260,800	94,700	129,600	219,600	268,000	162,300
Hardwoods:								
Red alder	104,200	4,100	17,800	4,600	9,200	15,900	40,500	12,100
Other hardwoods ⁴	77,700	400	16,900	700	5,100	25,300	18,600	10,700
Total	181,900	4,500	34,700	5,300	14,300	41,200	59,100	22,800
All species	1,358,700	46,300	295,500	100,000	143,900	260,800	327,100	185,100

¹ See "Inventory Procedures" for an explanation of growth estimates and the actual periods over which growth was measured.

² Negative growth is the result of mortality exceeding gross annual growth.

³ Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

⁴ Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, and Oregon ash.

Table 30. — Average annual mortality of growing stock on commercial forest land, by species and ownership class, Puget Sound area, Washington, 1966¹
(In thousand cubic feet)

Species	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Softwoods:					
Douglas-fir	14,200	4,700	3,000	2,700	3,800
Western hemlock	26,400	12,300	5,600	6,800	1,700
Western redcedar	14,100	1,600	1,100	10,000	1,400
True firs	15,100	12,700	900	1,500	²
Other softwoods ³	5,700	2,900	800	1,000	1,000
Total	75,500	34,200	11,400	22,000	7,900
Hardwoods:					
Red alder	7,700	200	700	2,500	4,300
Other hardwoods ⁴	3,000	100	600	600	1,700
Total	10,700	300	1,300	3,100	6,000
All species	86,200	34,500	12,700	25,100	13,900

¹See "Inventory Procedures" for details on the mortality estimates and periods over which mortality was estimated.

²Less than 50,000 cubic feet.

³Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

⁴Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, Oregon white oak, and Oregon ash.

Table 31. — Average annual mortality of sawtimber on commercial forest land, by species and ownership class, Puget Sound area, Washington, 1966¹ (International 1/4-inch scale)
(In thousand board feet)

Species	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Softwoods:					
Douglas-fir	65,300	30,500	8,700	10,100	16,000
Western hemlock	145,600	79,200	31,200	31,200	4,000
Western redcedar	74,400	9,500	5,300	55,400	4,200
True firs	90,500	78,600	5,300	6,200	400
Other softwoods ²	30,700	17,300	3,100	5,700	4,600
Total	406,500	215,100	53,600	108,600	29,200
Hardwoods:					
Red alder	12,200	900	1,900	2,500	6,900
Other hardwoods ³	10,900	1,000	3,300	1,900	4,700
Total	23,100	1,900	5,200	4,400	11,600
All species	429,600	217,000	58,800	113,000	40,800

¹See "Inventory Procedures" for details on the mortality estimates and periods over which mortality was estimated.

²Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

³Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, and Oregon ash.

Table 32. — Average annual mortality of sawtimber on commercial forest land, by species and ownership class, Puget Sound area, Washington, 1966¹ (Scribner scale)
(In thousand board feet)

Species	All ownerships	National Forest	Other public	Forest industry	Farmer and miscellaneous private
Softwoods:					
Douglas-fir	51,200	25,700	6,400	7,200	11,900
Western hemlock	114,500	64,500	23,700	23,800	2,500
Western redcedar	66,700	8,000	4,000	51,000	3,700
True firs	72,200	63,700	4,000	4,400	100
Other softwoods ²	22,100	13,100	2,100	3,800	3,100
Total	326,700	175,000	40,200	90,200	21,300
Hardwoods:					
Red alder	12,000	800	1,800	2,500	6,900
Other hardwoods ³	10,400	900	3,200	1,800	4,500
Total	22,400	1,700	5,000	4,300	11,400
All species	349,100	176,700	45,200	94,500	32,700

¹ See "Inventory Procedures" for details on the mortality estimates and periods over which mortality was estimated.

² Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

³ Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, Oregon white oak, and Oregon ash.

