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STAGGERED SETTINGS IN DOUGLAS-FIR ON THE COLUMBIA NATIONAL FOREST

U.S. DEPARTMENT *of* AGRICULTURE • FOREST SERVICE

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

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ANNUAL REPORT OF THE PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION FOR THE CALENDAR YEAR 1947

Accurate gauges of the progress of forestry in the Pacific Northwest do not exist nor is it likely that accurate standards of measure can be developed. Changes are too swift and the economic balance too delicate. Trends may be isolated and studied; local areas may be examined from the point of view of the economic and social results of good and bad forest practices; but an over-all picture of so vast and diversified a forest empire is difficult to achieve.

Regional figures may be quite deceptive in that they conceal local disasters or results of grave mismanagement. Likewise, they may fail to reveal situations in which good management and foresight are paying certain rewards. For example, the existence of a vast reservoir of untouched virgin Douglas-fir in southern Oregon is of little significance to Grays Harbor, where the "boom" in production of 20 years ago lapsed into the "bust" of the mid-thirties. Regional volume production figures would conceal, however, the fact that Grays Harbor, utilizing more intensively the timber resources remaining and using species formerly considered not worthy of notice, is now able to keep employed about as many people as in former years, but consumes only about one-third as much timber volume.

Over-all regional figures would not reveal the fact that Columbia County, Oregon, 25 years ago was able to produce a half billion feet of logs a year, but in 1946 could only manage to produce 75 million. Thus the clamor from some quarters to the effect that the Douglas-fir region is on sustained yield has no real significance for two major reasons. The first is the lack of applicability of such regional figures to limited areas and the second lies in the fallacy of thinking that sustained yield has been reached when current cut equals current gross volume growth. There is involved in the concept of sustained yield the idea that growth should equal its potential on the lands concerned, both in quantity and quality. This goal will not be reached until the old-growth lands have been harvested and put into growing condition; until the 4 or 5 million acres of nonproductive land in the Douglas-fir region have been restocked and are growing to their capacity; until ingenuity and judgment have been able to make profitable the clean-up of harvest cuttings and the salvage of mortality now lost ahead of the harvest. The principal tasks are two: Insure a good job of harvesting old growth, and protect and manage second growth.

It is a strange phenomenon, fostered by erroneous stories in the press and elsewhere, that the popular mind believes that the rather weak forest conservation laws of Oregon and Washington guarantee sustained yield forestry. They do make a reasonable attempt to guarantee restocking of harvested timberlands, but they make no attempt to limit the volume cut nor the size of trees harvested. It is a startling fact that second-growth timber now accounts for about 25 percent of the annual cut in the Douglas-fir region and that this cut comes from about one-third of the total area harvested. Much of it is at a stage of heavy growth. Doubtless a great deal of the impact of high prices on second growth might be lessened if all federally owned old growth were being cut to sustained yield capacity. It is hoped that the policy of the Forest Service to bring all working circles to sustained yield cut as rapidly as possible may be implemented at an early date by the indispensable construction of the road systems necessary to bring this to pass. In the meantime, the premature harvesting of second growth is annually removing too large a percentage of the best growing stock of the region and thereby preventing the achievement of regional potential sustained yield capacity for a long time.

Another singular fallacy that has appeared prominently in all public hearings concerned with proposed cooperative sustained yield projects is the inability of part of the public to grasp the fact that sustained yield can only be achieved on overcut forest lands by heavy curtailment of present cutting volume until growth capacity has been restored. There is widespread, almost universal acceptance of the principle of sustained yield forestry as a code of ethics, but it is to be practiced apparently without any present hardship on those who have been reaping the temporary rewards of overcutting. Such a compromise cannot be achieved.

Another widely believed but often fallacious panacea is the acceptance of the universal dependence of sustained yield on "selective cutting." The work of this Station has demonstrated clearly the often poor results of the method of cutting by economic tree selection in Douglas-fir and spruce-hemlock types. Such cutting may be a deadly foe of sustained yield. No method of cutting can achieve sustained yield unless there is control of volume cut. Harvest by small area selection appears to be generally good practice, but even this must be used within the limits of the growth capacity of a working circle or an economic zone.

Thus far no proposals are in sight looking toward the successful organization of small timber ownerships for purposes of cooperative sustained yield. Since nearly 60 percent of the lands in private ownership in Oregon and Washington occur in ownerships of less than 5,000 acres, it is clear that only a part of the total problem can be solved unless and until some way is found of obtaining satisfactory management practices on this very large productive area.

The timber account of western Washington and northwest Oregon has been overdrawn for years. This overdraft is now being partially replaced by overdrawing southwest Oregon. The magnitude of the change in mill population may be illustrated in the following table:

Mills:

	1945	1946	Increase
Oregon	745	1,316	571
Washington	502	643	141
Total	1,247	1,959	712

Lumber Production:

Oregon	5 billion	6.3 billion
Washington	3.3 "	3.4 "
Total	8.3 billion	9.7 billion

The total number of mills in the Douglas-fir region increased from 383 in 1932 to 1,445 in 1946. It may be noted that while the number of mills in the State of Washington increased by 141 from 1945 to 1946, lumber production was practically constant. Oregon, however, with an increase of 571 mills also increased its lumber production by 1.3 billion. The loss of several very large mills by closure has been compensated by a big number of smaller mills located farther south.

Lane County, Oregon (now being seriously overcut), according to a recent survey made by Oregon State College, had (1) 238 operating mills with installed daily capacity of 6,069,800 board feet; (2) 76 mills constituting 46 percent of the installed capacity adjacent to federally owned timberlands; (3) 68 mills with 56 percent of the installed capacity were cutting principally old-growth fir, the remainder cutting mainly second growth, and; (4) only 53 mills with 50 percent of the installed capacity estimated that more than 10 years' timber supply was in sight. Twelve mills representing about 21 percent of the installed capacity are working toward sustained yield or have definite possibilities. Only 2 mills, installed capacity 275,000 per day, are definitely working toward sustained yield and have tree farms.

This report emphasizes to an alarming degree the migratory and transitory nature of a large part of the presently installed mill capacity.

The former widespread aversion of sawmill operators and loggers toward owning timberland still exists but is becoming much less pronounced. Although the measure can only be a rough one, at least a fair implication of the advancing idea of managing forest lands as part of coordinated and integrated forestry and utilization operations may be given by the following figures. In 1940 there were 20 private foresters

employed by operators in Oregon and Washington. There were about 20 firms of consulting foresters. In 1947 there were about 250 foresters employed by operating companies. There were about 40 firms of consulting foresters. Assuming about 3 foresters for each firm of consultants, there must now be about 370 foresters in private employment in the Pacific Northwest, a gain of nearly tenfold in seven years. It is too early to say that this movement toward good management will survive much beyond the present high levels of prosperity in the forest industries. It is reasonably certain that a large percentage of the firms already embarked on management programs will carry them forward even though present conditions do not continue. It is also fairly certain that some of them will lapse into former practices.

Forestry should be, like agriculture, a continuous, long-range, well-planned program. To be successful the practice of good forestry, protection, and management must continue through good times and bad. But logging and lumber manufacture and other forms of utilization can and do regulate their volumes of activity in accord with the demand for products. It seems clear, therefore, that two principal conditions must be satisfied in order to achieve high levels of management: (1) Stability of ownership of forest land, and (2) financial stability in utilization operations. It is to be noted that there is not involved in either condition any requirement as to size of operation. There are no logical reasons why small ownerships and utilization operations cannot be successfully carried on in the Northwest. Stability of land ownership and timber management policies seem to offer the very best guarantees of permanence and stability of integrated utilization enterprises.

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Excellent progress is reported for 1947 in all lines of Station activity when measured in proportion to the resources available in manpower and money. It is of deep significance that a major effort of the year has been a cooperative one in which all interested public and private agencies worked together in bringing in and compiling our available knowledge on the management of second-growth Douglas-fir. The work of this committee will continue and its results in guiding the research program of the Station, as well as making available the results of cooperating parties, should be of great service to the forest industry.

The Station's own program in practical management of second-growth stands has received notable impetus during the year and, barring unforeseen contingencies, should make rapid progress during 1948. Although the availability of satisfactory tracts for cooperative study was delayed, they are now available and the work planned will be executed.

The principal gaps in the broad program of the Station are set forth in the reports of the various divisions. Over all the region, however, it is an outstanding fact that downstream engineering developments are proceeding and are planned far ahead of knowledge of the watershed

management problems involved. It cannot be repeated too often that dam sites are irreplaceable resources. If they are used and the resulting reservoirs become silted and the capacity lost, there is no recourse except to move to another site which may not exist. This sort of problem looms as especially important in the Willamette Valley. Although the proposed Lookout Creek Experimental Forest contemplates close cooperative relationships with the Snow Laboratory of the Corps of Engineers, any real contribution in the form of watershed management must await the availability of funds for this sort of work.

Similarly, the pressing problems of maintenance of water supply east of the Cascades are still not being touched. There is no reason to believe that this country differs from other regions in the relative importance of high watersheds, but there are many problems posed that are specific to the region involved. Among them may be mentioned the radical change in the composition of forest stands over a great deal of the area where formerly open ponderosa pine stands occupied the ground and the grazing resource was important. A mixed and thick composition of ponderosa pine, Douglas-fir, white fir, larch, and lodgepole in various combinations is now taking over a great deal of land. The land so occupied is apparently neither producing good timber nor good forage. What the relation of these conditions may be to water flow is an absolute unknown.

It will take many years to achieve satisfactory rehabilitation of much of the summer range land on the East Side. But a start has been made. Excellent progress in the face of extraordinary difficulties has been made in the research program on range revegetation. It is not difficult to foresee that coming years may witness broad activity in the actual and positive management of these range lands based on sure, scientific knowledge of species to be used and methods to be followed.

There are no fundamental differences in a philosophy of sustained yield applied to forest and range lands.

FOREST ECONOMICS

Forest Survey

During the calendar year 1947 progress in the Forest Survey was marked chiefly by development and test of working plans and refinement of techniques. The rising cost of living and devaluation of the dollar were directly reflected in field and office work progress. Considerable effort was expended on consideration of plans for the growth, drain, and analytical phases of the Survey. Papers were prepared by Cowlin and Moravets dealing with aspects of growth, drain, and analysis for presentation at the Survey Techniques Conference at Eagle River, Wisconsin. Johnson also made special analyses of sampling problems for the same conference. This conference, held in October, was attended by Cowlin,

Moravets, and Johnson. The discussion and experience gained have clarified objectives and procedures for determination of growth and drain and analysis of the results of the Survey.

During 1947 the field inventory was completed for Lake County, Oregon (1,391,000 acres) and Jackson County, Oregon (1,459,000 acres). Field work was commenced in Douglas County, Oregon, and 783,000 acres of the county's 2,851,000 acres was completed.

A field survey of fuel wood and fence post production was made on a sampling basis in four counties to determine the feasibility of using data collected in the 1945 Census of Agriculture. Upon the basis of results obtained in the sample survey, plans have been made for adjustment of the 1945 data to a 1947 basis by survey of 14 sample counties selected at random.

Sawlog production for 1946 was collected at the source by species and county of origin for 1946 and compiled. Plans have been made for a survey of logging waste to be made in early 1948. When results of this survey are available total commodity drain will be determined.

Type data have been projected from the aerial photos to base maps for all of Jackson County and commenced for Lake County. Determination of type areas and timber volumes was near completion for Jackson County at the close of the year. Aerial photos have been procured for all of Douglas County.

Office compilation of type areas and timber volume was completed for Klamath and Multnomah Counties. "Forest Statistics for Multnomah County" was prepared and multigraphed; it was distributed after Christmas. "Forest Statistics for Klamath County" has been prepared in manuscript form and is ready for multigraphing.

Multnomah County, one of the smaller counties in Oregon, has a merchantable saw-timber volume of 2,307 million board feet, log scale. This is only 228 million feet less than the volume shown in the original inventory in 1932. In the last few years, depletion of saw timber, due to commodity production and other causes, has been little more than current annual net growth in saw-timber trees.

