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NATURAL VERSUS ARTIFICIAL REFORESTATION IN THE PACIFIC NORTHWEST

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BY

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INTRODUCTION

Forestry in the United States is becoming an art of land management. The value of timber along with other economic considerations is causing land or timber owners to study the possibility of profitable reforestation. There is now a general demand for information on the timber-growing methods which are best adapted to the various types of forest in the United States as well as the various costs of the different methods.

This report was written with the idea of bringing out the factors that effect reforestation and the best method or methods to use in renewing our timber crop in the northwest.

THE NORTHWEST IN GENERAL

When one speaks of the Northwest he is immediately asked what he considers the Northwest. In this paper as in almost all other literature, the Northwest includes Oregon, Washington, Idaho, and western Montana. This region is characterized by its many rugged mountain ranges intersected or divided by numerous small fertile valleys; these valleys represent the agricultural land of the region, and the mountains are given over to tree growth almost entirely. The climate varies from a rather warm humid climate along the coast west of the Cascades with an average rainfall of 50-65 inches and with a light westerly breeze daily to a rather hot dry climate in south-eastern and central Oregon,

central Washington, and southern Idaho with an average rainfall of 20 inches or less and long cold winters with heavy snows. Northern Washington, Idaho, and Montana have a cooler humid climate with 20-40 inches of rainfall. They also have long winters and heavy snowfall. North-eastern Oregon, south-eastern Washington and central Idaho have a rainfall of about 20-30 inches and long winters with abundance of snow.

This region is perhaps the most important forest region of the United States. Its forests of Douglas fir (pseudotsuga taxifolia), Western hemlock (Tsuga heterophylla), Sitka spruce (Picea sitchensis), Western larch (Larix occidentalis), Lowland white fir (Abies grandis), White fir (Abies nobilis),Ponderosa pine (Pinus ponderosa), Western white pine (Pinus monticala), Lodgepole pine (Pinus contorta), Western red cedar (Thuya plicata), and many other species make up about one-half of the entire standing timber in the United States. Under normal conditions, its mills turn out about one-third of the limber cut in this country; the timber and other forest products of the region are shipped to nearly all parts of the globe, much of it being sent to our own eastern states. The Northwest also represents about one-fifth of the forest producing area of the nation.

This region is of very great economic importance to the United States not only because of its present large supply of virgin timber but also because of the large part that it will play in supplying and producing the future timber crops of the nation. It is estimated that about 46,500,000 acres of this region is better adapted for forest production than for any other purpose.

Excepting the California redwood region, the average rate of tree growth is from three to seven times greater in the coast forest of the Northwest than the average for any other forest region of the country,

and natural reforestation as a whole is usually fairly rapid and without much trouble. Still we have many acres both large and small, scattered throughout the entire region that are not suited for anything but to grow a timber crop. There are various reasons for these many denuded areas. The larger unforested areas of Southeastern Oregon and southern Idaho are no doubt due to the arid condition of the country. Most of the unforested areas in the remainder of the Northwest have and will produce a timber crop. The main causes of these denuded lands are fires, insects, and diseases, winds or blowdowns, rodents, and other animal life, and last and perhaps most destructive of all is man:- he cuts and logs the timber with only one thought in mind and that is to make as large a profit possible out of the timber that he is now cutting without a thought of the possibility of a future crop. These barren areas must either be reforested by man or left alone for nature to reforest by her slow and uneven process.

SURVEY OF INDUSTRIAL FORESTRY IN THE NORTHWEST

Both public and private foresters are found in every forest region of the United States. They know the lumbermen intimately and know whether the lumbermen are striving for a quick clean-up and abandonment of the region or if he is interested in conservative logging practice, and they also know the lumbermen who plan on using and treating their lands so as to have a perpetual timber supply. Data for the "Foresters' Survey of Industrial Forestry" was obtained by the cooperation of United States Forest Service, the Society of American Foresters, the American Forestry Association, the United States Chamber of Commerce, and the

National Lumber Manufacturers' Association.

The following information was taken from"Deforested America" in which was an abbreviated report, extracted from the Foresters' Survey and published in 1929:

OREGON - Mt. Emily Lumber Co. cuts 45,000,000 feet annually; the present operation has a twenty-five year life; they have no general reforestation policy, but they leave a few trees on their cut-over area which act as seed trees.