Table 33. — Average annual mortality of growing stock on commercial forest land, by species and county, Puget Sound area, Washington, 1966¹
(In thousand cubic feet)

Species	County							
	All counties	Island	King	Kitsap	Pierce	Skagit	Snohomish	Whatcom
Softwoods:								
Douglas-fir	14,200	700	2,100	600	5,900	600	2,700	1,600
Western hemlock	26,400	200	7,300	300	4,600	4,000	5,000	5,000
Western redcedar	14,100	300	2,400	100	7,100	800	2,000	1,400
True firs	15,100	---	1,900	---	2,000	4,300	2,500	4,400
Other softwoods ²	5,700	---	2,400	300	1,600	---	1,000	400
Total	75,500	1,200	16,100	1,300	21,200	9,700	13,200	12,800
Hardwoods:								
Red alder	7,700	200	1,300	1,200	1,000	1,100	2,200	700
Other hardwoods ³	3,000	---	400	300	300	800	800	400
Total	10,700	200	1,700	1,500	1,300	1,900	3,000	1,100
All species	86,200	1,400	17,800	2,800	22,500	11,600	16,200	13,900

¹ See "Inventory Procedures" for details on the mortality estimates and periods over which mortality was estimated.

² Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

³ Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, Oregon white oak, and Oregon ash.

Table 34. — Average annual mortality of sawtimber on commercial forest land, by species and county, Puget Sound area, Washington, 1966¹ (International ¼-inch scale) (In thousand board feet)

Species	County							
	All counties	Island	King	Kitsap	Pierce	Skagit	Snohomish	Whatcom
Softwoods:								
Douglas-fir	65,300	2,900	11,800	1,400	22,700	2,800	13,800	9,900
Western hemlock	145,600	600	39,700	1,600	25,400	20,700	25,800	31,800
Western redcedar	74,400	600	8,800	400	44,300	3,500	8,600	8,200
True firs	90,500	---	11,600	---	12,800	23,600	13,400	29,100
Other softwoods ²	30,700	---	13,900	700	7,500	400	5,800	2,400
Total	406,500	4,100	85,800	4,100	112,700	51,000	67,400	81,400
Hardwoods:								
Red alder	12,200	---	2,100	1,500	900	2,200	4,100	1,400
Other hardwoods ³	10,900	---	400	1,600	900	2,900	3,500	1,600
Total	23,100	---	2,500	3,100	1,800	5,100	7,600	3,000
All species	429,600	4,100	88,300	7,200	114,500	56,100	75,000	84,400

¹ See "Inventory Procedures" for details on the mortality estimates and periods over which mortality was estimated.

² Includes Sitka spruce, Engelmann spruce, Alaska-cedar, mountain hemlock, lodgepole pine, and western white pine.

³ Includes bigleaf maple, black cottonwood, Pacific madrone, western paper birch, and Oregon ash.

Table 35. — Average annual mortality of growing stock and sawtimber on commercial forest land, by cause of death and by softwoods and hardwoods, Puget Sound area, Washington, 1966

Species	Cause of death					
	All causes	Fire	Insects	Disease	Other ¹	Miscellaneous and unknown ²
----- Thousand cubic feet -----						
Growing stock:						
Softwoods	75,500	1,000	1,900	8,900	45,400	18,300
Hardwoods	10,700	---	---	400	6,200	4,100
Total	86,200	1,000	1,900	9,300	51,600	22,400
----- Thousand board feet, International 1/4-inch scale -----						
Sawtimber:						
Softwoods	406,500	6,200	11,800	51,100	239,000	98,400
Hardwoods	23,100	---	---	600	12,700	9,800
Total	429,600	6,200	11,800	51,700	251,700	108,200
----- Thousand board feet, Scribner scale -----						
Sawtimber:						
Softwoods	326,700	5,000	9,500	42,700	188,500	81,000
Hardwoods	22,400	---	---	600	12,400	9,400
Total	349,100	5,000	9,500	43,300	200,900	90,400

¹ Mostly weather killed, some of which had been predisposed to windbreak or windthrow by root rot, heart rot, and by the opening of stands by logging and road building. A rather small volume of timber in this group was killed by animals, suppression, and natural mechanical agents such as rockslides and falling snags.

