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HIGHLIGHTS OF DOUGLAS FIR NATURAL REGENERATION

By Leo A. Isaac, Associate Silviculturist

Note: Douglas fir natural reproduction studies, that have been under way for a number of years under the direction of Leo A. Isaac, have brought to light many important findings which have a definite bearing on the silvicultural treatment of the type. Mr. Isaac summarized these significant findings in an article which was published in the 1936 Annual Cruise of the Forestry School of Oregon State College. It is herewith reissued for the benefit of the larger audience it should have.

These studies are more completely reported in a forthcoming article by the same author in the Journal of Agricultural Research and a proposed technical bulletin on natural regeneration in the Douglas fir type of Oregon and Washington.--Thornton T. Munger, Director.

HIGHLIGHTS OF DOUGLAS FIR NATURAL REGENERATION

By

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Enough natural reproduction to produce a fully stocked stand immediately after logging occurs on only a small percentage of the clear-cut and broadcast-burned areas in the Douglas fir region. Studies have been made of the environmental factors that enter into this rather hesitant transition from old forest to new in order to work out a silvicultural system for the type that will result in more prompt and adequate restocking following logging, and some of the more recent findings are given in the following paragraphs.

An adequate seed supply was found to be the first essential for natural regeneration. Douglas fir is an average seed producer; a 28-year record kept by the Forest Service in this region indicates that bumper crops occur from 3 to 7 years apart. During the intervening years light or medium crops may occur or there may be a complete crop failure. Douglas fir seed is particularly attractive to birds and rodents. It is estimated that practically all of the seed is consumed during years of light and medium crops, and most of the good stands of reproduction spring from the surplus of seed that occurs during the years of heavy crops.

Not all trees are seed producers, and it has been calculated that the average old-growth tree left after logging produces about a

pound of seed (40,000 seeds) during a good year. Eight to ten times that amount would ordinarily be required to seed up a single acre.

Single seed trees at the rate of approximately two per acre on national forest timber sales have been found to do some reseeding, but they are by no means adequate. Our studies indicate that 75 percent of these trees are lost within 10 years after logging, and those that are not destroyed by logging or slash burning, either windfall or die from exposure, insect injury, or decay. The best assurance of an adequate seed supply is a nearby block of uncut timber.

There is a widely accepted theory that seed of Douglas fir on the forest floor remains viable for a number of years, but studies made indicate rather definitely that seed not consumed by birds and rodents either germinates or decays within one year after it falls. This conclusion is substantiated by the findings on sample plots on cut-over lands and also on crown-burned areas. In a survey of the great Tillamook Burn made during the past year it was found that abundant 1934 reproduction was associated with 1933 cones either on the ground or still clinging to fire-killed trees, while abundant 1935 reproduction was found only in the vicinity of living trees.

Another point over which there is a great deal of conjecture is the distance to which Douglas fir seed may be carried by the wind. Measurements of seed flight were made by releasing seed from a box kite and also by catching seed in traps adjacent to green timber. These findings were substantiated by a study of the occurrence of seedlings on cut-over areas and old burns. The results indicate that an area will seed up for an average distance of a quarter mile. However, air movement is so

variable that no positive distance of seed flight can be set up for a specific area. Douglas fir seed falls at a rate of approximately 2 miles per hour and the distance it may be carried may be greatly affected by local topography and by vertical as well as horizontal air currents. Recent studies by aeronautical meteorologists have brought out that rising air currents from 1 to 10 miles per hour frequently occur over warm slopes. Should falling seed encounter a rising air current that exceeded its rate of fall it might be carried unbelievable distances; similarly, falling air currents may bring seed to the earth much more quickly than normal fall. This explains the occurrence of reproduction at long distances from a source of seed.

The necessity for an abundant and continuous seed supply is very evident when the probable annual seedling loss is considered. Studies at the Wind River Experimental Forest, wherein environmental factors were measured, show that from 66 to 95 percent of the annual seedling crop is lost from one cause or another. The principal causes of seedling mortality recorded on this area in the approximate order of their importance are: heat injury to the stem (sun scald), drought, rodents, frost, insect injury, and competition from other vegetation. Some losses may come from a combination of the above causes and in some years any one of the above causes may be responsible for the loss of the major portion of the season's seedling crop.

Heat injury may begin when the surface soil (upper 1/8 inch) attains a temperature of about 123° F. if the seedlings are less than a week old, and death may follow if this temperature is continued long enough. As seedlings grow older, they become more resistant, some

surviving temperatures as high as 150° F. Drought losses are serious and would likely be the most certain to occur annually if they did not come along during the periodic dry spell of midsummer after most seedlings had been killed off by other causes. Rodents, particularly the white-footed mice, are sometimes a problem; in one instance they consumed practically the entire season's crop of newly germinated seedlings on sample plots. Late spring frosts kill tender seedlings by freezing, and injury starts at air temperatures of 30° or lower; late fall and winter frosts cause seedling loss by "soil heaving". Some losses on this area were caused by strawberry weevil and cutworm, and some seedlings were choked out by other vegetation.