California and Oregon Paper and Lumber Co. has a twenty-five year lumber supply and they have no plan of reforestation.

Crown Willamette Paper Co. is now (1930) planting a tree for every one removed. They own 125,000 acres of timber and cut-over land, and run on a rotation of 40 years for pulp.

Booth Kelly Lumber Co. has 30,000 acres of cut-over land and 90,000 acres of standing timber; they have sixty years' cut available. The stockholders are to determine whether to have long-term cut or permanent cut; and, this depends on tax, fire, and economic conditions.

Hawley Pulp and Paper Co. uses 60,000 cords a year and has a twenty year supply on hand; the company depends on purchases to keep it supplied with timber.

WASHINGTON - Weyerhauser Lumber Co. has holdings in Oregon and Washington. They have 285,000 acres of cut-over land; they are classifying their lands, but as yet they have no planting program, and restocking is slow on account of fire. In 1928, C. S. Chapman states, "A few are working toward sustained yield for their operations, and a few are not relying upon natural restocking of cut-over areas but are resorting to planting."

Shevlin Hixon Co. cuts over 8000 acres and has 300,000 acres avail-

able for immediate operation. They claim that they need some assurance as to taxation before practicing forestry on its 200,000 acres of holdings. At this time (1928) they were thinning some of their areas but still leaving them fully stocked.

West Fork Logging Co. is not practicing forestry since they still have available virgin timber. They own 30,000 acres of forest and there are 70,000 acres of state and national government forest lands available for cutting.

The following is what the manager of the Long Bell Co. said in 1927:

"We found that selective logging is impracticable here because of the dominant species, Douglas fir. Clean cutting is the proper practice and slash burning. We do not leave seed trees as they represent considerable value. Artificial planting gives us the spacing and species that we desire; fire protections costs no more upon well-stocked land than upon barren or weed-covered areas. The extraordinary burden of reforestation here consists only of money actually spent in planting and forest supervision. I believe that the market value of well stocked land any time after the trees get up above the stumps will be great enough to retire the investment plus at least savings-bank interest, provided one has good forest land, complete stocking of valuable species, and real protection."

IDAHO - Boise-Payette Lumber Co., a Weyerhauser concern, owns 295,565 acres of timber land, 50,000 of which has been cut over. Most of their timber is in virgin stands, and their purpose is to keep two mills running, each with a capacity of 50,000,000 feet annually. At first, they planned to cut out all the standing timber that they could get, then close their plants, but now they are seriously considering

the question of reforestation and sustained yield. The company has a very effective insect control and fire organization; they pile and burn their slash, and they have been cutting infested trees so that now they are in complete control of the insect situation.

Clearwater Land Co. has too many large mills for sustained yield cut, but they have about 3,000,000,000 feet of virgin timber and plans to hold for second cut. They also plan on buying as much adjacent timber as possible.

MONTANA - The Clearwater Land Company's holding extends over into western Montana, and there are no other large companies interested in forest production in this area.

FACTORS THAT DETERMINE REFORESTATION METHODS

There are many factors to be taken into consideration in determining whether nature or man shall take over the role of reforesting a given area or whether the combined forces of the two should do the job. These major factors are:

1. Cost
2. Species
3. Site factors
4. Object of forest
5. Rodents and other animal life.

Each of the above factors will be discussed in detail, but before beginning the detailed discussion, let us consider the methods of artificial reforestation in the Northwest.

ARTIFICIAL REFORESTATION IN THE NORTHWEST.

Up until the last few years, planting was not practiced very

extensively in this region due to the large supply of virgin timber on hand, and the close competition between timber owners which made it impracticable for them to replant their logged off areas. At the present time, the Forest Service is doing considerable planting, and a few of the large timber owners have started to reforest their lands by planting or direct seeding.

There are a number of different species planted in the Northwest, but only a few of them are of major importance. They are Douglas fir, Ponderosa pine, Sitka spruce, Western white pine, and some true firs. In most cases, artificial reforestation is accomplished by planting seedlings obtained from various nurseries that are scattered throughout the region, but sometimes direct seeding is practiced; therefore, both methods will be described.

