

FORESTS AND FOREST INDUSTRIES
OF THE
GRAYS HARBOR UNIT

FOREST ECONOMICS REPORT NUMBER 1



U.S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

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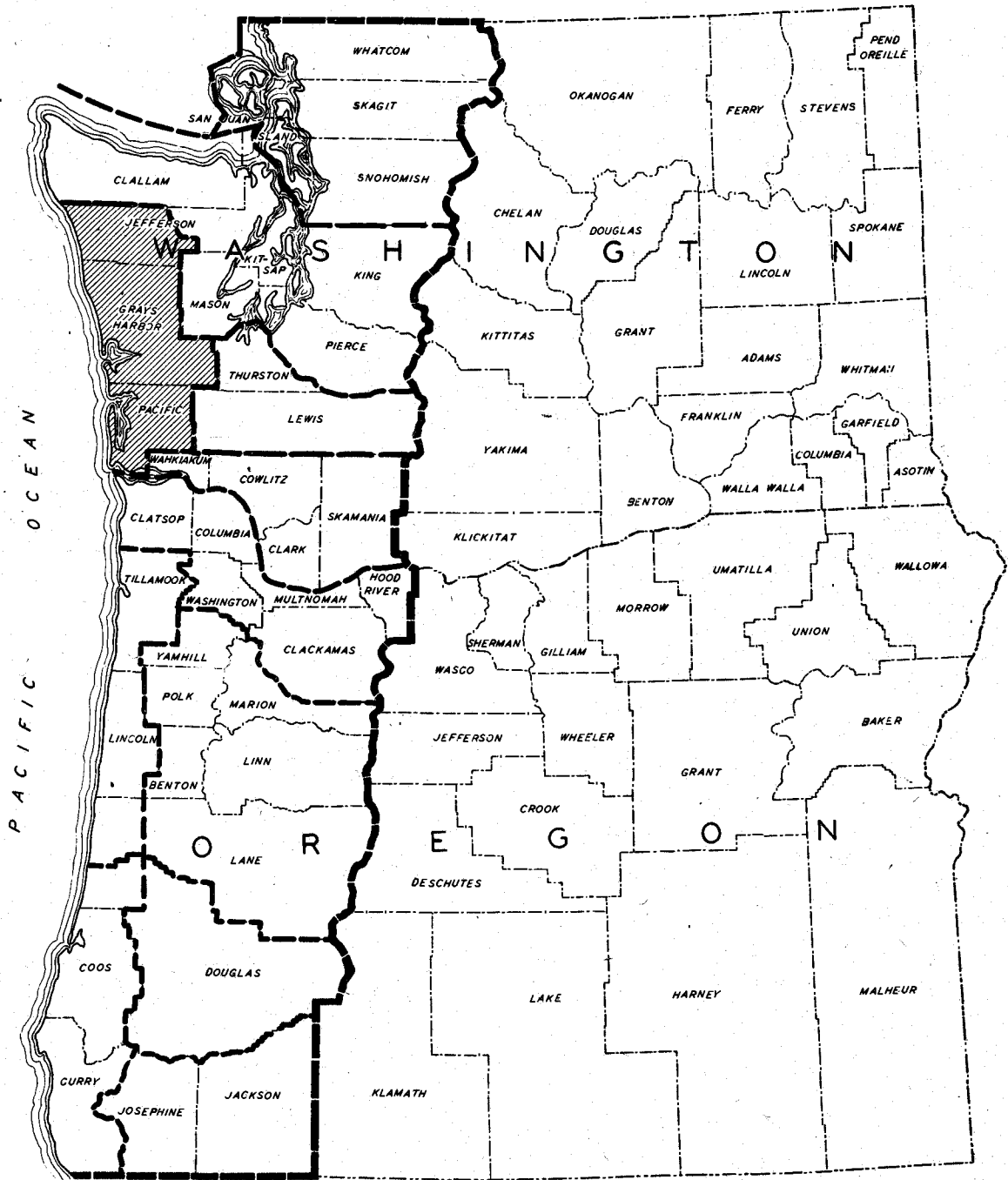
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FIGURE 1

THE ELEVEN FOREST UNITS OF THE DOUGLAS-FIR SUBREGION

1944



FOREWORD

The Pacific Northwest, composed of Oregon, Washington, Idaho, and western Montana, has been aptly described as more strongly knit by physiographic, economic, and cultural ties than any other of the regions in the United States.^{1/} Recently notable progress has been made in studying and determining the physical, economic, and social conditions that link the population of this great region with its physical environment.

Chief among the region's natural resources are its forest lands and forest stands. Owing to geographic differences in forest conditions, however, the region must be divided into smaller subdivisions for analysis of forest problems. For example, Oregon and Washington west of the summit of the Cascade Range is called the Douglas-fir subregion. The forest situation in this area has been previously analyzed in its entirety.^{2/} That analysis disclosed that, although timber supplies on a region-wide basis were apparently in no immediate danger of exhaustion, there were unmistakable signs of shortage in some localities. Any comprehensive analysis of forest problems must proceed from a smaller unit than a region or subregion; accordingly the Douglas-fir subregion was divided into eleven units (figure 1).

Probably none of the other units presents so critical a problem as Grays Harbor. In a region of singular dependence upon forest resources, this unit stands out. Its history may well forecast what will happen in many other parts of the region if forest exploitation is allowed to follow similar paths. Furthermore, owing to its key position, the course of forest exploitation and forest development here will greatly influence similar action elsewhere in the region. For these reasons it was selected as the subject of the first of a series of studies and reports planned to cover the entire region eventually.

Availability of forest survey data on forest inventories, growth, and depletion from field studies in 1931 and 1937 and brought up to date as of January 1, 1941, furnished a factual basis. Other divisions of the Station were brought into the study so that a complete analysis might be made. A survey of the forest industries and production of minor forest products was made by Dr. J. E. Lodewick and H. M. Johnson of the Division of Forest Products. Sinclair Wilson, Division of Forest Economics, compiled and analyzed data on tax delinquency and forest land ownership. P. A. Briegleb calculated forest growth and analyzed cutting budgets on the basis of the most recent data on forest conditions. Data on forest drain were assembled by F. L. Moravets. Others of the Station staff contributed information which was incorporated in this report.

^{1/} Pacific Northwest Regional Planning Commission. Development of resources and of economic opportunity in the Pacific Northwest. 178 pp., illus. Washington, D. C. 1942.

^{2/} Andrews, H. J., and Cowlin, R. W. Forest resources of the Douglas-fir region. U. S. Dept. Agr. Misc. Pub. 389, 169 pp., illus. 1940.

CONTENTS

	<u>Page No.</u>
A Summary of the Forest Situation	1
Current Forest Situation	1
The Forest Problem	3
A Forest Program	3
The Fundamental Physical Elements - What Man Started With	4
Geography	4
Land - The Basic Resource	5
Soils	5
Vegetation	6
Climate	6
Rainfall	6
Temperature	7
Growing Season	7
Wind Velocity	7
Water - A Natural Resource	7
Hydroelectric Power	8
Irrigation	8
Domestic and Industrial Water Supply	8
Source of Sea-food Products	8
Mineral Resources	8
The Creation of an Economy upon a Wealth of Natural Resources ..	9
History of Land Settlement and Pre-emption	9
Farm Land	9
Forest Land	10
Development of Communities and Growth of Population	11
Establishment of an Industrial Base	12
Growth and Significance of the Forest Industries	12
Production of Forest Products	12
Returns to Capital	15
Returns to Labor	15
Returns to the Soil	15
Returns to the Public	15
The Current Situation	16
The Forest Resource	16
The Land Area Available for Forestry	16
The Forest Cover	17
The Growing Stock - Timber Volumes	19
Forest Land Ownership	24
Agriculture	27
The Extent of Area in Agriculture	27
The Farms	27
The Crops	28

	<u>Page No.</u>
Forest Industries	28
Logging	29
Lumber Manufacture	29
Pulp and Paper Manufacture	30
Shingle Manufacture	30
Veneer and Plywood Manufacture	30
Secondary Wood-Using Industries	30
Economic Dependency	31
Trends in the Forest Situation	33
Forest Drain	33
Cutting	34
Fire	35
Insect Losses	36
Wind-Throw Losses	37
Summary of Forest Drain	37
Forest Growth	38
Kinds of Growth Calculations	38
Standards of Measure	38
Current Annual Growth	39
Periodic Growth	40
Potential Annual Growth	40
Comparative Analysis of Growth	41
Industry Demand for Raw Material in Relation to Supply	41
Lumber Manufacture	42
Wood Pulp Manufacture	43
Plywood and Veneer Manufacture	44
Shingle Manufacture	44
The Situation as a Whole	44
Utilization of Waste as a Raw Material	45
Markets for Forest Products	47
Resource Management	48
The Status of Forest Management	48
Forest Land Tenure	49
The Reversion of Forest Land to Public Ownership ...	49
Trends in Tax Delinquency and Tax Forfeiture	51
Byproducts of a Stable Forest Resource	52
Byproducts	52
Other Forest Uses	52
The Forest Problem	53
The Problem of Maintaining Forest Lands Continuously	
Productive	53
The Problem of Putting Lands to Highest Use	53
The Problem of Achieving a Balanced Economy	54
The Problem of Supplying Industry with Raw Material	55
The Problem of Supplying Stable Employment and Adequate	
Living Standards to Local Populations	55

	<u>Page</u> <u>No.</u>
A Program	56
Forest Management	56
Forest Protection	56
Logging Practice	56
Rehabilitation of Underproducing and Nonproducing Areas	57
Timber Budgeting	57
The Allowable Cut Under Sustained Yield	58
Anticipated Volume of Future Cutting	58
Industrial Practice	59
More Complete Utilization of Forest Resources	59
Waste Utilization	59
Increased Local Remanufacture	60
Economic Measures	61
Stabilization of Forest Land Ownership	61
Reorganization of Local Government	61
Legislative Action	61
Measures Requiring State Action	61
Measures Requiring National Action	62

List of Figures

Figure
No.

1. The Eleven Forest Units of the Douglas-fir Subregion... Inside cover	
2. Annual Lumber Production, Grays Harbor Unit, 1925-1941... 14	14
3. Annual Sawlog Drain, Grays Harbor Unit, 1925-1941 14	14
4. Outline Map of Grays Harbor Unit, Washington Opposite 16	Opposite 16
5. Area of Unreserved Commercial Conifer Forest Land by Ownership Class, Grays Harbor Unit	19
6. Volume of Unreserved Sawtimber by Species Group, Grays Harbor Unit	22
7. Tax Reversion and Delinquency by Generalized Cover Types, Grays Harbor Unit	51
8. Average Annual Cut 1936-40, Estimated Future Depletion and Allowable Cut Under Sustained Yield	60

List of Tables

<u>Table No.</u>		<u>Page No.</u>
1.	Agricultural development in Grays Harbor unit, 1880-1940..	10
2.	Population of important towns in the Grays Harbor unit, 1890-1940	11
3.	Unreserved commercial conifer land by site quality class..	17
4.	Area of forest and land-use types in the Grays Harbor unit by ownership class	18
5.	Area, in acres, of certain immature conifer forest types, by age class and degree of stocking	20
6.	Volume of timber, log scale, Scribner rule, in the Grays Harbor unit, by species and ownership class	21
7.	Economic availability classification of nonreserved conifer saw-timber volume, by ownership and species class.	23
8.	Cubic volume of timber in the Grays Harbor unit, by species and ownership class.....	25
9.	Installed sawmill capacity in the Grays Harbor unit, 1929 and 1941	29
10.	Employment in agriculture and forest industries compared to total employment, Grays Harbor Unit and State of Washington, 1940	32
11.	Annual sawlog production in the Grays Harbor Unit in 1925-42, by species	35
12.	Area of forest land burned over by type group and saw- timber volume burned in the Grays Harbor Unit annually, 1936-40	36
13.	Average annual current depletion in Grays Harbor Unit from all causes	37
14.	Current annual conifer growth in the Grays Harbor unit ...	39
15.	Estimated periodic net conifer growth in the Grays Harbor unit	40
16.	Potential annual growth on conifer sites in the Grays Harbor unit	41
17.	Annual lumber production in the Grays Harbor Unit in 1925-42, by species	42
18.	Area of tax forfeited lands and of lands delinquent and not delinquent for taxes levied in 1939 and prior years for a portion of the Grays Harbor unit by gen- eralized cover type	50
19.	Annual cut allowable of unreserved forest lands under sus- tained yield management	58

FORESTS AND FOREST INDUSTRIES OF THE GRAYS HARBOR UNIT

A SUMMARY OF THE FOREST SITUATION

The Grays Harbor unit, composed of Grays Harbor, Pacific, and western Jefferson Counties, is situated on the coast of Washington, has an area of 3,878 square miles, and supports about 70,000 persons.

The population relies chiefly on the forest resources for a livelihood. Forest exploitation started in a small way nearly a century ago but did not reach full swing until early in the 20th century. In the short space of two decades many large forest industries were created, modern thriving communities were built, and the climax of forest cutting passed. The peak of log production was reached in 1929 and of lumber production in 1926. Even with the urgent necessity of wartime use of forest products, the current level of production is less than half the 1929 and 1926 rates.

The answer to this apparently unreasonable situation is depletion of the raw material. The capacity of the forest industries to consume was far in excess of that of the forest to produce.

Paraphrasing a famous quotation summarizes the current forest situation: "Too little and too great"--too little timber of the desired species and quality and too great a manufacturing capacity in primary producers. However, it is not too late to start putting the forest industries on a sustained-yield basis.

Current Forest Situation

The Grays Harbor unit has a total area of 2.5 million acres, of which 2.3 million is forest land. Of the forest land, 1.2 million acres is in forests of saw-timber size (16" diameter breast high), 0.5 million acres is in second growth less than saw-timber size, and 0.4 million acres is deforested or recently cut over; the remainder, 0.2 million acres, is in hardwoods or noncommercial forests. Approximately half the forest land is privately owned, one-fourth is in State, county, and municipal ownership, and the remainder is federally owned or managed.

The saw-timber forest is chiefly hemlock, cedar, and upper slope type, and much of it is second growth. The virgin old-growth Douglas-fir stands have been virtually exhausted except for comparatively small areas in public ownership. Approximately half a million acres of saw timber is privately owned; of this less than 15 percent is Douglas-fir old growth.

The unit now has a total saw-timber stand of 46.5 billion board feet. It is estimated that the original primeval forest was about 90 to 100 billion board feet. Of the 46.5 billion feet left, 37.0 billion feet is available for cutting. Of the latter amount 18.5 billion feet is

privately owned, 8.1 billion is State or county owned, 2.9 billion is owned by Indians, and 7.5 billion is national forest (available for conversion). Approximately 9.5 billion is reserved from cutting--8.9 billion in national park, 0.4 billion in national forest, and 0.2 billion in other public ownership.

Of the total unreserved timber 4.8 billion feet is old-growth Douglas-fir, 1.0 billion is second-growth Douglas-fir, 2.8 billion is spruce, 18.4 billion is hemlock, 4.8 billion is cedar, 5.0 is other conifers, and 0.2 is hardwoods.

Current annual drain from all causes totals about 900 million board feet. Cutting is by far the greatest single drain factor; in 1941 sawlog production totaled 939 million feet, in 1942 it totaled 865 million feet. Approximately 46 percent of the 1942 out was Douglas-fir, 28 percent hemlock, 13 percent cedar, and 13 percent spruce. The other depletion agents--fire, insects, disease, and wind throw--have not caused the loss of much saw timber in the past few years. Previously catastrophes, such as the "Olympic Blowdown" of 1921, have been responsible for serious losses. These may occur in the future. Fire causes future loss of saw timber through burning of second growth and reproduction, particularly on out-over lands.

Current growth falls short of meeting current drain by a large margin. Based on 1941 conditions, current annual growth is 279 million board feet, about 86 percent taking place in the spruce-hemlock forests. The Grays Harbor unit contains some highly productive forest lands, capable if properly managed of far exceeding current growth. The potential annual growth of the unreserved forest lands is 1,154 million board feet. To attain this goal would require much more intensive forest practice than now prevails, but it is by no means an impractical goal. In fact, some public and some private lands (recently) are now being managed on such a scale. In converting to sustained yield, the allowable annual out would be 806 million feet, which is much less than potential annual growth. This condition is due to several factors, including understocking of existing stands and unbalanced distribution of age classes.

The reason why timber inventories, forest growth, and rate of drain are important factors is obvious when the economic dependency and industrial organization are analyzed.

The unit had 35 sawmills in 1941 (the number changes from year to year) with an installed capacity of over 3 million feet per 8-hour shift. These mills out 810 million feet in that year; in 1942 the out dropped to 773 million feet (in 1926 the out was 1,811 million feet).

There is one pulp mill with a daily capacity of 270 tons and a paper mill with a daily capacity of 50 tons.

Veneer and plywood manufacture is important here; four plants make plywood, chiefly from Douglas-fir, and two make veneer for containers, chiefly from spruce.

Shingle manufacture is also important, and 37 shingle mills operated during 1941.

Although there are 19 secondary wood-using industries making 7 different types of products, they are not on a scale commensurate with the primary forest industries.

Approximately 24,000 of the unit's population were gainfully employed according to the 1940 Census. Forty-three percent were directly employed in forest and wood-working industries, 6 percent were in agriculture, and the remaining 51 percent were in other manufacturing, trade, professions, and service occupations.

How to keep the forest industries going is of concern to every inhabitant of the unit. The fact that lumber production, in spite of wartime demands, is less than half that of peak years is evidence that manufacturing demands have outstripped the raw material supply.

The Forest Problem

How to bring supply and demand into balance is the chief forest problem in the unit. Calculations show that under sustained-yield forest management the unreserved forest lands would permit an allowable annual cut of 806 million board feet annually. Comparing with current annual depletion this does not look unfavorable until analyzed further. Three-fourths of the allowable cut would have to come from spruce-hemlock and upper slope types, leaving only one-fourth or about 200 million feet for Douglas-fir and cedar. The 1942 cut of the latter two species was in excess of 500 million feet. The problem, then, involves increasing consumption of hemlock and balsam fir logs and decreasing consumption of fir and cedar. This might mean conversion of forest industries to a type that could use those species. In addition, further expansion of secondary wood-using industries is desirable so that greatest possible advantage may be taken of the forest resources. Attention should be given the possibility of establishing wood chemical industries using waste wood.

A Forest Program

Briefly, the principal measures necessary to obtain the maximum economic and social benefits from the forest resource are:

1. Provide adequate forest protection.
2. Employ forest practices that will leave the land in a productive condition.
3. Rehabilitate underproducing and nonproducing areas.
4. Budget timber cutting on a sustained-yield basis.
5. Develop primary forest industries that will use to fullest advantage the raw material available.
6. Find ways and means of utilizing material now wasted in the woods and at the mill.
7. Increase local remanufacture.
8. Stabilize forest land ownership.

THE FUNDAMENTAL PHYSICAL ELEMENTS - WHAT MAN STARTED WITH

Geography

The geography of the Grays Harbor unit has been a major factor in its economic development. Primarily a coastal province, it has a frontage on the Pacific of about 150 miles broken by two deeply indented, large, natural harbors--Willapa Bay and Grays Harbor. The unit contains parts of two mountain ranges, the Coast Range and the Olympic Mountains. The Coast Range extends north from the Columbia River to the Chehalis River Valley. Although not exceeding 2,000 feet in elevation, it is extremely rough and broken with many short steep slopes. North of the Chehalis Valley the topography is dominated by the Olympic Mountains, a rugged range which reaches its highest elevation in this unit. Mount Olympus in western Jefferson County is just short of 8,000 feet. A coastal plain extends from both ranges to the sea; in the southern part of the unit it is narrow, usually not more than a mile or two wide, north of Willapa Harbor it widens and reaches a width of 15 to 20 miles fronting the Olympics.

The principal drainage systems are the Chehalis River which empties into Grays Harbor; North River, Willapa River, and Naselle River which flow into Willapa Harbor; Grays River which flows into the Columbia; and the Hoh, Clearwater, Queets, and Raft Rivers which drain directly from the Olympic Mountains to the Pacific Ocean. The Chehalis River Valley attains fair size, but the other streams form only narrow alluvial valleys.