² Includes hemlock dieback.

Table 36. — Net volume of salvable dead sawtimber on commercial forest land, by volume-per-acre class and owner group, Puget Sound area, Washington, January 1, 1967

Volume-per-acre class	Total	National Forest	All other owners
----- Thousand cubic feet -----			
Cubic feet:			
1 - 199	23,600	16,100	7,500
200 - 499	109,000	43,000	66,000
500 - 999	118,500	67,900	50,600
1,000 - 1,999	106,800	63,100	43,700
2,000 or more	88,900	47,400	41,500
Total	446,800	237,500	209,300
----- Thousand board feet, International 1/4-inch scale -----			
Board feet:			
1 - 499	16,400	16,400	---
500 - 999	89,600	56,200	33,400
1,000 - 2,499	487,400	193,800	293,600
2,500 - 4,999	619,400	346,700	272,700
5,000 - 9,999	710,200	461,200	249,000
10,000 or more	902,600	490,000	412,600
Total	2,825,600	1,564,300	1,261,300

Table 37. — Net volume of salvable dead sawtimber on commercial forest land, by volume-per-tree class and species group, Puget Sound area, Washington, January 1, 1967

Volume-per-acre class	Total	Douglas-fir	Hemlock	Cedar	True firs	Other softwoods	Hardwoods
----- Thousand cubic feet -----							
Cubic feet:							
1 - 49	73,300	16,200	21,900	11,000	13,700	2,600	7,900
50 - 99	88,800	15,000	21,100	10,800	19,200	14,200	8,500
100 - 499	228,300	23,400	89,800	33,200	72,300	9,000	600
500 or more	56,400	12,600	13,900	21,400	8,500	---	---
Total	446,800	67,200	146,700	76,400	113,700	25,800	17,000
----- Thousand board feet, International 1/4-inch scale -----							
Board feet:							
1 - 149	175,900	37,700	49,000	27,900	31,400	7,700	22,200
150 - 499	563,700	116,900	128,900	70,700	124,200	59,100	63,900
500 - 2,499	1,444,300	138,300	550,300	186,400	474,700	83,300	11,300
2,500 or more	641,700	135,600	211,700	172,900	121,500	---	---
Total	2,825,600	428,500	939,900	457,900	751,800	150,100	97,400

Table 38. — Timber harvest by ownership class, Puget Sound area, Washington, 1950-68 (International 1/4-inch scale)
(In thousand board feet)

Year	All ownerships			Private ¹			State ¹			National Forest			Other public		
	Total	Live	Dead ²	Total	Live	Dead ²	Total	Live	Dead ²	Total	Live	Dead ²	Total	Live	Dead ²
1950	1,368,209	³	³				1,112,437	³	³	218,668	³	³	37,104	³	³
1951	1,319,901	³	³				1,054,043	³	³	259,504	³	³	6,354	³	³
1952	1,315,087	1,266,542	48,545				1,091,257	1,076,719	20,538	223,536	195,531	28,005	294	292	2
1953	1,097,718	⁴	⁴				856,764	834,486	22,278	240,555	³	³	399	³	³
1954	1,017,685	946,151	71,534				788,413	764,492	23,921	226,432	180,084	46,348	2,840	1,575	1,265
1955	1,233,138	1,145,507	87,631	830,815	801,740	29,075	150,784	145,703	5,081	243,966	191,792	52,175	7,573	6,272	1,301
1956	1,373,996	1,289,108	84,888	922,585	888,653	33,932	194,530	190,758	3,772	249,849	202,776	47,073	7,032	6,921	111
1957	1,079,263	991,984	87,279	688,180	654,350	33,830	100,299	98,706	1,593	286,789	235,314	51,475	3,995	3,614	381
1958	939,437	861,396	78,041	635,697	607,073	28,624	21,025	18,606	2,419	280,550	234,559	45,991	2,165	1,158	1,007
1959	1,340,721	1,254,959	85,762	827,747	801,835	25,912	103,987	101,602	2,385	407,219	349,998	57,221	1,768	1,524	244
1960	1,364,543	1,282,068	82,475	959,823	909,314	50,509	72,646	66,560	6,086	329,263	303,530	25,733	2,811	2,664	147
1961	1,178,124	1,150,677	27,447	772,539	758,666	13,873	67,348	66,856	492	335,409	322,417	12,992	2,828	2,738	90
1962	1,360,067	1,290,474	69,593	848,975	834,080	14,895	94,027	93,281	746	413,035	359,083	53,952	4,030	4,030	---
1963	1,454,210	1,202,035	252,175	809,796	646,915	162,881	217,157	176,429	40,728	417,381	370,548	46,833	9,876	8,143	1,733
1964	1,640,098	1,418,382	221,716	990,488	876,810	113,678	148,577	111,419	37,158	486,181	417,357	68,824	14,852	12,796	2,056
1965	1,651,959	1,541,849	110,110	1,004,729	956,526	48,203	128,695	105,390	23,305	474,955	439,107	35,848	43,580	40,826	2,754
1966	1,497,741	1,428,060	69,681	934,490	892,660	41,830	125,578	117,211	8,367	384,731	367,713	17,018	52,942	50,476	2,466
1967	1,554,560	1,484,025	70,535	1,005,736	984,717	21,019	73,447	71,590	1,857	402,414	355,430	46,984	72,963	72,288	675
1968	1,630,052	1,572,839	57,213	1,029,594	1,027,443	2,151	130,711	130,317	394	390,086	335,558	54,528	79,661	79,521	140