Klamath County, which had in 1934, at time of the original inventory, a merchantable saw-timber volume of 22,437 million board feet, log scale, now has a total of 13,863 million feet. This great reduction in volume--8,574 million feet--emphasizes the extent of lumbering operations in this county. The bulk of the reduction in volume was of ponderosa pine, which totaled 17,040 million feet in 1934 and 9,395 million in 1945. Seventy-three percent of the ponderosa pine volume is in virgin stands; 27 percent in reserve stands on selectively cut areas.

When it is realized that the volume of ponderosa pine sawlogs cut during the 11-year period was 30 percent greater than the remaining

virgin pine volume, the prophesied reduction in lumbering activity in Klamath County, because of timber shortage, becomes more realistic. Reduction began in 1943 and has subsequently continued in the face of an active demand for lumber and a favorable price situation. Two large operations closed down completely and others have reduced their output. Lumber production in the county in 1945 was only slightly more than half that of 1941.

The Forest Survey field manual was completed and multigraphed. Initial distribution to interested agencies was made late in 1947. Judging from the number of requests for copies and comments upon the contents, it will prove useful to many other agencies. The section on interpretation and use of aerial photos in forest surveys has been in special demand.

Requests for Survey data in special tabulations, statistical reports, and type maps continue in heavy volume. In addition, numerous requests for advice and consultation on use of aerial photography in forest surveys and management have been received.

Cooperative Lumber Census

The annual census of lumber, lath, and shingle production conducted in cooperation with the Bureau of the Census was completed for 1946. The task of collecting and compiling these data was complicated by the large increase in the number of mills over previous years, particularly in the small size classes. During 1945 a total of 1,247 mills, 745 in Oregon and 502 in Washington, reported production; during 1946 the number increased to a total of 1,959 mills, 1,316 in Oregon and 643 in Washington. Total 1946 lumber production was 9.7 billion board feet, 6.3 billion in Oregon and 3.4 in Washington. This compares to a total of 8.3 billion feet in 1945, of which 5.0 billion feet was cut in Oregon and 3.3 billion in Washington.

Financial Aspects

Lumber-grade recovery studies. With the steady increase in stumpage prices it becomes more and more important to have better data on lumber-grade recoveries that can be expected from logs of various sizes and grades. Prior to the last war, studies were completed for the ponderosa pine type and these data were immediately used and are still used by government and private timber operators as the basis for establishing stumpage prices. A similar series was started in the Douglas-fir region and one study was completed just before the beginning of the war. This project was then left dormant until about a year ago, when considerable pressure was exerted by private and government forestry agencies for continuing these studies in the Douglas-fir region as there simply were not sufficient basic data available for accurately estimating timber values.

Since only a limited amount of funds was available from the Forest Service and interested cooperators, it was necessary to lessen considerably the man-day requirements used in past studies. Since the primary need is to get expected log-grade recoveries from the various sizes and grades of logs in commercial use in this region, the study plan was "streamlined" to meet this objective. Two studies in mills cutting old growth and four in mills cutting second growth were completed during the year with only about one-quarter of the man-days required per study as was the case using previous methods.

Columbia River Basin Study (Bonneville Cooperative Project)

The Bonneville Cooperative Project, a forecast of the probable levels of production and employment in the forest industries of the Columbia River Basin for the period 1955-65, initiated July 1945, was completed June 30, 1947. By agreement with the Bonneville Administration the project was extended six months to include an intensified study of specified Oregon counties. The supplemental study forecasted production and employment in the timber industries by products for each year 1948 to 1960 and covered Coos, Curry, Douglas, Klamath, Lake, Lane, Linn, Jackson, and Josephine Counties, Oregon. It has been completed and the final reports submitted to the Bonneville Administration.

The findings of this project in terms of forecasted employment and power requirements will be incorporated into the report to Congress of the entire Columbia Basin study by the Corps of Engineers. Prior to submission to Congress the final results will not be published independently. Data on the physical resource, its current and predicted condition, however, may be published or released. Marquis used such material and other Forest Survey data in an article published in The Timberman, April 1947, "Log Production and Sustained Yield." This article shows graphically and statistically that during the past two decades log production has been out of balance with saw-timber volume geographically within the Douglas-fir region and also with the species composition of the saw-timber stand. For example, until the last five years too great a proportion of the annual log cut has come from western Washington. This trend was reversed abruptly and now the western Oregon saw timber is being overdrawn. Douglas-fir has been overcut during the entire two decades but the proportion Douglas-fir constitutes of total log production is slowly diminishing. According to the composition of the remaining saw-timber stands a greater proportion of the cut must come from species other than Douglas-fir if the current level of production is to be maintained.

The study also shows that to maintain current levels of activity in the timber products industries, lesser-used species must be utilized to a greater extent. Conversion of material now wasted in woods and plant to useful products is another source of increasing industrial employment.

The conclusion of the study is that the minimum employment in timber products industries forecasted for 1955-65 is slightly less than 1945 levels and the maximum is about one-third higher. A decrease in production and employment is anticipated in logging and lumber, but increases are expected in the chemical and fiber industries and in secondary manufacture and remanufacture.

FOREST UTILIZATION SERVICE

The outstanding developments in the forest industries of the Pacific Northwest during 1947 again emphasized the need of integrated utilization--integration of the growth of the forest with diversified and coordinated processing plants. The forests must be considered as a source of more than one product and many operators now are recovering a number of products from their timber holdings. A decided trend has developed in this direction.

Experimental cuttings of hop poles, pulpwood, and small sawlogs are being made as stand improvement thinnings. From the old-growth forests, which contain both small, very dense, suppressed trees and, especially in southwestern Oregon, large quantities of decayed Douglas-fir often approaching as high as 60 percent of the stand, considerable low-grade and non-sawlog material is being removed. This material may be removed in a prelogging, a complete logging, or a relogging operation. The material removed is going into the manufacture of lumber, pulp, or slicer blocks. As a step in this direction a report was published during the year by Elmer E. Matson, formerly of the Forest Utilization Service of this Station, and Professor John B. Grantham, at Oregon State College, on "Salvage Logging in the Douglas-Fir Region of Oregon and Washington."

The good lumber and pulp markets and the growing shortage of readily accessible timber have caused the timber industry to become more concerned with logging waste. Several companies have undertaken salvage operations which are proving economical provided proper equipment and methods are used. This study by Matson and Grantham showed that not only is it practical to salvage the material left by the original operation which averages 10,000 board feet net log scale per acre, but that there are also other advantages. These advantages, which are receiving serious consideration by the wood-using industry, include (1) lengthening the life of individual plants, thereby reducing depreciation and similar fixed costs; (2) permitting a higher regional production rate under present sustained yield cutting budgets; (3) decreasing necessity of cutting immature timber; (4) reducing the fire hazard and at the same time providing better conditions for the establishment of a new crop; (5) providing an additional supply of high-grade lumber so necessary in retaining eastern markets for west coast lumber; (6) providing a new source of raw material for pulp mills.

It has been estimated that during the year 1947 approximately 730 million board feet of logs were salvaged from operations in the Douglas-fir region of Oregon and Washington.

It is clear that in order to recover the most material from old-growth timber stands as well as to obtain modern management practices, a closer tie is needed between the management of forest lands and the development of utilization plants. Without the utilization plants it does not appear economic to make improvement thinnings from second-growth stands or to remove the wealth of material left in the woods as a result of normal logging operations which are designed for the manufacture of only one product. Because of the recognition of this need, representatives of the Forest Products Laboratory have spent considerable time during the year in this region with the Forest Utilization Service. This has resulted in a closer understanding by the personnel of the Forest Products Laboratory of what must be done to further better woods practices.

The major fields of activity of the Forest Utilization Service during the past year can be enumerated:

1. Study of the "Cost of Hauling Logs by Motor Truck and Trailer."

2. Seasoning of lumber--principally kiln drying.

3. Shipping containers for fruit.

4. Plywood--the expansion of the softwood plywood industry through the use of veneer cut from low-grade logs.

5. The development of a cut-stock industry based upon salvage of mill waste.

6. The fabrication of wood products of glued-laminated construction.

7. The use of local hardwoods for pulp, lumber, and veneer stock.

8. The expansion of the pulp and paper industry based on sawmill waste, logging waste, and second-growth thinnings.

9. The development of insulating and hardboard plants to utilize so-called waste wood.

10. The production of alcohol, molasses, and yeast from wood waste.

11. The development of cooperative feeding tests programs for wood molasses and yeast at the Agricultural Experiment Stations in Washington and Oregon.

Log Hauling Costs

Because of the need by road designers and logging engineers for data on which to base estimates on the cost of hauling logs by truck and trailer and the effect of road design on hauling, a joint project was undertaken by three of the Forest Service regions and the Pacific Northwest Forest and Range Experiment Station. The project, headed by J. J. Byrne, resulted in the publication of a detailed report, "Cost of Hauling Logs by Motor Truck and Trailer." In addition to the engineers and technicians from the Northern, California, and North Pacific Regions, 19 operating companies located in Washington, Oregon, California, British Columbia, Montana, and the Oregon State Highway Department contributed assistance and data to this thorough investigation.

Seasoning

Pacific Coast softwood lumber has moved throughout the year in large volume under the active market demands. Much of it has been shipped green although later used where dried lumber is more desirable and would provide more satisfactory service. Industry leaders indicate a definite trend toward more extensive seasoning of the lumber output and new dry kilns are being built on a scale which will materially increase the drying capacity of the industry. Although such kilns are contemplated for the immediate drying of Douglas-fir and hemlock, they are suitable, also, for drying other softwood species which will be cut in greater amounts in the future.

Increases in the freight rates for lumber have made the lower weights for kiln dried lumber more attractive to lumber producers and of particular importance to mills cutting young or second-growth timber in which sapwood comprises a larger percentage of the volume of lumber produced than for mills cutting old-growth Douglas-fir.

Increased interest in kiln drying dimension lumber items has led to strong desire among the smaller sawmills for a type of dry kiln which would be built at relatively low cost and could be heated by some means which would not require the building and operation of a steam boiler plant. One development in this direction is the wind-tunnel drier which operates at moderate temperatures (slightly above outdoor conditions) and can be heated by a sawdust-burning furnace. This kiln development has not yet proven its value for the commercial drying of lumber and further experimental and engineering work needs to be done before its potential use can be estimated.

The lumber industry is interested in more widely developing technical understanding of the seasoning of wood among lumber-producing mills. The Forest Products Laboratory in the last two years has resumed field courses in kiln drying, and during the year held one at Longview, Washington. This was the first such Forest Service training course in the Pacific Northwest since 1922. Interest in this type, of course, continues and it is expected that additional courses may be given annually,

largely through cooperation between the Forest Service, State agencies, and industry associations.

Another channel through which the Forest Utilization Service has brought technical information on the kiln drying of lumber to the industry is through meetings of Dry Kiln Clubs, which are composed of the dry-kiln operators. Technical topics are discussed by men drawn from forestry schools as well as the Forest Service.

Seasoning still is a bottleneck in the conversion of a number of western hardwoods into lumber. Under present active lumber markets, western oaks, and probably some other species, would make satisfactory flooring and fixture material if they could be satisfactorily dried. Although some preliminary kiln-drying studies on western hardwood species have already been made at the Forest Products Laboratory, further experimental work is necessary before a satisfactory commercial practice can be set up. Such experimental work is about to be undertaken by the Oregon Forest Products Laboratory, which during the year has organized and set up new experimental dry-kiln equipment.

Shipping Containers for Fruit

The fruit-producing areas of central Washington and Oregon require a large production of wooden boxes and containers for marketing their products, especially apples and pears. Ponderosa pine lumber has been favored for boxes because it lends itself readily to resawing and nailing. The reduced supply of pine for this purpose has interested box makers in utilizing other species found in the region--white fir, Douglas-fir, larch, etc. One major difficulty in using these species for box ends, sides, and bottoms is met in the automatic nailing machine where, due to splitting and to leading of the nail point in following the annual ring of the wood, "shiners" result.