The Chehalis River watershed includes the major part of the unit's area. The river heads in eastern Pacific County, flows eastward out of the unit and after following a tortuous course reenters the unit in eastern Grays Harbor County, flowing westward to the ocean. From the north slope of the Olympic Mountains, the Satsop, Wynoochee, Wishkah, and Hoquiam Rivers flow south into the Chehalis and are paralleled by the Humptulips which flows directly into Grays Harbor. These streams dissect the alluvial slopes and low hills which extend from the Chehalis River 15 to 20 miles north to the base of the Olympic Mountains.

The Chehalis Valley forms a gap between the Coast Range and the Olympics and opens into the Puget Trough. The upper end of the valley contains large areas of gravel and sand plains, the outwash of the glacier which filled the Trough and thence flowed to the Pacific by the Chehalis River course. The remainder of the valley consists of recent and old alluvial deposits.

Although Willapa Bay and Grays Harbor are quite large, there is much shallow water and extensive areas of tide flats. Considerable improvement work is required to keep channels open but, nevertheless, these two ports rank with most others on the coast except for Puget Sound, Columbia River, and San Francisco Bay.

Land - The Basic Resource

The greatest resource this unit possesses is its land. Climate, soil, and topography create conditions highly favorable to the production of conifer forests. This fertility of soil does not, however, always produce equally valuable farm crops. As a matter of fact, only a relatively small part of the unit's land area is suited for agriculture under current practices and conditions. The greatest part, by far, of the land is eminently suited for growing forest crops.

Soils

Soil surveys are not available covering the entire area, but a large part has been examined and it is possible to generalize on the basis of this information. Soils of all but a small area may be classified according to origin into the following four main groups: (1) recent alluvial soils, (2) residual soils, (3) soils derived directly from old sedimentary deposits believed to be marine, and (4) soils derived directly from glacial deposits. Other soils of lesser economic importance include aeolian and tidal deposits.

The most important agricultural soils fall in the first group, the alluvial soils, but by far the largest area falls into the second and third groups, the residual soils and the soils derived from old sedimentary deposits. Soils in the fourth group are found in the eastern part of Grays Harbor County and occupy relatively small areas.

The recent alluvial soils found along the flood plains of the principal stream courses form a relatively small portion of the unit's area. They are classified by soil technologists as the Chehalis series, and are silty clay loams, silty clays, and clays. They are found on comparatively level locations, are deep, and have high moisture-holding capacity. The silty clay loam soils are well utilized for agriculture, but much of the area of silty clay is undeveloped and requires drainage and diking before it can be tilled.

Small areas of peat soil are found which are used for cranberry culture.

The glacial soils are classed as gravelly sandy loams or gravelly loamy sands and are usually porous and excessively drained. They are used in a small way for agriculture. Generally they are used primarily for grazing rather than crop production and are classed as supplemental farming areas.^{3/}

The Elma soil series derived from mixed glacial, colluvial, and alluvial material are also used for agriculture. They occupy a small area only which limits their use for agriculture.

^{3/} Landerholm, Edwin F., and Bell, Roscoe E. A reconnaissance land use classification of Grays Harbor County, Washington. Resettlement Administration. 17 pp., illus. Mimeo. December 1936.

The residual soils occur mainly in the hilly and mountainous districts. They are clay loams and loams and are mainly in the Melbourne and Olympic soil series. They are often shallow and erode easily. Where topography and other factors are favorable they may be used for agriculture, chiefly dairying. In the main they are considered as forest soils.

The soils derived from old sedimentary deposits occur chiefly on benchlands and rolling hills. They are clay loams and silty clay loams and represented by the Hoquiam, Copalis, and Montesano soils series. Impervious subsoils are common and the drainage is often poor. Under proper conditions these soils may be cultivated, but they too are generally classed as forest soils.

The cost of clearing is a deterring factor in the conversion of the lower quality soils to agriculture. With but few exceptions they were covered with dense forests of large trees leaving when cut over many big stumps and large quantities of debris.

Vegetation

It is estimated that all but 100,000 acres of the unit's total area of 2,481,700 acres was originally forested. The original nonforested land was made up of sand barrens, tide flats, swamps, rocky barrens above timber line in the Olympic Mountains, narrow strips of open bottom land along the larger streams, and a small area of gravelly prairie land in eastern Grays Harbor County. Of the total forested area, roughly 2,100,000 acres was covered with commercial conifer forests including some of the finest stands found in western Washington and western Oregon. It is unlikely that at any one time all of the commercial conifer land was completely covered with old-growth forests. Undoubtedly, here and there, second-growth stands occupied areas where the old-growth forests had been destroyed by insects, fire, or wind throw. As near as can be determined, about one million acres has been logged or cleared for agriculture since the date of first settlement. The forests that have been cut were, on the whole, denser and higher in quality than the remaining virgin forests. It is believed that the volume of the original forest was around 90 to 100 billion board feet, of which at least 35 to 40 billion feet was Douglas-fir.

Climate

The greatest part of the Grays Harbor unit is in the coastal fog belt which is characterized by heavy precipitation, high humidity, and moderate temperatures.

Rainfall

Winds, which occasionally reach gale force, sweep in from the southwest bringing heavy precipitation all but a few months of the year. Average annual rainfall at points near the coast, like Aberdeen in Grays Harbor County, and South Bend in Pacific County, is approximately 80 inches. Quinault, located at the foot of the Olympic Mountains, has an

average annual precipitation of about 120 inches. In some years precipitation has exceeded 150 inches at points near the coast and monthly rainfall of more than 30 inches is not uncommon. The driest part of the unit is in eastern Grays Harbor County in the vicinity of Oakville where the average annual precipitation is between 45 and 50 inches. Analysis of records for a number of years indicates that normally nearly half the annual rainfall occurs during November, December, and January. July and August are the dry months with about 1 to $1\frac{1}{2}$ inches normally falling in each of these two months. Except in the Olympic Mountains, nearly all the precipitation falls as rain. Average annual snowfall in the lowland ranges from 6 inches to 15 inches.

Temperature

In the inhabited portions of the unit, temperatures are moderate without any great seasonal or diurnal changes. At Aberdeen the average minimum temperature was 33° Fahrenheit and the average maximum was 45° F. during January, the coldest month, based on 38 years of records. The hottest month, August, had an average maximum temperature of 70° F. and an average minimum of 50° F. There is no record of below zero weather and seldom does the temperature exceed 100° F.

Growing Season

As indicated by frost data, most of the unit has a comparatively long growing season. Based on 40 years' records, Aberdeen has an average of 188 consecutive days without killing frost, and South Bend, according to 32 years' records, has a growing season of 198 days.

Wind Velocity

Along the coast strong winds are common throughout the year. Inland wind velocity is not excessive. Wind velocity of 112 miles per hour was estimated in January 1921, the date of the famous "Olympic Blowdown", at the mouth of the Columbia River by the North Head Station. Recorded velocities of 60 to 70 miles per hour are not uncommon at this station.

Water - A Natural Resource

An abundant water supply is one of the valuable natural resources of this unit although currently its potentialities are largely undeveloped. Like forests, the water resource can be damaged irreparably through continued misuse. The danger to the water resource lies in slow insidious reduction in value stemming from destruction of the protecting vegetation and manifested in a lowering of the quantity and quality of water supplies. One of the chief requirements of water resources is regularity of supply which is maintained by "keeping watersheds green." Flood control is a more spectacular aspect of the water situation which is also closely connected with forestry.

Hydroelectric Power

Installed hydroelectric power plants in this unit total but 715 horsepower. Through public utility districts, Bonneville-Coulee power is distributed to industries and domestic consumers in this unit. The Bonneville Power Administration maintains substations at Cosmopolis and Raymond. There are six plants using wood fuel which generate electric power. Two of these are not public utilities and develop power only for their own industrial use. Potential hydroelectric power on the major drainages in the unit aggregates 123,600 kw. 90% of the time or 197,100 kw. 50% of the time.^{4/} The streams involved are the Wynoochee, Quinault, and Hoh Rivers.

Irrigation

Irrigation of farm lands is a little-used practice here. Apparently the dry season is so short that increased farm productivity through irrigation does not repay costs of installations. It may be that experimentation will point the way for increased use of irrigation.

Domestic and Industrial Water Supply

Supplies of accessible pure water for domestic and industrial purposes are ample for present demand and existing installations are capable of supplying considerable increased demand. The Aberdeen domestic supply taken from the Wishkah River is estimated to have a capacity of two to three times present consumption. The Aberdeen industrial water system draws water from the Wynoochee River at a current rate of 30 million gallons daily; it can supply 8^{1/2} million gallons daily or 165 million through use of booster pumps.^{5/} The Hoquiam water system taken from Davis Creek and the Little Hoquiam River has a daily capacity of 5 to 10 million gallons compared to current consumption of 1^{1/2} million gallons. Other communities are equally well supplied.

Source of Sea-food Products

The bays, harbors, and coastal waters yield salmon, halibut, albacore tuna, other fish, oysters, clams, and other shellfish for use, fresh and canned. The annual value of fishery products from this unit is estimated at roughly from 1.0 million to 1.5 million dollars.

Mineral Resources

Actual development or mining of mineral resources is negligible. Undoubtedly the heavy forest mantle has retarded prospecting and location of mineral deposits. Anticlinal structures and oil seeps have been found

^{4/} Tyler, Richard Gaines. Water resources of Washington. Wash. (State) Univ. Engin. Expt. Sta. Series, Report No. 4. 61 pp., illus. June 1938.

^{5/} Market Development Section, Bonneville Power Administration. Western Washington industrial surveys--Aberdeen and Hoquiam. Portland, Ore. September 1943.

in the unit but drilling has failed to bring oil although small amounts of natural gas were obtained. It is the consensus of authorities that petroleum prospects are poor. Structural clays, molding sand, limestone, and gravel are known to occur but there has been little development except road quarries. Some hope is attached to the development of low grade manganese in Grays Harbor and Pacific Counties. The inaccessibility of these deposits will probably preclude their early development.

THE CREATION OF AN ECONOMY UPON A WEALTH OF NATURAL RESOURCES

The history of this section of the Pacific Northwest dates from the discovery of Grays Harbor by Captain Robert Gray in May 1792. Exploitation of the natural resources soon commenced with occasional visits of trappers and traders. However, more than half a century passed before permanent settlers appeared. The first settler apparently was William O'Leary, a ship's deserter, who built a cabin on the shore of Grays Harbor in 1849. Exploitation of other natural resources followed. In 1852 there is a record of 19 white men living on Willapa Bay, then called Shoalwater Bay, collecting native oysters for shipment to California. Five other white men were engaged in cutting piling and timbers for the San Francisco trade, the first authentic record of lumbering in the unit.

History of Land Settlement and Pre-emption

Farm Land

The first extensive assertion of landownership was for the establishment of farms. Settlers commenced to arrive in the Grays Harbor and Willapa Harbor areas from Chehalis Valley about the time Washington became a Territory in 1853. The rich bottom lands along the larger streams were prized and claims were laid out to obtain the maximum acreage of this land. The forest was regarded largely as an impediment to be removed as quickly and cheaply as possible. A few local mills, powered by water wheels, commenced operations to satisfy demands of local settlers for building materials. Following the Civil War the stream of settlers increased and with the building of the transcontinental railroads westward migration grew. By 1880 there were 230 farms comprising a total of 61,363 acres or an average of 267 acres each. Only 16,720 acres of this total was improved, however. This land was acquired chiefly by the original settlers as donation land claims, and by later settlers under the Homestead Law of 1862. Other laws relating to the disposal of the public domain were also used by private persons to acquire land.

Agricultural settlement continued to expand through the 1880's and 1890's but by about 1900 (see Table 1) it began to stabilize and from 1900 to 1930 increases in "all land in farms" and "improved land in farms" were not large. The depression of 1930-34 brought a back-to-the-land movement that increased "all land in farms" over 40 thousand acres in five years; however, only about 4,000 acres of this area was put in condition for cultivation. Between 1935 and 1940 this movement was arrested insofar as acquisition of farms was concerned. This five-year

Table 1.--Agricultural development in Grays Harbor unit, 1880-1940^{1/}

Census of	All land in farms		Number of farms	Average size of farms	Improved land in farms	
	Acres	Percent of total area of unit		Acres	Acres	Percent of all land in farms
1880	61,363	2.5	230	267	16,720	27.2
1890	79,676	3.2	414	192	25,773	32.3
1900	137,150	5.5	942	146	29,849	21.8
1910	131,439	5.3	1,089	121	35,471	27.0
1920	143,571	5.8	1,517	95	39,307	27.4
1925	146,412	5.9	1,803	81	37,801	25.8
1930	145,903	5.9	1,721	85	44,553	30.5
1935	186,919	7.5	2,829	66	48,713	26.1
1940	188,718	7.6	2,625	72	57,698	30.5

^{1/} Data from Bureau of Census reports. Data are not available for western Jefferson County which has but a negligible area of farm land.

period can be characterized as a period of consolidation and improvement of existing farm lands. Nearly nine thousand more acres was put under cultivation during the same period but "number of farms" decreased from 2,829 to 2,625 and "average size of farm" increased from 66 acres to 72 acres.

Forest Land

The acquisition of forest land for timber values undoubtedly commenced in the Grays Harbor unit on a small scale soon after first settlement. News of the opportunities for profitable exploitation of the forests of this territory spread rapidly throughout the lumbering regions of the East and Lake States and the great forested public domain commenced to pass into private hands. The Pre-emption Law of 1841, the commutation clause of the Homestead Act of 1862, and the Timber and Stone Act of 1878, were utilized to acquire timberland. However, such transactions were of little consequence compared to the grant to the Northern Pacific railroad which, by extending its line to Grays Harbor about 1890, acquired the largest block of timberlands in the area. The major part of the Grays Harbor unit was within the primary and indemnity limits of the railroad grant. The Northern Pacific grant was the foundation for the current pattern of ownership in the area. The Weyerhaeuser holdings, now the largest single private ownership in the unit, were built up mainly through purchases of large blocks of timber from the Northern Pacific Railway Company about 1900. Undoubtedly there was considerable speculative buying and claiming of timberlands in the 1880's and 1890's but the real boom came immediately after 1900 when many operators from the East acquired extensive blocks of timber for future operation.

Grants to the State after Washington was admitted to the Union in 1889 resulted in the disposal of large areas of the public domain. By February 22, 1897, little public domain was left except in Jefferson

County and northern Grays Harbor County, when President Cleveland created the Olympic National Forest. The original area included in the Olympic National Forest was much larger than later, extending to the ocean on the west. In 1901 the forest was reduced to approximately the boundaries that existed prior to the creation from it of the Olympic National Park. The area removed from the national forest on the west passed into private hands. By 1901 or soon thereafter the general pattern of forest land ownership was fairly well fixed for years to come. Consolidation of the larger private holdings proceeded at the expense of the smaller holdings but the unappropriated public domain was reduced to scattered areas of poor land.

In the past decade, reversion to public ownership has taken place by forfeiture of tax-delinquent lands to the county and the purchase by the State of extensive areas of cut-over land. Recently a considerable acreage of tax-forfeited land bearing second growth has been acquired by timber companies.

Development of Communities and Growth of Population

The early communities in the Grays Harbor unit developed chiefly as trading centers for farmers, fishermen, and trappers. Communication with the outside world was principally by boat and sites selected were on tide-water. Not until lumber manufacture became the leading industry did these communities show any appreciable growth. The chief communities are Aberdeen, Hoquiam, Raymond, Montesano, South Bend, and Elma. Hoquiam was founded in 1854 and incorporated in 1868. Aberdeen was first settled in 1868 and incorporated in 1890. The growth of population in these communities and the unit as a whole has followed closely the fortunes of the lumber industry. The population of the entire unit showed an increase each successive census year until the 1940 census which showed a decrease of about 8 percent from 1930. Some communities commenced to decline earlier, others are holding their own. Table 2 gives the population history of the principal towns.

Table 2.--Population of important towns in the Grays Harbor unit 1890-1940^{1/}

Town	Census of					
	1890	1900	1910	1920	1930	1940
Aberdeen	1,638	3,747	13,660	15,337	21,723	18,846
Hoquiam	1,302	2,608	8,171	10,058	12,766	10,835
Raymond	^{2/}	^{2/}	2,450	4,260	3,828	4,045
Montesano	1,632	1,194	2,488	2,158	2,460	2,242
South Bend	-	711	3,023	1,948	1,723	2,242
Elma	345	894	1,532	1,253	1,545	1,370

^{1/} From Bureau of Census reports

^{2/} Records not available.

Establishment of an Industrial Base

The first manufacturing industry known in this unit was a small water-powered mill located at Cedarville on the Chehalis River which cut about 1,000 board feet of lumber a day. This mill was established prior to 1855 and served local farmers only. In 1855 a mill of 2,000 feet daily capacity was founded on Willapa Harbor near the present site of South Bend. In 1858 a mill was erected at Knappton on the Columbia River, the forerunner of a larger mill built in 1869 and operating until 1941 when it was destroyed by fire. The opening of trade routes to California, the Orient, and Atlantic Coast brought other mills to tide-water locations on Willapa Harbor, Grays Harbor, and the larger rivers. Commencing about 1880 the lumber industry began to expand; in 1881 Captain Simpson located a mill at the mouth of the Hoquiam River. In the late 1880's the famed Grays Harbor Commercial Company was founded at Cosmopolis, a firm which during half a century of activity probably imported thousands of workers of many nationalities to work in the forest industries of this area.

Review of the history of industrial development indicates that it was founded almost entirely upon the forest resources. Two factors brought forest exploitation to this territory at a relatively early date in the history of the Pacific Northwest. These were high quality timber stands on favorable logging ground and transportation facilities within easy reach of the forests.

The Northern Pacific extended its line to Grays Harbor about 1890, and later built a line to Willapa Harbor. The Chicago, Milwaukee, St. Paul, and Pacific built parallel lines to both these points later. In the past few decades, a network of public highways has been constructed opening up new areas for timber exploitation. With the exception of Jefferson County and parts of Grays Harbor County in the Olympic National Forest and the Olympic National Park, the unit is well served by transportation facilities.

Growth and Significance of the Forest Industries

Production of Forest Products

From a very small beginning prior to 1855, the lumber industry grew to prodigious proportions, fed by what was first thought of as an almost limitless supply of logs. Lumber manufacture far exceeded other forest industries in importance until the late 1920's when plywood, veneer, pulp, and paper manufacture commenced, on a small scale at first but increasing rapidly in volume of business and importance. The bulk of the forest products shipped still is in the form of lumber, much of it in the first stages of manufacture. By far, most of the lumber shipped has been by vessel and much of it was unsurfaced and green direct from the headsaw. War conditions have diverted much of the lumber shipping to rail. Recent years have seen an increase in the refinement of manufacture.

The peak of lumber manufacture was reached in 1926 when 1.8 billion board feet was produced. Production declined steadily until 1932 (figure 2); since then it has shown minor ups and downs but even in 1941, a comparatively peak year of national lumber production, cut in the Grays Harbor unit was less than half of that in 1926.

Other primary forest industries have not followed the same course and sawlog production, although declining, has maintained a higher relative position than lumber production. Figure 3 shows sawlog production for the Grays Harbor unit by year and species for the period 1925-41, inclusive. (Records for prior years are not available.) The peak year of sawlog production was reached in 1929 when more than 2 billion board feet was cut. During this 17-year period a total of 19.5 billion board feet of sawlogs was produced, an annual average of 1.1 billion board feet. Considering that production in 1925 was 1.9 billion feet it is not unreasonable to assume that as much or more was cut prior to 1925 than has been cut since. Estimates of the original stand support this conclusion for they indicate that 45 to 50 billion feet has been removed from the forest land since white settlement either by cutting, land clearing, fire, wind throw, or insect attack, with cutting accounting for the great bulk of this enormous drain.

At least since 1925 the annual production of sawlogs has considerably exceeded the annual lumber production. During the past three or four years the excess of log supply over lumber production has approximated the quantity required by the local pulp mill and plywood factories. However, prior to that time the log surplus was exported to other parts of the Douglas-fir region for manufacture. What is actually happening now is that while logs are being shipped from the Grays Harbor unit to Puget Sound sawmills and pulp mills, logs are being imported from Oregon by Grays Harbor plywood factories and sawmills. Before 1930 lumber manufacture accounted for practically all logs consumed locally. Allowing for overrun (1000 board feet of logs will produce roughly 1100 to 1150 feet of lumber) an average of about half a billion feet of logs was shipped out of the Grays Harbor unit annually during 1925 to 1929.