¹ Data for private ownership combined with State ownership for 1950-54.

² Includes snags and down material existing prior to initial logging. Salvage of this material does not constitute drain on the volume of the forest inventory of live trees.

³ Data not available.

⁴ Incomplete data.

ACCURACY OF CURRENT INVENTORY DATA

Forest Land Area and Timber Volume

The estimates of forest land area and timber volume in the Puget Sound area were derived by sampling and consequently have sampling errors. Sampling errors have been computed for the estimates of commercial forest land area, noncommercial forest land area, net cubic-foot volume of growing stock, and net board-foot volume (International ¼-inch scale) of sawtimber. These sampling errors are presented in table 39 as a percent of the estimated total at the 68-percent and 95-percent probability levels. They may be interpreted as meaning that the odds are two out of three for 68-percent probability, or 19 out of 20 for 95-percent probability, that the ranges shown include the true value (i.e., the results of a 100-percent inventory). For example, we can expect, with

95-percent confidence, that the estimate of total commercial forest land area — 3,300,000 acres $\pm$ 2.3 percent (75,900 acres) — includes the true value.

In addition to measurable sampling errors, there may be other nonsampling errors due to mistakes in judgment, measurement, and compilation. The magnitude of errors from these sources cannot be determined. However, such errors are kept to a minimum through training, supervision, field checking, and complete editing and machine verification in compiling the data.

The sampling error of any breakdown of these totals will be substantially greater than for the total. The smaller the breakdown, the larger the sampling error. An approximation of the increasing sampling error can be obtained from table 40, which shows the sampling error associated with smaller estimates.

Table 39. — Sampling errors of estimates of forest area and timber volume, Puget Sound area, Washington, January 1, 1967

Item	Estimated total	Sampling error in percent	
		68-percent probability	95-percent probability
Commercial forest land	3,300,000 acres	± 1.2	± 2.3
Noncommercial forest land	1,563,000 acres ¹	± 1.7	± 3.3
Volume:			
Growing stock	14,715 million cubic feet	± 1.5	± 2.8
Sawtimber (International ¼-inch scale)	74,859 million board feet	± 1.5	± 2.8

¹Of the estimated 1,563,000 acres of noncommercial forest land in the Puget Sound area, 896,000 acres were classified by complete enumeration on maps and have no sampling error. The remaining 667,000 acres were classified by sampling procedures and have a sampling error of 4.1 percent at the 68-percent probability level and 7.8 percent at the 95-percent probability level.