The supply of wood for the fruit packing box is expected to become more critical. The ends, sides, and generally the bottoms of apple boxes are presently sawed from lumber produced in the fruit-growing region. However, apple production is expected to increase appreciably above present levels and it is estimated that the wood boxes required to pack the fruit crop in Washington will require more lumber than will be produced on the East Side from all species when the lumber-producing industry operates on a sustained-yield basis.

Even now some high-grade ponderosa pine lumber is being cut into box shook to accommodate the local need for apple boxes instead of being shipped at higher realization to current pine lumber markets.

Initial steps toward developing more satisfactory boxes from the supplementary species of the area were taken by the Forest Products Laboratory and the Forest Utilization Service, whose representatives during the apple packing season made a preliminary investigation of the use and performance of all species currently going into boxes.

In addition to the use of other species, considerable interest has developed in containers composed solely or in part of various forms of fiberboard. Several research projects have been undertaken by a number of industrial concerns. This surface has only been "scratched" in the development of new types of containers.

Plywood

The softwood plywood industry continues to move southwest into central Oregon for a major source of timber supply. Through improved processes for patching open defects and for edge-gluing narrow sheets of veneer, plywood mills have found it practical to supplement the supply of peeler grades with sawmill grades of logs and thereby sustain production. The No. 1 sawmill log has all but disappeared from sawmills. While some attention is given to the use of other species, such as hemlock and noble fir, their use is less favored because of the higher cost of converting them into plywood. Their disadvantages are increased time for drying (due to higher initial moisture content) and lack of natural durability under outdoor service conditions. The continued use of Douglas-fir for plywood also is sustained by the development of green peeler plants which can be built near the timber source with relatively low capital investment and from which the veneer product can be moved to the existing main plant under milling-in-transit advantage. In the Douglas-fir region green veneers can be moved by rail without risking the serious damage from stain which is encountered in many other species used in the production of veneer.

A new trend in the softwood-plywood industry is to produce sliced vertical grain Douglas-fir veneer for plywood faces and to some extent the same practice is being applied to Western redcedar. The use of hardwood veneers, imported from both domestic and foreign sources, for facing Douglas-fir plywood has also been developed and will be augmented by the renewed availability of Philippine woods.

Production of plywood faced with resin-impregnated paper overlays continues in a small segment of the industry. Current fabrication practice requires that the veneer over which the paper is applied be of solid wood (may be patched) and there is still need for the development of a face material which can satisfactorily mask open as well as solid defects.

Cut Stock From Salvage

While a large volume of mill waste of high quality continues to find its way into fuel of low monetary value or into refuse burners, salvage operations in some mills are producing from slabs and edgings cut stock of clear grade. The recovery at some mills has run as high as 4 percent of the lumber production from the mill. Increased salvage operations may be expected throughout the industry with the cultivation of greater markets for cut stock. During the year the Forest Products Laboratory, in cooperation with the three Pacific Coast Forest Utilization

Service units, has begun to investigate more intensively the volume and character of cut stock which could be salvaged at both lumber and plywood mills and to survey in consuming areas the markets for such cut stock. Bark-free Douglas-fir veneer waste already is being salvaged to an appreciable degree by chipping and marketing to sulfate pulp mills at returns several times its value as fuel. Results of the survey should reveal what additional markets may be developed for cut stock.

Lamination

The practice of gluing pieces of wood together to produce large pieces is expanding appreciably. During the year additional gluing plants have come into operation. Some use this method for producing wide items from small, clear cuttings, taken from what otherwise would be mill waste. Others cut up lumber to segregate defects from clear cuttings. Others glue structural items of lumber which admit classified sizes of knots and other growth defects. All operate to better utilize the volume of wood grown in the tree. Such processing will become of even greater importance as the quantity of old-growth Douglas-fir decreases. The gamut of products so produced includes such items as paneling, furniture parts, door parts, ironing boards, wagon box boards, laminated beams, curved rafters for barns, farm animal houses, etc.

The application of high-frequency heating for quick curing of glue bonds is a subject of major interest. Its use is confined largely to gluing with urea resins wood dried to a moisture content under 10 percent. However, considerable progress also is being made in the use of resorcinol resins for high-frequency heating, and at least one operator is successfully using the resin in commercial production of laminated members. The production of glued wood products from Douglas-fir can be expected to increase rapidly, especially for outdoor purposes when the use of highly waterproof glues cured by high-frequency heating is developed to a successful commercial process.

Poles

The weakening of the markets for non-pressure treated poles has reduced the interest of small producers of preservatively treated products. On the other hand, the retort volume of the pressure treating industry was increased by 12 percent in Oregon and Washington during 1947.

New Sulfate Pulp Capacity

The past year has seen the construction of additional sulfate pulp capacity and the announcement of a sulfate container-board mill in the region. This expansion is predicated upon the utilization as raw material of sawmill waste and logging waste. The reason that sulfate capacity is increasing is twofold; first, the process can utilize all species of wood found in the region and, second, the advancements in bleaching of Douglas-fir sulfate pulp.

Modified Sulfite Pulp Process and Newsprint

One important plant modification which now is in progress is the conversion of the Weyerhaeuser Timber Company's sulfite mill at Longview to magnesium base. In this process the waste liquor will be evaporated and burned for fuel. Many of the other sulfite mills in the region consider this as the probable solution (along with Weyerhaeuser) of their pollution problem. Likewise, during this past year construction of another pulp mill was begun. The raw material for this operation--a groundwood newsprint plant--will be largely thinnings from second-growth timber.

An additional two pulp mills are in the discussion stage. Both will probably be sulfate and will be located in western Oregon. Both will be predicated on material which is not suitable for the operation of sawmills. Again, it should be stressed that increased capacity of pulp mills will make possible better utilization of our forests.

Alder for Pulp

In this connection the use of alder for sulfate pulp has been investigated by the Forest Products Laboratory and at least three industrial concerns. The alder would be utilized largely as an additive material in the manufacture of specialized products extending from high-grade book papers to insulating board. The preliminary results are very encouraging.

Fiberboard

The new insulating board plant of the Simpson Logging Company at Shelton, Wash., began production in the spring of 1947. It is now operating at a level 50 percent in excess of the design.

The Chapman Manufacturing Company, in the hardboard field, has progressed to a degree in the working out of a small hardboard plant. This company is designing a number of other plants to convert unused material at primary manufacturing plants to hardboard. The importance of this development is such that it has created national interest and appears to point a way in which a sawmill owner may construct one type of suitable byproduct plant.

Wood Sugar and Products

One of the major projects of the Forest Utilization Service of this Station has been the conversion of the waste wood to a sugar solution and the subsequent manufacture of molasses, alcohol, and yeast. The Springfield alcohol plant, of course, has been of primary importance. This plant, although closed at the present time and now in the custody of the War Assets Administration, was in partial experimental operation for about six months during 1947. The plant was closed down primarily because of two factors: (1) The necessity to convert this plant from

wartime operation to peacetime operation, which involved the negotiation of a suitable peacetime lease; and (2) the correction of shortcomings which are always inherent in a new chemical plant. Due to many unforeseen difficulties, it does not appear that this plant will be back in production until late 1948 or early in 1949. No insurmountable difficulties have arisen but time will be required before this plant is in suitable operating hands and the necessary modifications made. In the meantime the Forest Products Laboratory has accelerated its research program in this field. It is currently producing molasses which is being investigated as a chemical raw material by chemical concerns and as a livestock feed by a number of agricultural experiment stations and feed manufacturers.

In this connection the Pacific Northwest Forest Experiment Station has cooperated with the Agricultural Experiment Station at Washington State College, where molasses has been investigated as a feed for chicks. Satisfactory results in the preliminary tests were achieved with chicks up to 15 percent of their diet. Molasses was used as a preservative for grass silage and this material now is being fed to dairy cattle. Further work is planned.

A cooperative research program has been set up with the Oregon Forest Products Laboratory and the Agricultural Experiment Station at Oregon State College. The two initial projects will be the use of wood molasses as an energy feed for pigs and dairy cattle. Here again additional projects will be carried on.

At both the agricultural experiment stations in this region feeding tests will be started on wood yeast as soon as supplies of it are available. By about June 1948 the Forest Products Laboratory will probably be able to produce yeast from wood sugar at about 20 pounds of dried yeast per day. While this material will only be sufficient for preliminary tests, it will serve to point the direction more detailed tests should take.

Preliminary tests at the Agricultural Experiment Station at Pullman, Wash., have shown that yeast from waste sulfite liquor and pear cannery waste is high in vitamin content and compares favorably with fish meal as a high-vitamin, high-protein supplement for poultry feed. Of special importance was the high hatchability factor of eggs from hens which were fed this yeast. The conversion of wood waste to a sugar solution from which a number of products can be manufactured appears as one of the most important possibilities for utilizing material now wasted in the conversion of our forests to lumber.

Charcoal

The past year has seen added interest in manufacture of charcoal. The announcement of additional industrial plants which could utilize charcoal as an electric furnace fuel has made the establishment of a charcoal industry in the Pacific Northwest much closer. A new pilot

plant is now in construction to produce Douglas-fir charcoal briquettes from sawdust. The Oregon Forest Products Laboratory has continued operation of its pilot plant at Corvallis and plans are being drawn for the expansion of this operation.

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On November 1, J. J. Byrne, Chief of the Forest Utilization Service, was transferred to San Francisco where he is Regional Engineer for Region 5 of the U. S. Forest Service. Due to curtailed finances it was not possible to replace Byrne. As a result it has been necessary to curtail the work of this unit, especially in the development of practices and equipment for harvesting and processing.

FOREST MANAGEMENT RESEARCH

The division entered the year with a new staff of 15 technical workers just organized. New branch centers at Olympia and Corvallis had just been set up and the reactivation of Cascade Head, Pringle Falls, and Wind River Experimental Forests started. During the year one forester was added to the technical staff--Bullard to take charge of Wind River. Negotiations were completed for the establishment of two new Douglas-fir second-growth experimental forests on private lands under cooperative agreement with the owners and ground work was completed for the establishment of a new experimental forest and watershed in old-growth Douglas-fir on the Willamette National Forest. The Station organized the Douglas-Fir Second-Growth Management Committee to guide and assist its expanded program in this field.

Much of the year's work laid the basis for studies which will contribute comprehensive findings in the years ahead, but short-term results in the form of research publications also began to accumulate. The past year's principal activities, significant findings, and plans for the year ahead are given in the following pages.

In spite of the increased activity, the forest management program falls seriously short in several respects. Southwestern Oregon, greatest timber storehouse in the nation and scene of accelerating cutting, is virtually unserved and cannot be served under present staffing. Likewise, forest management in the Blue Mountains and on the east slope Cascades of Washington, both in the ponderosa pine subregion, is without specific research guidance. Fire research is seriously undermanned in both fir and pine, and modernized growth and yield studies are at a virtual standstill for want of a staff mensurationist.

Partial Cutting in Old-Growth Douglas-Fir

With the upsurge of truck and tractor logging that occurred about a decade ago, partial cutting spread quickly over the Douglas-fir region without benefit of research guidance. Most selection was on an economic

basis. Virtually nothing was known about the ability of the residual trees to survive exposure and logging damage or to respond to release. Nevertheless, it was argued by exponents of the method that selection cutting would restore to a condition of net growth the static or decadent overmature stands and, in addition, yield high current returns.

The Station has 76 acres of permanent plots on 18 areas distributed throughout the region. These were put in a decade or so ago specifically to sample growth and mortality following such cutting. The 5- and 10-year remeasurements of these plots established in advance of logging show that more often than not partial cutting in old growth has been followed by heavy mortality. Five years after cutting 12 of the 18 areas showed a net loss of volume, and the average net loss for all 18 areas was 1,100 board feet per acre per year. Six of the areas were under observation for 10 years, and half of these showed a continuing loss in volume during the second 5-year period. Averaged together the 6 areas showed a net loss of 800 board feet per acre per year for the period 5 to 10 years after cutting. Thus, these stands must make a net growth of 950 board feet per acre per year for the next decade if losses suffered since cutting are to be restored and a volume equal to that reserved is to be again attained within 20 years.