During the course of the logging industry in this unit a large quantity of logs has been shipped elsewhere for manufacture. How much is not known exactly since no records are available covering the period prior to 1925, but as a conservative estimate the quantity would be enough to keep the unit's sawmills running at current production levels another 5 to 10 years and possibly longer. If this raw material could have been husbanded for this purpose, the beneficial effects would not have been limited to merely prolonging industrial life for the stipulated period. The timber left standing would have aided reforestation of cut-over lands, more time would have been allowed second-growth stands to reach merchantable size, contributions in taxes would have made local government more stable, and many other benefits accruing from more orderly economic processes would have resulted.

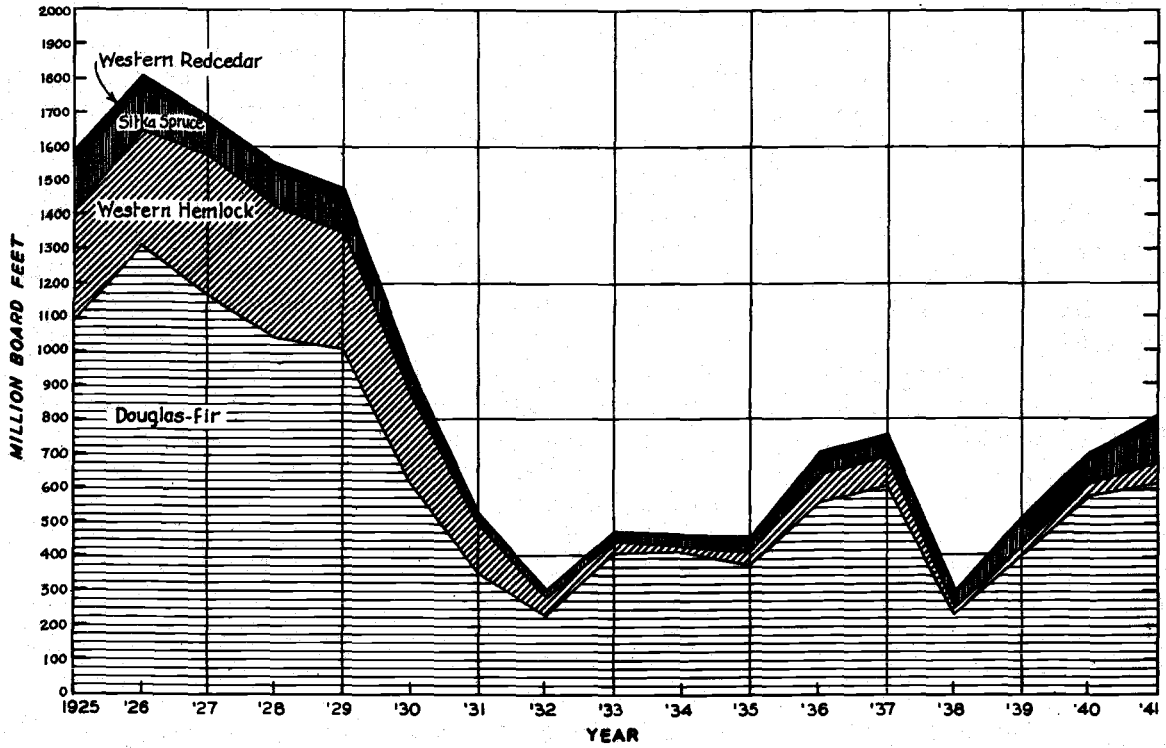


FIGURE 2 ANNUAL LUMBER PRODUCTION, GRAYS HARBOR UNIT, 1925 - 1941

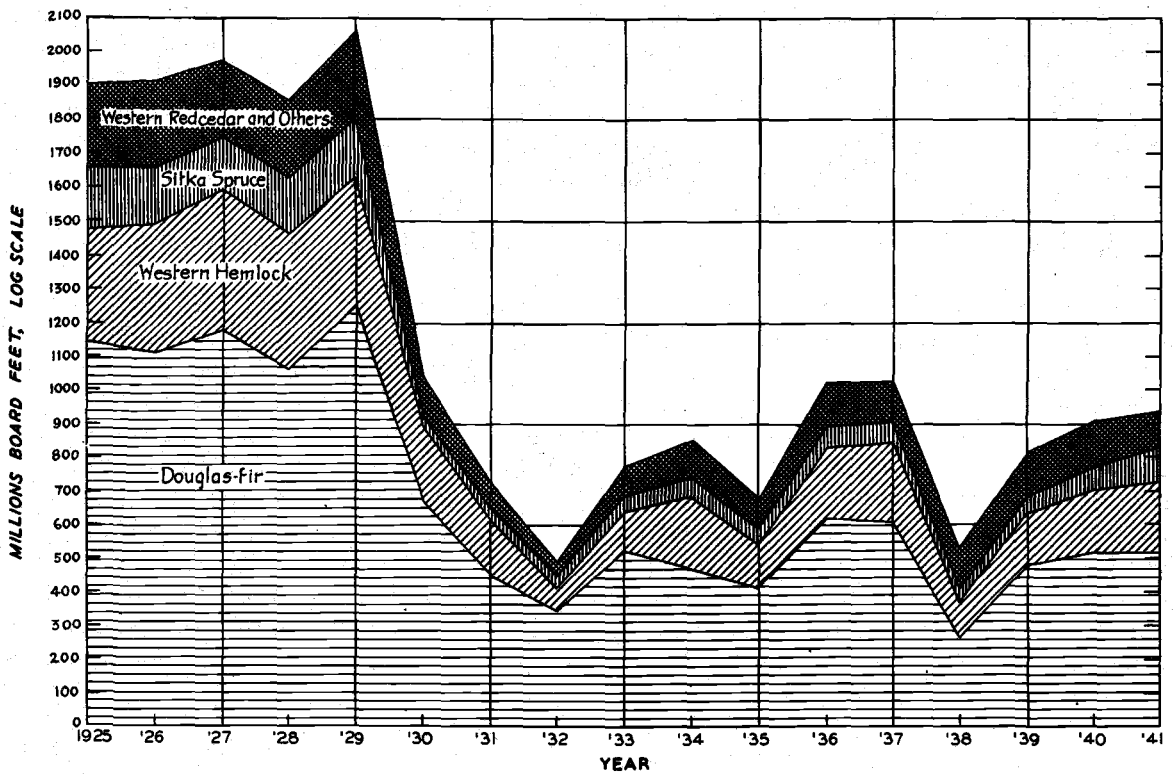


FIGURE 3 ANNUAL SAWLOG DRAIN, GRAYS HARBOR UNIT, 1925 - 1941

Returns to Capital

It is not possible to determine precisely the profits made by timber operators. The period of liquidation was rapid here and the bulk of the values was liquidated before taxes and other carrying charges accumulated. Much of the timberland was acquired at low prices and unquestionably profits were high. The total return to capital invested in timberlands alone has undoubtedly been many millions of dollars. Added to this, capital invested in forest industries and shipping facilities has received rich returns from harvesting, manufacturing, and shipping products of the unit's forests.

Returns to Labor

Although no exact figures are available covering the entire history of the forest industries in this unit, it is known that wages paid to labor over the years amount to a tremendous figure. In 1929, a peak year in production and one in which wage rates were also high, the forest industries of this unit paid an estimated total of about 20 million dollars in salaries and wages. In 1939, the total paid in wages and salaries by the forest industries is estimated at 11 to 12 million dollars. In October 1942, forest industries had payrolls totaling \$1,350,000, according to records of the State Department of Labor and Industries. In addition to the workers engaged directly in the forest industries, many other workers are employed in other industries and occupations servicing these primary workers.

Returns to the Soil

Until the past few years, practically none of the value removed from the forest soil has been used to enrich it or even maintain it for future crops. Protection has been accorded the forest cover against fire, but this has not even been adequate and cut-over land has received far less consideration than land bearing saw-timber forests. Only in the past few years has action been taken towards restoring cut-over land to productivity, notably on the part of the State of Washington and several large timber concerns.

Returns to the Public

A large part of the profits and interest on capital invested in timberland and forest industries has flowed out of the unit to other parts of the country. Many timberland owners are nonresident and a substantial part of the ownership of the forest industries was held by non-residents. At the same time taxes paid on this property have been the principal support of local government. Schools, roads, and other government services are available to the local population as a result.

Probably the bulk of the money received as salaries and wages paid by the forest industries was spent locally. However, in a large measure this money was spent for commodities produced elsewhere such as foodstuffs,

clothing, automobiles, household furnishings, etc. The economy of this unit is based almost entirely upon the extraction of raw materials and the manufacture of forest products. The unit produces only a small part of its other needs and its economy is unfavorably one sided.

As is common with economic units that are on a liquidating basis, public institutions and functions have been on the whole well supported during the days of ascending production. The unit has good roads and well-equipped schools, and other institutions are on a comparable basis. Modern, well-constructed communities have developed. These structures, physical and economic, have been erected on a scale to fit the peak period of economic activity. The period of contraction now in progress may result in a scaling down of the public services or a reorganization of facilities unless subvented by other parts of the State or by the Federal Government.

THE CURRENT SITUATION

The Forest Resource

Ninety years of human activity has not materially reduced the total forest area available for growing forest crops but it has greatly reduced the timber volume growing on the land. This situation would not be unfavorable if a complete new forest was replacing the old but there are extensive areas that are bare of trees or support a scanty growth only.

The Land Area Available for Forestry

Land now supporting forest growth or deforested and not put to other use totals 2.3 million acres, 93 percent of the unit's total land area. This land, however, is not all available for growing commercial forest products; some is incapable of supporting a commercial forest and some is reserved for special purposes such as recreation. The total area of commercial conifer land is given in table 3 and totals 1.9 million acres, which is 81 percent of the total forest land area. A small acreage of land suitable for growth of hardwood forests is also of commercial character. The commercial conifer land is not all alike in its ability to produce forest crops and accordingly it was classified by site quality class, i.e., a rating of forest land productivity. Two general types of forest predominate in this unit, the spruce-hemlock type near the coast and Douglas-fir in the interior. A separate classification was used for each of these two broad types and all commercial conifer land was classified according to productivity under one or the other of the two categories (table 3). In each case five site classes are recognized--Site I being the most productive and thence down the scale to Site V, the poorest. Forest land productivity in the Grays Harbor unit averages much higher than that of the Douglas-fir region as a whole. For example, the regional average site class for Douglas-fir land is roughly Class III, for the Grays Harbor unit Class II. Thus this unit averages about one class higher which makes a substantial difference in rapidity of growth and

FIGURE 4
 OUTLINE MAP OF GRAYS HARBOR UNIT, WASHINGTON
 1942

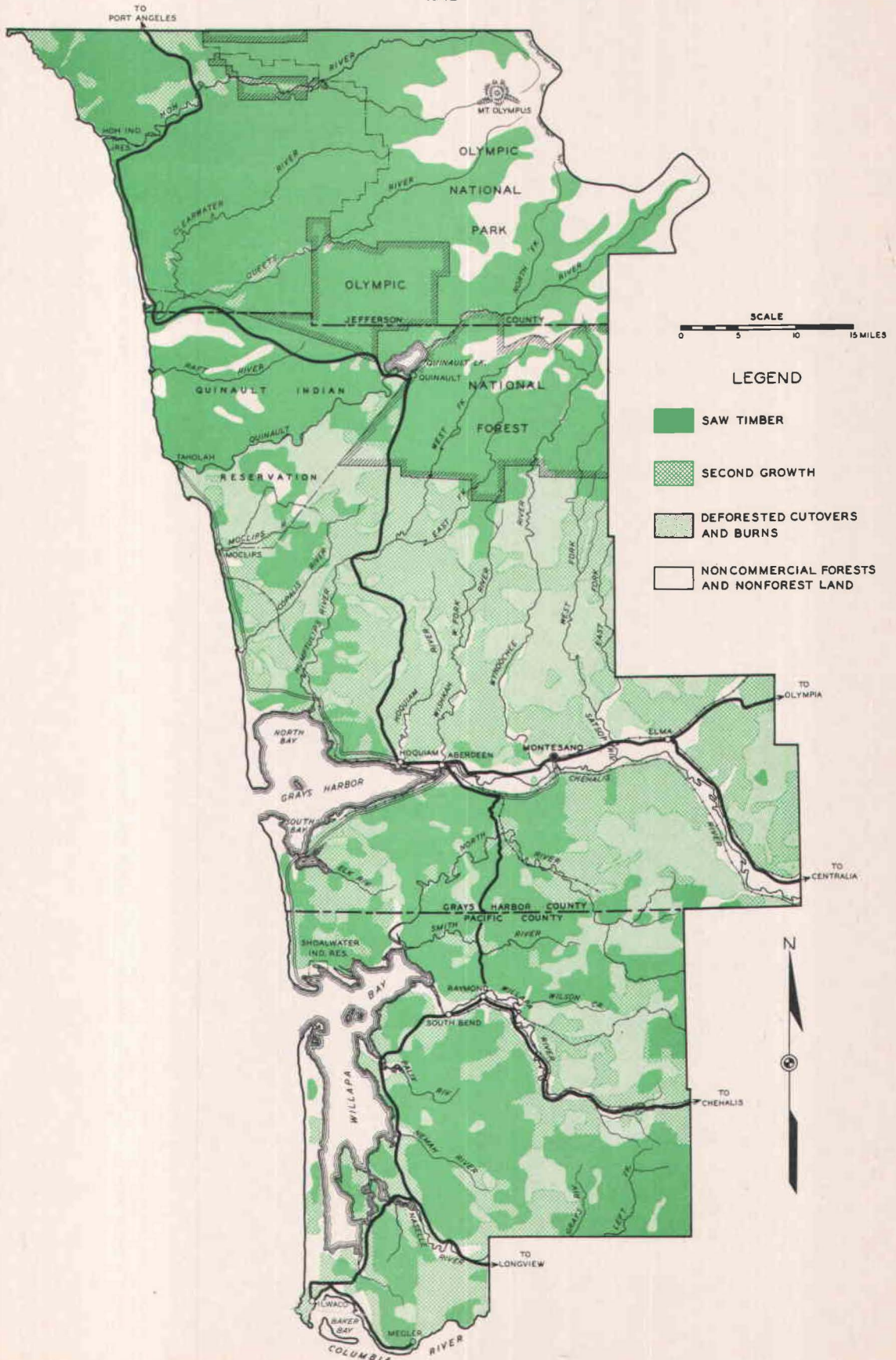


Table 3.--Unreserved commercial conifer land by site quality class

Site quality class	Area in unreserved commercial conifer land	
	1,000 acres	Percent
Douglas-fir		
Class I	86.2	4.6
Class II	538.1	28.8
Class III	87.4	4.7
Class IV	48.3	2.5
Class V	18.1	1.0
Total	<u>778.1</u>	<u>41.6</u>
Spruce-hemlock		
Class I	97.9	5.2
Class II	723.3	38.7
Class III	196.2	10.5
Class IV	59.9	3.2
Class V	15.1	.8
Total	<u>1,092.4</u>	<u>58.4</u>
Grand Total	1,870.5	100.0

quantity of yields. As a matter of fact, this unit probably outranks most, if not all, of the other ten units comprising the Douglas-fir sub-region in intrinsic productivity of forest soil.

The Forest Cover

A half century of active exploitation has altered the forest cover greatly (figure 4). The original virgin forest has been removed from the greatest part of Grays Harbor County and a large part of Pacific County. Western Jefferson County is still practically untouched by cutting. Table 4 gives the area of broad forest and land use types by ownership class and figure 5 shows area of unreserved conifer forest land by ownership class. About half the forest land is occupied by saw-timber size forests, nearly a quarter by second-growth forests less than saw-timber size, about one-sixth is deforested as a result of fire and cutting, and the remainder is occupied by hardwood or noncommercial forests.

The saw-timber forests consist chiefly of spruce-hemlock, cedar, and upper-slope types. The virgin Douglas-fir forests have been practically exhausted by cutting except for the publicly owned which are a small part of the original forest. Of the privately owned saw timber less than 15 percent is Douglas-fir old growth.

Table 4.--Area of forest and land-use types in the Grays Harbor unit by ownership class, January 1, 1941

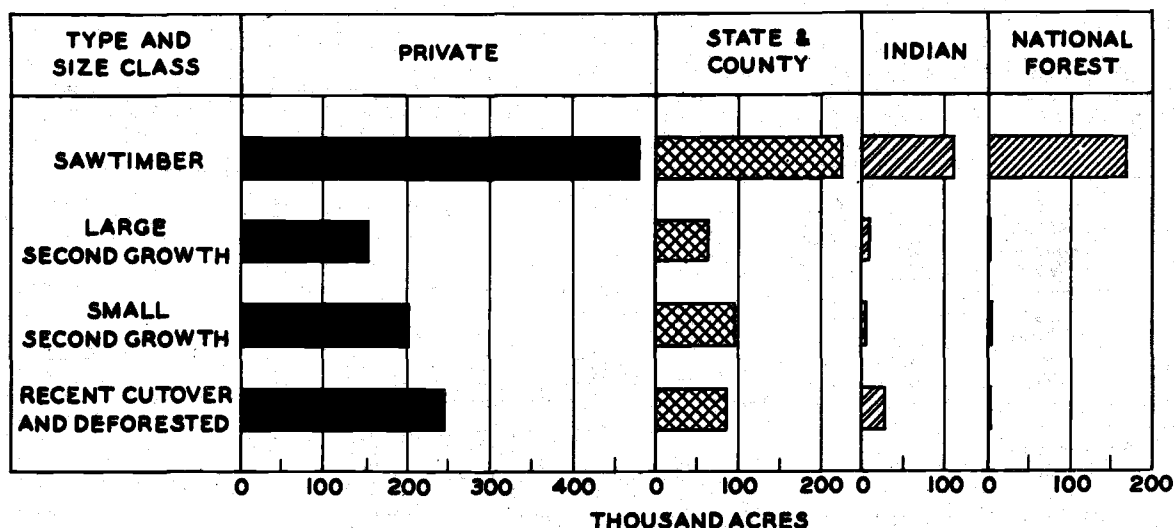
Type	Privately owned	State, county, municipal		Federally owned or managed					Total
		Unreserved	Reserved	1/	National forest		National park 2/	3/	
				Indian	Unreserved	Reserved	Other		
1,000 acres	1,000 acres	1,000 acres	1,000 acres	1,000 acres	1,000 acres	1,000 acres	1,000 acres	1,000 acres	
Saw-timber size	478.8	225.6	2.6	109.6	165.7	9.1	204.0	3.2	1,198.6
Second growth 6-20" d.b.h.	150.7	61.8	5.2	8.7	.5	.4	1.8	.3	229.4
Second growth 0-6" d.b.h.	204.7	96.4	3.4	4.3	3.0	-	2.6	.7	315.1
Burns, other deforested, and recent cutover	246.9	86.0	2.5	25.5	.7	-	3.6	.1	365.3
Total commercial conifer	1,081.1	469.8	13.7	148.1	169.9	9.5	212.0	4.3	2,108.4
Hardwood	54.7	7.4	.4	2.5	2.2	.1	3.2	.9	71.4
Noncommercial forests	10.1	3.9	.1	24.7	13.1	4.5	74.2	.1	130.7
Total forest	1,145.9	481.1	14.2	175.3	185.2	14.1	289.4	5.3	2,310.5
Nonforest	113.2	5.4	.5	3.2	.3	.2	47.5	.9	171.2
Total all land	1,259.1	486.5	14.7	178.5	185.5	14.3	336.9	6.2	2,481.7

1/ Indian lands are available for cutting under management plans administered by the Indian Service.

2/ Reserved from cutting. Includes lands being acquired under "declaration of take" in western Jefferson County.

3/ Includes public domain, railroad selection pending, military and lighthouse reservations, and wildlife refuges. There are no statutory limitations on cutting these lands. Actually cutting is not practiced.

FIGURE 5
AREA OF UNRESERVED COMMERCIAL CONIFER FOREST LAND
BY OWNERSHIP CLASS, GRAYS HARBOR UNIT, AS OF JAN. 1, 1941



The second-growth types less than saw-timber size shown in table 4 total 544.5 thousand acres. These types are classified according to age class and degree of stocking in table 5. A few thousand acres were not so classified and consequently the total area covered by table 5 is 541.4 thousand acres. This table reveals a serious gap in the distribution of age classes, with well over half the area occupied by stands in the 10-year age class, and with a great scarcity of stands older than the 40-year class. Not included in this table, however, are stands of saw-timber size, and this unit possesses a large acreage of 80- and 90-year-old spruce-hemlock saw-timber stands. Such stands are growing rapidly and if properly managed will contribute greatly to future timber supplies. Their cutting now while the old-growth stands are being liquidated would retard the stabilization of cutting in the unit to a level that can be maintained. Their withholding from cutting until they can be integrated in an orderly plan of operating the unit's forests would be of great future benefit.