Table 40. — Approximate sampling error by size of estimate, Puget Sound area, Washington, January 1, 1967

Commercial forest land		Growing stock		Sawtimber	
Area	Sampling error ¹	Volume	Sampling error ¹	Volume	Sampling error ¹
<i>Thousand acres</i>	<i>Percent</i>	<i>Million cubic feet</i>	<i>Percent</i>	<i>Million board feet, International 1/4-inch scale</i>	<i>Percent</i>
3,300	1.2	14,715	1.5	74,859	1.5
1,188	2.0	8,277	2.0	40,993	2.0
528	3.0	3,679	3.0	18,219	3.0
297	4.0	2,069	4.0	10,248	4.0
190	5.0	1,324	5.0	6,557	5.0
48	10.0	331	10.0	1,640	10.0
21	15.0	147	15.0	729	15.0
12	20.0	83	20.0	410	20.0
8	25.0	53	25.0	262	25.0
5	30.0	37	30.0	182	30.0
3	40.0	21	40.0	102	40.0
		13	50.0	66	50.0
		9	60.0	46	60.0
		7	70.0	33	70.0
		5	80.0	26	80.0
		4	90.0	20	90.0
		3	100.0	16	100.0

¹ By random sampling formula; 68-percent probability.

INVENTORY PROCEDURES

The summary tables in this report include data from the inventories of the Mount Baker and Snoqualmie National Forests, conducted by the Division of Timber Management, Region 6, U. S. Forest Service; and data from the inventory of lands outside the National Forests, conducted by the Forest Survey project, Pacific Northwest Forest and Range Experiment Station. National Forest lands were inventoried in 1964-66, lands outside the National Forests in 1966-67. No updating was done to bring data to a common date. The same general standards and definitions were used for both National Forests and lands outside the National Forests, except as explained in the following paragraphs.

National Forest Lands

Field plots were distributed on a systematic grid at 1.7-mile intervals on National Forest lands.

On the north half of the Mount Baker National Forest, field plots consisted of three 1/5-acre subplots located 6 chains apart. They were originally established in 1957. The current inventory data are based on the 1965 remeasurement of these plots. There were 891 subplots on the north half of the Mount Baker National Forest.

Field plots on the south half of the Mount Baker National Forest consisted of 10 sample points distributed systematically over an acre. The variable-radius plot sampling principle was used at each point to select the trees to be tallied. Where no trees were tallied, a ground cover class was recorded. Summations of the 10-point tally expressed the timber resources and conditions for that acre and were used to estimate forest area and volume. There were 223 10-point plots on the south half of the Mount Baker National Forest, established in 1966.

All field plots on the Snoqualmie National Forest consisted of three 1/5-acre subplots located 6 chains apart. Permanent 1/5-acre subplots were established on the Snoqualmie, Cedar River, Green River, and White River blocks of the Snoqualmie National Forest in 1957 but not on the Skykomish and Mineral blocks. The current inventory data are based on the 1964-65 remeasurement of the 1/5-acre subplots established in 1957 and on new 1/5-acre subplots established in 1964 and 1965. There were 822 subplots on that part of the Snoqualmie National Forest that lies within the Puget Sound area.

Growth estimates were based on data from the remeasurement of trees on the 1/5-acre subplots and from tree borings on newly established 10-point plots. Multiple regression equations were used to estimate tree diameter 1 year ago on the 10-point plots, and net volume was computed for both present and past diameters. Gross growth was obtained by subtracting past from present net volume.

Estimates of annual mortality were based on (1) the tally of dead trees previously recorded as live on the 1/5-acre subplots originally established in 1957 and (2) the tally of dead trees estimated to have died since 1961 on the newly established 10-point plots.

Lands Outside National Forests

A double sampling design was used for lands outside the National Forests. First, aerial photo sample plots were distributed systematically across the area. Photo plots were classified into one of three major land classes — commercial forest, noncommercial forest, and nonforest — and the commercial forest plots were further classified into stand volume classes. All photo plots were classified by kind of owner from public records. About 9,200 photo plots were examined. The second stage consisted of a basic

systematic grid of field plots 3.4 miles apart with supplemental plots added. A total of 787 field plots were established at photo plot locations. Plots consisted of 10 sample points distributed systematically over an acre. The same plot procedures used on the south half of the Mount Baker National Forest (see preceding section) were used on lands outside National Forests.

