DOUGLAS-FIR IN THE PACIFIC NORTHWEST

By

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A summary of the literature concerning Douglas fir forests, silviculture, utilization, and management.

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INTRODUCTION

The largest and best stands of Douglas fir (Pseudostuga taxifolia) are found in the western parts of Washington and Oregon. Douglas fir is here the dominant species and comprises about 66% of the stands west of the Cascade Range in these two states, and one-fourth of all the virgin timber remaining in the United States. Douglas fir contributes 7,462 million board feet, or 21% of the total yearly cut in the forests of the United States.

An immense logging and lumbering industry has sprung up in this region in the past few decades. Washington ranks first in lumber production, and Oregon is second. This logging and lumbering industry constitutes 65% of the entire industrial payroll of the states of Washington and Oregon.

From this it can be seen that Douglas fir is an important forest tree and as such deserves thorough study to determine the best methods of using this tree to secure maximum benefits. The purpose of this report is to summarize all the important factsfrom the standpoint of silvics, silviculture, and management, which have to do with Douglas fir. The facts presented in this report were obtained from various publications on Douglas fir, a list of which is appended.

THE DOUGLAS FIR REGION AND ITS FORESTS

The Douglas fir region lies between the Pacific Ocean and the crest of the Cascade Mountains, in western Washington and Oregon, from British Columbia to the California line. In size this area is 120 mile wide by 470 miles in length, with a total area of 56,000 square miles. With the exception of a few meadows and sterile mountain tops, this area was continuous forest on the advent of the white man. The original forest in this region covered 28,000,000 acres; forest fires, logging, and land clearing have reduced this area by approximately 4,000,000 acres.

Climate and Topography

Except at high elevations in the mountains, this region has long, warm summers and mild winters. The amount of preciptation varies in this region, but most of the region receives about 50 inches of rain during the year and some localities have more than 100 inches.

The Fog Belt, which comprises the western slopes of the Coast Range, receives the highest precipitation of the region. During the wet season, which commences in September and extends into late July, this area is subject to heavy rainfall and to moist, dripping fogs which roll in from the Pacific Ocean. The dry season is of short duration.

That part of the region lying between the Coast Range and the crest of the Cascade Range receives less rainfall and has longer dry seasons. Towards the south the precipitation is less and the dry season becomes longer. The dry season varies in length, but in general starts in the latter part of May, or early July, and extends to September and October. During this period there is practically no rainfall.

Typical of the region are rugged mountains and broad, fertile valleys. In Washington, especially, there are flat valleys and gravelly plains. The soils of the region include sterile gravels, sands, heavy clays, loose friable loams, volcanic ash, and almost every combination of thesa classes. The Cascade Mountains roughly divide the states of Washington and Oregon into unequal parts, and are a bold continuous range extending from British Columbia southward almost to the northern boundary of California. Some of the highest peaks are 14,000 feet above sea level. As a rule the slopes of the mountains have fertile soils and support a rank growth of forest. Between the Cascade Mountains and the Coast Range Mountains are broad valleys. The Coast Range Mountains are not as high as the Cascade Mountains, and border the Pacific Ocean; on many parts of the coast they end abruptly at the sea. The Siskiyou Mountains are in the southern part of Oregon extending southward into California. These mountains contain sterile, rocky soils and are sparsely covered with trees.

Types

The Douglas fir region has three distinct types. They are the Douglas fir type proper, the fog belt type, and the upper slope type.

The Douglas fir type proper

In this type Douglas fir comprises 60% or more of the total volume of timber. The Douglas fir type proper covers three-fourths of the forested area of Washington and Oregon, and an even larger proportion of the commercial timber.

Other species which occur with Douglas fir in this type are, western hemlock (Tsuga heterophylla), western red cedar (Thuja plicata), Sitka spruce (Picea sitchensis), silver fir (Abies amabilis), noble fir (A. nobilis), white fir (A. grandis)

and western white pine(Pinus monticola).

As the site becomes wetter a larger proportion of other species enter into the composition. The proportion of hemlock increases with altitude and with the approach to the fog belt. Northward, with the increase in humidity and coolness, the proportion of other species grows larger also.

In southern Oregon on the foothills of the warm dry valleys and on the hotter slopes of the mountains Douglas fir gives way to western yellow pine (Pinus ponderosa).