DIRECT SEEDING

Of the two methods of artificial reforestation, direct seeding offers the easiest and cheapest of the solution of the reforestation problem where it can successfully be practiced. Up until the last few years, the greater portion of the Forest Service reforestation programs was conducted by direct seeding, but now much more planting is being done than direct seeding.

BROADCASTING

In broadcasting, seeds are acattered by hand or by the use of a mechanical sower; the method to use depends upon the size of the seed. The larger seeds, such as sugar pine, Ponderosa pine, or Western white pine, can be sown by hand, but the smaller seeds, such as larch, spruce,

lodgepole, and Douglas fir, should be sown with a mechanical sower. The best results are obtained by going over the entire area and sow half the seeds; then traverse it again at right angles to the original courses and sow the remainder of the seeds.

Very good results are obtained by making some preparation of the ground before planting, such as harrowing or plowing, but this increases the cost so much that it is prohibitive. Sowing after the ground has been trampled by sheep often gives excellent results. Burned areas with a very thin cover of brush, and with practically no leaf litter, offers a very good site for broadcast seeding without preparing the ground. The ground should have a very light vegetation because if it is too heavy, it will choke out the young seedlings if the seeds germinate, and if the soil has no ground cover, the young seedlings will die from excess heat and drought. This type of planting is often successful when the seed is sown on top of the snow, especially where seed eating rodents are bad.

This method is the least successful of the direct seeding methods. It is expensive, if ground is prepared; it requires large quantities of seed; the crop is apt to be spotted because of erosion and rodents; and it must be confined to areas where the mineral soil is exposed. On the other hand, it is an easy and fast method. One man is able to sow 20-40 acres a day; and seeding can be conducted in winter when other work is not very pressing.

SOWING IN STRIPS AND BLOCKS

In this method, narrow strips three feet wide or less are prepared by plowing, harrowing, or raking, but sometimes no preparation at all is made. The strips should run along the contour lines on the hillside,

sothat the precipitation will be caught and retained; also to prevent the seed from being washed down the hill. On the level, the strips should run east and west and the plow furrows should be turned toward the south, thus protecting the seedlings from the sun for the first season or two. The main advantage of this method is that less seeds are used and the entire area does not require working. The strip method is particularly adapted to quick-growing species which will produce seed at an early age and thus seed up the intervening areas. This method is used but very little if at all in the Northwest.

REGULAR SEED SPOTS

In this method, small spots 10 to 20 inches square are prepared for planting by the use of shovels, hoes, or some other type of tool. On locating the spots, one should take advantage of as much shelter as possible to protect the young seedlings from wind and sun. The more the grass and root competition, the larger the spot should be. The seeds are sown and covered to a depth of about one-half inch. The chief functions of the spot method are to eliminate root competition of grass and other plants and to make sure that the seed comes in contact with the mineral soil. This method seldon is used in the Northwest.

SIMPLE SEED SPOTS

This method is similar to the regular seed spot method except that the spots made by this method are smaller and deeper. (Usually prepared with one stroke of the mattock). This method is especially suited for seeding on very dry, barren, stony ground or in very hot or windy situations. The main objection to this method is that the soil is likely to wash in from above and cover the seed to too great a depth. This system

is not being practiced in the Northwest to a very great extent.

CORN PLANTER SEED SPOTS

In this method, the seeds are sown by use of a corn planter; the tool is regulated to drop the desired number of seeds in each spot. This method ranks next to broadcasting in ease and speed of application. One man can plant 2000 to 3000 spots per day. The objections to this method are that the seeds are not well covered and that the seeds are easily located and destroyed by rodents.

CHOICE OF METHODS

Of the above methods of direct seeding, the "regular seed spots" gives the best results but it is also the most costly. Broadcast seeding is the only one that has been practiced very extensively in the Northwest; the others were only carried on experimentially.