In addition to the two-stage sample using 10-point variable radius plots, previously established 1/5-acre plots were remeasured in all counties except Snohomish. The remeasured data were used to develop multiple regression equations of diameter growth, which in turn were used to estimate diameter 1 year ago for all trees on the 10-point variable radius inventory plots. Net volume was computed for both past and present diameters and gross growth was obtained by subtracting past from present net volume. Variables in the regression equations included d.b.h., average stand diameter,

basal area per acre, tree age, crown ratio, site index, and combinations of these.

Annual mortality estimates are based on the tally of dead trees recorded as live on the originally established 1/5-acre plots in all counties except Snohomish, where mortality back-dating methods were used. The mortality period is from 1957 to 1966 for Skagit and Whatcom Counties, 1959 to 1966 for King County and eastern Pierce County (in general the country east of Eatonville, Kapowsin, and Orting), and 1959 to 1967 for Island and Kitsap Counties and western Pierce County.

Timber Harvest

The timber harvest figures used in this report have been obtained from various reporting agencies using varying standards and methods of reporting. These timber cut figures are therefore not strictly comparable to Forest Survey's commercial forest land, volume, and growth data but are considered adequate for the analyses made.

DEFINITION OF TERMS

Land Area

Total Land Area

Includes dry land and land temporarily or partially covered by water, such as marshes, swamps, and river flood plains; streams, sloughs, and canals less than 1/8-mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

Forest Land Area

Land at least 16.7 percent stocked by trees of any size, or formerly having such tree cover, and not currently developed for nonforest use. Minimum area of forest land recognized is 1 acre.

Nonforest Land Area

Land that has never supported forests and lands formerly forested where use for timber management is precluded by development for other uses. Included are areas used for agricultural crops, improved pasture, residential areas, city parks, improved roads of any width and right-of-way clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and other nonforest strips must be more than 120 feet wide, and clearings, etc., more than 1 acre in size, to qualify as nonforest land.

Forest Land Classes

Commercial Forest Land Area

Forest land which is producing or capable of producing industrial wood and not withdrawn from timber utilization.

Noncommercial Forest Land Area

Unproductive forest land incapable of yielding crops of industrial wood because of adverse site conditions, and productive public forest land withdrawn from commercial timber use through statute or administrative regulation.

Productive-reserved. — Public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land. Also included are forest lands managed exclusively for Christmas tree production.

Unproductive. — Forest land incapable of yielding crops of industrial wood products because of adverse site conditions such as sterile soil, poor drainage, high elevation, steepness, and rockiness.

Forest Types

Forest types are determined on the basis of species plurality of all live trees that

contribute to stocking, considering both size and spacing.

Tree Classes

Growing-stock Trees

Sawtimber trees, poletimber trees, saplings, and seedlings; that is, all live trees except cull trees.

Acceptable trees. — Growing-stock trees of commercial species meeting specified standards of size and quality but not qualifying as desirable trees.

Desirable trees. — Growing-stock trees of commercial species (1) having no serious defects in quality limiting present or prospective use for timber products, (2) of relatively high vigor, and (3) containing no pathogens that may result in death or serious deterioration before rotation age.

Sawtimber trees (11.0-inch d.b.h. and larger). — Live trees of commercial species. Softwood trees must contain at least one 12-foot saw log with a top diameter not less than 6 inches inside bark; hardwood trees must contain at least one 8-foot saw log with a top diameter not less than 8 inches inside bark. At least 25 percent of the board-foot volume in a tree must be free of defect for either softwoods or hardwoods.

Poletimber trees (5.0- to 10.9-inch d.b.h.). — Live trees of commercial species not less than 50 percent sound on a cubic-foot basis and with no disease, defects, or deformities which are likely to prevent their becoming growing-stock sawtimber trees.