The Growing Stock - Timber Volumes

The total volume of saw timber now standing amounts to 46.5 billion board feet. It would seem, on casual consideration, that with such a substantial quantity timber supply would not be a serious problem in this unit. Analysis of the character of this timber volume shows the contrary is true. Table 6 gives saw-timber volume data by species group and ownership class as of January 1, 1941. Figure 6 shows volume of unreserved saw timber by species and ownership. Twenty-two billion feet or nearly half the remaining saw-timber volume is western hemlock. Douglas-fir ranks next in total volume with 7.8 billion board feet, of which 6.8 billion feet is old growth.

Table 5.--Area, in acres, of certain immature conifer forest types, by age class and degree of stocking, January 1, 1941

Age class (years)	Degree of stocking	Type number and name									Total
		10 Douglas-fir seedlings and saplings	13 Sitka spruce seedlings and saplings	16 Western hemlock seedlings and saplings	9 Douglas- fir small second growth	12 Sitka spruce second growth	15 Western hemlock second growth	19 Western red- cedar small	24 Fir- mountain hemlock small		
10	Good	34,370	1,080	55,710				1,185		92,345	
	Medium	57,230	1,370	51,765				1,195		111,560	
	Poor	73,885	855	27,440				4,870		107,050	
	Total	165,485	3,305	134,915				7,250		310,955	
20	Good	1,180		5,775	5,170		8,225	2,095		22,445	
	Medium	3,515		690	12,085	245	5,160	675		22,370	
	Poor	120			875		160	90		1,245	
	Total	4,815		6,465	18,130	245	13,545	2,860		46,060	
30	Good			60	13,220	2,325	21,565	75	90	37,335	
	Medium				9,415	1,240	23,525	130		34,310	
	Poor			95	850	130	1,700	30		2,805	
	Total			155	23,485	3,695	46,790	235	90	74,450	
40	Good				8,770	2,335	18,045			29,150	
	Medium				3,820	1,050	22,705	295		27,870	
	Poor				225	310	1,735	185		2,455	
	Total				12,815	3,695	42,485	480		59,475	
50	Good				1,140	145	5,650			6,935	
	Medium				125	105	2,215	240		2,685	
	Poor				315		1,600	15		1,930	
	Total				1,580	250	9,465	255		11,550	
60	Good					180	11,100	105		11,385	
	Medium				95	390	7,690	175		8,350	
	Poor				25	205	2,965			3,195	
	Total				120	775	21,755	280		22,930	
70	Good						5,215	40		5,255	
	Medium						2,765	540		3,305	
	Poor				55		730			785	
	Total				55		8,710	580		9,345	
80	Good				555	250	465	130		1,400	
	Medium				220	280	1,410	210		2,120	
	Poor				40	40	225			305	
	Total				815	570	2,100	340		3,825	
90	Good						35			35	
	Medium						235	110		345	
	Poor					20				20	
	Total					20	270	110		400	
100+	Good						265	625		890	
	Medium					460		930		1,390	
	Poor							125		125	
	Total					460	265	1,680		2,405	
Total all ages	Good	35,550	1,080	61,545	28,855	5,235	70,565	4,255	90	207,175	
	Medium	60,745	1,370	52,455	25,760	3,770	65,705	4,500		214,305	
	Poor	74,005	855	27,535	2,385	705	9,115	5,315		119,915	
	Total	170,300	3,305	141,535	57,000	9,710	145,385	14,070	90	541,395	

Table 6.--Volume of timber, log scale, Scribner rule, ^{1/}in the Grays Harbor unit, by species and ownership class January 1, 1941

(In million board feet; i.e., 000,000 omitted)

Species	Privately owned	State, county, and municipal owned		Federally owned or managed					Total
		Unreserved	Reserved	Indian owned ^{2/}	National forest		National park ^{3/}	Other ^{4/}	
					Unreserved	Reserved			
Douglas-fir									
Old growth	3,077.4	470.4	0.3	111.9	1,105.7	28.5	1,953.7	36.6	6,784.5
Second growth	862.6	107.9	6.7	10.7	13.1	-	50.5	2.2	1,053.7
Western hemlock	10,129.8	3,908.1	41.7	738.1	3,650.2	146.9	3,280.9	58.7	21,954.4
Sitka spruce	1,807.7	524.2	4.1	298.4	150.0	78.1	765.3	9.9	3,637.7
Western redcedar	1,731.9	1,075.8	1.2	1,411.5	564.8	37.7	772.3	5.6	5,600.8
Balsam firs	741.1	1,994.0	-	248.0	1,940.3	130.3	1,999.8	.6	7,054.1
Other conifers	9.4	2.4	-	31.7	12.9	14.0	64.6	-	135.0
Hardwoods	176.4	29.0	.1	26.9	10.3	.8	6.2	.8	250.5
Total	18,536.3	8,111.8	54.1	2,877.2	7,447.3	436.3	8,893.3	114.4	46,470.7

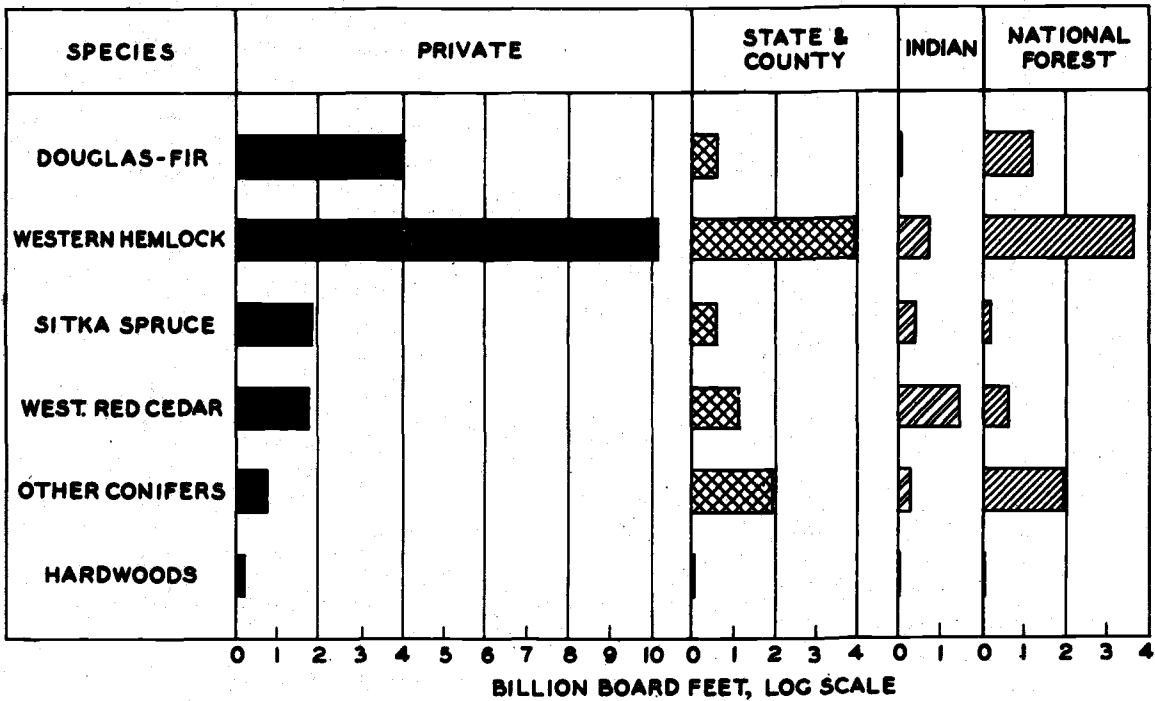
^{1/} Includes conifer trees 15.1 inches d.b.h. and larger and hardwood trees 11.1 inches d.b.h. and larger.

^{2/} Indian lands are available for cutting under management plans administered by the Indian Service.

^{3/} Reserved from cutting. Includes timber volume on lands being acquired in western Jefferson County by the Federal Government under a declaration of take.

^{4/} Includes timber volume on public domain, railroad selection pending, lands, military and lighthouse reservations, and wildlife refuges. There are no statutory limitations on cutting these lands. Actually cutting is not practiced.

FIGURE 6
VOLUME OF UNRESERVED SAWTIMBER BY SPECIES GROUP
GRAYS HARBOR UNIT, AS OF JAN.1, 1941



Approximately 60 percent of the total saw-timber volume is publicly owned or managed and 40 percent is privately owned. Not all of the public timber is available for cutting. Of the 27.9 billion feet in public ownership, 9.4 billion feet or more than a third is reserved from cutting, chiefly located in the Olympic National Park.

There is slightly more than 3 billion board feet of old-growth Douglas-fir in private ownership, a scanty supply for the sawmills and plywood factories. During 1941 and 1942, about one-third of this was cut.

This saw-timber volume varies considerably in quality, size, stand density, location, and other factors that determine its economic availability for conversion to merchantable forest products. Accordingly, the nonreserved saw-timber volume was classified by three classes of economic availability. The results of this classification are given in table 7 by species group and ownership class. Any such classification must of necessity be based on broad estimate; limitations of time and expense do not permit a field appraisal of all timber stands. It is believed, however, that the results give a realistic and reasonably comprehensive view of the situation. The factors that govern economic availability are dynamic and such classifications are out-dated within

Table 7.--Economic availability classification of nonreserved conifer saw-timber volume, by ownership and species class^{1/}
Timber volumes as of January 1, 1941

Species	Private				State and county				Indian				National forest				All ownerships			
	Total volume	Volume in class			Total volume	Volume in class			Total volume	Volume in class			Total volume	Volume in class			Total volume	Volume in class		
	Million bd. ft.	I	II	III	Million bd. ft.	I	II	III	Million bd. ft.	I	II	III	Million bd. ft.	I	II	III	Million bd. ft.	I	II	III
Douglas-fir																				
Old growth	3,077	91	9	-	470	86	14	-	112	85	15	-	1,106	80	18	2	4,765	88	12	<u>2/</u>
Second growth	863	70	30	-	108	69	31	-	11	64	36	-	13	69	31	-	995	70	30	-
Sitka spruce	1,808	78	20	2	524	69	31	-	298	74	24	2	150	75	22	3	2,780	76	22	2
Western hemlock	10,130	60	37	3	3,908	49	46	5	738	60	35	5	3,650	50	43	7	18,426	56	40	4
Western redcedar	1,732	79	21	-	1,076	71	29	-	1,411	50	50	-	565	73	26	1	4,784	68	32	<u>2/</u>
Other conifers	750	48	46	6	1,996	31	64	5	280	34	56	10	1,953	39	51	10	4,979	37	56	7
Total all species	18,360	69	29	2	8,082	51	45	4	2,850	55	43	2	7,437	54	40	6	36,729	61	36	3

^{1/} The economic availability classification, based on estimate, is as follows:

- I - Timber that could be logged profitably under marketing and operating conditions prevailing during 1936-39;
- II - Timber unprofitable to log under 1936-39 conditions which would become loggable as a result of more favorable market conditions, lower operating costs, or removal of competition of more favorably located timber, or any combination of these factors;
- III - Timber of commercial species that to the best of present knowledge has little or no potential value for conversion by competitive enterprise.

^{2/} Less than 0.5 percent.

a few years. For example, it is generally reported that 1941, 1942, and 1943 were generally more profitable to the Douglas-fir logging and lumber industries than other recent years. Increased stumpage prices confirm these statements. During these three years, very probably some timber was logged at a profit that could not have been so operated during 1938, a relatively unprofitable year, or even under the average of 1936-39 conditions, a period which included profitable and unprofitable years.

Table 7 shows that private timber generally ranks highest in economic availability and that 69 percent was placed in class I. For the unit as a whole, 61 percent was in class I. The old-growth Douglas-fir ranks highest of the species and it was estimated that 88 percent was in class I. Sitka spruce, a species in great demand for airplane manufacture, does not rank as high as might be expected because the best timber was cut during 1917-18 and during the past few years.

In addition to the board-foot data, volume of standing timber was computed in cubic feet. Results of this computation are given by species and ownership class in table 8. The preponderance of western hemlock is even more striking in cubic volume than in board-foot volume. This species is destined to increase in importance if the forest industries of this unit are to maintain anything like current levels of production.

Forest Land Ownership

The importance of forest land ownership as a factor in the rate and method of timber exploitation is patent upon examining the record. Generalizations concerning the influence of ownership upon forest resource management and utilization must be guarded, however, as ownership policy, particularly of private owners, can change rapidly. Policies governing public timber and land may also change. This unit illustrates that point probably as well as any other in the Douglas-fir subregion.

Preceding tables presenting forest inventory data indicate that private ownership still leads all other classes of owners in area of forest land and volume of standing timber. The area of forest land and volume of standing timber in private ownership, however, has declined in recent years. A large area of privately owned forest land, chiefly cut-over land, has passed into public ownership through foreclosure for tax delinquency and through purchase by the State. About 25 thousand acres in Jefferson County was recently acquired by the Federal Government for addition to the Olympic National Park. Since the 1933 forest inventory the area of privately owned forest land has decreased about a quarter of a million acres. Saw-timber volume in private ownership decreased approximately 6.5 billion board feet between 1933 and 1941, almost entirely the result of cutting.

A liquidation policy has ruled the operation of private timber almost exclusively until the past few years. After the peak of timber production passed changing trends in private forest policy became

Table 8.--Cubic volume of timber^{1/} in the Grays Harbor unit, by species and ownership class, January 1, 1941

(In million of cubic feet; i.e., 000,000 omitted)

Species	Privately owned	State, county, and municipal owned		Federally owned or managed					Total
		Unreserved	Reserved	Indian owned ^{2/}	National forest		National park ^{3/}	Other ^{4/}	
					Unreserved	Reserved			
Douglas-fir	849.0	120.8	1.3	23.4	202.5	4.7	361.5	6.6	1,569.8
Old growth									
Second growth									
Western hemlock	2,656.4	911.4	9.8	177.2	780.5	31.0	642.1	12.9	5,221.3
Sitka spruce	449.6	117.8	.9	60.0	28.4	14.4	122.3	2.0	795.4
Western redcedar	402.8	250.4	.2	316.3	127.6	8.6	150.5	1.3	1,257.7
Balsam firs	160.1	433.0	-	44.0	416.4	43.4	418.5	.1	1,515.5
Other conifers	3.6	.6	-	6.8	3.1	3.5	15.5	-	33.1
Hardwoods	92.4	9.7	-	10.9	6.0	.4	3.6	.5	123.5
Total	4,613.9	1,843.7	12.2	638.6	1,564.5	106.0	1,714.0	23.4	10,516.3

1/ Includes all sound wood in stems of all living trees 5.1 inches d.b.h. and larger from stump to 4-inch tip inside bark, excluding bark and limb wood.

2/ Indian lands are available for cutting under management plans administered by the Indian Service.

3/ Reserved from cutting. Includes timber volume on lands being acquired in western Jefferson County by the Federal Government under a declaration of take.

4/ Includes timber volume on public domain, railroad selection pending, lands, military and lighthouse reservations, and wildlife refuges. There are no statutory limitations on cutting these lands. Actually cutting is not practiced.

apparent, at least in the case of a few large owners. One of these, the Weyerhaeuser Timber Company, has been a dominant factor for many years. Although at times following a policy of disposal of cut-over lands, they recently made a start towards permanent forest land management. Still retaining a large part of the remaining saw timber in private ownership, they also possess extensive areas of second growth, large and small. Recently they have blocked up a large area, known as the Clemons Tree Farm, which contains mostly cut-over land. In the past year they have acquired additional acreage of cut-over land from the county and other private owners for addition to the Tree Farm. The company plans to give this area intensive protection and artificially reforest areas where natural regeneration has failed, according to announced plans. The Crown Willamette Paper Company, owner of extensive stands in the southwestern part of the unit, has definite plans toward permanent management; it acquired its timberlands more recently than Weyerhaeuser and many areas when acquired were occupied by second-growth forests.

Polson Logging Company, Schafer Bros., and Simpson Logging Company are also actively engaged in organizing their holdings and acquiring lands for tree farm purposes. The Grays Harbor Tree Farm was established by Polson Logging Company and the South Olympic Tree Farm by Simpson Logging Company and Weyerhaeuser Timber Company. Only a part of the latter farm is in this unit, the remainder is in Mason County. Many of the lands now being acquired for tree farm purposes are tax-delinquent and tax-foreclosed lands.

This unit is characterized by strong and diversified public ownership of forest land and timber. The largest public holding both in area and timber volume is the Olympic National Park which contains about 337 thousand acres in this unit and nearly 9 billion board feet of timber. This area is reserved from cutting and is devoted primarily to recreation. The State of Washington owns over 300 thousand acres supporting more than 8 billion board feet of timber. Some of this area is in the State school and other grant lands and some is under the jurisdiction of the State Forest Board. Practically all of saw timber falls in the first class. This timber is all available for cutting. Not all is under sustained-yield management as the timber on grant lands can be sold upon application without regard to rate of disposal. The State of Washington, unlike some other western states, husbanded its grant lands and now is in an effective position to institute a program of permanent retention and sustained-yield management. State lands in western Jefferson County were purposely blocked through exchange with the national forest. It is planned to operate this area as a sustained-yield unit. Most of the remaining grant lands are in Pacific County where they are checkerboarded with private lands. Possibilities for cooperative management with private lands exist here. State Forest Board lands are chiefly concentrated in eastern Grays Harbor County in or near the Capitol State Forest, also the seat of the State Forest tree nursery. It is definitely planned to operate this as a State Forest on sustained yield. Much of the land acquired from private owners was deforested and needed rehabilitation, which is proceeding under the direction of the State Supervisor of Forestry.

The Olympic National Forest contains 200 thousand acres, of which 14 thousand acres is reserved from cutting. About 7.4 billion board feet of saw timber is growing on the unreserved national forest lands. This, like other national forest land, is being managed under sustained yield principles.

The Quinault Indian Reservation which is administered by the Indian Service contains 178 thousand acres and has 2.9 billion board feet. This timber is managed under definite plans somewhat like the national forests.

The county-owned lands comprised a sizable acreage (1941), about 182 thousand, but supported only a relatively small amount of timber, totaling less than half a billion feet and chiefly consisting of low quality material. The magnitude of county holdings is constantly changing and as a general trend has been increasing. The counties follow a disposal policy and attempt to pass the lands back into private ownership whence they came. The market for county-owned forest lands has become active in the past year or two and the trend of previous years has been reversed.

Agriculture

Although subordinate to forestry, agriculture occupies an important place in the economy of the unit and the prospects of expanding agricultural production will have considerable influence on future forest management.

The Extent of Area in Agriculture

The total area in farms according to the 1940 Census of Agriculture is 188,718 acres, exclusive of western Jefferson County for which figures are not available. (Census reports now available do not show data for minor civil subdivisions.) The western part of Jefferson County has very little farm land and the omission of these data will not greatly change the unit figures. Of the total area in farms 34,399 acres or 18.2 percent is cropland, 23,249 acres or 12.3 percent is plowable pasture, 64,236 acres or 34.1 percent is woodland, and 66,834 acres or 35.4 percent is classed as all other land. The woodland category includes both woodland pastured and woodland not pastured; the 1935 Census showed 60 percent of the woodland in farms was pastured. The "all other" category includes pasture other than plowable or woodland, barnyards, roads, wasteland, etc.

Only a small acreage of the farm land is irrigated. The 1940 Census reports 483 acres of irrigated cropland harvested and 577 acres of irrigated pasture in these two counties.

The Farms

There was a total of 2,625 farms averaging 71.9 acres each in size according to the 1940 Census. The average farm contains 13.1 acres of cropland of which 11.4 acres was harvested, 1.4 acres was idle or fallow, and 0.3 acre was crop failure. It contained 8.9 acres of plowable pasture, 24.5 acres of woodland, and 25.5 acres of "all other land."