POUNDS OF SEED REQUIRED PER ACRE
(Standard Stocking of 800 Trees per Acre)

SPECIES	BROADCAST SOWING	SEED SPOT SOWING
Western red cedar	1 1/2 - 2 1/2	3/5
Douglas fir	4 - 5	3/5
Grand fir	8 - 10	1 1/2
Noble fir	8 - 10	1 1/2
Lodgepole pine	2 - 3	3/5
Sugar pine	10 - 20	3
Western white pine	8 - 10	1 1/3
Ponderosa pine	6 - 8	1 1/3
Sitka spruce	2 - 3	3/5
Engelmann spruce	2 - 4	3/5

PLANTING

Planting is on the increase in the Northwest. In western Oregon and western Washington, 60% of the logged off areas are reforesting and the other 40% is barren of any useful tree growth. In western Montana,

Idaho, and eastern Washington, most of the cut-over white pine lands burn two, three, or four times, and are in very bad condition for timber growing. Many of these areas have been burned so many times that it is impossible for them to restock naturally. These lands will have to be reforested by planting or direct seeding.

For many years, the Forest Service has been planting these devastated areas. The age and cost of the planting stock varies with the species. The plants are usually spaced about 8 by 8 feet (about 680 plants per acre). All planting should take place in the fall after the fall rains set in or in early spring. Spring planting in considered the best and is usually recommended. A 75 to 100% survival may be expected if the operations are conducted properly during the right season and suitable stock is used. In actual practice, the percentage of survival usually runs from 55 to 95, but the great loss can almost invariable be traced to faulty planting or poor weather conditions at time of planting.

CLASSES OF STOCK FOR PLANTING

SPECIES	REGION	CLASS OF STOCK IN ORDER OF PREFERENCE		
Douglas fir	Oregon and Washington	1-1	2-0	
Douglas fir	Southern Idaho	2-2	3-0	2-1
Douglas fir	N. Idaho and Montana	2-1		
Ponderosa pine	Oregon and Washington	1-1	2-1	
Ponderosa pine	Southern Idaho	2-0	2-1	
Ponderosa pine	N. Idaho and Montana	2-0	1-2	
Western white pine	N. Idaho and Montana	2-0	1-2	
Noble fir	Oregon and Washington	2-1	1-1	
Silver fir	Oregon and Washington	2-1		
Western red cedar	N. Idaho and Montana	4-0	2-2	
Engelmann spruce	N. Idaho and Montana	3-0	2-2	
Engelmann spruce	Southern Idaho	2-2	3-0	
Lodgepole pine	Southern Idaho	2-1	3-0	2-0
Western larch	N. Idaho and Montana	1-2		

PLANTING METHODS

There are several methods of planting but only one is used very extensively in the Northwest. Most of the methods will be mentioned but not discussed thoroughly.

MIDDLE HOLE METHOD - A square hole seven or eight inches across and about a foot deep is dug with a spade or mattock. The seedling is placed in the center of the hole, the roots held out in a spreading manner with one hand and the dirt is filled in with the other. The better soil is placed next to the roots and packed well around them with the fist; the remainder of the dirt is thrown in and well packed. The top portion is left loose to serve as a mulch.

SIDE HOLE METHOD - This method is a slight modification of the middle hole method. The only difference being that the seedling is placed at one side of the hole, thus making it a little more rapid than the middle hole method. This is the method that is used in the Northwest, but sometimes the method is much abbreviated, and tends to become a cross between the side hole and the slit method.

CONE METHOD - This is another modification of the middle hole method; the great difference is that a cone like mound is built up in the center of the hole and the roots of the seedling are spread over this mound.

SLIT METHOD - A wedge-shaped slit or crevice is made in the ground with an ax, spade, or mattock; this is done by inserting the tool in the ground then moving the handle backward and forward until a hole 2 or 3 inches broad at the top is made. The seedling is then put in this hole and the dirt packed around it by inserting the heel of the shoe in the soil a few inches from the plant and then pushing vigorously toward the plant. There are several modifications of this method but will not

be discussed in this paper.

OTHER METHODS - There are various other methods such as plowing and mattock method, pit method, pot planting, and the ball method, but none of these are being used to any great extent if at all in the Northwest.

SPECIES AND REFORESTATION IN THE NORTHWEST

Most of the important species of this region reforest naturally and very abundantly, and as far as the species alone are concerned, we have no need for artificial reforestation. This can possibly be shown best by considering some of the tree species.