Sapling and seedling trees (less than 5.0-inch d.b.h.). — Live trees of commercial species with no disease, defects, or deformities which

are likely to prevent their becoming growing-stock poletimber trees.

Nongrowing-stock Trees

Cull trees. — Trees of noncommercial species and trees of commercial species which are too defective or which are unlikely to become growing-stock trees due to deformity, disease, low vigor, etc.

Sound cull trees: Trees of noncommercial species or with excessive defect due to form, roughness, etc.

Rotten cull trees: Trees with excessive defect due primarily to rot.

Mortality trees. — Trees of commercial species which have died from natural causes within a specified period and which were not cull trees at the time of death.

Salvable dead trees. — Standing or down dead trees of commercial species 11.0 inches or more in diameter that contain 25 percent or more of sound volume and at least one merchantable 16-foot log if a softwood or one merchantable 8-foot log if a hardwood.

Stand-size Classes

Sawtimber Stand

Stand at least 16.7 percent stocked with growing-stock trees, with half or more of this stocking in sawtimber and poletimber trees, and with sawtimber stocking equal to or greater than poletimber stocking.

Large sawtimber stand. — Stand in which the majority of the sawtimber stocking is in trees 21.0-inch d.b.h. and larger.

Small sawtimber stand. — Stand in which the majority of the sawtimber stocking is in trees from 11.0- to 20.9-inch d.b.h.

Poletimber Stand

Stand at least 16.7 percent stocked with

growing-stock trees, with half or more of this stocking in sawtimber and poletimber trees, and with poletimber stocking exceeding sawtimber stocking.

Sapling and Seedling Stand

Stand at least 16.7 percent stocked with growing-stock trees, with more than half of this stocking in saplings and/or seedlings.

Nonstocked Area

An area of commercial forest land less than 16.7 percent stocked with growing-stock trees.

Stocking

Stocking is an expression of the extent to which growing space is effectively utilized by present or potential growing-stock trees of commercial species. "Percent of stocking" is synonymous with "percentage of growing

space occupied" and means the ratio of actual stocking to full stocking for comparable sites and stands. Basal area is used as a basis for measuring stocking.

Age

Stand Age

Stand age is based upon growing-stock stocking. In order for a stand to be even-aged, a majority of the growing-stock stocking must be in two adjacent age classes. Stands that do not meet this criterion are classified as uneven-aged, under or over rotation age.

Rotation Age

The period of years between establishment of a stand of timber and the time when it is considered ready for cutting. Rotation age in

softwood stands is 100 years; in hardwood stands, it is 50 years.

Old-growth Sawtimber Stand

Sawtimber stand in which 50 percent or more of the growing stock is in trees at least 140 years old.

Young-growth Sawtimber Stand

Sawtimber stand in which more than 50 percent of the growing stock is in trees less than 140 years old.

Timber Volume

Live Sawtimber Volume

Net volume in board feet of live sawtimber trees of commercial species. Net volume equals gross volume less deduction for rot, sweep, crook, and other defects that affect use for lumber.

Scribner rule. — The common board-foot log rule used in determining volume of sawtimber in Washington. Scribner volume in the Puget Sound area is measured in terms of 32-foot logs.

International 1/4-inch rule. — The standard board-foot log rule adopted nationally by the Forest Service for the presentation of Forest Survey volume statistics.

Saw-log portion. — That part of the bole of sawtimber trees between the stump and the saw-log top.

Upper-stem portion. — That part of the bole of sawtimber trees above the saw-log top to a

minimum top diameter of 40 inches outside bark or to the point where the central stem breaks into limbs.

Growing-stock Volume

Net volume in cubic feet of live sawtimber trees and live poletimber trees from stump to a minimum 4.0-inch top (of central stem) outside bark. Net volume equals gross volume less deduction for rot and missing bole sections.

All Timber Volume

Net volume in cubic feet of live and salvable dead sawtimber trees and poletimber trees of commercial species, and cull trees of all species from stump to a minimum 4.0-inch top outside bark.