There is indication that some trees and some stands survive selection far more successfully than others. On one 36-acre sale area in the Wind River Valley, made by economic tree selection, loss has averaged 1,200 board feet per acre per year since cutting. On another 320-acre tract in the same watershed where silvicultural principles were followed insofar as possible, mortality since cutting amounted to only 176 board feet per acre per year, which was less than one-third of the estimated growth laid on.

Little attention was given to the injury inflicted upon the residual stands in these early cuttings, although observations on some areas indicated that one-half of the remaining trees were damaged by the logging. Two and one-half years ago a region-wide study was started cooperatively with the Division of Forest Pathology to determine extent of decay following such injury. Results of the first year's field study, published in The Timberman during the year, show that decay follows most injuries and that over an average period of 11 years it amounted to 41 percent of gross growth on damaged hemlock since logging and nullified 43 percent of the growth laid on the outside of injured spruce.

These findings have resulted in revised cutting plans on many logging operations on both private and public lands.

It is planned to summarize and publish results of the Station's partial cutting studies in old-growth Douglas-fir during the coming year, and to further test the promising leads obtained on applied forest management experimental areas. To compare growth, mortality, and ecological trends in natural old-growth stands with those in the partially cut, a

permanent plot sampling was installed last summer over the 1,000-acre natural area on Wind River Experimental Forest.

To Plant or Not to Plant?

This is the question puzzling every tree farmer holding recently cut-over and burned lands for restocking and another crop. He ponders whether to save time and plant or to save money now and rely on nature to do the job. Results obtained by last year's study of stocking trends in central western Washington will be of help in determining the answer. For understocked areas having a reasonably good source of seed, i.e., generally within a distance equal to twice the height of seed-bearing trees bordering or scattered over the area, the improvement in stocking that occurred in 15 years was not uniformly satisfactory. On favorable exposures, i.e., northerly or easterly or quite gentle, where brush cover was light and threat of brush encroachment not serious, areas 10 percent stocked in 1931 improved to 60 percent stocking by 1946. However, on steep south or west slopes only one-third stocking was attained, on the average, after the wait of 15 years. Planting is needed to restore promptly to productivity such areas as the latter.

Better Forests From Better Seed

Five million acres of cut-over and burned land in western Washington and Oregon is rated as non- or unsatisfactorily stocked. To restore productivity, most of this area must be planted. In recognition of this problem both private and public owners have started an expanding program of artificial reforestation. Success or failure of this tremendous undertaking will depend in part on obtaining the best seed for each planting site. Two years ago the University of Washington and the Station in cooperation started to summarize existing information on the science of Douglas-fir seed selection, and to map the program of research needed to insure that plantings in the Douglas-fir region will be made with high-quality, rapidly growing, disease-resistant stock. Isaac uncovered records of elite strains of Douglas-fir in European test plantations that had made treble the growth of the poorest under the same conditions. His report will appear as a University of Washington bulletin within a few months. Leading private and public timberland owners in the region have already adopted many of Isaac's preliminary seed-selection recommendations and are looking for further improved techniques.

Twenty years ago the Station set out 6 experimental plantations throughout the region testing in each the seed from 10 regional races of ponderosa pine. Results to date are summarized by Munger in Research Notes No. 39. Trees grown from seed from the Willamette Valley, from the Rogue River, from the Bitterroot Mountains, from the Deschutes, and the Eldorado in California outstripped those from the seed taken from the Steilacoom Plains of Washington, from the Lassen, and from the Black Hills. The study indicates that some considerable differences in growth must be caused by factors other than the geographic source of the seed. Existence of strains significantly superior to others growing in the same

area is a distinct possibility. These must be sought and tested if future pine yields are to reach their potential levels.

In the spring of 1939 cuttings from the 25 best hybrid poplars developed in the Northeast were set out in the Northwest in a test plantation in cooperation with the Crown Zellerbach Corporation. Results of this test and comparison with growth made by native cottonwoods are summarized in Silen's Forest Research Notes No. 35. Average growth made by the best was more than double that of the poorest. Dominants and codominants among the better hybrids averaged 53 to 58 feet in height after 1 year in the nursery plus 8 years in the plantation. The native cottonwoods show up fairly well in comparison. Although the natives of comparable age averaged only 48.5 feet in height, the tallest measured 59 feet, suggesting that superior strains may exist among our own Northwest stock. The most promising of the hybrids are to be further tested with selected strains of local cottonwood.

Douglas-Fir Second-Growth Management

Douglas-fir region forests are no longer predominantly virgin old growth. The 1945 Forest Survey summaries show only 9 million acres of virgin saw timber remaining. In contrast, second-growth areas had climbed to more than 11 million acres, and in addition poorly stocked regenerating areas plus nonstocked and recent cutovers covered more than 5 million acres. Thus, second-growth forests, plus the area that should be supporting full stands of second growth, total almost 17 million acres. This amounts to two-thirds of the commercial forest land total.

Latest Forest Survey data show that second-growth cutting accounted for 13 percent of the saw timber harvested during the decade 1935-44. Figures prepared by the West Coast Lumbermen's Association for the year 1945 indicate a sharp increase to 27 percent of the total in western Oregon, accounting for 44 percent of the total area covered by logging that year. Clearly, the Douglas-fir industry is well into the transition to a second-growth industry. Demand for information on second-growth forestry is far beyond the supply afforded by the meager research to date. In recognition of this the Station proposed early in 1947 an expanded program of Douglas-fir second-growth management research. In response to the urgent requests by industry, a 3-point plan was presented. First, the Station would, with the help of forest owners and agencies, put together as quickly as possible what foresters now know about Douglas-fir second-growth management. This would serve as a working guide which could be improved as more is learned. Second, the Station proposed the setting up of permanent experimental tracts in cooperation with forest owners to try out the promising possibilities of stand improvement, utilization, and cutting methods. And, third, it was proposed, also with the help of timberland owners, to study and report the results of all classes of current cuttings in second-growth stands. This program was presented to Douglas-fir foresters and owners in a town-hall meeting last March. It was unanimously endorsed and the Station moved quickly to organize a 9-man Douglas-fir second-growth management committee representing the

schools, industries, State and Federal departments to promote the program both as a guiding and a working group. Named on this committee were:

W. D. Hagenstein	- West Coast Lumbermen's Association and Pacific Northwest Loggers Association
W. F. McCulloch	- Oregon State College and Office of State Forester of Oregon
D. G. McKeever	- Weyerhaeuser Timber Company
T. P. Plair	- Soil Conservation Service
C. A. Rindt	- Region 6, U. S. Forest Service
E. P. Stamm	- Crown Zellerbach Corporation
L. T. Webster	- Office of State Forester of Washington and University of Washington
L. A. Isaac, Secretary	- Pacific Northwest Forest and Range Experiment Station
P. A. Briegleb, Chairman	- Pacific Northwest Forest and Range Experiment Station

The cooperating members have demonstrated literally that they are indeed a hard-working as well as an advisory committee. As a result the proposed "quickie" report has been prepared and will be distributed as a Station multigraph early in 1948. The committee assisted in locating second-growth cutting areas for "post-mortem" study. Twenty of these were systematically sampled by Station field crews last summer. The results now being compiled will be issued during 1948. It is planned that the "quickie" report of 1947 will be revised in 1948, following wide review, and then printed cooperatively with State and industry agencies.

The cooperative experimental forest phase of the second-growth program though approved in theory was not so quickly accepted in fact by forest owners. A number were encouraged and helped in the development of test cuttings on their own lands and arrangements made to pool results with others in the region. But few offered private lands for cooperative development of experimental cuttings with the Station. Nevertheless, within the year two excellent study tracts on private lands were located, both in western Washington. They will be developed under 20-year cooperative lease agreements, one with the St. Paul & Tacoma Lumber Company, the other with the Simpson Logging Company. Covering agreements were completed at the turn of the year.

Ponderosa Pine Silviculture

For the 16 million acres of commercial forest in the ponderosa pine subregion of Oregon and Washington the Station's full-time staff on management research during 1947 totaled 2 men. This was an increase from zero as of the start of 1946 but still far short of the number required to deal adequately with the problems at hand.

Conversion of the virgin old-growth forest to a managed, rapidly growing condition is a major everyday job of forest managers in the pine region. In an attempt to accelerate this transition there was widespread increase in lighter selection cutting beginning about a decade ago. This was facilitated by improvements in trucks and tractors giving greater flexibility to loggers and by Keen's development of an intensified tree classification which made silviculturists far more aware of subtle but significant variations in the silvicultural characteristics of individual ponderosa pines. To test the effect of various newly proposed pine marking methods the Station installed at Pringle Falls Experimental Forest a series of 7 sample plots, each 60 to 100 acres in area, in the fall of 1937. Volume removal ranged from 20 percent of the total on the lightly cut plots to 80 percent on the heavily cut. On all plots, trees of highest risk were removed. Each year since the cut, mortality has been recorded and last fall the plots were given their 10-year remeasurement. This represents the first actual 10-year experience test of growth performance of the various Keen tree classes.

The reduction in mortality effected by the silvicultural selection has been impressive. Losses, caused mostly by insects, have averaged only 9 board feet per acre per year, or 0.1 percent annually. In contrast, annual mortality in the adjacent virgin forest has exceeded this by more than fivefold, averaging about 49 board feet per acre, or about 0.3 percent of the timber stand each year. It is significant that the 20 percent removal was just as effective in reducing mortality as were the heavier cuts. This winter's compilations, which will give full growth and mortality comparisons by tree class and cutting method, are awaited with interest.

Supplementing the data from Pringle Falls will be that from 6 other large-size methods of cutting plots on the Deschutes National Forest and 4 on the Rogue River, all of which were given their 10-year remeasurements during the year.

Indication of high second-growth ponderosa pine yields possible with good stocking comes from the Lookout Mountain Division of Pringle Falls Experimental Forest. Most mature pine forests in this region normally make a gross growth of about 100 board feet per acre per year, all or most of which is usually offset by beetle-caused tree mortality. In contrast, the results of growth studies and a 40-acre thinning installed in a 102-year-old even-aged stand in 1940 show periodic annual growth rates for the past 6 years of 618 board feet per acre per year in the natural stand, 566 in the thinned.

Although growth in the thinned stand was about 9 percent less than that in the uncut, there is already evidence that the untreated forest is ripe for accelerated bark beetle inroads. In an attempt to forestall such losses and to maintain a high rate of growth, a series of light, frequent, and medium stand improvement thinnings will be made on this forest starting in 1948 on a larger commercial scale. Records of costs and returns as well as silvicultural results will be obtained to guide management of the increasing area of second growth.

Heavy live-crown pruning reduces growth of young ponderosa pine. Preliminary studies show a highly favorable cost-benefit ratio for pruning of pole-sized pine, but measurements compiled at Pringle Falls during the year indicate that such prunings should not remove too much of the live crown. Cutting of one-fourth of the crown length resulted in no significant reduction in diameter growth rate, but removal of one-half of the crown reduced growth to 76 percent of that made by unpruned trees. Removal of three-fourths of the crown cut growth to only 37 percent of that made by check trees during the 7 years since pruning.

Growth and response to thinning of lodgepole pine was studied in the Pringle Falls vicinity in response to increased interest in this species. Preliminary results from thinning plot remeasurements indicate that net growth was increased by light thinning but reduced by heavy thinning that led to abnormal mortality caused by wind and excessive exposure. A "post-mortem" study of ponderosa pine cuttings on the Deschutes-Klamath Plateau was made to determine yields obtained from commercial lodgepole cuttings and the growth obtained following logging. Indications are that solid-wood growth of well-stocked lodgepole compares favorably with that for ponderosa pine and ranges from 25 to 60 cubic feet per acre per year. Rate of mean annual increment was found to be on the increase from ages 55 to 70, and appafently still climbing. For use in preliminary management plans it is recommended that rotations of not less than 70 years be used.

Study of pine planting problems will be extended during 1948 in anticipation of the expanding ponderosa planting program. Effects of planting method, class of stock, and wax coating treatments to retard transpiration will be tested in the studies planned.

Being neglected in the pine research program is the management of the pine and mixed types in the Blue Mountains and on the eastern Cascade Range in Washington where slopes are steeper and stands more variable than in central Oregon. The effect of prescribed burning on the ecology of the pine and mixed types is also in urgent need of study that cannot be given with present staffing.