Douglas fir is the most important tree west of the Cascade Mountains and its reseeding ability will roughly fit the cases of most of the true firs. The proposed methods of natural restocking are largely based on the seed characteristics and the storage of seed in the forest floor. Seed must be produced and distributed, and it must have the ability to retain its vitality until it has an opportunity to germinate in order to assure reproduction after a fire or after logging. Although in some species such as White fir, Sitka spruce, Englemann spruce, Western and Mountain hemlock, Western red cedar, and other very tolerant species, the reproduction may be on the ground as an understory ~~after~~ before logging. We will discuss the Douglas fir as typical of the Pacific coast region.

In the Douglas fir, good seed years occur at irregular intervals, usually every two or three years. There is seldom a very heavy seed crop the year following a good crop, but the production of seed is unquestionably influenced by the age, size, health of tree, density of stand, soil, latitude, and altitude. The average 15 year old tree produces 4000 seeds, the average 100 to 200 year old tree produces 40,000

seeds, and the average 600 year old tree produces 7000 seeds. At elevations of 300 to 600 feet above sea level, the average tree produces about 34,000 seeds per crop as compared with 4000 seeds for the average tree at 3000 to 4000 feet above sea level. The difference in latitude is very noticeable since the average tree in central Oregon produces 35,000 seeds per tree and the average tree in northern Washington only produces 7000 seeds per tree; this wide variation may not be maintained through every seed crop, but it does show that latitude does play an important part. The effect of health upon the tree is also quite noticeable. A severely affected diseased tree produces 7700 seeds, and a sound healthy tree of the same age, size and locality produces 14,000 seeds. The type of soil does not seem to effect the quantity of seeds produced but it does seriously effect the quality. Trees on poor soil produce about two-thirds as many good seeds as trees on good soil. The average Douglas fir produces $2\frac{1}{2}$ bushels of cones per tree, with an average of 1000 cones per bushel; and it produces about 40,000 seeds per crop with an average of about 34,600 to 55,500 seeds per pound.

The chief agents of distribution of seed are: wind, animals, man, gravity, water, snowslides, and landslides. Wind and animals are the only ones that play any very significnat part in seed distribution in the Northwest.

The distance that the seed is carried by the wind varies with the height of the parent tree, the strength of the wind, and the density of the stand. Experiments show that on an average, Douglas fir seeds are carried from 100 to 900 feet from the parent tree. The largest percent falls under the 250 foot mark.

The part that animals take in seed distribution will be discussed under rodents.

Ponderosa pine, the important tree on the east side of the Cascade mountains, may be chosen as another typical tree of the Northwest. This tree is intolerant; therefore it will not grow very well as an understory if the stand is dense. Since Ponderosa pine will not grow as an understory, reproduction after a fire or after logging will have to be from seed stored in the duff or from seed trees on the area if natural reproduction is obtained.

The Ponderosa pine has a good seed year about every three to five years. Trees under 50 years of age or under about 10 inches in diameter seldom produce seed, although under favorable conditions trees 20 to 25 years old produce seed. The seeds have a high rate of germination, but some authors say that only one out of every 100 seedling lives. One good seed tree will seed one-fourth of an acre in an ordinary seed year. The wind and animals are mainly responsible for the distribution of the seed. The seed cannot be carried far by the wind because of its weight (8000 to 9000 seeds per pound). The seed germinates quickly (8-10 days) in the spring after dissemination.

Western white pine, the most important tree of northern Idaho and Montana, bears a good seed crop about every three or four years. This tree is fairly tolerant in early life; therefore it may come up as an understory, but it usually reproduces from seed stored in the duff. The seed of this tree, like that of Douglas fir, may lay dormant in the duff for 6 or 8 years. There are 24,000 to 29,000 seeds per pound, and are usually distributed by wind and animals. The seeds are carried by wind from 50 to 400 feet with the greater portion of the seed falling 100 feet or below. It usually takes 15 to 20 days for the seed to germinate.

By taking the above species as an examples, we can readily see that artificial reforestation is not needed if the proper methods of forestry

are practiced.

SITE FACTORS AND REFORESTATION

Some of the site factors were discussed in their relation to seed production a little earlier in this paper. From that discussion, it is easy to see that in the high altitudes and the northern extreme of the range of the species, artificial reforestation would be best, as valuable trees would have to be left for seed trees, and since many trees would have to be left because of the small quantity of seed produced.