Industrial Wood

All roundwood products, except fuelwood.

Net Annual Growth

The increase in net volume of a specified size class for a specific year. (Components of net annual growth include the increment in net volume of trees at the beginning of the specific year surviving to the year's end plus net volume

of trees reaching the size class during the year minus the net volume of trees that died during the year minus the net volume of trees that became culls during the year.)

Ownership Classes

National Forest Lands

Federal lands which have been designated by Executive order or statute as National

Forest or purchase units, and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones title III lands.

Other Public Lands

Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies, and lands owned by States, counties, and local public agencies, or lands leased by these governmental units for more than 50 years.

Forest Industry Lands

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

Farmer-owned Lands

Lands owned by operators of farms.

Miscellaneous Private — Corporate Lands

Lands owned by companies or corporations that do not operate wood-using plants. Included are corporate farms, some railroad lands, oil company lands, real estate and land-holding company lands, and lands held by banks and other financial institutions and various other companies and corporations.

Miscellaneous Private — Noncorporate Lands

Privately owned lands other than forest industry, farmer-owned, or corporate lands. Included are lands owned by professionals such as doctors, college professors, industrial engineers, and business managers; permanent and summer homesite lands outside city limits; and other lands held by private individuals.

Normal Yield Table

A normal yield table is a tabulation of the volume, basal area, number of trees, etc., per

acre found in fully stocked stands on specified sites at specified ages.

TREE SPECIES

Principal tree species found on the commercial forest land in the Puget Sound area include:

Softwoods:

Alaska-cedar (*Chamaecyparis nootkatensis*)
Douglas-fir (*Pseudotsuga menziesii*)
Engelmann spruce (*Picea engelmannii*)
Grand fir (*Abies grandis*)
Lodgepole pine (*Pinus contorta*)
Mountain hemlock (*Tsuga mertensiana*)
Noble fir (*Abies procera*)
Pacific silver fir (*Abies amabilis*)
Pacific yew (*Taxus brevifolia*)¹
Ponderosa pine (*Pinus ponderosa*)²
Sitka spruce (*Picea sitchensis*)
Subalpine fir (*Abies lasiocarpa*)
Western hemlock (*Tsuga heterophylla*)
Western redcedar (*Thuja plicata*)
Western white pine (*Pinus monticola*)
Whitebark pine (*Pinus albicaulis*)³

Hardwoods⁴:

Bigleaf maple (*Acer macrophyllum*)
Black cottonwood (*Populus trichocarpa*)
Cherry (*Prunus* spp.)¹
Crab apple (*Malus* spp.)¹

Hawthorn (*Crataegus* spp.)¹
Oregon ash (*Fraxinus latifolia*)
Oregon white oak (*Quercus garryana*)
Pacific dogwood (*Cornus nuttallii*)¹
Pacific madrone (*Arbutus menziesii*)
Red alder (*Alnus rubra*)
Western paper birch (*Betula papyrifera*
var. *commutata*)
Willow (*Salix* spp.)

¹ Noncommercial species.

² Extremely limited in the Puget Sound area. Found in a few natural stands on the Fort Lewis Plains and in a few plantations.

³ Found only in high mountains near timberline, generally on noncommercial forest land.

⁴ In the Puget Sound area, a number of "brush" species occasionally attain tree size. They were not tallied as trees on this survey. Included are:

Cascara buckthorn (*Rhamnus purshiana*)
Elderberry (*Sambucus* spp.)
Indian plum (*Osmaronia cerasiformus*)
Ocean spray (*Holodiscus discolor*)
Rhododendron (*Rhododendron* spp.)
Serviceberry (*Amelanchier* spp.)
Sitka alder (*Alnus sinuata*)
Vine maple (*Acer circinatum*)

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This report summarizes the latest inventory of Island, King, Kitsap, Pierce, San Juan, Skagit, Snohomish, and Whatcom Counties, Washington. Accompanying the 40 tables of detailed forest area, volume, growth, and mortality statistics is an analysis of the present timber resource situation and problems affecting present and future production.

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