The Fog Belt Type

This type is found on the humid western slopes of the Coast Range Mountains. The principal species here are Sitka spruce and western hemlock,though Douglas fir is never absent over a large area. Western red cedar is also conspicuous here, and farther south Port Orford cedar(Chamaecyparis lawsoniana) is important. Most of this type is the scene of the most active logging operations of the Douglas fir region.

The Upper Slope Type

At certain altitudes on the Cascade,Olympic,and Siskiyou mountain ranges, Douglas fir disappears altogether. The types here are made up of a varying proportion of silver fir,noble fir, mountain hemlock (Tsuga mertensiana),western hemlock,western white pine,lodgepole pine (P.contorta),alpine fir(A.lasiocarpa), and others. For the most part these upper slope types have little commercial value because of their inaccessibility.

SILVICAL CHARACTERISTICS OF STAND

The Young Forest

In the Douglas fir region there are whole townships of immature timber. Extensive logging operationsare as yet not concerned with this young timber, but as the supply of mature timber becomes less these forests will furnish a large part of the timber of the region.

These young forests originated naturally after logging operations or following severe fires that killed the former forests. Some of these stands are almost pure Douglas fir, are very extensive, even-aged, uniformly stocked, and unbroken over thousands of acres; others are small patches surrounded by timber of other age classes.

The most reliable estimate places the total area of Douglas fir younger than 120 years at 2,500,000 acres in Oregon and 2,000,000 acres in Washington. One half of this timber is privately owned. A survey in 1922 by the Forest Service on 6,910,529 acres of National Forest within the Douglas fir zone showed2,009,580 acres,or 34%, of Douglas fir under 120 years.

Old Forests

The old mature stands of Douglas fir lose their pure, even-aged character as they grow older. On gaining maturity the crown cover is more or less broken and under growth is present. There is usually a mixture of other species in the stand, of younger age classes. These species are largely hemlock,western red cedar,white pine,and others. Pure stands of very old Douglas fir are never found.

64 YEAR OLD STAND OF DOUGLAS FIR
80,000 Scribner bd.ft.
Lane Co., Ore.
Site II.

EFFECTS OF IMPROPER SPACING IN ABOVE STAND

Life Cycle of the Forest

The new forest starts with many thousands of small trees to the acre, but only a small proportion of these survive until the stand reaches maturity. At ten years of age on reasonably good land there are about 900 trees per acre, some of them 10 to 12 feet tall, and having limbs to the ground. At 30 years at least one-half of these trees are left, and the sizes are much greater, some trees on each acre being 12 inches or more in diameter and 90 feet tall. The lower limbs have been killed off by the dense shade but still remain on the tree. At 100 years there are about 80 trees per acre living (90% of the original number having died) with diameters of 2 to 3 feet and heights up to 200 feet. At this time the trees have almost reached their full height growth. The boles have cleaned to almost one-half the total length; the bark has thickened greatly, becoming deeply furrowed, and the canopy has opened up thus allowing the tolerent hemlocks and cedars to appear in the older forest.

DOUGLAS FIR REPRODUCTION

SIVICAL CHARACTERISTICS OF TREE

Size and Form

In the Pacific Northwest Douglas fir is a tall,massive tree with gradually tapering trunk, attaining great size and age. Trees 5 or 6 feet in diameter and 250 feet tall are common in mature forests. Trees larger than 8 or 9 feet in diameter and 375 feet height are rare. These trees are generally over 500 years of age. The greatest diameter authentically reported is of a tree,still standing,near Mineral,Washington. The measurementsoon this tree, made by R.E.McArdle in 1924 with Abney level and diameter tape,were 15.4 feet D.B.H., and 225 feet to a broken top. The tallest tree on record was reported by E.T.Allen in 1900. This tree, near Little Rock, Washington, was 330 feet tall and had a diameter of 71.6 inches. Other tall trees on which accurate information was given are; near Hoquiam,Washington, 318 feet;Little Rock, Wash., 325 feet. Some volumes are;log 12 feet at butt and 274 feet long scaled 105,000 board feet, Scribner scale, Bellingham,at Clear Lake, log 12.9 feet by 170 feet scaled 78,000 board feet. The oldest tree on record was found by Ranger Ralph Hillingoss on Finney Creek,30 miles east of Mt.Vernon, Wash. The age count showed 1,375 rings.