It was found that shade is of importance not only to keep the soil surface cool in the daytime but to keep it warm at night as well. During the summer months of the five consecutive years of this study maximum soil temperatures on a fully exposed surface averaged 49 percent higher than the air, under a brush cover they averaged 29 percent higher, while under virgin timber they were practically the same as the air. While too much shade may be as detrimental as no shade, it can readily be seen how some shade may prevent great seedling loss by moderating surface temperatures. Minimum air temperatures as low as 28° were recorded in late spring in this study. It was found that when the air temperature was 32°, the temperature of fully exposed mineral soil surface was likely to be about 4° lower, while under the shade of brush or debris, it was likely to be 4° higher.

Shade likewise influences evaporation from the soil and tends to retard transpiration. The evaporation from porous cup atmometers in full

exposure on a clear-cut area averaged about 28 cubic centimeters daily; under a bush on an adjacent clear-cut area it was 17 cubic centimeters, and in an adjoining stand of virgin timber it was only 15 cubic centimeters. On the fully exposed cut-over area, the soil always had less moisture at a depth of 3 inches than soil under mature Douglas fir timber or under brush cover. At a depth of 6 inches the soil moisture content on the three areas was about equal. At a depth of 12 inches, however, there was more moisture in the soil of the fully exposed area. Contrary to the findings in many other forest regions, practically all moisture available for seedling growth during the summer months is water stored in the soil during the preceding wet winter months as there is usually little or no midsummer rainfall. The top 6 inches of soil was almost always found to be drier than the lower strata.

On the area studied the average annual rainfall is 85 inches, but during 5 years the greatest total rainfall in July and August amounted to only 0.76 inch. During three of these years no rain fell in July. Seedling mortality from drought was sometimes caused by a gradual decline in soil moisture as the season progressed, but at other times was the result of only a few dry, hot days. Occasionally, when the soil moisture content already was low, a single hot day would dry the soil enough to kill many seedlings. As might be expected, seedling mortality was greatest on the logged area which most recently had burned.

"Dead shade", i.e., the shade of logs, stumps, and debris, is more favorable to seedling growth than the shade of weeds and brush because it provides the same protection against evaporation, sun, and frost but does not compete with the seedling for moisture and plant food.

For the first few years of a seedling's life, vegetative cover (if not too dense) is helpful because of the indirect benefits resulting from its shade. After the cover is well established, however, the presence of this competing vegetation appreciably retards seedling growth and also prevents new seedlings from coming in.

Thus far studies have been confined chiefly to clear-cut areas. Suddenly, with the advent of the truck and tractor, there is a pronounced movement toward partial cutting in the type, and foresters are faced with a brand new set of problems. Knowing that Douglas fir is an intolerant tree and will not reproduce in its own shade, it is at once evident if the species is to be maintained in the type, at least half of the crown will have to be removed or the cutting will have to be done in clear-cut spots. Preliminary studies indicate that there are stands in the region where either of these methods or a combination of them may be used but there are other stands where partial cutting will not work. On moist sites or exposed places windfall is heavy if the crown is opened up. In rough topography and dense stands it is all but impossible to remove part of the trees without serious injury to the reserve stand. Some stands may be highly defective or do not have the range of age and diameter classes necessary for partial cutting. On the other hand, there are suitable stands on sufficiently favorable ground to permit partial cutting and opening of crowns sufficiently to allow Douglas fir reproduction to come in. However, it behooves the forester to analyze his stands and apply the partial cutting system with caution lest he find himself with depleted stands made up of defective trees and inferior species.

In summing up the situation to date three points stand out:

1. Broad areas that have been devastated by clear-cutting and repeated fires and are beyond reach of a source of seed will not reforest naturally for generations. If they are to become productive, they must be seeded or planted.

2. If future clear-cutting is to be followed promptly by a new forest, patches of timber must be left to break up large areas cut in order to form better fire protection and a more adequate seed supply, and there must be less burning and no reburning.

3. If partial cutting is contemplated, care should be taken to determine if the stand is suitable for some form of selective logging.

If these points are observed it is reasonably certain that in future cutting the normal cycle of forest succession will not be interrupted, there will be no semi-permanent brush stage; defective trees and inferior species will not be gaining possession of the land, and old forests will be followed by new in a single step.