Mensuration

Stimulated by the high level of activity in preparing management plans on both private and public lands, the demand for results of forest mensuration research is far beyond the capacity of the Station to supply.

Still lacking a mensuration project leader, the year's accomplishments in this field have been attained largely incidental to other work, and through the employment by the Station of Professor George Barnes of Oregon State College during the summer. Barnes made substantial progress on the job of revising the hemlock-spruce site index curves and added to the evidence that separate site curves and yield tables must be prepared for Western hemlock and Sitka spruce. The division cooperated with the Forest Survey division and Oregon State College in the preparation of five new volume tables on modernized standards of measurement for second-growth species of the Douglas-fir region. Similar cooperation with the firm of Mason, Bruce & Girard resulted in the preparation and publishing by the firm of a new set of form-class Scribner volume tables on a 32-foot log basis for Douglas-fir region species. A companion set similarly prepared on a 16-foot log basis for pine region species is at the printers. Preliminary tests of these tables indicate that they will have wide application in the Northwest and for much work may be adopted as standard.

In cooperation with pulp companies in western Washington, preliminary cubic-foot to cord converting factors and cordwood volume tables based on current cutting practices were prepared for second-growth Douglas-fir, hemlock, and cottonwood. Solid-wood content of 8-foot stacked Douglas-fir pulpwood was found to average 83 cubic feet per cord regardless of average bolt diameter, but it is suspected that further sampling may show a relationship with bolt size. Average solid-wood contents of Western hemlock pulpwood ranged from 80 cubic feet per cord to 92 cubic feet per cord, for stacks having average bolt diameters of 7 inches and 16 inches, respectively. Factors for cottonwood range from 84 to 99 cubic feet per cord, also depending on average stick size. The report summarizing results of this study is planned for publication the early part of 1948.

Millions of acres of burned, cut-over, and reforesting land in the Douglas-fir region has been classified for status of stocking by the stocked-quadrat system, but not until this year has there been any measure for estimating what a given quadrat stocking percentage means in terms of future stand volume. By reexamination of reproducing areas mapped by the Forest Survey in 1931-32 a procedure for expressing quadrat stocking in expected future volume equivalents was developed at the Western Washington Branch of the Station. It is shown, for example, that an area of site II 50 percent stocked by quadrats at age 5 years should at age 20 years be expected to support 56 percent of the cubic volume shown by the normal yield tables. For site V, however, 50 percent quadrat stocking at age 5 years was found to produce, on the average, only 12 percent of the normal volume at age 20 years. A 50-percent stocking on site V at 15 years produces 33 percent of normal volume at age 30 years. Trees grow larger the better the site, and fewer large trees than small are required to stock fully a given area. Thus, for intensive management, size of reproduction quadrats should be varied site by site.

Probably the most significant development in the field of mensuration during the year was the development, also at the Western Washington

Branch, of preliminary growth rates for second-growth Douglas-fir by tree class. The forester planning thinnings for specific stands needs to know which size classes, vigor classes, and ages of trees are contributing the most to total growth. Based on some 25,000 individual tree measurements on permanent sample plots the new analysis shows that in a given natural stand the most efficient producers of wood volume are the dominant and codominant crown classes. On the average, the smaller dominants and codominants add to their present volume at a relatively more rapid rate than do the larger trees in the same crown classes. The reverse is true of the intermediate and suppressed; for these, growth percent is greater the larger the diameter. A progress report on this study is planned for 1948, but some years of management experience will be required to reveal effects of skillful cutting practices on growth and mortality trends.

Fire Studies

In a region such as this with high forest values and extreme fire hazards the need for effective fire control forces is unquestioned. Presently the expenditures in Oregon and Washington for this purpose total some 8 million dollars annually. In incongruous contrast the financing available for the Station's program of forest fire research is barely sufficient to support a one-man project. Though pitifully inadequate in scope, the work last year yielded significant contributions. Some of these are summarized below together with plans for 1948.

Measuring fire weather. Fire losses and fire suppression costs vary from year to year as result of several factors including both fire control efficiency and fire weather. When reviewing the history of a fire season as a basis for improvements in control organization and methods the administrator must judge the effect of weather on past losses and costs. Several weather elements affect fuel dryness which in turn controls day-to-day or year-to-year changes in inflammability. Wind velocity affects the rate at which fires spread. Analysis of the combined effect of wind velocity and fuel moisture at 96 fire-danger stations, mostly at the lower elevations on the national forests of Region 6 in Oregon and Washington for the period July 16 to August 31 each year beginning with 1941, shows that the past summer in eastern Washington and in western Oregon was more favorable than in any of the other years. But in eastern Oregon the past summer was less favorable than 1941, and in western Washington it was slightly less favorable than 1944. Fuel moisture summaries at 65 stations, about half of which were at lookout points and half at the lower elevations, show that west of the Cascade Summit 1947 was the most favorable year in the period 1941-47 except on the peaks of western Washington where 1944 was more moist. East of the Cascades 1941 fuel moisture was the most favorable. For the national forests in the region as a whole, acreage burned, number of fires over 10 acres in size, and number of fires requiring more than one day of work to control were much less in 1947 than in any of the years beginning with 1941, even though the number of fires started in 1947 was nearly as great as in three of the other seven years. The increased

success in fire suppression was evidently due partly to favorable weather and partly to more efficient fire control.

The best available device for measuring the comparative amount of change from day to day or the average annual level in dryness of the forest fire fuels that control rate of fire spread in Oregon and Washington is the fuel moisture indicator stick developed by forest fire research. This stick, used at several hundred fire danger rating stations, is exposed to rain, dew, atmospheric humidity, wind, heat of direct sunlight, and air temperature in the same way as forest fuels. Its dryness depends on the severity of each of these factors and the intricate effect of the duration of each factor. The wood selected for the sticks meets strict specifications concerning its ability to absorb and lose moisture readily. The stick moisture content is determined by weighing and is expressed in terms of percent of the oven-dry weight. For convenience oven-dry weight is determined before the stick is set out at the beginning of the fire season. One element of error in the moisture content indicated by the stick is the gradual change in the oven-dry weight of the wood owing to outdoor weathering.

Tests have been conducted for several years at the Wind River Experimental Forest and sticks from all national forests in Oregon and Washington have been tested in two different years to determine the extent of weathering in different localities and years. Preliminary results indicate that weathering at most stations east of the Cascades is small and has no significant effect on the use of the sticks for fire danger rating purposes. However, if the danger at a station east of the Cascades is to be compared precisely with that at a station west of the Cascades a correction of 1 to 2 percent moisture content should be added to the west side value. Failure to make this correction may lead to errors in fuel moisture determination as great as 30 percent of the true value. The difference in weathering in different seasons has been found to be small and no correction will be necessary when comparing the fire danger in different years at the same station or same group of stations.

Douglas-fir slash is accumulating. What should be done about the hazard? Approximately 200,000 acres of forest land is clear-cut each year in the Douglas-fir region and until recent years State laws or policies required practically all of it to be burned to reduce the fire hazard. It is now legal to leave slash unburned if it is evident that a slash fire would hinder restocking. Yet very little is known about the ecological effects of burning versus non-burning upon the establishment and rate of growth of tree seedlings, brush, and other vegetation. To provide more knowledge for management of this great area of annual cutting the Station is establishing numerous pairs of test plots in clear-cut logging slash. One plot in each pair is protected from burning while the other nearby plot under similar slopes, aspect, soil, slash, original forest, and seed supply conditions is burned in the normal manner. Some receive burns that barely scorch the duff, some receive burns of moderate intensity, and some are severely burned leaving no duff. The effect of burning with a given severity in each case will be shown by the difference in establishment, composition, and growth of vegetation on the unburned

plot. The difference caused by light burning can then be compared with that caused by severe burning. Sufficient plots will be selected in each climatic zone and on each class of slope, aspect, forest composition, etc., to give the precision necessary for an average representing each factor.

During the past summer 7 pairs of plots selected in the 1946 burning season were permanently established and given their first annual examination, and 28 additional pairs were laid out for burning next year. Selection and establishment will continue for several years.

One of the objections against using a system of partial cutting that removes as much as 30 percent of the stand volume in overmature Douglas-fir types is the increased fire hazard from logging slash. The slash cannot be broadcast burned as on clear-cut areas without excessive damage to the reserve stand. An intensive study immediately after such a selection cutting showed that along the truck and tractor roads, where debris is usually concentrated, the average small fire will spread about 13 times as fast as before cutting. At a distance of 70 feet or more from the roads the rate of spread was found to be about 5 times as great as before cutting. Roads occurred at an average interval of 220 feet. Along the roads fire fighting would be somewhat easier than before cutting, but brush and litter will invade them and after several years reduce their usefulness. By systematic rating of both increased rate of burning and improved control conditions it is estimated that the suppression manpower needed in such an area the first year after cutting would be 4 times greater than before logging. These relationships should be kept in mind when planning protection of partially cut stands.

Two additional slash hazard studies will be started in 1948 to assist in solving two relatively new problems. When main truck logging roads are constructed through blocks of timber to be left standing several years or more while the road is used heavily to haul logs from more distant areas, the debris from the road-clearing operation endangers the green timber. The debris can be burned as a hazard reduction measure but at a rather high cost. Thus, the Station plans to study the cost and hazard reduction effectiveness of burning this material, and the comparative cost and effectiveness of extra fire control measures in lieu of burning. Relogging or salvage logging reduces the quantity of large fuels on a slash area and makes more skid trails on the ground. Does it reduce significantly the probable rate of spread and resistance to control of a fire? If so, is the hazard reduced to a level comparable with that ordinarily found after burning the normal slash? To find the answers, hazard will be systematically rated before and after salvage logging and after burning on similar areas where no relogging is done.

How fast does fire travel? During the past season test fires in sagebrush on level ground with low relative humidities of 14 percent or less and wind gusts of 12 miles per hour were measured spreading $1\frac{1}{2}$ to $2\frac{1}{2}$ miles per hour. In contrast, test fires in cheatgrass on level ground with a high relative humidity of 40 percent or more and wind gusts of

20 miles per hour advanced with equal velocity. Under comparable weather conditions the spread of fire in cheatgrass undoubtedly would have been far more rapid than that in the sagebrush. A Douglas-fir slash fire on moderate slopes with dense slash, duff that was somewhat moist from rains ending 4 days before, a very light wind, and relative humidity as low as 24 percent, gave no trouble at all and was confined entirely to the slash area by careful and slow setting of parallel lines of fire beginning at the tops of the slopes.

Accurate fire behavior and rate of spread estimates are keystones to efficient suppression tactics, fire danger rating, and planning for adequate protection facilities. Yet only crude estimates and rules of thumb are available for this region. Presently we cannot satisfactorily forecast what a given fire will do or where it will be in the next hour. Intensive study of fire behavior is needed to provide this information vital to efficient fire control, but must be held in abeyance for lack of funds. In the meantime, measurements of rate of spread and basic behavior data will be collected whenever possible on wild fires, slash fires, and test fires.

How soon are lightning fires discovered? Lightning causes 75 percent of the fires on the national forests of Oregon and Washington and 25 percent of those on private land. Last year's study of national forest lightning fire reports gives information helpful in planning the discovery and suppression organization for these fires. About 45 percent of such fires are discovered in the first hour after the storm in Washington, but only about 20 percent are discovered in the first hour in southern and eastern Oregon. If rain accompanies the lightning the ignited wet fuel often produces insufficient heat and smoke to be seen until dry weather develops several days later. For the national forests of Washington and Oregon as a whole 31 percent of the lightning fires are discovered in the first hour. The discoveries decrease rapidly until 8 hours after the storm, then gradually increase until the sixteenth hour, then decrease until the thirty-second hour, then increase until the forty-second hour, then gradually decrease. About 20 percent remain to be discovered after 24 hours and 4 percent after 7 days. This knowledge can be used when planning for prompt discovery by emergency lookouts and airplane patrols, prompt attack by suppression crews, and duration of need for emergency help.