Tolerance

Douglas fir is classed as a medium tolerant tree,but its sensitiveness to shade varies with age. The tree is tolerant at an early age,but at 25 years it begins to become less tolerant. After the tree has reached an age of about 25 years it cannot endure side or overhead shading. The inability of Douglas fir to live in forest shade allows the cedar and hemlock to creep

into the stand which causes the old,mature stands to become mixed in character.

Windfirmness

Douglas fir is in general a windfirm tree,especially on dry,gravelly soils. On moist clay soils,however,a shallow root system developes, making the tree liable to wind-throw. Large areas of blow-downs,as in the case of the Olympic Blow-down,have usually been due to extremely high winds rather than to lack of windfirmness on the part of the tree. In the case of large blow-downs all species on the area suffered equally.

Temperature Requirements

Douglas fir grows well in situations having temperatures as high as 113°F during the hottest of the summer days,and zero weather in winter. This species makes its best development in the Pacific Northwest where the winters are short and mild,having a mean winter temperature of 32°,and the summers ~~have~~ a mean temperature of 70°. Altitude shows the preference of Douglas fir for the warmer condition, as it occurs from sea level to about 6000 feet elevation,where it thins out rapidly.

Soil Requirements

Douglas fir grows best on sandy loam soils. The next best in the order of importance are clay loams,clays,sands,and gravels. The presence of rock in these soils does not appear to decrease the quality of these soils. The least desirable of the soils are the gravels,which occur in isolated patches. These soils occur in many mixtures throughout the region. Drainage is an important factor as the best growth of Douglas fir has been on slopes of 40 to 50 percent,where the drainage is good.

Moisture

The Pacific Northwest, where Douglas fir reaches its best developement, is characterized by abundant precipitation. Except at high elevations this takes the form of steady soaking rains,which may last for weeks,during the wet season. The wet season,in general,is of seven to eight months duration. In the Douglas fir type proper there are periods of clear weather mixed in with the rainy. In the fog belt the rains are augmented at frequent intervals by dripping fogs from the Pacific Ocean.Parts of the fog belt receive 100 inches of rainfall during the year. The average for the Douglas fir type proper and the upper slope type is close to 50 inches of rainfall each year.

For best development Douglas fir requires 50 inches of rainfall,but it will grow and does fairly well on less, On the east slopes of the Olympic Mountains near Port Townsend the annual precipitation is between 18 and 20 inches per year. Here the Douglas fir trees are short with limby trunks and thin grey-white bark.

Reproductive Ability

Reproduction in Douglas fir is from seed and does not occur from sprouts as in the case of hardwoods and a few other conifers. Douglas fir bears some seed every year and generally has a good seed crop every three years, but only a full seed crop is sufficient to fully stock an area in any one year. Reproduction from scattered seed trees is slow. The best results are obtained by seeding from the side from a solid bank of timber.

Reproduction from seed stored in the duff(3) has been a comfortable solution of the problem for many years,but the method has been largely theory and late investigations by the Forest Service tend to disprove this theory. It has been found that seed stored in the duff germinates in from one to two years after being placed there,and that most of the seed in the duff does not remain viable longer than about five years after falling.

Rate of Growth

It is quite obvious that the yield of a forest in one locality will not be as large as that of a forest of the same age in another. Soil, altitude,exposure,and rainfall contribute towards making some areas very productive and others less so. The quality of the site is the resultant of all the various physical factors which have a share in promoting the growing of timber.

The best growth of Douglas fir is found on clay-loam and sandy-loam soils,which are deep and well drained,lie below 1500 feet in elevation,and which receive a large amount of rain,especially in the spring and summer months. The best growth has been found on slopes from gentle slope to about 40 percent having a north to east aspect. Clay soils under the same conditions generally rank second best in site quality with sand and gravel soils indicating a poor site.

The rate of growth also varies with the age of the stand, increasing rapidly when the stand is young but soon reaching a maximum and then declining slowly but steadily. In gross total volume the amount of wood added to the original volume will be ~~found~~ from 100 to 150 percent,depending on site, between 20 and 30 years of age. For a forest on the best

quality of site, the fastest production of wood occurs between its twentieth and thirtieth years when there is added on each fully stocked acre 292 cubic feet per year. In the decade between 150 and 160 years only 61 cubic feet of wood is produced each year on one acre.(2)

Sixty-five years is the age at which the greatest mean annual production of wood in cubic volume is indicated on all qualities of site. The peak of mean annual increment for the entire age of the stand when reckoned in board feet comes at about 88 years of age on site I, at 91 years on site II, 107 years on site III, and 137 years on site IV. The fastest current annual increment in a Douglas fir forest comes in the first 50 years of its life and the greatest average yearly production is reached when the forest is about 100 years old. If quantity production only were desired the best rotation age on these three sites qualities would be from 90 to 100 years.