Analysis of number of farms by size class shows many small farms. There were 67 farms under 3 acres in size, 618 from 3 to 9 acres, 648 from 10 to 29 acres, 347 from 30 to 49 acres, 142 from 50 to 69 acres, 256 from 70 to 99 acres, and 547 one hundred acres or larger. Part-time farming is extensive in this unit. A total of 1,541 farm operators reported work off their farms in 1939 for pay or income, 1,009 reported no work off their farms, and 75 failed to report. About 60 percent of those reporting engaged in outside work--considerably above the average for the state. Operators engaged in work on farms other than their own totaled 132 in the two counties and worked a total of 7,685 days in 1939 or an average of 58 days each. Compared to this 1,466 engaged in non-farm work for a total of 271,248 days or an average of 185 days during the year. Although definite information is lacking, very probably the forest industries were the chief source of this outside employment.

The total value of farms (lands and buildings) is given in the 1940 Census as \$11,359,469 for the two counties. Of 2,339 farms in the two counties operated by owners, 902 or 38.6 percent were mortgaged. The average debt per farm for those operated by full owners was \$1,650 and the ratio of debt to value was 35 percent. The average debt per farm for those operated by part owners (those who own part and rent from others the remainder of the land they operate) was \$2,777 and the ratio of debt to value was 44.5 percent.

The Crops

Dairying is the principal type of farming practiced in the unit and the chief crops are hay, oats, and small grains. Green peas and cranberries are the principal specialty crops. Cranberries are grown chiefly for export. A canning and quick-freezing plant has been established by a local cooperative and expansion of this industry is anticipated. Small amounts of berries and fruits, chiefly apples and prunes, are produced. Other than dairy and poultry products, green peas, cranberries, and potatoes, it is doubtful if the unit raises sufficient of the common farm products to satisfy local demands.

Forest Industries

Chronologically, the foremost of the forest industries is logging because this industry converts the living tree into products usable by the other primary wood-using industries. The products of the primary wood-using industries may be a finished product in themselves or may be raw materials used by secondary industries. Theoretically, at least, the greater the proportion of logs used by primary industries within the area in which they are produced to manufacture higher products and the greater the proportion of the products of the primary industries that are used by secondary industries, the more stable the communities. Certainly, greater refinement of the basic raw material leads to increased pay rolls, better and more complete utilization of natural resources, and a greater return to the timber operator. To what extent this has taken place here is revealed by analyzing the various types of forest industries, their relative capacities, and their demands for raw material.

Logging

The logging industry has always been prominent in the Grays Harbor unit, in fact until recently more logs were produced than were used within the unit. In recent years, however, local log supply, at least of Douglas-fir, has failed to meet requirements of local industries, in spite of a marked decrease in installed plant capacity of the leading industry, lumber manufacture.

During 1941, 65 separate logging enterprises operated within the unit and produced 939 million board feet of sawlogs of all species. Some of these were independent loggers, unaffiliated in ownership with manufacturing enterprises. They may own timber, they may operate on timber purchased as they cut, or they may contract their services to timber owners. Open log markets operate in both Grays Harbor and Willapa Harbor where logs are bought and sold. Logging companies range in size from small operations which may operate a small camp using a few tractors or a donkey for logging and a few trucks for log transportation to large operators maintaining several "sides" and using heavy steam skidders and transporting by rail. Changes in logging capacity respond quickly to shifts in timber supply and changes in market conditions. The smaller operations and many of the larger possess a high degree of mobility and can quickly shift operations to an entirely different part of the region. Operators owning standing timber and having large investments in railroad lines are more stable. Log production has been generally downward since 1930. Production in 1941 was higher than any year since 1930 except 1936 and 1937.

Lumber Manufacture

The sawmill industry is the largest single consumer of logs. Since 1930 the number of mills within the unit has been in the neighborhood of 30; in "off years" fewer have operated; in good years a few more have come into existence only to shut down and possibly disappear when lumber demand decreased. Since 1929 there has been a severe decrease in sawmill capacity as shown in table 9.

Table 9.--Installed sawmill capacity in the Grays Harbor unit, 1929 and 1941

Condition	1929	1941	Percent 1941 is of 1929
	M bd. ft. per 8 hrs.		
Active	4,704	3,149	67
Idle	150	-	-
Total	4,854	3,149	65

In 1941 there were 35 active mills in the unit and the average capacity was approximately 90 thousand board feet per 8-hour shift, which is more than twice the regional average. The Grays Harbor unit is one of large- and medium-sized sawmills.

In 1941 the mills of the unit produced 810 million board feet of lumber using about 700 million feet of logs in the process.

Pulp and Paper Manufacture

The unit has one pulp mill which has a daily capacity (24-hour basis) of 270 tons and a paper mill with a daily capacity of 50 tons. The pulp mill produces bleached sulphite pulp, the paper mill produces sulphite bonds, writing paper, and specialties. These plants were erected in 1928.

Shingle Manufacture

The manufacture of western redcedar shingles has long been an important industry in the Grays Harbor unit. During 1941, 37 shingle mills operated. The number of shingle mills has increased steadily since 1930. At the same time, output per mill has decreased which may be attributed to one or both of two factors. Lately, the shingle industry in this region has encountered competition from Canadian mills, which falls heavily on large mills leading to curtailment or part-time operation. Coincident with this, small mills operated by the owner or by the owner and one or two helpers have been erected and appear to be less affected during poor market periods.

Veneer and Plywood Manufacture

The phenomenal growth of this industry has contributed considerably to stabilizing the forest industries since the sawmill industry commenced to decline in 1929. Two types of plants make up this industry; plants producing plywood chiefly from Douglas-fir logs of which there are four, and plants producing veneer for fruit and vegetable containers chiefly from Sitka spruce of which there are two. This unit produces about one-fourth of the total plywood manufactured in the State and about half the veneer for containers.

Secondary Wood-Using Industries

The unit has a total of 19 secondary wood-using plants representing 7 different types of industries. The variety of plants and products manufactured makes it difficult to appraise the importance of this group on the basis of installed capacity or output of physical units. Data on value of products are not available. Probably the best available measure is the quantity of raw material used--in this case the products of primary wood-using industries. During 1940, these 19 plants used 75 million board feet of lumber, and 18 million square feet of plywood. Approximately 90 percent of these requirements were obtained from local primary producers; the remainder consisted chiefly of lumber shipped from Puget Sound territory. About 12 thousand feet of lumber and 2 thousand square feet of plywood were of species not native to this unit.

On the basis of quantity of raw materials used, the sash and door industry ranks first. The unit has two plants, one at Hoquiam and one at McCleary. During 1940, they used 41.3 million feet of Douglas-fir lumber and 7.6 million square feet of Douglas-fir plywood in producing 1,275,000 doors and an unestimated number of sash.

Next in importance is the furniture industry which used 24.7 million feet of Douglas-fir lumber and 10.0 million square feet of Douglas-fir plywood during 1940. One concern, located in Hoquiam, comprises this industry which started ten years ago in a small way producing chairs from red alder sawed in its own mill. Now this company manufactures unfinished furniture of many types--chairs, cabinets, tables, bedroom suites, dining room sets, corner shelves, etc. This remarkable increase in output volume and shift from one species of raw material to another illustrate the adaptability of industry to markets and possibilities of utilizing the raw material available in large quantities at a reasonable price.

Third in rank is a plant manufacturing specialty products entirely from Sitka spruce. This concern can furnish almost any type of article from a small turned ash tray to a violin back, a piano sounding board, or a built-up wing beam for an airplane. Approximately 7.6 million feet of lumber was used in 1940.

One small box factory in Aberdeen used about 425 thousand board feet of lumber in 1940, about half Sitka spruce and half Douglas-fir. A portion of the requirements is purchased in the form of lumber, but much of it comes from the sawmills in the form of shims, thin pieces which might otherwise be unused.

The unit has nine cabinet and millwork shops which used a total of 370 thousand board feet of lumber and 160 thousand square feet of plywood during 1940, principally Douglas-fir.

Boat building was once an active industry; in 1940 four concerns were operating on a small scale. One specialized in light fishing and pleasure boats with molded plywood hulls; the others built and repaired fishing boats, mostly trollers. Approximately 166 thousand board feet of Douglas-fir lumber and 23 thousand square feet of Douglas-fir plywood were used during 1940. Wartime demands have stimulated the shipbuilding industry and wooden barges, tugs, and small boats are now being constructed at shipyards in the unit.

One foundry, in Hoquiam, used nearly 12 thousand board feet of western redcedar for patterns and 3 thousand board feet of Douglas-fir for flasks during 1940.

Economic Dependency

The Grays Harbor Unit had a total population in 1940 of approximately 70,000, according to the U. S. Census, which is about 4 percent of the total for the State of Washington. About 55,000, aged 14 years or over, form the segment of population from which workers are drawn. Occupational analysis can be made for residents of Grays Harbor and Pacific Counties, but not for western Jefferson County since Census statistics are not broken down for units less than a county; however, since only a few hundred people reside in western Jefferson County, omission of these data will not be serious. The total labor force in the two counties in 1940 was 29,035 of which 24,176 were employed (other than on public emergency projects),

1,701 were on public projects such as WPA and NYA, and 3,158 were seeking work. A total of 25,908 persons were not in the labor force and included housewives, school children, incapacitated, inmates of institutions, etc. The ratio of these various categories corresponds fairly closely to state ratios; in Grays Harbor, 83.2 percent of the labor force was employed compared to 84.8 percent for the state as a whole, 5.9 percent was on public emergency projects compared to a state figure of 5.3 percent, and 10.9 percent was seeking work compared to 9.9 percent for the state as a whole.

Table 10 presents an analysis of the dependency of the working population upon agriculture and forest resources for employment.

Table 10.--Employment in agriculture and forest industries compared to total employment, Grays Harbor Unit and State of Washington, 1940

Occupation	Grays Harbor Unit		State of Washington	
	Persons	Percent	Persons	Percent
Agriculture	1,488	6.15	83,475	13.74
Forestry and fishing	541	2.24	4,957	0.82
Logging	3,522	14.57	21,374	3.52
Sawmills and planing mills	5,420	22.42	34,694	5.71
Paper and allied products	616	2.55	9,631	1.58
Furniture & misc. wooden goods	357	1.48	5,144	0.85
Other ^{2/}	12,232	50.59	448,397	73.78
Total	24,176	100.00	607,672	100.00

1/ Excluding western Jefferson County.

2/ Includes mining, other manufacturing, wholesale and retail trade, professions, and service occupations.

The importance of the forest industries is emphasized by the figures in this table. A total of about 40 percent of the gainfully employed in this unit work in forest industries. Probably an equal number in other occupations gain their livelihood from services rendered forest industries and forest industrial workers. It may be safely asserted that about 80 percent of the population depends upon the forest resources either directly or indirectly. Comparison with state figures again emphasizes the heavy dependence of the Grays Harbor unit upon forests.

The slightly higher percentage of the labor force in the Grays Harbor unit on public emergency projects and seeking work compared to state totals is indicative of the industrial nature of this unit's economy. These statistics were taken during March 1940, when forest industries are not usually as active as later in the year. Lumber production for the entire Douglas-fir region during 1940 was about 80 percent of 1941 and 1942 levels and very probably most of the people on public emergency projects or seeking work have been absorbed since, either in forest

industries or in other expanded industrial activities. The over-all size of the labor force has probably been increased materially also through persons not normally in the labor force (women and young people of school age) seeking work during the war emergency.

Another comparative measure of the economic dependency in the Grays Harbor unit can be obtained from the 1939 Census of Manufacturers. It showed that 8,907 wage earners (exclusive of salaried employees, officers, and proprietors) engaged in manufacturing in this unit were paid \$11,603,394 in wages and the value of products produced totaled \$43,925,829. In contrast, the Census of Agriculture for 1939 shows that the value of farm products sold, traded, or used by farm households totaled \$2,189,013 for the year.

Estimates based on reports of the Washington State Department of Labor and Industries indicate that wages paid in the forest industries of the unit totaled about 13 million to 14 million dollars during 1940 and 17 to 18 million dollars during 1941. The pay roll for 1942 is estimated to have exceeded 20 million dollars paid to some 10,000 workers.

Expansion of war industries has not been as sensational as in the Columbia River and Puget Sound districts but several small boatbuilding plants and other industries now furnish employment to a number of people. A subassembly plant of the Boeing Aircraft Company employes several hundred. However, the main source of employment is still the forest industries.

TRENDS IN THE FOREST SITUATION

The dynamic nature of the forest resource is graphically illustrated by review of high points in the history of forest exploitation in the Grays Harbor Unit. Cutting of commercial timber products commenced the middle of the last century, not increasing much in volume until the latter part of the century when the opening of the unit to rail transportation gave impetus to the lumber industry. For the first three decades of the present century the drain on the forest increased steadily. The peak of forest exploitation was reached in 1929-30; since then the decline, forced partly by the general business depression and partly by lack of suitable raw material, has been sharp and severe. While the forest is being exhausted, it is also being replenished by growth; it cannot be replaced, however, as quickly as it has been depleted.

Forest Drain

The chief instrument of forest drain has been cutting and the chief product removed from the forests of the unit has been the sawlog. Other factors have added to the total drain and other products have been taken from the forests but they have been of lesser consequence.

Cutting

Since commercial timber operations commenced, it is estimated that over 850 thousand acres has been cut over and more than 50 billion board feet of timber has been taken from the forests. Approximately 400 thousand acres cut over prior to 1920 produced roughly 25 billion board feet, principally Douglas-fir. As early as the beginning of the century E. T. Allen⁶ reported areas of 10 thousand acres cut over annually in Grays Harbor County alone (then called Chehalis County). In the decade 1920-29 loggers really "went to town" cutting over 285 thousand acres in removing 17 billion feet of logs. The general economic depression and growing scarcity of stumpage combined to slow down cutting commencing in 1930. During the 13-year period 1930-42, inclusive, approximately 200 thousand acres was cut over and 10.5 billion feet of logs produced.

Sawlog production for the period 1925-42 is given by year and species in table 11. Over the past 18 years, sawlog production has fluctuated from a high of 2,054 million board feet in 1929 to a low of 497 million board feet in 1932. Despite these violent short-run fluctuations a consistent long-time trend is fairly evident. From a plateau of nearly 2 billion feet in the period 1925-29 the general trend has been steadily downward ignoring local variations introduced by market conditions.

In spite of a growing shortage of available Douglas-fir stumpage, the proportion of species produced has been fairly uniform throughout the years. The proportion of Douglas-fir sawlogs produced has ranged from 46 percent to 70 percent of the total averaging 59 percent. In ten of the eighteen years, the proportion of Douglas-fir ranged from 58 to 62 percent, a narrow range. Western hemlock varied from 13 to 28 percent, averaging 20 percent. Western redcedar averaged 12 percent and Sitka spruce 8 percent during the eighteen-year period. Production of other species has been insignificant. As a general trend, the proportion of Douglas-fir is decreasing and that of western hemlock increasing.

Cutting of minor forest products has been a negligible factor in total forest drain. A number of items are produced but the quantities are small and much of the material removed has been obtained from trees less than saw-timber size or from dead timber. A survey made in 1940 showed measurable quantities of the following items produced: fuelwood, forest pulpwood, fence posts, poles and piling, veneer blocks, shingle bolts, and shake boards.

Fuelwood is the most important of the minor forest products. During 1940 about 18,000 cords of Douglas-fir, 4,500 cords of red alder, and 1,500 cords of western hemlock were cut. The total cut of 24,000 cords is roughly equivalent to 12 million board feet or 2,265 thousand

⁶/ Allen, E. T. The western hemlock. U. S. Bureau of Forestry Bul. 33, 55 pp. illus. 1902.

Table 11.--Annual sawlog production in the Grays Harbor Unit in 1925-42,
by species

(Million board feet; i.e. 000,000 omitted)

Year	Total	Douglas- fir	Western hemlock	Western redcedar	Sitka spruce	Other conifers	Hard- woods
1925	1,899	1,145	334	236	178	6	1/
1926	1,910	1,115	376	244	169	6	1/
1927	1,973	1,178	418	222	149	6	1/
1928	1,854	1,065	403	217	163	6	1/
1929	2,054	1,253	376	235	181	7	2
1930	1,046	674	219	114	36	2	1
1931	732	448	165	71	45	3	1/
1932	497	347	67	46	37	1/	1/
1933	773	523	123	78	44	2	3
1934	852	474	216	100	59	1	2
1935	677	416	125	81	52	1	2
1936	1,025	621	206	125	65	4	4
1937	1,034	608	235	123	62	3	3
1938	527	263	100	114	46	3	1
1939	817	478	158	123	48	8	2
1940	906	521	183	120	68	12	2
1941	939	522	216	103	93	3	2
1942	865	399	243	114	107	2	1/

1/ Less than 0.5 million board feet.

cubic feet. Twelve hundred cords of western hemlock forest pulpwood were cut during 1940 which is the equivalent of 720 thousand board feet or 151 thousand cubic feet. It is estimated that 50,000 cedar fence posts were cut during 1940 which approximately equals 250 thousand board feet or 55 thousand cubic feet. The production of shingle bolts cut from dead cedar trees totaled 12 thousand cords or roughly 6 million board feet during 1940. Shake boards also cut from dead cedar totaled 1,125 thousand board feet. The production of veneer blocks during 1940 amounted to 300 thousand board feet or 52 thousand cubic feet of Douglas-fir and 350 thousand board feet or 63 thousand cubic feet of Sitka spruce. The cut of Douglas-fir poles and piling amounted to 100 thousand lineal feet or the equivalent of 86 thousand cubic feet. A total of 20 thousand lineal feet of cedar poles equaling 14 thousand cubic feet was also produced.

Fire

The universal enemy of the forest is fire and the situation in this unit is no exception. Recently considerable improvement in fire protection can be observed as a result of work of private, State, and Federal agencies. Table 12 gives the acreage burned over annually for the period

Table 12.--Area of forest land burned over by type group and saw-timber volume burned in the Grays Harbor Unit annually, 1936-40

Year	Area burned over				Saw-timber volume burned		
	Total	Saw timber	Second growth	Recent and nonrestocked cutover	Killed	Salvable	Destroyed
	<u>acres</u>	<u>acres</u>	<u>acres</u>	<u>acres</u>	<u>M board feet, log scale</u>		
1936	2,075	-	76	1,999	-	-	-
1937	5,055	121	1,331	3,603	750	-	750
1938	22,300	576	10,910	10,814	841	150	691
1939	3,443	16	2,050	1,377	51	-	51
1940	5,862	64	2,067	3,731	272	103	169
Total	38,735	777	16,434	21,524	1,914	253	1,661
Average	7,747	155	3,287	4,305	383	51	332

1936-40 by cover type class and total merchantable volume killed, salvaged, and lost for the same period. The average annual acreage of 7.7 thousand acres of forest land burned over is not excessive, amounting to 3/10 of one percent of the total forest land area. Unfortunately, these data which are based on the State Supervisor of Forestry's reports do not include fires occurring outside the regular fire season, the so-called fern or spring fires. Such fires sweep over cut-over lands destroying reproduction and hindering their reforestation. Neither do these figures indicate the threat of catastrophic fires which are likely to occur any time in spite of improved protection methods.

Insect Losses

The spruce-hemlock forests of this region are subject to epidemic attacks of the hemlock looper, a defoliating insect that has caused great damage in the past. Two severe epidemics are known to have occurred in this unit, one about 1889 to 1891, of which there is no authentic record of the losses sustained, and one from 1929 to 1932 which covered 50,000 acres, chiefly in Pacific County, destroying about 200 million feet of timber. Control measures employed--dusting the infested forests with arsenic compounds from airplanes--are believed to have checked the spread of the last epidemic. Undoubtedly these epidemics have occurred in the past and were probably followed by fires since the defoliated forests soon dry out creating a serious fire hazard. Such cycles are believed responsible for the extensive stands of even-aged hemlock and spruce about 90 to 100 years of age which occur in this unit. Epidemics will probably occur in the future, but with use of control measures and prompt salvage, heavy losses should be avoidable.

Wind-Throw Losses

The most destructive windstorm in the history of the Pacific Northwest struck the Olympic Peninsula in January 1921. Although destruction centered in Clallam County, forests of western Jefferson County immediately south suffered serious damage. It is estimated that the total loss in this storm was 5 billion board feet.

Situated on the coast where southwest gales frequently strike, future wind-throw losses are bound to occur in the Grays Harbor Unit. Abnormal losses can be averted in part by prompt salvage which should become increasingly feasible as more areas are opened up to transportation.