Forest fire field manuals revised. Principles previously developed by fire research frequently need to be restated in the form of brief field handbooks for men in the woods. Last year a section of the Forest Service handbook on aerial fire control was written by Morris to explain how best to look for smokes from airplanes so as to employ known facts concerning visibility distance with different background and sunlight conditions. Morris also revised and rewrote the section of the "Western Fire Fighters Manual" describing fuel moisture and weather relationships for the Western Forestry and Conservation Association.

Forest Soils Studies

As western forestry becomes more intensive the need for better understanding of the fundamentals underlying tree growth increases. In the Pacific Northwest one of the basic factors in tree production, the forest soil, has scarcely been touched by research. To fill this gap in silvical knowledge a forest soils study project was initiated at the Station late in 1946. Inevitably, 1947 has been a year of program building. It has also yielded some usable results and served to give direction to future study.

The current program has three main divisions:

(1) Study of soil and site factors influencing tree growth.

(2) The role of soil and site factors in artificial and natural regeneration.

(3) The problems of soil deterioration.

Primary effort has been focused upon the first two of these divisions. The first phase of the soil-site and tree growth-rate study, correlating Douglas-fir site quality and soil fertility, is ready for report. Investigation of soils phases of regeneration problems has been concentrated in the pine types on and adjacent to the Pringle Falls Experimental Forest. Study of soil deterioration problems will be launched next fall in connection with the Station's Douglas-fir slash burning experiments.

Preliminary analyses show that Douglas-fir soils from site I to site IV, that have not been abused, are all quite well supplied with the nutrient elements considered essential for tree growth.

Significant variation in calcium and organic matter content in both A_2 and B horizons has been found between the several localities of the Douglas-fir subregion. The pH value, total nitrogen, and available phosphorous in the B horizons also varied significantly from place to place. However, no strong relationship has been found between fertility and site quality class. These findings give strength to the hypothesis that physical properties of soil and site may be the most important influences on tree growth. Detailed study during 1948 will be directed toward these physical properties.

Late in 1946 the Station cooperated with Region 6 and the Bureau of Plant Industry, Soils and Agricultural Engineering, in a soil survey and study of the soil-forest type relationships found in the pumice region of central Oregon. During 1947 follow-up on this study further confirmed the relationship found to exist between soil drainage and the occurrence of lodgepole and ponderosa pine. This information detailed in Research Note No. 36 has practical application in determining feasibility of planting ponderosa pine on various soil types of the Deschutes-

Klamath plateau. Indications are that ponderosa pine plantings should be confined to well-drained sites. Lodgepole was found to grow vigorously on wetter flats to the virtual exclusion of ponderosa.

Analysis of the textural and moisture-holding characteristics of the BPISAE soils samples has revealed in some ponderosa soils a zone of relatively high accumulation of fine material at a depth of 20 to 40 inches below the surface. This finding lends direction to efforts to improve pine plantation survival and growth. The zone of fine material has a higher moisture and nutrient-supplying capacity than the coarser material above, and is probably the upper limit of most subsoil moisture movement. If this zone can be accurately located on areas being planted, methods could be directed toward establishment of seedling roots in this desirable stratum as soon as possible. Such methods might include furrowing, use of deep planting tools, and production of longer-rooted seedlings. This hypothesis will be tested during 1948.

A handbook, "A Guide for Forest Soil Examination in the Douglas-Fir Region," was written for the use of west side foresters. This booklet outlines rudiments of forest soil science and gives directions for examining forest soil profiles. It is hoped that the publication will increase knowledge and interest in forest soils as an essential factor in tree production.

Applied Forest Management

One of the serious obstacles to the application of silvicultural research findings is the lack of specific information on how to bridge the gap between small-plot results and practical woods operation. To fill this need the Station established late in 1946 the new Applied Forest Management Project. The end of 1947 finishes the first full year of this activity, the objectives of which are (1) to test on logging operations of commercial size, conclusions reached from previous silvicultural, mensurational, fire, and economic studies, and (2) to provide effective study theaters for carefully controlled research in both biological fields and economics of production.

Under this project systematic timber-cutting experiments were installed this year at Cascade Head Experimental Forest in 100-year-old spruce-hemlock by commercial timber sale of 8 million board feet. The new Henderson Creek experimental tract in 150-year-old Douglas-fir, near Florence, was developed in cooperation with the Siuslaw National Forest. The first experimental sale on this tract, totaling 11 million board feet, was negotiated during the year. Plans and ground layout were completed for an 8-million-foot experimental sale in old-growth Douglas-fir and hemlock at Wind River Experimental Forest, and for an experimental stand improvement cutting of 2 million feet by commercial sale in 105-year-old ponderosa pine second growth on the Lookout Mountain Division at Pringle Falls. As previously mentioned, two new experimental tracts of second-growth Douglas-fir were located on highly accessible private lands in western Washington and 20-year cooperative agreements for their development

completed with the owners, the St. Paul & Tacoma Lumber Company and the Simpson Logging Company. Ground work was completed for the designation of a new experimental forest and watershed in old-growth Douglas-fir on the Willamette National Forest.

Forest management and road problems were reviewed on the ground with National Forest and Regional Office personnel on all of the Station's six experimental forests and schedules drawn for development.

A full program for 1948 will be required to push ahead on schedule the applied forest management experiments initiated during 1947. Several phases of the project have already brought forth valuable research results:

Forestry - logging plan study. As the demand for national forest stumpage grows and the allowable annual cut is approached on a number of working circles, the timber sale administration problems become increasingly complex. The problems encountered in opening up completely undeveloped drainages are numerous and difficult. Mistakes can be extremely costly. For example, the cost of an average mile of surfaced west side logging road is approximately $20,000. If a mile has to be abandoned because of improper location, the timber consumer and the Government both lose because road costs are paid for by appraisal allowance. Improper sale layouts cost more to log and result in lower stumpage returns and higher priced lumber. Such mistakes reduce the value of timber left for future cuts as well as that being currently logged. Additional logging costs that will have to be incurred in logging the delayed settings because of original improper road location or "leave" units of inefficient size and shape will reduce future stumpage returns and increase timber costs accordingly.

Because of topographic or climatic conditions, most Douglas-fir region logging is by clear-cutting. For silvicultural reasons, clear-cutting is swinging to a staggered setting pattern; on the national forests the size of the maximum opening is now limited to about 80 acres. Staggered-setting logging with small openings appears to offer definite protection, regeneration, and silvicultural advantages, but this cutting method also tends to complicate and increase the forestry and engineering work necessary. The quality of forestry that can be obtained on the ground largely depends upon the decision as to what timber will be cut first--the size and location of the area to be logged in the initial cutting. Forestry and the practical logging requirements have to be combined in the sale layout or logging plan. Conflicts frequently occur between the desirable from a forestry standpoint and the practical from a logging standpoint. The economics of the situation considered from a long-term basis, usually influences the decision. A paper plan alone, regardless of how good it is, will not produce the best results. The logging plan must be marked out on the ground so that the logger and his employees can understand what is wanted and why and how the logging job is to be done.

To get this type of prelogging planning and preparation is one of the biggest problems confronting Douglas-fir landowners and loggers at the present time. On the national forests, sometimes insufficient personnel aggravates the problem.

In order to obtain some information on the advantages and the costs of complete timber-sale preparation, a pre-sale combination forestry-logging plan was prepared for the Henderson Creek area. A report on this study is being prepared. The advantages apparent at this time are:

(1) The plan on Henderson Creek covered 414 acres on which the cruised volume amounted to 35 million board feet. Of the 414 acres, 251 acres will be logged during the first cutting cycle, either by clear-cutting or partial cutting. Cost of logging unit planning and layout totaled $1,575. This included the selection of cut and leave areas, running and posting the boundaries of the various areas to be logged, a center line location of the roads marked on the ground, locations of landings for the areas to be logged as well as the leave areas marked out on the ground, mapping the entire area, and the preparation of an accurate map. Costs do not include cruising which had been done previously. On the basis of the 11 million board feet sold, costs amounted to $0.143 per M. On the basis of the 35 million board feet served by this work, the cost was only $0.045 per M. Continuity of work and more experienced personnel could materially have reduced the cost on this project. It is estimated on the basis of this experience that a competent forester-logging engineer and a helper in training could readily prepare for sale from 35 million to 50 million board feet annually on a staggered setting basis. Assuming that about one-third of the volume within the newly developed tract would be removed in the first cut, the forestry-engineering work thus could be completed for 100 million to 150 million board feet annually by such a 2-man crew.

(2) The plan resulted in increased stumpage return to the Government. As a result of the plan the bidders knew exactly what was expected. They had accurate data from which to estimate their probable logging costs. For example, on the Henderson Creek area the operators knew exactly how many feet of surfaced and dirt road were necessary, they could estimate road construction costs because the road location was in, they knew how many feet of timber would be tractor-logged, how much would have to be cold-decked and swung, and how much would be yarded without swinging, and they knew exactly what timber volume and areas they had to log. As a result, many of the risks of the venture were eliminated and they could calculate costs closely. On the Henderson Creek sale the 11 million feet was appraised at $65,255 with cooperative deposits, and $113,698 was bid. Not all of the increase between the appraised valuation and the bid price can be attributed to the pre-sale plans, but such planning must be credited with a fair portion.

(3) The complete pre-sale forestry-logging plan promotes good forestry practice. In addition, the information obtained on logging

requirements helps the Government appraiser in making an intelligent stumpage valuation. This is extremely important where competition does not occur. It might be considered almost a necessity for sales in cooperative sustained yield units.

(4) Because of the plan, the need for subsequent sale administration will be decreased and a savings effected. Furthermore, the chance for misunderstandings is decreased. The demand for compromises will lessen. Compromises become complicated with the staggered-setting system because changes affect not only the area to be logged but they also affect the leave areas.

Although the present experiment was worked out on a national forest sale area, the advantages of sound, pre-cutting forestry-logging plans will apply to all timberland owners striving to sustain production and to minimize logging costs.

Quality timber production. Quality timber production is a stated objective of the national forests and local companies are increasingly concerned about growing a grade of raw material that will maintain their competitive position in the timber industry. In the Douglas-fir region the urgency of this problem is temporarily concealed, because most of the cut still comes from old growth. However, in order to produce quality timber for the future a start must be made now. Previous work by the Station shows that Douglas-fir requires about 100 years to develop a completely surface clear 16-foot log, and that it takes about 150 years for Douglas-fir to produce clear wood in commercially important quantity. This is 30 to 60 years past the age at which mean annual increment culminates and the rotation ages commonly anticipated in the calculations of allowable annual cut. Culmination of mean annual growth is ordinarily expressed in board feet on an acre basis. On an acre of Douglas-fir around culmination age, indication is that certain of the best trees (usually the better dominants and codominants) are producing the bulk of the net growth and that such trees have not yet reached the culmination of their mean annual increment. If such stands could be thinned by a series of improvement cuttings, the increase in volume and quality growth might make it very profitable to manage them on rotations up to 200 to 250 years. By thinning thrifty mature stands ranging from 100 to 200 years on an improvement-cutting basis, the defective and low-producing elements could be salvaged, and the bulk of the annual growth would be of high quality. The hypothesis is that in such stands the rotation can be extended to obtain quality timber production without loss of volume growth, without an investment for artificial pruning, and without waiting 100 years for natural pruning to do the job. With present logging equipment, however, such partial improvement cuttings can be made only in stands on favorable topography. Probably not over 40 percent of the total forest land and perhaps 20 percent of the national forest land in the Douglas-fir region is on topography suitable for effective tractor logging so that thinnings can be made to forestall mortality loss and remove the defective and low-producing trees. Logically, since it is so limited, all favorable topography should be dedicated to quality timber

production provided the practicability of improvement thinnings in Douglas-fir can be demonstrated. The testing of this theory is one of the main objectives of the Henderson Creek experiment now under way on the Siuslaw National Forest.

RANGE RESEARCH

The Range Research Division had at the beginning of 1947 set up the following objectives to be fulfilled during the year:

(1) Completion of detailed study plans for all studies under way, of problem analyses for eastern Oregon and Washington, and of plans for grazing studies at Starkey Experimental Forest and Range.