Resistance to Injury

Fire- Crown fires occur most frequently in old growth timber, due to the large amount of brush and young growth present because of the open nature of the stand. The amount of destruction due to crown fires is greater in old growth timber than in young growth. The dense cover presented by the young forest keeps the area clear of ground cover, and crown fires are less liable to get a start in young timber. Ground fires cause much damage in young stands because the bark has not thickened sufficiently to afford protection. In the old growth timber the thick bark prevents damage to the timber.

Insects - In early life Douglas fir has greater resistance than most trees to both insect and fungus attack. The susceptibility of the tree to insect attack increases but

slightly with age and the great thickness of the bark serves as a protection from serious damage. Dendroctinus pseudostugae does the most damage but its activities are limited to scattered localities. What will happen when the activities of man have sufficiently disturbed the biotic balance of the practically virgin forests of the Coast region remains to be seen. A serious outbreak may result. The control of D.pseudostuga is not difficult at present, and consists in the location and barking of infected trees during the period between November and the following March.

Fungi - The most important of the fungi affecting this tree are Trametes pini, Polyporous Schweinitzii, and Fomes laricis. The rot caused by Trametes pini is the characteristic 'pecky rot' and causes great damage in old stands. In stands under 100 years of age less than 0.5 percent of the merchantable volume is affected by fungi.(Boyce,J.S.)

Technical Qualities of the Wood

Two general classes of Douglas fir are recognized by lumbermen,'yellow' and 'red' fir, according to the color and quality of the wood. The 'yellow' fir is soft,easily worked, elastic,and has a light yellow color with no pronounced demarcation between sapwood and heartwood. This wood comes from old trees. 'Red' fir has a reddish heartwood with a light sapwood,and comes from 'second growth',or young trees. The red wood is hard,brashy and has a tendency to warp.

UTILIZATION

Logging

During the early period of the logging industry on the Pacific Coast oxen, and later horses, served as the source of power. Because of the great size of the timber and the rough topography, power logging with steam machinery soon supplanted logging with animals, and is now a prominant feature of logging in the Douglas fir region. The latest tendency is towards machinery of a lighter type, such as the gasoline skidder which is used by many companies in "relogging" operations.

Power logging involves the use of a large amount of heavy machinery in the form of skidders, yarders, loaders, and miles of standard gauge railway with specially adapted rolling stock. The investment is large and the cost of logging is great.

Logging is done in practically the same manner throughout the region. The most widely used system is what is termed the 'high lead', or 'skyline' system. This system consists essentially of two spar trees between which the leads are strung, and the donkey engine, the source of power, which is located at one of the spar trees. In some instances the logs are hoisted clear of the ground on being hauled to the landing, in others one end of the log only is raised clear of the ground. A modification of this system uses but one spar tree located at the donkey engine, the far end of the cable being anchored to a stump. In the ground lead system, which is very rarely used in the Douglas fir region, spar trees are not used, the logs being dragged along the ground directly to the landing. Some of the systems used in high lead logging are;

Double Slack Line System

Dunham "

North Bend System

Slack Line "

Lidgerwood "

Tyler "

The above involve the use of two spars, and in the Lidgerwood system one spar is of steel construction. The others use for spars large trees with the tops sawed out. In some operations the source of power is modified by using gasoline and electric donkey engines. In the "relogging" operations light two-speed skidders and caterpillar tractors are used.

The bulk of the timber logged in this region is transported over standard gauge railways. These railroads in most cases are owned by thelogging company, or, the logging companies have enough railroad to bring the logs to some point on a common carrier railroad. These railroads traverse rough country in order to tap remote bodies of timber, and the cost of their construction is great. In many instances the cost of construction runs up to $ 20,000 per mile. The railroads are equipped with specially designed rolling stock to take care of the logs.