In climates where there are strong winds during the fall and spring natural reforestation is apt to be abundant. In regions of little wind or where continuous wet weather prevails throughout the season of pollination, natural reforestation will be sparce and much of the area will have to be restocked artificially. Also in regions of exceeding dry climate, a better stand may be obtained by planting since the seedling would have a larger root area and could be planted so as to take advantage of the wet season, whereas the seed for natural reforestation would only germinate in the spring and die of drought during the summer. Natural reforestation is best in regions where a few warm and rainy days occur after seed dissemination.

Where there is a heavy cover of litter and duff, natural reforestation will probably be abundant after a fire or after logging due to large quantities of seed stored in the duff; this is especially true of Douglas fir, Western white pine, Noble fir, Silver fir, Western hemlock, Sugar pine, Incense cedar, and Pacific yew. Western yellow pine does not seem to retain its vitality long. Artificial regeneration is undoubtedly superior to natural on areas covered with grass and other small growth because under such conditions, the seed could not reach mineral

soil to get a start, and if it did, it would probably be crowded out shortly after germination. Under such handicaps, the planted tree can be given an opportunity to grow to considerable size before starting to compete for plant food, and therefore will be able to survive. On poor or rocky soils, a better crop is obtained by artificial reforestation than by natural because man can place the seeds or plants in the better spots of the soil so that they will have room for root development. Nature's seed crop on these types of soil is poor and neither has she the ability to place the seed in the best places for growth. On exceedingly steep and rough mountain sides, a tree will reseed the area for great distances down the hill but only for a very short distance above; therefore, if seed trees are left, they should be left near the top and not the bottom of the slope.

OBJECT OF FOREST AND REFORESTATION

It is obvious that the object of the forest and the method of management plays a large part in determining the method of restocking to use. If the area is to be used as a park or similar recreational purpose and is started from a logged off or treeless area, planting would undoubtedly be the ideal and practical method to use because the desired specie and location of each can be obtained.

If the area is for watershed alone, nature can usually restock it sufficiently. Much of the area would probably be covered with brush and grass shortly after a fire and also many seedlings would shoot up from seed stored in the duff. In case of excessive erosion on a watershed, artificial reforestation should be resorted to.

On areas whose primary purpose is the production of a timber crop,

to be marketed, the method of reforestation will vary considerably according to the method of cutting and slash disposal. This can best be shown by discussing the cutting practices of the Northwest.

In the Douglas fir region, Western Oregon and Washington, clear cutting and broadcast burning is practiced almost entirely, and the only natural reforestation that can take place is from seed stored in the duff, and perhaps a very little from the adjacent timber or ~~those~~ from defective trees left standing on the area. The adjacent timber will give effective restocking for about 300 or 350 feet, but all the small seedlings that were on the area before logging would be destroyed by logging or by the broadcast slash burning. Many of the seeds stored in the duff will survive and germinate after the fire due to the protection given by the deep duff and mineral soils. From tests made, it was found that Douglas fir seed will withstand a dry heat of 200°F and a moist heat of 160°F for long periods. In spite of the protection of duff and the ability of the seed to withstand heat, it is a known fact that logged unburned areas will produce ten seedlings to one on a similar area logged and burned.

Quite often the defective tree left in the area will be destroyed by wind and fire, and it is also known that these trees will not produce as many fertile seeds as strong healthy trees. In some instances sufficient natural restocking will be obtained from the above mentioned sources of seed, but in most cases about 30 to 40 percent of the area will need to be planted if complete stocking is obtained.

In the Ponderosa pine region, we have a very different method of cutting and slash disposal. Here we have more of a selective and seed tree methods of cutting and piling and burning of slash. Only the mature merchantable trees are removed and at least 4 trees to the acre are

left for seed trees. There is considerable advanced reproduction in some of the Ponderosa pine stands because of the open canopy which makes conditions favorable for reproduction. Not over 10 percent of the advanced reproduction and rarely over 2 percent of the trees left on the area are damaged any by slash burning. In almost all cases, sufficient natural reproduction is obtained and in those few scattered spots where natural reproduction does not occur, nursery stock should be planted.