Summary of Forest Drain

Much of the drain on the unit's forests is not reflected in the figures of saw-timber loss. Table 13 summarizes annual drain in cubic feet through cutting, fire, wind throw, and insect epidemic. Estimates of loss from wind throw and insect epidemic are based on periodic losses that have occurred in the past. The total current annual drain based on these figures is 238.6 million cubic feet annually; slightly more than half the drain was in Douglas-fir forests, nearly a fourth was in western hemlock forests, and the remainder was nearly all made up of western redcedar and Sitka spruce. More than 96 percent of the total drain was caused by cutting.

Table 13.--Average annual current depletion^{1/} in Grays Harbor Unit from all causes

(Thousands of cubic feet)

Cause of depletion	Total	Douglas-fir	Western redcedar	Sitka spruce	Western hemlock	Other conifers	Hard-woods
Cutting ^{2/}	229,997	122,957	35,406	14,554	53,214	2,314	1,552
Fire	3,555	2,067	345	190	953	-	-
Wind throw ^{3/}	3,600	720	180	720	1,800	180	-
Insect attack ^{3/}	1,400	-	-	-	1,400	-	-
	238,552	125,744	35,931	15,464	57,367	2,494	1,552

- 1/ Sawlog cutting and fire loss based on 1936-40 records, cutting of minor products based on 1940 data, and cutting of understory trees based on 1933-40 records. All trees 5.1 inches d.b.h. and larger included.
- 2/ Includes sawlog cutting, woods waste, cutting of minor products and loss of understory trees during logging in trees 5.1 inches d.b.h. and larger.
- 3/ Abnormal loss only; does not include normal wind throw and loss from endemic insect attack. Includes all trees 5.1 inches d.b.h. and larger.

Current annual drain of saw timber from all causes totals about 900 million board feet, practically all the result of cutting. Abnormal wind throw, epidemic insect attacks, and catastrophic fires may occur in the future and, in considering possible future depletion, allowance should be made for such contingencies. However, improved forest protection should diminish risk of such loss, and expansion of transportation facilities should reduce actual losses through prompt salvage.

Forest Growth

Kinds of Growth Calculations

The counter force of drain is forest growth which is constantly taking place. Old-growth stands, i.e., conifer forests over about 160 years of age, on the whole do not make any net growth because what growth is taking place is nullified by decay and mortality. The second-growth stands change rapidly adding to the complexity of estimating growth over large areas. The time element thus becomes an important factor in choosing a growth formula. Probably the first objective is the determination of the actual growth taking place now; this is accomplished by computing current annual growth. It should be stated that a district possessing large areas of nongrowing old-growth forests would show relatively little current annual growth and on the other hand a district with little old growth and large areas of nonproducing cut-over land would also show comparatively little current annual growth. It has often been said that in this region we must cut the old-growth forests to increase growth, which is but a partial truth. To increase growth, nongrowing forests must be converted to a growing condition which requires that cutting of old growth be followed immediately by complete and desirable regeneration. In addition, cut-over land now idle must be restored to full productivity.

The next objective in analyzing forest growth is the determination of growth at stated future times on the basis of a realistic estimate of future conditions governing growth. This can be done through the calculation of periodic annual growth which involves the determination of the growth for the decades 1941-50 and 1951-60 assuming certain rates of future depletion as well as certain degrees of restocking.

Finally, growth possible under intensive forest management should be determined to show the goal or ultimate objective of forest land use. This is typified by what is called potential annual growth.

Standards of Measure

Just as the time element dictated the use of three different growth formulas or concepts, so does it influence the standard of measure. In recognition of possible shifts in utilization practice with passage of time, three standards of measure are used; board feet, trees 15.1 inches d.b.h. and larger; board feet, trees 11.1 inches d.b.h. and larger; and cubic feet, trees 5.1 inches d.b.h. and larger. Growth of all trees of the designated size class are computed in board feet, log scale, or cubic feet as the case might be. Current practice in sawlog production is not to remove trees below about 16 inches d.b.h. A small amount of cordwood and fuelwood cutting may take smaller trees.

Current Annual Growth

Table 14 gives current growth by broad ownership class and type group. The total current annual growth in the unit as of 1941 was 279 million board feet, log scale, in trees 15.1 inches and larger, 376 million board feet in trees 11.1 inches and larger, and 61 million cubic feet in trees 5.1 inches and larger. Practically all of the current growth is taking place on unreserved lands, chiefly in private ownership. The public forest lands, reserved and unreserved, are mainly either non-commercial or support old-growth forests. Significantly, 86 percent of the current board-foot growth is taking place in the spruce-hemlock forests despite long concentration of cutting in the privately owned Douglas-fir forests. One reason for this condition is that most of the nonrestocked and recent cut-over lands originally supported Douglas-fir forests, another that large areas of second-growth hemlock growing on old burns or insect-killed areas are near the peak of growth. Coupled with the fact that the bulk of the remaining saw timber is hemlock, this emphasizes the necessity for shaping the forest industries towards increased consumption of hemlock and decreased consumption of Douglas-fir. Much of the cut-over land has not had time since cutting to grow trees of saw-timber size; estimates of cubic-foot growth include smaller trees, however, and a larger portion of the total cubic-foot growth is on Douglas-fir trees.

Table 14.--Current annual conifer growth in the Grays Harbor unit
January 1, 1941

Ownership class	Trees 5.1"+ d.b.h.			Trees 11.1"+ d.b.h.			Trees 15.1"+ d.b.h.		
	Spruce-hemlock & upper slope	Douglas-fir and cedar	Total	Spruce-hemlock & upper slope	Douglas-fir and cedar	Total	Spruce-hemlock & upper slope	Douglas-fir and cedar	Total
	Million cubic feet			Million board feet			Million board feet		
<u>UNRESERVED</u>									
Private, state and county	42.9	13.5	56.4	288.7	57.9	346.6	219.3	36.5	255.8
Indian	2.0	.4	2.4	16.4	2.4	18.8	14.9	1.3	16.2
National forest	.4	-	.4	1.9	.2	2.1	1.7	.2	1.9
Total available	45.3	13.9	59.2	307.0	60.5	367.5	235.9	38.0	273.9
<u>RESERVED</u>									
National park	.1	.1	.2	1.2	.8	2.0	.7	.6	1.3
National forest	.1	-	.1	.6	-	.6	.4	-	.4
Other	1.0	.2	1.2	5.4	.5	5.9	3.2	.1	3.3
Total reserved	1.2	.3	1.5	7.2	1.3	8.5	4.3	.7	5.0
Unit Total	46.5	14.2	60.7	314.2	61.8	376.0	240.2	38.7	278.9

Periodic Growth

Table 15 gives the estimated periodic net growth by ownership class and type group computed according to the three standards for the decades 1941-50 and 1951-60. These estimates represent the net increment anticipated on stands assumed to survive to the end of the specified decade, allowance having been made for drain in the immature stands from cutting, fire, wind throw, and insect attacks. Since ownership is subject to unpredictable change, no breakdown other than separating "unreserved" from "reserved" was attempted. The average annual board-foot growth for the first decade is 272 million feet which is actually slightly less than current annual growth. Douglas-fir stands, however, show an increase over current growth. This is accounted for by the distribution of age classes in the growing stands and anticipated future depletion of the immature stands, particularly western hemlock. Growth in cubic feet, which includes the younger stands, shows an increase commencing at once.

Table 15.--Estimated periodic net conifer growth in the Grays Harbor unit

Class of ownership and forest type	Trees 5.1"+ d.b.h.			Trees 11.1"+ d.b.h.			Trees 15.1"+ d.b.h.		
	1941-50	1951-60	Total	1941-50	1951-60	Total	1941-50	1951-60	Total
	Million cubic feet			Million board feet			Million board feet		
UNRESERVED									
Pulpwood types	519.5	563.5	1,083.0	2,952.9	3,224.7	6,177.6	2,223.0	2,381.2	4,604.2
Douglas-fir and cedar	169.5	198.1	367.6	655.6	766.5	1,422.1	439.6	473.3	912.9
Total available	689.0	761.6	1,450.6	3,608.5	3,991.2	7,599.7	2,662.6	2,854.5	5,517.1
RESERVED									
Pulpwood types	16.1	17.7	33.8	95.0	107.0	202.0	55.2	77.6	132.8
Douglas-fir and cedar	.9	.9	1.8	6.8	7.2	14.0	4.9	5.7	10.6
Total reserved	17.0	18.6	35.6	101.8	114.2	216.0	60.1	83.3	143.4
Unit Total	706.0	780.2	1,486.2	3,710.3	4,105.4	7,815.7	2,722.7	2,937.8	5,660.5

1/ The period covered is 10 years and the values given represent the total growth.

Potential Annual Growth

If forest management of reasonable intensity is practiced, growth can eventually be increased to more than four times current growth. Table 16 shows potential annual growth of commercial conifer sites on the basis of present ownership. Before this goal can be attained even under the most favorable rate of progress, many years must pass; in the meantime ownership may change radically. The total potential annual growth on "unreserved" lands in board feet, trees 15.1 inches and larger, is 1,154 million board feet, log scale, of which 360 million feet would be Douglas-fir and cedar. If trees as small as 11.1 inches d.b.h. can be utilized, this can be increased to 1,472 million board feet of which 495 million feet would be Douglas-fir. The potential annual growth of the "unreserved" lands is 260 million cubic feet. The bulk of the growth would be on lands now in private, State, and county ownership, which are inherently the most productive.

Table 16.--Potential annual growth on conifer sites in the Grays Harbor unit
January 1, 1941

Ownership class	Trees 5.1" + d.b.h.			Trees 11.1" + d.b.h.			Trees 15.1" + d.b.h.		
	Spruce-hemlock & upper slope	Douglas-fir and cedar	Total	Spruce-hemlock & upper slope	Douglas-fir and cedar	Total	Spruce-hemlock & upper slope	Douglas-fir and cedar	Total
	<u>Million cubic feet</u>			<u>Million board feet</u>			<u>Million board feet</u>		
UNRESERVED									
Private, state, & county	138.1	85.0	223.1	826.6	444.9	1,271.5	675.6	327.5	1,003.1
Indian	7.7	7.8	15.5	43.5	36.0	79.5	34.4	22.7	57.1
National forest	18.9	2.9	21.8	106.3	14.3	120.6	83.8	9.8	93.6
Total available	164.7	95.7	260.4	976.4	495.2	1,471.6	793.8	360.0	1,153.8
RESERVED									
National park	19.7	4.1	23.8	106.1	20.7	126.8	81.3	14.5	95.8
National forest	1.2	.1	1.3	7.1	.5	7.6	5.8	.2	6.0
Other	1.4	.7	2.1	8.1	3.7	11.8	6.6	2.8	9.4
Total reserved	22.3	4.9	27.2	121.3	24.9	146.2	93.7	17.5	111.2
Unit Total	187.0	100.6	287.6	1,097.7	520.1	1,617.8	887.5	377.5	1,265.0

Comparative Analysis of Growth

Comparison of current annual and potential annual growth indicates the current stage in progress towards the ultimate goal of resource management. Current annual growth is approximately one-fifth of potential annual growth. According to the periodic growth calculations, this ratio will not increase to much more than one-fourth by 1950 to 1960. Acceleration of growth should be more rapid following 1960, if restocking of cut-over lands continues to improve, for extensive areas now non-restocked or restocked with seedlings should be large enough to accumulate measurable growth. Despite the most optimistic estimate, it is inconceivable that the goal of potential growth can be achieved in this century.

INDUSTRY DEMAND FOR RAW MATERIAL IN RELATION TO SUPPLY

A complete analysis of the supply of raw material available to the forest industries of the unit must include the following four factors: (1) size and character of the raw material inventory, (2) the depletion trend, (3) the growth prospects, and (4) the trends in industrial production as determined by market conditions. The first three factors have been analyzed independently; now they must be integrated with the fourth, quantitatively and qualitatively. This analysis may proceed two different ways--by species of raw material or by industry. The industrial approach is probably the most realistic in attempting to answer pressing current economic problems. It is, of course, possible that industries may continue to draw upon areas outside this unit for raw material, and on the other hand raw materials may be exported from this unit as has happened in the past. For sake of simplicity, these contingencies will be excluded from this analysis.

Lumber Manufacture

The trend of lumber production has been downward since the peak year, 1926, table 17. Production in 1940 was 710 million board feet and the volume of sawlogs required to produce this amount was approximately 617 million board feet, log scale. Production of lumber during 1941 stimulated by war demands increased 100 million feet from 1940, but receded about 35 million feet in 1942. When the peak of war demand is over, a more rapid decline is probable. With a total saw-timber inventory on commercial forest lands of 37.0 billion board feet, it would seem to the superficial observer that the sawmills are not in peril of immediate raw material shortage. The problem cannot be dismissed so summarily, however, for other facts have a bearing. In the first place, needs of other forest industries must be considered. Next, all the inventory is not suitable for lumber manufacture as now conducted in the unit. Finally, publicly owned timber is not all available for immediate exploitation; it must be cut under long-time sustained yield plans which reduce allowable cut to amounts sustainable continuously.

Table 17.--Annual lumber production in the Grays Harbor Unit in 1925-42,
by species

(Million board feet; i.e., 000,000 omitted)

Year	Total	Douglas-fir	Western hemlock	Western redcedar	Sitka spruce	Other conifers	Hard-woods
1925	1,584	1,086	325	45	126	2	<u>1/</u>
1926	1,811	1,305	344	42	119	1	<u>1/</u>
1927	1,687	1,154	422	19	92	<u>1/</u>	<u>1/</u>
1928	1,553	1,034	392	20	106	1	<u>1/</u>
1929	1,482	1,001	350	40	87	2	2
1930	950	619	259	15	54	2	1
1931	514	350	139	10	14	<u>1/</u>	1
1932	301	234	43	9	15	<u>1/</u>	<u>1/</u>
1933	473	401	45	8	16	<u>1/</u>	3
1934	467	405	21	11	28	<u>1/</u>	2
1935	453	372	34	10	32	1	4
1936	710	558	82	18	48	<u>1/</u>	4
1937	763	609	82	16	53	1	2
1938	302	236	8	11	45	<u>1/</u>	2
1939	518	392	31	20	72	1	2
1940	710	574	36	25	71	2	2
1941	810	615	52	36	104	1	2
1942	773	531	87	25	129	1	<u>1/</u>

1/ Less than 0.5 million board feet.

Analysis of table 17 reveals significant characteristics in the trend of lumber production over the past eighteen years. The average annual total lumber production during the period 1925-42 was 881 million feet. Production in each of the six years from 1925 to 1930, inclusive, exceeded the average; in each of the following twelve years it was below average. The downward trend of lumber production commenced in 1926 and outlived the general business depression. A partial recovery took place in 1936 and 1937 but it did not measure up to the regional trend and production during the 1938 recession dropped to practically the 1932 low. Production stimulated by war requirements reached 1936-37 levels during 1940-42.

When past lumber production is analyzed by species certain facts stand out. During the period 1925-42, Douglas-fir averaged 72.4 percent of the total lumber production, western hemlock 17.4 percent, Sitka spruce 7.6 percent, western redcedar 2.4 percent, and other conifers and hardwoods 0.2 percent. From 1925 to 1931 Douglas-fir averaged about 68 percent, from 1932 to 1942 about 78 percent of the total lumber cut. Western hemlock lumber production on the contrary has declined steadily in relative importance since 1931; from 1925 to 1931 it amounted to nearly 23 percent of total production; in 1942 it was but 11 percent. Peak of western hemlock lumber production was in 1927 when 422 million feet was produced; in 1938 but 8 million feet was cut. This severe decline in hemlock lumber production took place in spite of plentiful stumpage supplies and evidently was entirely the result of lack of market demand. As was pointed out before, stumpage shortage has been a governing factor in production of Douglas-fir lumber in this unit within the general framework of market demand. In other words, production of Douglas-fir lumber probably would have been much higher in 1937 or 1942 if stumpage had been as plentiful as it was in 1925 or 1926. Production of western redcedar lumber has been relatively stable and the demand for lumber of this species is comparatively inelastic. Production of Sitka spruce lumber normally is also comparatively stable. Demand for airplane material generated by war conditions accelerated production of Sitka spruce which, however, would probably have been much higher if supply of suitable raw material had been greater. Production of spruce in 1942 exceeded predepression levels.

Wood Pulp Manufacture

The problem of supplying the pulp industry is relatively clear cut in this unit. The unit's one pulp mill has a daily capacity (24-hour basis) of 270 tons of wood pulp. During the early days of operation this mill purchased practically all of its wood requirements in the form of mill waste. When production of western hemlock lumber declined during the depression, this source of supply became unreliable and a shift was made to forest wood (cordwood cut in the woods). When wages were low and employment was scarce, forest wood was forthcoming at a price the mill could pay but this source also proved inadequate and unreliable. Consequently, equipment for "breaking down" logs was installed and since then logs have supplied almost the entire requirements of the plant, though forest wood is still purchased when offered. During 1941 this industry used approximately 100 to 110 million feet of logs, practically all western hemlock.

Plywood and Veneer Manufacture

The problem of supplying this thriving industry with raw material is complex. In reality two industries are involved, of which the manufacture of plywood is by far the most important. The unit has four plywood plants which in 1939 (the last year for which figures are available) used 117 million feet of logs and produced 254 million square feet of plywood (3/8-inch basis) practically all Douglas-fir. A large part of the requirements of this industry are for high grade Douglas-fir old growth, so-called peeler logs. The industry like the pulp industry has relied on the open log market or other loggers to supply the raw material. Recently, plywood concerns have been active obtaining affiliations with logging operators. Little if any standing timber is owned by this industry locally. It has had to draw on other territory for part of its raw material, some coming from as far away as the Willamette Valley and Tillamook County on the Oregon Coast. Fortunately, it has been able to pay a price that will attract logs from distant points. The unit has two fruit and vegetable container plants which used 13 million feet of logs during 1939 to produce 90 million square feet of veneer, practically all Sitka spruce obtained within the unit.

Shingle Manufacture

The last of the log-using industries is the redcedar shingle industry which used 77 million feet of logs during 1941 in the manufacture of nearly a million squares of shingles. This unit is one of the large shingle-producing sections of the region.

The Situation as a Whole

Combining the demands of all forest industries for raw material by species reveals the critical nature of the problem. Approximately two-thirds of the volume of current demand is for Douglas-fir. A large percentage of the Douglas-fir demand is for high quality logs which means they must be cut from old-growth trees. In recent years a portion of this demand has been filled by importing logs from outside the unit, chiefly "peeler" logs to keep the lathes of the plywood factories turning. During 1941 and 1942 the unit produced a total of 921 million board feet, log scale, of Douglas-fir sawlogs. Table 6 shows the total stand of Douglas-fir on unreserved lands to be 4,765 million feet of old growth and 994 million feet of second growth. If all this were immediately available, which it is not, production at this rate could be sustained for another decade starting with 1943; during this period the accumulated growth would not be sufficient to make another year's supply. However, over a billion feet of the Douglas-fir is on the national forests and will be cut on a sustained-yield program prolonging the life of this part of the supply but making a corresponding reduction in the volume of immediate production. The owners of the remaining private Douglas-fir stumpage may endeavor to prolong the supply for their own consumption. This leads to the conclusion that lumber production probably will decline in the near future unless other sources of log supply can be found.

The possibilities of increasing production of cedar and spruce lumber are restricted. Normally the demand is not strong enough to warrant expanded production and the supply of raw material is not plentiful enough to support any marked increase in production. Most of the demand for spruce lumber is for high quality material and it is becoming exceedingly difficult to find timber suitable for production of the upper grades. In addition to lumber, Sitka spruce is used for the manufacture of basket veneers which requires high grade logs. If anything, production of spruce lumber may be expected to decrease, not increase, over the next few decades. Possibilities of alleviating the situation by increasing the production of cedar lumber likewise may be dismissed as equally unpromising. The situation with respect to western hemlock is different to the extent that apparently the stumpage supply is ample to support the current rate of lumber production indefinitely.

Other problems arise in diverting a greater portion of total lumber production to western hemlock. As previously pointed out, the lumber markets lost by hemlock during the depression have never been fully regained. This condition was not limited to the Grays Harbor unit although other hemlock-producing units did not suffer as severely. This may be explained by the assertion frequently made that lumber produced from coast hemlock is inferior to that produced from trees growing at higher elevations. Other factors may also be responsible for failure to produce more hemlock lumber. The bulk of the hemlock logs produced in the unit is used for manufacture of wood pulp. The present inventory of western hemlock is large enough to supply current demands indefinitely. As a matter of fact, current growth exceeds current cutting drain in western hemlock forests. The problem of industrial supplies of raw material in the unit resolves itself to the question of using the material on hand, western hemlock, to replace the scarce species, Douglas-fir and Sitka spruce.