Kinds of Products

During the early stages of the lumber industry on the Pacific Coast, the product consisted of rough lumber and large timbers shipped green directly from mill to remanufacturing centers in various parts of the United States, and to foreign countries. This period was followed by the establishment of yards and dry kilns, and the product was completely seasoned before shipment. The latest tendency is towards the development of remanufacturing plants located on the Pacific Coast, and the shipment of the finished product in the form of dressed lumber, moulding, flooring, and interior finsh, from there.

Because of its strength and lightness, Douglas fir is widely used as a structural material. Large sizes in high quality material are obtained, and the great bulk of the product of the fir mills takes the form of large dimension stock. Douglas fir timbers are preferred in all kinds of construction where long clear lengths and large cross-sections are desired, as in the building of bridges and for freight car beams. The Douglas fir stands are practically the only remaining source of such material in abundant quantities.

Douglas fir ismuch used also for small dimension material. Vertical grain flooring finds a ready market in the west where hardwood is scarce, The production of flooring requires clear old-growth timber of large size and only a small proportion of each log can be cut into vertical grain material. Other classes of fir products are; furniture, interior finish, sash and door, sheathing, crate and box, poles and post.

Douglas fir is cut into the following recognized grades;

Selects.- Admitting no defect of any kind.

Clear.- #1 Practically the same as the select grade, and in some localities this grade is the select.

#2 Admits a small check, or pitch seam at the edge or at one end.

Common.

1. Admits sound knots not over an inch in diameter spaced one and one-half or more feet apart. No other defect allowed.

2. Admits knots up to two inches in diameter, and some of them may be loose. A small amount of pitch seams maybe allowed.

3. Contains unsound knots, pitch seams, and checks. This is the poorest grade.

SILVICULTURE

Methods of Cutting

The present methods of cutting being largely on private lands are concerned with the removal of all merchantable timber with the utmost of efficiency, and without a view to future use of the land for timber growing. Due to the large timber and the heavy machinery necessary in logging, the method used is to clear-cut the area. After the resulting slash is disposed of by broadcast burning, the original forest has completely disappeared. If fires are kept out Douglas fir naturally reestablishes itself in pure stands following the logging operations. Douglas fir is ideally adapted to the clear cutting methods as is evidenced by the splendid reproduction which characterizes much of the logged over lands and burns in this region. The silvicultural method best suited to Douglas fir would appear to be clear cut under three methods. They are (1) the scattered seed tree method, (2) strip method, (3) clear-cut-and-plant method.

The Scattered Seed Tree Method

The practice under this method is to clear-cut the area, or unit, leaving from two to five seed trees for every acre. Upon these remaining trees the area depends for additional seed from the time of logging, to stock the area. As a rule these trees are left to insure reproduction in case fire destroys the seedlings from the last crop of seed cast by the original stand.

The cutting should be planned so that it comes during, or shortly after, a good seed year. The logging should take place during the winter, and the slash disposed of the following spring. If the slash is not disposed of the spring following cutting it should be allowed to remain unburned, as a later fire will

destroy the reproduction which has established itself.

Usually there are enough defective trees in the forest to serve as seed trees. These trees will serve as seed trees equally as well as sound trees, as the defect, usually a heart rot, does not affect the quality or quantity of the seed. In many cases all the trees are sound, in which event a commercial loss must be taken by leaving trees for seeding purposes. In selecting seed trees large crowned, windfirm individuals are desired. Douglas fir trees produce seed after they are 25 years of age. This allows smaller trees to be used. If smaller trees are to be used the area must be protected against fire as the smaller trees succumb to fire because of their thinner bark. The young trees have the advantage of being able to go through a second rotation, and there is thus no loss of timber.

The scattered seed trees remaining on the area after logging are unable to reproduce the area in a single year. It may take three or four years to completely stock the area by depending on scattered seed trees alone. This delay in securing reproduction opens the area to the establishment of a brush cover which once accomplished renders proper stocking of the area with forest trees very difficult. The scattered seed tree method should be used on areas where complete fire protection is had, and prompt reproduction depended of from the initial crop of seedlings which spring from seed left by the logged-off stand. Since reproduction is not assured this method is the least desirable of the three clear cutting methods.

The Strip Method

The effective use of this method in old growth timber is prevented because of the great size of the timber . The costly machinery used in the removal of these stands makes it

necessary to clear-cut a large area at one setting. In some cases logging can be so regulated as to take alternate "sides," thus allowing the uncut "side" to stock the logged area. The strip method must be reserved for the smaller stands of the future and to the present second-growth timber.