In case of large fires that destroy the entire stand of Ponderosa pine, planting will have to be resorted to for restocking of area, as there is no duff on the floor to protect seeds. Seeds can only be dissiminated about 100 feet by the wind.

In the Western white pine forests of Idaho and Montana, removal of all white pine, then broadcast burning was practiced for sometime. This burning killed much of the remaining trees, species and the fire hazzard was worse than before the burn. Much of the logged off land was burned over three or four times so that now natural reforestation of such areas is impossible. Planting will have to take place if these lands are made productive again.

At the present time, we have a different form of management in the Western white pine stands. The areas are clear cut or sometimes only 2 or 3 trees per acre are left, and the slash is piled and burned. Under ordinary conditions 60 to 75 percent of the stand will have satisfactory reproduction of the desired species without seed trees due to the large supply of seed stored in the forest floor. Since entire restocking can not be obtained from seed stored in the duff, 2 to 6 white pine trees per acre and the same number of some other specie, preferably larch or cedar, are selected and reserved. Artificial reforestation is seldom needed in the Western white pine stands under the present system of management.

RODENTS, ANIMAL LIFE, AND REFORESTATION

Sheep, goats, cattle, horses, and other animals have a beneficial effect upon reforestation by helping prepare a seed bed and distributing the seed. They also have harmful effects since they will eat and destroy the seedlings.

Rodents (squirrels, chipmunks, mice, etc.) also are helpful by preparing seedbeds and distributing seed. Munger says that a large percentage of the seedlings of Ponderosa pine in eastern Oregon are due to rodents. They seem to have the ability to pick the choice of cones and therefore get the best seed. They are similar to an old miser in the effect that they bury their gatherings in several different places so that if their neighbors find one cache he will always have more left. Caches as large as 40 pounds have been found, and it is said that the pine squirrel can pick a cone per second when he is preparing for winter. Many of these caches are not uncovered, and under the proper conditions the seeds will germinate and produce seedlings.

The rodents are not altogether beneficial because many seeds are eaten. Seedlings are also destroyed by the rodents eating and cutting the roots. In many small local areas, they do considerable damage to planted stock. Their workings also have a tendency to dry the soil out to such an extent that the seedlings fail to get enough moisture to continue to grow.

On areas to be planted where rodents are bad, measures should be taken to exterminate the pests before restocking. This can usually be accomplished best by use of poisoned bait. The following poison mixtures have given excellent results:

Rolled oats	25 quarts
Strychnine (pulverized)	1 ounce
Saccharine	1 teaspoon
water	6 quarts

Barley (cleaned)	16 quarts
Strychnine (powdered)	1 ounce
Bicarbonate of soda	1 ounce
Saccharine	1/8 ounce
Heavy corn sirup	¼ pint
Thin starch paste	¼ pint
Glycerine	1 tablespoon

The above two mixtures are very successful as squirrel poisons, and the two following mixtures are very good pocket-gopher bait. when placing the bait for gophers the runways are located,and a very small tablespoon full of bait is dropped in,then the opening is closed with a sod or clod, so that the light is excluded and no dirt will fall on the bait.

10 pounds green clover tips
1 ounce strychnine (alkaloid)

The bait is mixed by spreading the tips in a tight box, and then sprinkle the strychnine on from a pepper shaker and stir until thoroughly mixed. Only mix the amount that can be used in one day.

1 ounce strychnine
1/8 ounce saccharine
16 quarts sweet potatoes, carrots, or parsnips.

The vegetable should be peeled and cut into small cubes and thoroughly dusted with the mixture of strychnine and saccharine.

COST AND REFORESTATION

Cost is perhaps the most important factor in determining the method of reforestation. The cost varies considerable with the value of the species in question, and the cost of labor. It is obvious that if the value of the seed trees left was greater than the cost of planting, it would far more economical to cut the trees and plant the area. No hard and fast rule can be laid down as to the cost that would apply over the entire region, but the owner can determine the costs of both methods that would apply to his area before he cuts his timber crop.

In determining the cost of natural reforestation,the owner will have to consider the cost of disposing of the slash for natural reforestation as compared with the cost that would accumulate if he was going to plant. He would also have to determine the value of the seed trees left. He would need to

take into consideration other minor items such as the percautions taken not to destroy any seedlings while logging etc. At best, the result will be only an approximate cost.