Proposed expansion of western hemlock use must consider the possible effect on the cost of logs involved in the shift from logging mixed Douglas-fir, Sitka spruce, and western hemlock stands to logging stands predominantly or pure western hemlock. In the past, the higher prices paid Douglas-fir and spruce logs have permitted the recovery of associated hemlock logs that would pay the bare costs of logging. The straight hemlock operations must then produce logs cheaper or obtain higher prices than have prevailed in the past.

A sufficient supply of cedar stumpage is available to maintain the shingle industry for several decades.

Utilization of Waste as a Raw Material

The possibilities of waste wood utilization as a raw material for existing or new industries merits attention. This field is now expanding rapidly, and is probably only in its infancy. Of immediate interest is the profitable use of waste from sawmills--sawdust, slab, and such materials.

In surveys recently conducted by the Forest Experiment Station it was found in west side sawmills an average of 7/8 of a ton, dry weight, of wood waste accumulates from the cutting of 1 M board feet of lumber. Thus a sawmill cutting 100 M board feet per day would have available about 87 tons of wood waste per day. These surveys further showed that an average of about 30 percent of this waste was used at the mills to generate steam, about 27 percent was sold for industrial or domestic fuel, and about 43 percent could be considered as actual waste because it was unused and was destroyed in the burners. The mills surveyed were distant from any large metropolitan centers, hence the market for industrial and domestic fuel was considerably less than in a number of other localities. The percentages quoted are therefore not universally applicable, but they indicate that in many localities not close to large centers of population there may be available for whatever utilization modern technology can make of it as much as 700-800 pounds, dry weight, of wood per 1,000 board feet of lumber cut.

The profitable uses to which this sort of wood material can be put fall into three general categories--additional fuel, pulping material, and raw chemical material. Its use as fuel might be of special value to certain localities because it might make possible the existence of other industries to which a local source of fuel would be necessary. At the present time a much higher proportion of the mill waste than the above percentages indicate is being sold for fuel to the local mills on Grays Harbor. Should this local fuel supply be indispensable to these pulp mills its use for this purpose might be the most advantageous in relation to the local economy. In the Willapa Bay vicinity, on the other hand, considerably more waste is being produced than is being used or sold. Any new use for this material would be of distinct economic gain to the community.

At one time, hemlock mill waste was used in Grays Harbor for pulp but this source became undependable when production of hemlock lumber declined to a small volume. Should hemlock lumber manufacture again increase, mill waste might again be used for pulp. Research may find ways to use waste from other species for pulping. A real possibility is the use of waste sulphite liquor for manufacture of industrial alcohol. Plans have been approved for the establishment of such a plant at Bellingham.

In the light of recent developments, it seems reasonable to assume that the chemical utilization of wood will undergo far-reaching development in the near future. Mill waste is an excellent form of wood material for this purpose because its cost is low. Because it is necessarily transported from the woods to the mill in log form, the cost of its transportation is normally borne by the lumber. Where it must be disposed of as waste, by burning, it constitutes an added item of expense in mill operation. It can be hogged or chipped readily for economical transportation to chemical plants.

The most immediate possibilities of chemical wood utilization lie in the fields of wood hydrolysis and wood carbonization. Wood hydrolysis

results in the formation of sugar from the cellulose constituent in the wood. The sugar, formed in solution, can be fermented to alcohol, or to grow yeast, rich in protein and valuable as a food for livestock. As a result of a critical demand for alcohol for war use, at least one wood hydrolysis plant, to manufacture alcohol, will be erected in the Douglas-fir region in the near future. Manufacture of fodder yeast has not yet reached the stage of industrial practice. In wood hydrolysis the lignin constituent of wood is not converted to sugar and is available for other use. It is technically possible to develop products of considerable value from this lignin.

The present demand by the metallurgical industries of the region for suitable forms of carbon may develop a profitable wood carbonization industry. Wood carbonization by modern retort methods results in a high grade charcoal, and gas, pyroligneous acid, and wood tar as byproducts. The development of this industry may depend upon the permanence of the metallurgical industries, and the development of other products from the wood tar.

In considering the establishment of chemical wood utilization plants it must be remembered that in most cases chemical plants are costly to construct, and must be assured of an adequate supply of wood over a sufficiently long period to retire the investment and show a profit. An alcohol plant manufacturing 5 million gallons of alcohol annually would require 120,000 units (200 cubic feet) of sawmill waste a year for alcohol manufacture and plant use. An annual lumber production of from 175 to 200 million feet would be required to supply a plant of such size, assuming that the sawmills used 30 percent of the waste accumulating for generation of power and plant steam and assuming that no waste was sold for other uses. The erection of such a plant would be justified only in locations where a supply of timber was known to be available for a long period, and would be best justified where a sustained-yield woods operation supplied the logs to support both the sawmills and alcohol plant.

Markets for Forest Products

Lumber produced in the Grays Harbor unit is shipped chiefly to California and Atlantic markets by vessel during peacetime. Rail shipments have increased recently, however, owing to shortage of vessels and other war induced conditions, causing some shifts in markets. Eastern rail markets are ordinarily beyond reach for most lumber items produced here owing to the high freight cost. Middle western markets and intervening areas are accessible to west coast lumber although many of the Grays Harbor mills are not properly equipped with drying facilities to enter this market normally on a large scale. Local demand, as a result of war construction, has increased recently offsetting adverse market developments. In normal times a considerable lumber volume is exported from this unit to many parts of the world; this trade is now virtually at a standstill.

A part of the output of the wood pulp plant in the unit supplies the paper mill that operates in conjunction with it. The remainder is shipped to other plants where it is used chiefly for rayon manufacture.

Plywood manufactured in the unit is marketed in many parts of the country and is filling an expanding number of uses. Cedar shingles and other forest products of the unit are likewise widely marketed throughout this country.

RESOURCE MANAGEMENT

The Status of Forest Management

Things happen on a large scale in the Grays Harbor unit. Logging and lumber manufacture almost from the very beginning were large scale. Vast areas were cut over and much of it was logged so completely that chances for satisfactory natural restocking were poor. A neglectful attitude towards protection of cut-over lands against fire resulted in repeated burning of large areas. Consequently, the unit has extensive areas of nonrestocked forest land. On the other side of the ledger several significant occurrences in the past few years foretell a reversal of resource management policies prevailing in the past. The first positive action was the adoption by the Washington Department of Conservation and Development, Division of Forestry, of a policy of acquiring and rehabilitating cut-over and other forest lands from the private owners and counties. Since this program was initiated in 1935, the State has acquired about 24,000 acres direct from private owners and 16,000 acres from the county in the Grays Harbor unit. Of this total, 4,957 acres has been artificially reforested with stock from the State nursery. A large part of this area has been formed into the Capitol State Forest in eastern Grays Harbor County, the site of the nursery, which has an annual capacity of 5 million seedlings.

Of more recent occurrence but equally significant is the rapid development by private operators of Tree Farms in the past three years. Most of the lands included are of excellent site quality and with the intensive protection now being given them, high yields are expected. Other instances of the awakened interest in the productive capacity of the forest resources have been observed.

Cutting methods currently practiced in the unit vary widely. Large operators generally clear cut and during favorable markets such as now prevail utilize merchantable material very closely. Partial cutting of various degrees of removal and care for the residual forest is taking place. One company has experimented with the selective cutting of second-growth hemlock stands using approved forestry methods. Unfortunately, other cutting of second growth is taking place that is destructive of the forest and site. Cutting of second growth to diameter limits as low as 14" to 16" was observed. Many cases of removal of high-quality spruce, Douglas-fir, and western redcedar from mixed forests occur. This practice designed to bring highest immediate returns even at sacrifice of future values usually results in the leaving of low-grade forests and heavy fire hazard.

Fire protection generally has progressed considerably during recent years. Instability of forest land ownership is one of the impediments

to complete protection. Other factors retarding improved fire protection are apathetic public attitude and the long nonrevenue producing period between harvests of forest lands under liquidation management.

Forest Land Tenure

The importance of landownership in the forest situation has been indicated previously. The manner in which the public domain was disposed of, the character and extent of the private holdings created from the public domain, and the dispersion of residual public holdings among State and Federal agencies have exerted strong influence on forest resource management and on the fabric of economic development founded upon this source of industrial raw material throughout the unit's entire history. Exploitation has been largely opportunistic and not until recent years has any course even resembling a continuing policy of forest land management been evident except for the Federally owned and managed lands. Ownership has been in a constant state of flux and lands are constantly shifting from one ownership to another.

The Reversion of Forest Land to Public Ownership

The reversion of forest land to public ownership through tax forfeiture has been a persistent and pressing problem in forest regions where large areas of cut-over land accumulate rapidly. In the Grays Harbor unit, the situation is acute and despite moratoria on tax foreclosures, arrangements for delayed and installment payment of delinquent taxes, aggressive policies of disposing of foreclosed land, and other measures, a large area of forest land has passed to the county and a larger area suffers from chronic delinquency. Table 18 gives the tax delinquency data as of January 1, 1941. It shows not only the extent and degree of delinquency but also the type of land that is becoming delinquent. A total of 197,765 acres was tax forfeited not including land which was forfeited and subsequently resold to private parties. It does include 18,735 acres which are being sold under contract of sale. A total of 16,230 acres forfeited to the county was later transferred to the State or Federal Government. The area tax delinquent was 282,880 acres; delinquent taxes were being paid under agreement on 157,795 acres of this total. The total area of tax-forfeited and private lands is 1,419,130 acres, the area of private lands not tax delinquent is 938,485 acres or 66 percent of the total, and the total tax delinquent and forfeited lands is 480,645 acres or 34 percent of the total.

The deforested lands and the lands supporting second-growth stands are the most heavily involved in delinquency. However, nearly 80 thousand acres of saw timber was either tax delinquent or had been forfeited. Much of this land had been cut over selectively and the high-value trees removed leaving a second-rate forest of saw-timber size. Figure 7 shows the percent of each cover class in the various stages and conditions of delinquency or forfeiture, and percent of each tax delinquency and forfeiture status class in the various cover classes as well as the acreage in each of these various conditions of delinquency and cover.

Table 18.--Area of tax forfeited lands and of lands delinquent and not delinquent for taxes levied in 1939 and prior years for a portion of the Grays Harbor unit^{1/} by generalized cover type, as of January 1, 1941

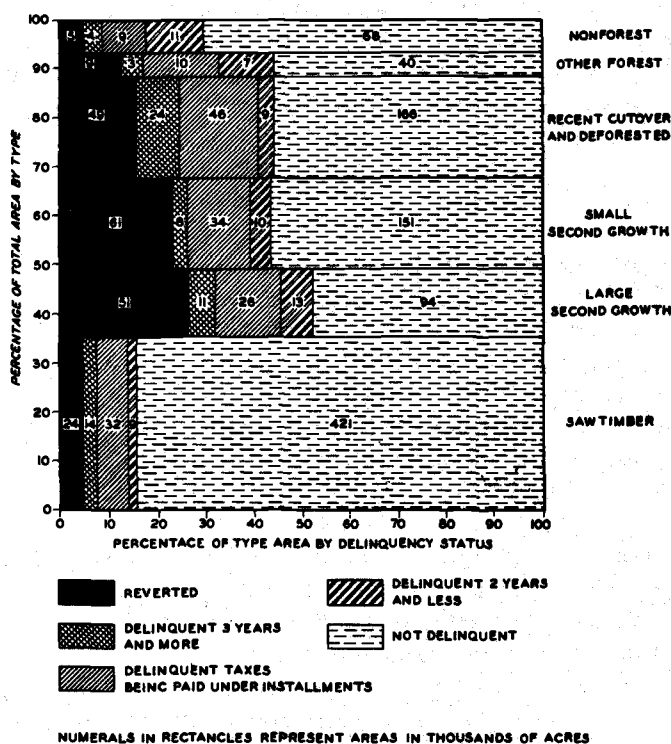
Tax delinquency status	Total	Generalized cover type							
		Commercial conifer					Noncommercial conifer	Hard-wood	Non-forest
		Total	Saw timber	Second growth		Cut-over & burned			
acres	acres	acres	Large	Small	acres	acres	acres	acres	
Tax forfeited land									
County owned not under contract of sale	162,800	152,230	18,660	42,935	51,525	39,110	2,710	4,300	3,560
County owned under contract of sale	18,735	16,550	3,365	7,185	2,970	3,030	705	615	865
County owned transferred to state	15,695	14,985	1,075	1,280	6,260	6,370	-	480	230
County owned transferred to U.S.	535	415	415	-	-	-	120	-	-
Total	197,765	184,180	23,515	51,400	60,755	48,510	3,535	5,395	4,655
Lands delinquent for taxes levied									
1937 and prior years	64,565	57,355	14,475	10,670	7,775	24,435	540	2,590	4,080
1938	16,300	11,445	2,785	2,820	2,295	3,545	340	2,455	2,060
1939	44,220	29,885	6,650	10,090	7,480	5,665	940	3,890	9,505
Delinquent taxes being paid under agreement	157,795	138,660	32,250	26,295	34,060	46,055	2,505	8,065	8,565
Total	282,880	237,345	56,160	49,875	51,610	79,700	4,325	17,000	24,210
Total tax forfeited and delinquent	480,645	421,525	79,675	101,275	112,365	128,210	7,860	22,395	28,865
Private lands not tax delinquent	938,485	831,145	420,570	94,190	150,930	165,455	4,580	34,475	68,285
Total all lands	1,419,130	1,252,670	500,245	195,465	263,295	293,665	12,440	56,870	97,150

^{1/} Does not include platted subdivisions, incorporated places, and certain other small areas. The total of these exclusions is comparatively small and has little forest land.

Trends in Tax Delinquency and Tax Forfeiture

The trends in tax delinquency and tax forfeiture have great significance in forest land ownership studies. In 1933, at the time of the original forest inventory, total area of county-owned lands in the Grays Harbor unit was but 13,300 acres; within eight years it had increased twelve-fold to 181,535 acres. An additional 16,230 acres had been foreclosed and transferred to the State or Federal Governments. Records of tax delinquency covering that period are not available for the unit as a whole; however, records taken in 1932 for Grays Harbor County alone afford a basis of comparison. As of August 1932, a total of 252,336 acres was tax delinquent in this county, of which 131,251 acres was involved in long-term delinquency (2 years or more delinquent) and 121,085 acres was involved in short-term delinquency (less than 2 years delinquent).^{7/} As of January 1, 1941, a total of 200,545 acres was tax delinquent, of which 170,790 acres was involved in long-term delinquency and 29,755 acres was involved in short-term delinquency. However, delinquent taxes were being paid upon 118,720 acres of the area involved in long-term delinquency under written tax agreements whereby interest and penalties were legally reduced and the period of delinquency extended far beyond the statutory limitation. The cover composition of county-owned and tax-delinquent private lands has not altered significantly between the two periods. In 1932 a greater percentage of the total area county owned and tax delin-

FIGURE 7
TAX REVERSION AND DELINQUENCY BY GENERALIZED COVER TYPES
GRAYS HARBOR UNIT, AS OF JAN. 1, 1941



quent was nonrestocked cut-over and recent cut-over lands than in 1941; this is accounted for by the restocking of these lands during this period and the decline in area of lands being cut each year. A smaller percentage of the 1941 total was in saw-timber size types than in 1932, a reflection of the improved market condition for operating properties.

The reason for the apparent decline in delinquency between the two periods is found in the great increase in county-owned lands; prior to

^{7/} Wilson, S. A. Comparative tax delinquency and reversion in selected counties of the Douglas-fir region, 1932-33 and 1940-41. 7 pp. Pacific Northwest Forest & Range Exp. Sta. Processed. June 1942.

1932 there had been little foreclosure, since then a more aggressive policy of foreclosing lands which have reached that stage of delinquency has been followed by county authorities.

During the past two years, 1942 and 1943, the flow of lands from private ownership to county through tax delinquency and foreclosure has been arrested and reversed. A considerable area, chiefly cut-over lands, has been acquired by large companies interested in tree farms. Speculative purchases have undoubtedly also been made and instances have been reported of exceptionally high prices being paid for lands considered not worth the payment of taxes a few years ago.

Byproducts of a Stable Forest Resource

Under a liquidating forest economy, in which the entire forest cover which has grown over several centuries is virtually removed in several decades to feed sawmills, pulp mills, and other wood-using plants, the other services and products the forest renders are dwarfed. Under a sustained yield forest economy, greater consideration is given these factors. At present these forest uses do not directly add much to the tangible income in this unit.

Byproducts

Chief among the byproducts of the forest is cascara bark, useful for its medicinal properties. The production of this commodity varies considerably from year to year, depending upon the price of bark and availability of more lucrative employment. Most of the bark is produced by small farmers and individuals ordinarily unemployable in the major industries. In 1940 total production of cascara bark in the unit was 340 tons. At a price of 8 cents a pound to the harvester, this makes an annual return of about \$55,000 to the unit.

Several attempts have been made to produce cedar leaf oil from twigs and leaves of western redcedar in this region during the past decade. The technology of the distillation process has been developed to the extent that oil could be successfully produced commercially, 100 pounds of raw material yielding one pound of oil. Owing to the low price of the crude oil, however, the industry was short lived. The weak stage in the production was the cost of transporting raw material to a central plant. Those familiar with the industry feel that, to be successful, portable plants would have to be used which could be set up in the vicinity of a plentiful supply of raw material.

War conditions, which have endangered foreign sources of tannin extract, have focused attention on other materials of which hemlock bark is one. Preliminary surveys have been made to determine feasibility of such an industry in this region.

Other Forest Uses

Watershed protection and recreation are acknowledged functions of the forest. Each of the large municipalities in the unit possesses a

forest watershed--Aberdeen, Hoquiam, Raymond, Montesano, and South Bend. Local residents use the forest in large numbers for recreation, including picnicking, camping, hunting, and fishing. Certain areas in the unit, notably the Olympic National Park and Quinault Lake, draw visitors from all sections of the country.

THE FOREST PROBLEM

Out of the mass of statistical and analytical material which describes the forest situation in the Grays Harbor unit, it is not possible to pick out any one fact or condition that can be truthfully said to epitomize the problem. The situation cannot be resolved that simply; it has many aspects and consequently many problems, but it is possible to sort and catalogue these problems under a few interrelated heads.

The Problem of Maintaining Forest Lands Continuously Productive

Maintaining forest lands continuously productive can be considered as an end in itself. Our concepts of future value are too limited to permit the justification of failure to provide that forest lands should be regenerated after cutting on the grounds that it is uneconomic or unprofitable to grow trees for commercial utilization except under very favorable circumstances. Such reasoning is predicated on calculations that involve the compounding of interest charges and accumulating of carrying charges. A broader basis of reasoning is available; namely, that forests always will be useful for many purposes and it would be totally uneconomic to allow forest lands to become nonproductive even for limited periods, particularly when productivity can be maintained by expenditure of reasonable care during the harvest period and exercise of reasonable protection efforts for relatively short periods thereafter. The relative shortness of the time timberlands are held by private owners prior to harvesting--usually it has not been more than 5 to 10 percent of the life of the forests cut over in this unit--places considerable responsibility on the operating owner to make every effort to leave the land productive. Practically without exception forests cut over in this unit were acquired in the old-growth state and were not held with any idea of growing timber but were acquired and held solely for the purpose of liquidating the timber values or for speculation. Any loss incurred through holding old-growth timber may be charged either to poor judgment or to speculative risks naturally associated with opportunities for large profits. If pre-emption had not taken place when and as it did, it is probable that liquidation of the old-growth timber would have been more orderly.

The Problem of Putting Lands to Highest Use

There is no disputing the basic tenet of land use; that is, lands should be used to render the greatest benefits to society. Within this general framework, distinctions must be made. Generally, it may be said that the long-term use should prevail over the short-term use when the two conflict. This distinction is implied in use of the term "society" which refers to the group or mass of the population, past, present, and

future, and not to the immediate individual. In the Grays Harbor unit the predominant uses of land are agriculture and forestry, and it is between these two that conflicts are inevitable. The area of soil and topography physically suitable for successful agriculture is limited and already has been largely converted to that use. Agricultural experts^{8/} recommend the clearing and drainage of nearly 100,000 acres of additional cropland, mostly located in the river valleys. If done, it would probably not decrease production of forest crops to any material extent as much of the land involved is now in farm ownership. The presence of large areas of clear-cut forest land apparently offers the opportunity of extension of agriculture; however, experience shows that agriculture usually fails on these lands. Appearance after logging of grasses, herbs, and shrubs on cut-over land suggests the possibility of grazing such lands at least for a few years. Other factors intervene to prevent widespread use of this temporary vegetation and grazing of cut-over lands is not widely practiced here. New or untried uses of lands should not be attempted without a detailed land classification. At present the problem is not acute and the sporadic attempts at converting strictly forest land to other uses are of the type that could only be controlled by rigid zoning.