The strip method removes the timber in a series of progressive or alternate strips and reproduction is depended on from seeding from the side. The former is desired because of the lessened danger from wind falling. In the progressive system the strip is cut on the leeward side of the forest, and the wind depended on to carry the seed from the remaining bank of timber over the cut-over strip. The width of the strip depends on the distance to which seed wil be carried by the wind. Experiments are under way which tend to show that seed will be carried a mile or more depending on wind velocity. Effective seeding up to one-half mile has been noted during these experiments.

The seed blowing in in large quantities, from a solid bank of timber, in addition to that left on the ground by the logged off stand, insures prompt reproduction. Prompt reproduction is desired in order that the young seedlings may take possession of the ground before the brush and weeds get started. Prompt reproduction also shortens the rotation.

The Clear-cut and Plant Method

This method differs from the others in that reproduction is made prompt and certain by artificial means. The areas are clear cut, and during the spring immediately following they are planted with stock from the nursery.

The clear cut and plant method is useful in the areas of old growth timber, where the size of the timber compels the logger to clear-cut large areas at one set-up of his

equipment. Following the removal of the timber the common practice is to remove the slash by broadcast burning to lessen thefire hazard. The remeval of the slash,if properly executed,clears the area of obstacles in the way of the planting crews and reduces the cost of reproducing the stand. Planting should be done the season after the slash is burned, as a delay of a year or two will result in the appearance of great quantities of weeds and brush on the cut-over areas. The obstacles presented by the brush cover are far greater than those presented by unburned slash,to the planting crews as well as to the planted trees. If planting is likely to be delayed a year or two after logging it will be better to leave the slash unburned.

The stock used in planting Douglas fir is obtained from nurseries as two year old seedlings. The best time for planting these trees in the field is in the early spring or late fall. Each season has advantages and disadvantages,but it is generally conceded that spring planting has the greater advantage. The chief advantage of fall planting lies in the rainy season which follows shortly after planting. The trees become established during the winter and are ready to make a good start the next spring. A prolonged dry season may result in the loss of the entire plantation. In the spring planting the ground contains much moisture,and rains during and shortly after planting may be relied upon. To firmly establish itself a tree requires plenty of moisture and warmth. It is important that the planted stand should stock the areathe first season, and not allow large fail areas to appear,making subsequent planting necessary. Such planting is always hindered by the appearance of brush. Spring planting generally gives the

best results. Douglas fir is now planted with an eight foot spacing by the Forest Service.

The reproduction of a stand by planting insures prompt and complete stocking of the area. The greater cost is offset by the lessened logging costs, and by the shortened rotation due to the prompt establishment of the new stand. The resultant stand is even-aged, uniformly stocked, and requires less thinning during the sapling stage. There is no loss of growth due to stagnation as in the too densely stocked areas in the reproduction and sapling stages.

Slash Disposal

Broadcast slash burning in theDouglas fir region has long been accepted as a necessary measure in securing reproduction, the claim being made that it bares the mineral soil, and in general stimulates germination of seed. Recent study on this subject by the Pacific Nortwest Forest Experiment Station tends to show that almost the opposite is true; that reproduction starts more promptly and abundantly where the slash is not burned . A comparison of a considerable number of burned and unburned areas, under similiar conditions otherwise, and quite recently cut over, shows ten seedlings on the unburned area to every seedling on the burned.(1)

The chief reason for burning slash as a forestry measure is to reduce the fire hazard, caused by a logging operation, that there may be less danger of from accidental summer fires.

A slash fire, however, never completely cleans up the area in such a manner as to leave it free from recurring fires. Even the hottest fire never consumes the coarser limbs, tops, cull logs, and rotten material on the ground; standing snags are not burned down. Usually enough unburned litter is left to

cause the area to reburn the following year when adjacent fresh slash is burned. In nine cases out of ten observed by the writer on the operations of the Owen-Oregon Lumber Company, all the promising young trees left on the area after logging have been killed during the slash fire. Also, in most cases the fires have 'gotten away' and damaged adjacent green timber, and in no cases has satisfactory reproduction resulted.

Following the first slash fire, various weeds (mostly not found in the virgin forest) take possession of the ground and create a cover which drying up each year, adds inflammable material to the area. Some of these weeds are; fireweed, thistle, hawkweed, senecio, and bracken-fern. The young trees which are killed but not consumed in the first fire become dry and add more fuel to next year's fire.