(2) Continuation of the reseeding studies as planned.

(3) Intensification of studies on effect of logging on forage production and on condition and trend of conifer ranges.

(4) Completion of weed section of plant course being prepared for Region 6 personnel.

(5) Construction of some of the necessary improvements on the Starkey Experimental Forest and Range.

Achievements were encouraging during the year even though objectives were not quite reached. With three new men at the Eastern Oregon Research Center much time was devoted to becoming acquainted with the flora and problems of the province. Nevertheless, many study plans were worked up even though not all were completed. The first rough draft of the eastern Oregon problem analysis is completed and that for Washington is moving ahead rapidly. Plans for the Starkey are being developed and fair progress was made in an improvement program. All other objectives were achieved in their entirety. In addition, unplanned achievements included study of Meeks Table and Devils Table, and helping with part of the big game range studies being conducted on five Region 6 forests.

With a new program getting under way, new personnel, and concentration of effort on planning and training, little in the way of dramatic and conclusive results is available. Even so, several items of information were secured which contribute materially to the over-all knowledge regarding management of range resources of the region and interrelationships of land uses.

Effect of Grazing on Tree Reproduction in the Ponderosa Pine Type

Abundance or overabundance of advance reproduction of ponderosa pine and associated tree species is a rather widespread condition in forests of the Blue Mountains and eastern Washington. The suggestion

that overgrazing may have been a major contributing factor comes from the contrast of two areas on the Snoqualmie National Forest in central Washington. These two areas, Meeks Table and Devils Table, are both in the ponderosa pine zone and are fairly comparable basalt-capped plateaus. Neither area has been logged. The major difference in their use is that Meeks Table is inaccessible to livestock and has only been grazed by deer and elk, while Devils Table has a history of heavy use by livestock and big game.

On Meeks Table very little tree reproduction is found. Less than half a dozen ponderosa pine seedlings and saplings were seen on the 70-acre area and none fell on the sample plots. The only tree reproduction found on the sample plots was a group of 8 white fir on one plot. In contrast, on Devils Table there were 2,033 ponderosa pine, 1,016 Douglas-fir, and 242 western larch per acre less than 4 inches d.b.h.

Data on density of forage are also of interest. Grazing on Devils Table has markedly reduced the forage density compared to the densities on Meeks Table.

Forage densities in pinegrass-elk sedge type on Meeks Table and Devils Table
(Recorded in percent ground covered)

Overstory	Meeks Table	Devils Table
Mixed ponderosa pine - Douglas-fir	22.4	12.1
Open ponderosa pine	35.1	13.8

These data may explain why Devils Table supports a dense stand of tree reproduction while Meeks Table has practically none. Lessening of the herbaceous plant cover by overgrazing on Devils Table may have been sufficient to reduce competition to tree seedlings, permitting them to become established and grow.

The Immediate Effect of Logging on Forage Production

In eastern Oregon and eastern Washington are 13 million acres of ponderosa pine forests, making up 89 percent of the summer range area and contributing 65 percent of the summer range grazing capacity. Timber on nearly all of this area will be harvested. Ground disturbance, accumulation of slash, and opening the tree canopy by logging must affect usable forage production in some manner. Range administrators, to properly manage the forage crop, must know the nature and extent of such effects.

The study of effect of logging on range values, begun on a small scale during 1945, was placed on an adequate basis during 1947. Some of the transects established in 1945 have been logged over. Preliminary results from three logging operations show 28 percent of the ground surface was skidded over during the logging operation. Over half of this

area was completely denuded of all range vegetation and the remainder partially denuded. An additional 12 percent of the cut-over area was covered with slashing left after logging and is, therefore, inaccessible to livestock grazing. On one logged transect the total density of forage dropped from 21.9 percent in 1946 prior to logging to 11.4 percent in 1947 following logging. An adjacent unlogged transect dropped only from 22.2 in 1946 to 18.2 percent in 1947.

Seeding Skid Roads Fills an Essential Place in Resource Management

As reported in the previous section, logging ponderosa pine forests disturbs and denudes a substantial percentage of the ground. This denuded area, including skid roads, landings, and spur logging roads, if left untreated, is subject to erosion--light or moderate on gentle slopes, but severe on steep slopes. Such areas produce little forage from one to several years after logging. Moreover, they offer an opportunity for encroachment of such noxious plants as cheatgrass (Bromus tectorum), St. Johnswort (Hypericum perforatum), and Canada thistle (Cirsium arvense). Erosion can be retarded, encroachment by noxious plants curtailed, and forage supplies augmented through seeding the denuded areas to perennial grasses immediately after logging.

Studies are being conducted to determine the best method and species to use when seeding logged-over areas. Observations have shown that orchardgrass (Dactylis glomerata), timothy (Phleum pratense), smooth bromegrass (Bromus inermis), tall oatgrass (Arrhenatherum elatius), and slender wheatgrass (Agropyron trachycaulum) give good results where moisture is ample and that crested wheatgrass (Agropyron cristatum) has given good results at the lower margin of the type. Planting by broadcasting without seed coverage seems to be satisfactory except in the southernmost portions of the region.

Spring Seeding is the Most Effective Method of Planting in Tarweed

Cluster tarweed (Madia glomerata) has become established on depleted ridgetops and open parks throughout the mixed conifer forests of eastern Oregon. Because of their gently sloping topography and open cover, these sites are preferred for grazing and hence are key areas in the utilization of the surrounding conifer ranges. They have, however, been so badly depleted that reseeding is necessary to restore grazing capacity. Past reseeding experience has shown that the dense stands of worthless tarweed give the seeded species severe competition and prevent them from becoming established.

Results of the 1947 tests of methods of reseeding tarweed areas made in the Wallowa Mountains confirm results of 1946 tests which showed that cultivation in the spring, when the tarweed is about an inch tall, followed immediately by broadcasting the seed and harrowing, gives the best grass stands on tarweed areas. Fair results from seeding in tarweed were also obtained by cultivating in July and broadcast seeding and harrowing either in the following fall or the following spring. But drilling

in the fall and broadcasting and harrowing in the fall, the two methods most commonly used in the past when seeding tarweed areas, gave negligible results because they did not eliminate or reduce the tarweed.

Seeding of Timber Burns Continues to Prove Successful

Seeding timber burns to perennial grasses has been found to decrease erosion following a fire and to provide increased forage for livestock and big game animals. Most specific information regarding methods and species to use when seeding burns was derived from results of the 1939 seedings on the Big Cow Creek Burn on the Malheur and Whitman National Forests. To provide a replication to this study under different conditions of soil, climate, and tree overstory prior to burning, species trials were established on the Wooley Creek Burn, Fremont National Forest, during the fall of 1946. Concurrently, the Fremont Forest seeded up the part of the burn occurring on forest lands.

Observation of results of the species trials on the Wooley Creek Burn showed orchardgrass and timothy to give the best initial stands. Other species in order of stands of seedlings obtained were crested wheatgrass, slender wheatgrass, Manchar smooth brome, and tall oatgrass.

Frost Heaving is a Serious Obstacle to Range Reseeding

Seeding trials during the fall of 1945 and 1946 and observations on administrative seedings during several years have shown that frost heaving is a very serious obstacle to successful seeding in the ponderosa pine zone. Not only are seedlings less than one year old heaved out but during the winter of 1946-47 year-old plants of good size were killed. For example, on the Ray Creek Ridge Nursery in the Whitman National Forest where 70 species were under trial in 1946, 26 species were rated as having produced good or very good stands. These same plantings, when rated during the summer of 1947, showed only two species still remaining in the good or very good category. The remainder of the species had been greatly reduced or entirely eliminated by frost heaving. Many other seeding trials in Oregon and Washington received this same damage.

Detailed studies in the ponderosa pine zone have been under way only two years so it is not known how frequently frost heaving conditions occur. But it seems clear that studies of method and time of seeding as well as species adaptability must take into account the danger of frost heaving.

Relation of Pocket Gophers to Condition of Mountain Meadows

Infestations of the Dalles pocket gopher (Thomomys talpoides quadratus) are very common on mountain meadows in the Blue Mountains of eastern Oregon. For many years it has been the common belief of stockmen and others that pocket gopher infestations are one of the primary causes of poor range conditions on many of these highly valuable meadows. As a result, on many areas rather intensive control work has been carried out in the past.

A study to determine the effects of pocket gophers on mountain meadow vegetation was initiated cooperatively by the Ochoco National Forest and the Fish and Wildlife Service in 1931. The Experiment Station took over the vegetative work in 1940.

Preliminary analyses of the effect of pocket gophers on mountain meadows indicate that meadows in poor conditions infested by gophers did not improve in range condition during ten years of observation, both where the area was grazed by sheep and where no livestock was present. Removal of pocket gophers from a meadow range in poor condition resulted in marked range improvement. This amounted to an increase in plant cover of 2.5 times on the grazed area and 4.3 times on the ungrazed area in seven years. During the same period, introduction of pocket gophers onto a meadow range containing a good mixture of perennial grasses and weeds, where food was plentiful, did not stop range improvement. With a few exceptions the plant species affected by the introduction of pocket gophers were not highly valuable as forage plants.

Pocket Gophers Cause Damage to Reseeded Areas

The Dalles pocket gopher when occurring even in moderate numbers on severely depleted ranges, the sites in greatest need of reseeding, keeps the soil well worked. This soil working is believed to have been the cause of some reseeding failures on newly seeded areas. Work of the Dalles pocket gopher has also been observed to be the cause of gradual depletion of some plantings. Stand depletion is brought about by the pocket gopher eating all or part of the root crowns from the established plants. Since the pocket gopher is active yearlong, this use goes on throughout the year.

Exploratory studies of the effect of pocket gophers on an ungrazed crested wheatgrass stand in Logan Valley showed that during the growing season of 1945 and winter of 1945-46, 12 percent of the plants had been completely killed by pocket gophers and an additional 20 percent of the plants had parts of the root crowns taken.

A secondary effect of gopher activity may be associated with the use of abandoned gopher runways by the whitefooted mouse (Peromyscus spp.) and meadowmouse (Microtus spp.). The whitefooted mouse especially is a seed eater and could conceivably be the cause of the absence of reproduction in crested wheatgrass stands.

During 1947 a cooperative study with the Fish and Wildlife Service was started on Logan Valley, Malheur National Forest, to determine the effects of the Dalles pocket gopher on both the establishment and maintenance of crested wheatgrass plantings.

Studies on Big Game Ranges Taken Over

In 1945 studies on big game ranges were initiated by Administration on the Fremont, Malheur, Whitman, Umatilla, and Snoqualmie National Forests.

Part of the program included the establishment of many 3-way enclosures--livestock and big-game proof, livestock-proof, and open to both classes of animals. They also included studies of resistance of some of the chief big game forages to five different intensities of clipping; none, 25, 50, 75, and 95 percent of the current year's growth. Many of the species being studied were also key forage plants for livestock.

Because of the close relationship between management of livestock and game range, Range Research took over much of the work on the enclosures and in the clipping studies this summer when lack of funds necessitated dropping of the work by Administration. An attempt will be made to salvage as much as possible of the information from the clipping studies and suitable enclosures will be fitted into the range research programs on condition and trend.

Development Begun of Starkey Experimental Forest and Range

During 1947 major emphasis was placed on construction and development of improvements needed on the Starkey Experimental Forest and Range preparatory to the initiation of intensive research work. A headquarters site plan was developed and laid out on the ground. The headquarters site was fenced, the area cleaned of debris, and construction of roads, parking, and service areas begun. A building to be used as a temporary office was moved to the site from Frazier Ranger Station on the Umatilla National Forest and a prefabricated residence delivered at the site to be erected during 1948.

Fences were constructed at the Ray Creek Ridge and Campbell Flat Nurseries. In addition, 5.5 miles of new boundary fence were constructed and 4.2 miles of abandoned boundary fence salvaged. The new fence includes 900 acres additional range, within the boundaries of the Experimental Forest and Range, part of which will be needed for experimental pastures.