Cost of artificial reforestation may be determined very accurately by considering cost of nursery and the cost of labor for planting. The average cost of planting in northern Idaho in 1926 and 1927 was $10 an acre for Western white pine. The plants were spaced 8X8 feet or about 680 plants to the acre.

The following table gives analysis of planting costs of Douglas fir in Region six for years from 1916 to 1931, inclusive.

Year	Cost of Mapping	Number of trees per acre	Cost of trees per M	Cost of Trees per Acre	Cost of planting exclusive of mapping and trees per M	Cost of planting exclusive of mapping and trees per A	Total Ave. cost per acre
1916	$0.00	624	$4.22	$2.63	$9.40	$5.85	$8.48
1917	.12	675	3.62	2.44	8.83	5.96	8.52
1918	.15	620	8.06	5.36	11.42	7.08	12.59
1919	.12	609	5.21	3.17	12.48	7.60	10.89
1920	.17	571	5.52	3.15	15.46	8.83	12.15
1921	.14	539	14.81	8.00	15.10	8.14	16.28
1922	.10	654	13.59	8.82	10.24	6.70	15.62
1923	.05	619	9.97	6.15	12.70	7.84	14.01
1924	.06	597	8.19	4.89	12.85	7.67	12.62
1925	.00	621	8.01	4.98	12.82	7.96	12.94
1926	.00	582	8.15	4.74	12.09	7.04	11.78
1927	.03	673	7.49	5.10	11.58	7.80	12.93
1928	.06	638	6.02	3.84	11.63	7.42	12.89
1929	.04	589	6.72	3.96	15.09	8.89	12.89
1930	.00	642	7.44	4.78	12.85	8.26	13.04
1931	.00	632	6.48	4.09	8.90	5.62	9.72
Av. 1926 to 1930	.03	625	7.16	4.48	12.65	7.88	12.38
% diff. 1931 from 1926-1930		plus1	-9.50	-9.00	-30.00	-29.00	-21.00

CONCLUSION

Many of the forest lands of the Northwest are barren and unproductive and they can only be made productive by artificial restocking, But

By careful management and proper cutting practice, the timbered areas will reseed themselves naturally to a very large extent, due to the seeding ability of the species and the nature of the soil.

A very good rule to follow in all cases is to let nature do her part then fill in the vacant spots by planting.

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REFERENCES

Ahern, Major George P.
1929, Deforested America. Document No. 216

Dearborn, Ned
1911, Seed-eating Mammals in Relation to Reforestation. U.S.D.A. 78

Hofmann, Julius V.
1924, Natural Reforestation of Douglas fir in Pacific Northwest U.S.D.A. Bull. 1200
1917, Natural Reproduction from Seed Stored in the Forest Floor Jour. of Ag. Res. Vol XI No. 1
1918, Importance of Seed Characteristics in Natural Reproduction of Coniferous Forests. Minn. Univ. Bull. 2

Koch, Elers, and Cunningham.
1927, Timber Growing and Logging Practice in the Western white pine and Larch-fir Forests of Northern Rocky Mts. U.S.D.A. 1494

Kummel, Julius F.
1932, Annual Planting Report of Region Six. Calendar year 1931 U.S.D.A. Forest Service

Munger, T.T.
1917, Western Yellow pine in Oregon. U.S.D.A. Bull. 418.
1927, Timber Growing and Logging Practice in Douglas fir Region. U.S.D.A. 1493.
1931, Slash Disposal in Western Yellow Pine Forests of Oregon and Washington. U.S.D.A. Tech. Bull. 259

Olson, D.S.
1930, Growing Trees for Forest Planting in Montana and Idaho. U.S.D.A. Circ. 120

Pinchot, Gifford
1910, Reproduction of Western Yellow Pine in Southwest. U.S.D.A. 174

Tillotson, C.R.
1917, Reforestation on the National Forests. U.S.D.A. Prof. 475
1917, Nursery Practice on National Forests. U.S.D.A. Bull. 479

Winkenwerder, Hugo
1928, Forestry in the Pacific Northwest.

Zon, Raphael
1915, Seed Production of Western White Pine. U.S.D.A. Bull. 210

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