Fresh seed that may be on the area mixed with the soil may escape destruction in the first fire, but if the slash burning is delayed one season this seed will have germinated and the seedlings cannot survive fire. A recurring fire on an area burned the last season, or a delayed burning, will result in lack of reproduction. In a logging operation, the surrounding timber is cut farther back each year, lessening the liklihood of the area receiving fresh supplies of seed from sources other than scattered seed trees. The seedlings on an unburned area will suffer less from the obstacles presented by the slash than they will in competition with such brush as hazel, snow-brush, and alder which comes in after slash fires.

If the slash must be burned at all costs it may be done either in the spring or fall. Weather conditions must be watched in both cases and the work carefully planned. A good sized crew is necessary to keep the fire from spreading. If burned in the spring, the work must be done early enough to prevent the

possibility of an earlier fire season finding the slash fire still smouldering, in which case the slash is wet enough to prevent a thorough cleanup. In many cases the slash the slash will not burn at all. In the fall the slash will be dry enough to make a clean job possible but delayed fall rains may cause disaster. In fall burning the seed which have germinated the previous spring will be burned with the slash.

It is a question as to whether it is cheaper to burn than to establish an intemsive patrol on the unburned area during the fire season until the hazard is diminished.

SLASH BEFOR BEING BURNED
Heavy- 80 cords per A.

ONE MONTH AFTER SLASH FIRE
Columbia,Co.,Ore.
110 cords material left
after burning.Fire re-
moved 21 cords.

ONE YEAR AFTER BURNING
Senecio

The ordinary methods of slash disposal has little or no influence in insect control,because the injurious species either do not breed in logging waste at all, or else they prefer only the large portions like large branches,broken logs,and stumps,which material is merely scorched in the slash burning. (Graham,S.A.,)

ROTATION

After the present supply is gone large timber will have become a thing of the past, and the product from the managed forest will be moderate in size. The forester will be forced to grow timber on a rotation which will give the greatest yield inthe shortest time. Timber older than 150 years will be rare. The length of rotation will depend on site quality,rate of growth of the species used, and on the market demands. This report is concerned chiefly with the silvicultural aspect of rotation lengths.

Rate of Growth and Yield

As is shown by yield studies carried out in Douglas fir, culmination of mean annual increment occurs(depending on site quality) at from 90 to about 130 years on all site qualities. 100 years,however, will be the maximum length of rotation for all general use to which timber is put,from pulp to sawlogs, and much timber will be cut on rotations of 50 to 60 years, although this means a loss of part of the timberwhich the site is capable of producing. Some timber will be allowed to run to 150 years for the production of large dimension material.

COST OF PRODUCTION - DOLLARS

LAND Yearly Rental Value	3%	5%	INTEREST RATE 3 % Cost per acre	Stumpage per M.B.M. Site I	Site II	INTEREST RATE 5 % Cost per acre	Stumpage per M.B.M. Site I	Site II
$ 2	.06	.10	$392.62	$3.41	$4.35	$2280.70	$19.80	$25.40
4	.12	.20	431.06	3.75	4.80	2541.70	22.10	28.20
5	.15	.25	447.28	3.90	4.97	2672.20	23.20	29.60
7	.21	.35	483.28	4.20	5.37	2933.20	25.25	32.60
10	.30	.50	538.38	4.65	5.96	3977.20	34.45	44.00

The following data and formulae were used in computing the cost of production;

Costs Per Acre

Planting $10

Land Rental Variable as given in table.

Gen.Protection .01

Taxes .25

Administration .01

Rotation 100 years

Expected Yield, Bd.Ft.

Site I 115,000

Site II 90,000

Formulae

$$C_n = C_o(1.op^n)$$

$$C_n = \frac{a(1.op^n - 1)}{(1.op - 1)}$$

In conclusion it may be said that Douglas fir is a rapid growing tree and produces a good quality of timber, and as there are many acres of cut-over land in the Pacific Northwest which will be unsuited to agriculture, this tree has potential possibilities of being useful in putting such idle land to a profitable use. Due to its rapid growth it will materially lessen the cost of producing timber.

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(A complete bibliography,of several hundred titles,on Douglas fir can be obtained from the U.S. Forest Service, Washington,D.C.)