Pastures have been located for the intensive grazing study comparing the effects on range, watershed, and timber values of season-long and deferred-rotation grazing at three different intensities. Fencing of these pastures and completion of water development now await approval of the plans and funds for construction.

Plans for 1948

Even though there are many vital range problems not being attacked in this region, no enlargement of the range research program is contemplated during the coming year. Every effort will be made to complete study plans, problem analyses, and plans for grazing studies on the Starkey Experimental Forest and Range. Following completion and approval of plans for grazing studies on the Starkey Experimental Forest and Range it is hoped to be able to construct one full set of pastures in 1948 so that grazing studies can be begun in 1949.

Reseeding studies are to be continued as planned. Results from 1945 and 1946 plantings will be reviewed and a set of brief guides prepared for administrative use. A special effort is to be made to formulate guides for seeding of skid roads, landings, and spur logging roads. In this, a review of administrative seedings will need to be made.

The final data on clipping studies started by the forests in connection with the big game range study will be secured and the data compiled. Studies on condition and trend of conifer ranges and of the effect of logging on forage production will be continued. A brief report for administrative use will be prepared regarding the immediate effects of logging.

A manuscript for publication as a technical bulletin will be prepared on the cooperative gopher study and the study of the effect of gophers on range reseeding continued.

PUBLICATIONS

Departmental Bulletins

Hall, J. A. (joint author with R. K. Winters and G. H. Chidester). Wood waste in the United States. 45 pp. Wash., Govt., 1947. (U. S. Forest Serv. Report from A Reappraisal of the Forest Situation no. 4).

Outside Publications

Byrne, J. J., Nelson, R. J., and Googins, P. H. Log hauling cost by motor truck and trailer. Pacific Logging Congress, 38th. Loggers handbook 7: 72-86. 1947.

Hall, J. A. Forest utilization. Unasylva 1 (1): 12-26. July/Aug. 1947.

_____ Glued products from second-growth management. Univ. of Wash., College of Forestry Bul. 2, pp. 33-35. 1947.

_____ Integrated utilization. British Columbia Lumberman 31 (12): 61-62, 66. Dec. 1947. (Slightly condensed in) Wood 2 (12): 20-21, 41-44. Dec. 1947.

_____ Possibilities in new forest products industries in the Northwest. Northwest Science 21 (3): 101-108. Aug. 1947.

_____ The wonders of wood chemistry. Washington State Forestry Conf., 25th (1946): 16-18.

_____ Wood sugar and sulfite spirit. Food and Agr. Organ. of the United Nations, First meeting of Subcommittee on Wood Chemistry, Sept. 3, 1947, pp. 7-13, processed.

_____ (joint author with H. J. Andrews). Managing the forests. Sunday Oregonian, March 30, 1947.

Isaac, L. A. (joint author with Ernest Wright and A. S. Rhoads). Decay losses following logging injury in partially cut stands of western hemlock and Sitka spruce. Timberman 48 (10): 52, 54, 72, 74, 76. Aug. 1947.

Knauss, A. C. Wood technology as it relates to gluing: a panel discussion. Univ. of Wash., College of Forestry Bul. 2, pp. 57-59. 1947.

Locke, E. G. Products from wood waste (yeast, molasses, wood flour, alcohol). Chamber Com., Spokane, Timber Prod. Bur. Wood Prod. Clinic, Proc. (1947) 2: II, 19-21, processed.

Marquis, R. W. Forest economy of Willamette Valley. Crow's Pacific Coast Lumber Digest 26 (10): 11-12. May 26, 1947.

_____ Log production and sustained yield. Timberman 48 (6): 36-38. Apr. 1947.

_____ Science and forestry goals. Northwest Science 21 (2): 63-68. May 1947.

Matson, E. E. Lumber grade recovery study of Oregon Coast Range type Douglas-fir timber. West Coast Lumberman 74 (5): 82, 86, 88. May 1947.

_____ and Grantham, J. B. Salvage logging in the Douglas-fir region of Oregon and Washington. Oregon State College, Oreg. Forest Products Lab. Bul. 1. 39 pp. Aug. 1947.

Morris, W. G. Looking for smokes from airplanes. Jour. Forestry 45 (1): 47-48. Jan. 1947.

_____ Moisture condition of fuels. Western Forestry & Cons. Assoc., Western fire fighters' manual, Supplement to Chap. VII. 17 pp.

Pechanec, J. F. The seed grower's stake in our national forests. Oregon Seed Growers League Proc. (1946) 6: 25-34.

_____ and Hull, A. C., Jr. Australian plow needs changes. Oregon Farmer 70 (22): 34. Nov. 1947.

_____ (joint author with A. C. Hull, Jr.) Cheatgrass - a challenge to range research. Jour. Forestry 45: 555-564. Aug. 1947.

Rapraeger, H. A. The change in the fire hazard on partially cut logging areas. Timberman 48 (9): 50, 52. July 1947.

Multilithed Reports

Byrne, J. J., Nelson, R. J., and Googins, P. H. Cost of hauling logs by motor truck and trailer. 112 pp. Oct. 1947.

Douglas-Fir Second-Growth Management Committee. Management of second-growth forests of the Douglas-fir region. Dec. 1947.

Moravets, F. L. Forest statistics for Klamath County, Oregon. 28 pp. June 1947. (Forest Survey Report no. 99).

_____ Forest statistics for Multnomah County, Oregon. 15 pp. June 1947. (Forest Survey Report no. 98).

Morris, W. G. What is the time between ignition and discovery of lightning fires? 5 pp. Dec. 9, 1947. (Forest Research Note no. 40).

Mowat, E. L. Effect of pruning on growth of ponderosa pine. 3 pp. Oct. 25, 1947. (Forest Research Note no. 38).

_____ High yields from young-growth ponderosa pine. 3 pp. Oct. 25, 1947. (Forest Research Note no. 37).

Munger, T. T. Growth of ten regional races of ponderosa pine in six plantations. 4 pp. Oct. 31, 1947. (Forest Research Note no. 39).

_____ The Wind River Arboretum from 1937 to 1946, progress report no. 3. 21 pp., illus. Sept. 1, 1947.

Pacific Northwest Forest and Range Experiment Station. Annual report - 1946. 31 pp. May 1947.

_____, Div. of Forest Economics. Forest survey field and office manual. 72, 21 pp. March 1947.

Silen, R. R. Comparative growth of hybrid poplars and native northern black cottonwoods. 3 pp. Oct. 1, 1947. (Forest Research Note no. 35).

Tarrant, R. F. First forest soil survey gives significant results. 4 pp. Oct. 15, 1947. (Forest Research Note no. 36).

_____ A guide for forest soil examination in the Douglas-fir region. 27 pp. Dec. 1947.

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J. Alfred Hall	Director
Samuel E. Kistler	Administrative Assistant
Stanley A. Norton	Chief Clerk
Frances Elliott	Clerk-Stenographer
Erna J. Jeppesen	Library Assistant
Leah Wheeler	Clerk-Stenographer
Cavel V. Sherman (10+ mo.)	Misc. Dup. Mach. Operator
Robin A. Hill (1+ mo.)	Misc. Dup. Mach. Operator
Inga E. Fulkerson (3+ mo.)	Statistical Clerk

Temporary

Millard M. Becker (1 mo.)	Misc. Dup. Mach. Operator

FOREST ECONOMICS

Robert W. Cowlin	Forest Economist
A. Kathryn Flaherty	Draftsman
Elsa E. Wasser	Clerk-Stenographer
Marion E. Anderson	Statistical Clerk

Cooperative Project with Bonneville Power Administration

Ralph W. Marquis (8+ mo.)	Forest Economist

Forest Survey Inventory

Floyd L. Moravets	Forest Economist
Richard C. Wilson	Forest Economist
Floyd A. Johnson	Forester
Willard H. Carmean (3 mo.)	Forester
Raymond M. Gregg (7 mo.)	Forester
Walter R. Johnson	Forester
Carl E. Mayer	Forester
Paul R. Thompson (5 mo.)	Forester
Charles E. Tyler (4 mo.)	Forester
Bruce A. Elmgren (1 mo.)	Agricultural Aid

Temporary

William B. Markowski (2 mo.)	Eng. Draftsman

Requirements, Production, and Supplies (RPS)

Sinclair A. Wilson (6 mo.)	Forest Economist

Lumber Census and Other Statistics

George E. Morrill (6 mo.)	Forest Economist
Christina M. McPhail	Clerk

FOREST MANAGEMENT RESEARCH

Philip A. Briegleb	Silviculturist
Robert F. Tarrant	Soil Scientist
Leona M. Bates	Clerk-Stenographer
Emma G. Johnson	Clerk-Stenographer

Temporary

Geraldine Laughman (5+ mo.)	Clerk-Typist
Evelyn B. Shurtleff (5 mo.)	Clerk-Stenographer
B. Carol Nedry (1+ mo.)	Statistical Clerk

Silviculture

Leo A. Isaac	Silviculturist

Applied Forest Management

Elmer E. Matson	Forester

Fire Protection

William G. Morris	Silviculturist

Forest Management Research Centers

Western Washington Research Center (Olympia, Wash.)

Norman P. Worthington	Forester
George R. Staebler	Forester
Melvin P. Twerdal	Forester
Ruth H. Campbell	Clerk-Stenographer

Temporary

Charles S. Callin (5 mo.)	Timber Mgmt. Assistant
James H. Mueller (3 mo.)	Timber Mgmt. Assistant

Western Oregon Research Center (Corvallis, Oreg.)

Robert Aufderheide	Forester
Harold A. Rapraeger	Silviculturist
Roy R. Silen	Forester
Nadine G. Schumacher (11+ mo.)	Clerk-Stenographer

Temporary

John R. Dilworth (1 mo.)	Silviculturist
George H. Barnes (3 mo.)	Forester
Clarence W. Jacobs (9+ mo.)	Agricultural Aid
James C. Lamy (1+ mo.)	Timber Mgmt. Assistant
Julian F. Miller (3 mo.)	Timber Mgmt. Assistant
Norman P. Sorenson (1 mo.)	Timber Mgmt. Assistant
James A. White (2+ mo.)	Timber Mgmt. Assistant

Forest Management Research Experimental Forests

Pringle Falls Experimental Forest

Edwin L. Mowat	Forester
Walter G. Dahms	Forester

Temporary

Kilbourne C. Pickett (3 mo.)	Timber Mgmt. Assistant

Wind River Experimental Forest

William E. Bullard (8 mo.)	Forester
Robert W. Steele	Forester

Temporary

William I. Stein (3 mo.)	Timber Mgmt. Assistant

Cascade Head Experimental Forest

Robert H. Ruth	Forester

RANGE INVESTIGATIONS

Joseph F. Pechanec	Forest Ecologist
Robert S. Rummell	Range Examiner
May W. Van Staaveren	Clerk-Stenographer

Temporary

Quentin Jones (3 mo.)	Timber Mgmt. Assistant

Range Investigations - Research Centers

Eastern Oregon Research Center (La Grande, Oreg.)

Elbert H. Reid	Forest Ecologist
George A. Garrison	Forest Ecologist
Robert W. Harris	Forest Ecologist
Ellerslie W. Stevenson	Forest Ecologist
Harold J. Jensen (5 mo.)	Agricultural Aid
Marion L. Halsey (11 mo.)	Clerk-Stenographer
W. Joan Eales (1 mo.)	Clerk-Stenographer

Temporary

John W. Bohning (3 mo.)	Timber Mgmt. Assistant
Lucian E. Whealy (2 mo.)	Timber Mgmt. Assistant

FOREST UTILIZATION SERVICE

James J. Byrne (10 mo.)	Technologist
Edward G. Locke	Chemical Engineer
Archibald C. Knauss	Technologist
Vivian B. Heigh	Clerk-Stenographer

Temporary

Jake Abramson (2 mo.)	Timber Mgmt. Assistant
Clyde J. Bagby (1 mo.)	Timber Mgmt. Assistant
Francis L. Ison (2+ mo.)	Timber Mgmt. Assistant
William B. Markowski (2 mo.)	Timber Mgmt. Assistant
Helen Sherman (2+ mo.)	Clerk
Mary C. Wiebusch (3+ mo.)	Clerk-Typist