The Problem of Achieving a Balanced Economy

The difficulties of achieving a balanced economy are particularly critical in a territory such as the Grays Harbor unit where extractive industries form the economic basis and where these chiefly center around a single natural resource which is exhaustible, the forests. Since the bulk of the products of the forest industries does not proceed beyond the primary stages of manufacture before shipment and since forests are replenishable, the economy can be expanded horizontally and vertically. Contraction of log production, however, is necessary in some cases to extend the life of the resource until it can be put on a self-sustaining basis. This need not necessarily result in a loss of employment and income if the degree of manufacture is increased.

A balanced industrial economy could be erected on the basis of a sole natural resource, the forests, if full advantage were taken of the manifold physical and chemical properties of wood. A "lumber economy," that is, the manufacture of lumber only and that in a comparatively crude stage, not only deprives the forest-producing area of labor opportunities and manufacturing income but is also subject to market vagaries of one commodity. This leads to an unstable condition. Manufacture of pulp, paper, and plywood in addition to lumber is a start in the direction of a balanced economy. Development of further wood fabrication plants would be a second step. A next step would be the manufacture of chemical derivatives such as alcohol, yeasts, and carbonized products from woods and mill waste. It is conceivable that such industries might become primary ones using logs as raw material. Research is constantly finding new uses for wood, and other industries may develop which would help balance the economy.

^{8/} National Resources Planning Board. Development of resources and of economic opportunity in the Pacific Northwest. 178 pp. illus. 1942. Washington, D. C.

Although new industries must be mainly forest industries using as raw material species or wood material not now used, we can expect that if forest industries are diversified and stabilized, other industrial expansion will follow. Business enterprises and industries are unlikely to establish themselves in communities whose future existence is uncertain, and markets, taxes, and other business considerations are unpredictable, but if forest industries are on a permanent basis the conditions change.

The Problem of Supplying Industry with Raw Material

This problem is one of maintaining the flow of raw materials and involves organizing industry to use the material available at a rate that can be sustained. It has been pointed out previously that raw material shortages apply to certain tree species and not to others. This problem may then be restated as also one of supplying a segment of the raw resource with industries. It is begging the question to assert that when the Douglas-fir, Sitka spruce, and western redcedar forests are exhausted, the sawmills and plywood factories will turn to western hemlock and balsam fir. Such reasoning is founded on historical precedent; in eastern forest regions progressive utilization of poorer tree species was nearly completed with the first industrial cycle. Applying this reasoning to the Douglas-fir region overlooks the differences in distance to consuming markets and the resurgence of eastern forest regions in supplying eastern markets.

It may be that only the choice grades and items of western hemlock and balsam fir lumber could compete in future markets on an equal basis with other species. If marketability of these species must depend upon a price differential, they might better be used for uses for which they are eminently suited such as pulp manufacture.

Grays Harbor industries have called upon other parts of the region to supply high grade logs in the past. It is problematical how long this practice can be continued. At the least, it is a precarious basis for future operations. As cutting progresses southward, the distance which logs must be transported to Grays Harbor increases and costs rise.

The Problem of Supplying Stable Employment and Adequate Living Standards to Local Populations

This problem is a corollary of those previously discussed and their solution will contribute greatly to the solution of this problem. Obviously, irregularity and instability of industry is going to result in unemployment and consequently lowered standards of living. Conversely, if sustained yield is established and if a balanced industrial economy is achieved, labor will benefit greatly. Work will be more regular, jobs more secure, and working conditions in general will be improved. In the long run, this will benefit labor and management both.

A PROGRAM

The presentation of a program should be something more than the mere listing of a number of things that everyone agrees should be done; it should suggest practical ways that these objectives can be reached.

Forest Management

Satisfactory forest management practices are fundamental measures in a program to obtain the maximum public benefits from the natural resources of the Grays Harbor unit.

Forest Protection

Protection against the natural enemies of the forest--fire, insects, and disease--is given first place because lack of it has proven to be the cause of failure of forest lands to regenerate and because it has been the chief stumbling block to instituting other forest practices. Fire protection is the big problem and it must be maintained continuously. Epidemic insect attacks may occur at any time in the hemlock and spruce forests, but control measures cannot be applied in advance. It is not unreasonable to assume that under managed cutting practices, losses from such epidemics can be reduced to a minimum and that losses from disease also will be reduced greatly.

Installation of intensive fire protection on the Tree Farms indicates that adequate protection of private lands, including cut-over areas, can be obtained when ownership is strong. Evidently the crux of the fire protection problem is stabilized ownership. Stabilized ownership of private cut-over lands usually implies plans for sustained-yield operation. Otherwise there would be no incentive for holding such lands. The extent of tax delinquency and tax forfeiture adds to the fire control problem. As the timber values are removed from forest land it becomes increasingly difficult to maintain the road system which is necessary for adequate fire protection. Judging from expenditures in selected areas, such as the Clemons Tree Farm, considerably more will have to be spent in remaining areas. A program for adequate fire protection would involve substantially increasing the annual charges for this function. In view of the reluctance of many owners to pay charges now assessed, this might lead to increased allotment of public funds. The expansion of the tree farm program, on the other hand, means betterment of protection and increased private expenditures. As a first objective, protection that would keep losses to less than 1/4 of 1% per year should be given all forest lands.

Logging Practice

Modification of logging practices formerly used is essential to establishment of new forests. Some progress in this direction has been noted in the Grays Harbor unit; more is needed. Selective cutting, using approved methods, is being tried experimentally in second-growth spruce and hemlock forests in the unit. At the same time, many second-growth

stands have been butchered to obtain immediate values; such forms of partial cutting must be curbed. On the other hand, improvement cutting of second-growth stands should be encouraged. Clear cutting of large continuous areas, which has left much nonstocked and poorly stocked land, will probably not take place in the future, if for no other reason, because of lack of opportunity. If clear cutting can be restricted to comparatively small areas, regeneration will not be handicapped.

It is generally recognized that some form of public regulation of forest practices on private lands is necessary. There is controversy over the form that this should take. It must be made effective if the full measure of benefit is to be obtained from the forest resource.

Rehabilitation of Underproducing and Nonproducing Areas

Full forest productivity will not be achieved in this unit until the several hundred thousand acres of nonstocked and understocked lands are restored to a satisfactory stocking. Evidence shows that natural restocking will not fill the gaps short of generations. This means that planting will have to be used. A planting program of this magnitude probably will have to be handled cooperatively by private and public agencies. A notable start has been made by the State through planting on the Capitol State Forest. The bulk of the lands in need of planting is now privately owned. The industry's Tree Farm Program is a promising start but other action is inevitable if the tremendous job is to be completed. Public participation may take place as a postwar measure to alleviate economic dislocation resulting from cessation of war industries and demobilization of armed forces; it may result through transfer of ownership from private to public agencies, either through tax forfeiture or outright acquisition, or other means may be taken to make sure that the job is done.

Timber Budgeting

When timber budgets are considered, a conflict of interests develops. The growth of industries in the unit has been unsystematic as far as the group is concerned. Each enterprise has considered only its own raw material needs and those only for a liquidating period. It can be asserted safely that not a single sawmill in this unit was constructed with the idea of operating permanently. As a result, industrial capacity has been developed far in excess of forest producing capacity. It is inevitable that contraction must come and this has commenced already. Timber budgets must be directed towards smoothing these dislocations as well as bringing raw material supply and demand together at the optimum level.

Where a number of concerns are operating, some sort of coordinated direction or control is needed to keep cutting within the budget. This problem may be partially solved when the Cooperative Sustained-Yield Act, recently passed by Congress, becomes effective. However, much of the unit's forest area is far removed from Federal holdings and would probably be outside the limits of cooperative sustained-yield units that

might be established under such a law. The State of Washington owns a substantial quantity of timber in the remainder of the unit which might be used to form other sustained-yield units. At the present, no other means of controlling the volume of cutting appears feasible except possibly voluntary and independent action by the several timber owners.

The Allowable Cut Under Sustained Yield

Commencing with 1941 the allowable annual cut under sustained yield is summarized in table 19 by ownership class and forest type group. In preparing these estimates, it was assumed that existing mature timber would be utilized to the standard of measure anticipated by the forest survey inventory, i.e., trees 16 inches d.b.h. and larger. It was also assumed that as cutting shifts to second growth, the standard of utilization will be trees 12 inches and more in d.b.h. scaled in 16-foot logs to an 8-inch top. A rotation of 100 years was assumed for the second growth.

Table 19.--Annual cut allowable of unreserved forest lands under sustained yield management, commencing 1941 in the Grays Harbor Unit

Ownership	Forest type group		
	Douglas-fir and cedar	Spruce-hemlock and upper slope	Total
	Million bd. ft.	Million bd. ft.	Million bd. ft.
National forest	18.0	62.0	80.0
Other	188.0	538.0	726.0
Total	206.0	600.0	806.0

Adoption of a program at this time that would limit cut to the precise amounts and species shown in table 19 is extremely unlikely. It would involve heavy immediate sacrifice, although over a long period this would be recompensed. Postponement of the adoption of a program leading to sustained yield means that allowable cuts will probably have to be reduced later. Three-fourths of the allowable cut would have to come from the spruce-hemlock and upper-slope types whereas more than two-thirds of the 1940 log production was obtained from the Douglas-fir and cedar types. The problem in this unit is chiefly one of shifting from Douglas-fir to western hemlock as a source of raw material for forest industries. If this can be accomplished, current levels of gross production can be maintained.

Anticipated Volume of Future Cutting

A realistic appraisal of the situation leads to the opinion that, short of governmental action, a sustained-yield program as outlined above will not be adopted. If this be true, what will happen? Considering location, character, and ownership of existing timber stands, estimates

of future cutting on a realistic basis were made for the next two decades. In making these estimates, it was assumed that the economics of the forest industries would not deviate radically from patterns of past performance; however, allowance was made for gradual trends towards closer utilization and substitution of other species for Douglas-fir. Estimated future depletion, recent saw timber cut, and allowable annual cut for legally available lands are shown in figure 8. Estimated future depletion is less than both recent cut and allowable cut if all species are considered. This condition would be forced by lack of Douglas-fir and cedar stumpage.

* Industrial Practice

More Complete Utilization of Forest Resources

The greatest opportunity for more fully utilizing forests of this unit probably lies in expanding use of the pulp species. No great change in the industrial situation can be accomplished by increased utilization of the hardwoods or such conifers as western white pine and Alaska yellow-cedar; the quantities involved are too small.

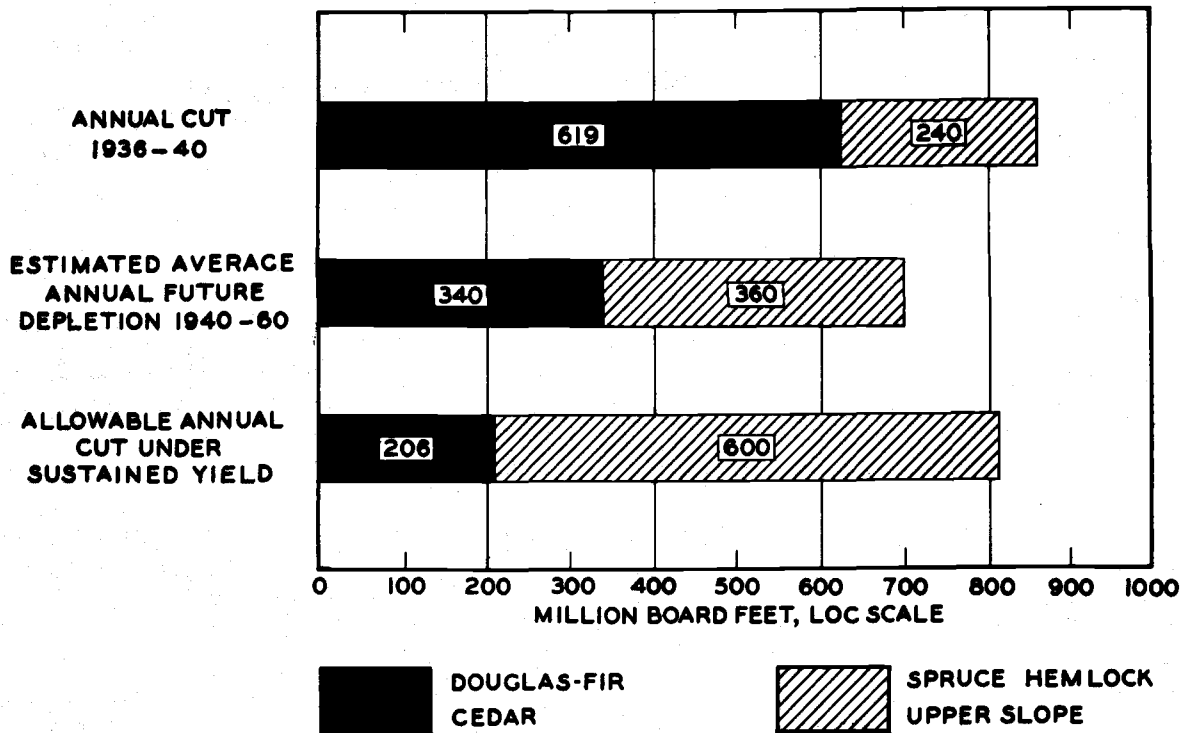
Specifically, it is through the increased use of western hemlock and Pacific silver fir that greatest opportunities for industrial development exist in this unit. The use of these species could be more than doubled without impairment of the raw-material supply. Apparently there are four ways hemlock and silver fir use can be increased: (1) greater use of these species in lumber manufacture, (2) expansion of the wood pulp industry, (3) use of hemlock in plywood manufacture, and (4) development of new industries such as chemical industries that would capitalize on the outstanding growth potentialities of western hemlock forests under short rotations.

Waste Utilization

The amount of cubic wood volume that is wasted in woods and mill is tremendous when related to the cubic volume of the finished product. It also varies from time to time depending upon many factors, chiefly economic. Many uses of wood waste are known, their employment being governed by cost of manufacture and marketing problems. A large percentage of the waste occurs in the woods and consists primarily of parts of the tree felled but left behind. When log prices are low, many rough, knotty, and small logs are unused; when prices are high, these may be used. The great variation in the size and quality of the trees in the virgin forest is partly responsible. Transfer of operation to second-growth stands on a sustained-yield basis should bring greater uniformity to this waste factor as well as diminishing the relative volume of waste.

In the mill, waste consists of sawdust, small pieces of wood, and bark. If manufacture of hemlock lumber can be established on a stable basis, hemlock waste wood could be used in pulp manufacture.

FIGURE 8
AVERAGE ANNUAL CUT 1936-40, ESTIMATED FUTURE DEPLETION
AND ALLOWABLE CUT UNDER SUSTAINED YIELD



Industrial research in wood utilization has been expanded both nationally and locally. War demands frequently stimulate the finding of new uses of native materials. The Grays Harbor unit will participate in the benefit of such developments. Prospects for finding commercial uses of hemlock bark are encouraging. Previous research has found methods of extracting tannin from hemlock bark. If bark can be removed cheaply and concentrated in sufficient quantities, extraction of tannin can be done commercially. Other uses for bark of all species are being sought by research workers.

The possibilities of manufacturing industrial alcohol, high proteids for stock feed, plastics, and other chemical products from waste wood are encouraging. What is needed now is the trial, at least on a pilot plant basis, of some of the known industrial processes.

Increased Local Remanufacture

The shipping of lumber and, to a lesser degree, other forest products to other sections of the country for further manufacture is a common practice. If more remanufacturing can be done locally, it will result in more efficient use of raw materials, more employment for labor,

and more stable industries. Lack of contact between lumber manufacturers and secondary or ultimate consumers of their products resulting from marketing through middlemen is probably retarding the development of refined manufacture and remanufacture by the mill operator. The migratory or transitory character of sawmills has also discouraged the growth of remanufacturing. There is good reason to believe that, with establishment of sustained yield, further refinement of manufacture will be more easily established.

Economic Measures

Constantly throughout this report the obstacle to forest measures has been described as economic. Often solution of these economic problems is beyond local action. Within the realm of local action there are certain measures that can be taken.

Stabilization of Forest Land Ownership

Policies of county governments and other local taxing bodies can contribute greatly to stabilization of forest land ownership. Elsewhere in this report the extent of county-owned and tax-delinquent lands has been shown. If these lands can be brought under some sort of organized management, great progress will result. Disposal policies should be directed towards placing the lands in stable ownership. Careful exercise of the taxing function and efficient administration of tax laws can ameliorate forest land delinquency and reversion.

Reorganization of Local Government

Any economies that can be effected in local government add to stability of landownership. Many local government units and functions were organized for previous modes of transportation and for populations that have been reduced. The problem of reorganizing local government units to fit existing needs should be attacked without delay.

Legislative Action

Measures Requiring State Action

Perennially legislation has been proposed that would change or modify the property tax laws as applied to forest land. To date the only special tax law that has been enacted is one (1931) that removes from the ordinary operation of the property tax certain cut-over and burned-over lands suitable for reforestation and not containing timber in merchantable quantities. Lands classified under this law pay a small annual land tax and a yield tax on timber products cut. What is needed now is a special forest tax law that would equalize the tax burden on deferred-income forest properties with that imposed on properties yielding a regular annual income.

Measures Requiring National Action

The report of the Joint Committee on Forestry, Congress of the United States, published in 1941, proposes a program which would establish a satisfactory national forest economy. This program consists of a set of public measures and actions, some requiring legislation and some not. Adoption of such a program, either in whole or in part, would have a notable effect on the Grays Harbor situation. The measures judged likely to have the greatest influence on local problems have been selected and are presented below.

1. Forest Fire Protection. The Committee recommended increasing the authorization of the Clarke-McNary Act for this purpose from \$2,500,000 to \$10,000,000. There is now pending in Congress (1944) legislation which would increase authorization for cooperative forest fire protection to \$9,000,000.

2. Cooperative Sustained-yield Units. Legislation authorizing the establishment of cooperative units to enable sustained-yield management of intermingled public and private holdings conditional upon approved management and woods practices was recommended by the JCC report. Such a measure was enacted by Congress and approved by the President in March 1944.

3. Forest Credits. The report recommended provision for a forest credit system to make long-term, low-interest-rate loans to private forest operators through facilities of existing government institutions. Loans should be conditional upon satisfactory forest management and sound investment principles.

4. Legislation authorizing a system of contributions to local government in lieu of taxes on forest land removed from tax rolls through Federal acquisition was recommended in the report. Two separate measures are now awaiting action in Congress, either of which would accomplish this general principle. These measures disagree in detail, chiefly with respect to the size of the contribution.

5. Other measures recommended by the Committee's report included expansion of forest extension and forest research, encouragement of farm forest cooperatives, and accelerated acquisition of forest land by State and Federal Governments.

Not included among recommendations of the Committee was forest fire insurance. Unavailability of insurance against fire loss or other catastrophic losses such as epidemic insect attack and wind throw is commonly considered as an obstacle to sustained-yield forestry on private lands. Federal action is evidently needed to provide impetus for establishing an insurance system and Federal participation may be necessary to keep it going at least until private forestry becomes universal.

The report of the JCC does not specifically recommend public regulation of forest practice on private lands. It does, however, point out that: (1) "Private ownership of forest land carries with it certain obligations that in the public welfare private owners must help redeem," and (2) "Public interests inherent in all forest lands carry with them certain obligations which the public must redeem."

In recognition of the above principles the Forest Service has adopted a three-point program consisting of public cooperation, public acquisition, and public regulation. The first two points have been previously covered in this report. Briefly the Forest Service position is that public regulation is needed to keep all forest lands cut over in the future reasonably productive and that basic Federal legislation is needed to assure satisfactory standards and Nation-wide application. The Service further believes that the States should be given the opportunity, within a framework of satisfactory standards, to assume the responsibility for handling regulation within their boundaries. However, where satisfactory State legislation is not enacted and where enforcement or the practices established are inadequate, the Federal Government should be empowered to act.