A Program of Forest Soils Research for the Pacific Northwest

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"PACIFIC NORTHWEST" and "great forests" are closely associated terms in the minds of most people. A great share of the regional income is derived from forest products, many towns in Oregon and Washington being established squarely on a base of forest harvests. A prosperous Northwest depends heavily on continued growth of trees on its large forest areas.

Underlying all timber production is the forest soil. Characteristics of the soil help determine how rapidly the tree crop is grown and the quality of the lumber sawed therefrom.

Forest soils of the Pacific Northwest have received but little study in the past, mainly because of a lack of demand for basic ecological data. This seeming disinterest in the processes underlying tree growth can be attributed in part to the comparative recentness of exploitation of the region. Until the past half-century or so almost the width of the nation has lain between the Pacific Northwest and the logger's axe. In this half-century, however, the demands of a growing country, a large export market, and two world wars put a heavy drain on the resource. Emphasis was on the harvest; thought of the future timber supply was largely put off to be worried about later.

Now it is "later," and with a continuing strong demand and steady shrinking of timber inventories, some attention has shifted from cutting trees to growing them for a continuing industry. This change in attitude focuses interest on the intensive management of timber lands which, in turn, emphasizes the importance of learning the relation of forest soils to tree growth.

This is essentially the same course followed in longer-settled forest areas of the United States. The ill effects of exploitation led to eventual interest in better management. This interest created the need for knowledge of all the factors involved in growing trees, and research was called upon to help provide that knowledge. This is the reason that almost all forest soils research has been centered in the older regions: the Lake States, Central States, New England, southern Appalachian States, and the South. All of these regions are deeply concerned with forest depletion; all are thinking of restoration and have turned to the study of forest soils for data basic to permanent production.

Because the Pacific Northwest is experiencing a rapid depletion of its timber resource, this region, too, needs a program of forest soils research to help provide necessary information to keep timber in permanent production. In recognition of this need, the work of the Pacific Northwest Forest and Range Experiment Station has recently been expanded to include a comprehensive study of forest soils problems in Oregon and Washington.

PREVIOUS FOREST SOILS RESEARCH IN THE NORTHWEST

IN 1928, THE NEED for forest soils investigations was emphasized by Munger (*1*), who held that the cooperation of the soil scientist with the forester was greatly needed in the solution of inseparable problems of tree growth and of soil. This was reaffirmed by Miller (*2*) who said: "Silvicultural research of the future will take far greater account of the relation of the soil to the tree. I venture to suggest that soil science has potentially as much to contribute to silviculture as to agriculture . . . soil studies should include analyses which will correlate the growth of forest trees with the physical and chemical properties of the soil. It is to be hoped that the organization of every forest experiment station and every forestry school in the not distant future will include a department of forest soils."

Research in forest soils has increased greatly since that statement was made in 1933, but there is still a great lack of forest soil information for the Pacific Northwest.

Early interest in the relationship of soil to tree production was shown by Hanzlik (*3*) who studied the growth and yield of Douglas-fir on different soils in western Washington and Oregon. Some conclusions drawn at that time were: (*a*) Douglas-fir makes best growth on slopes, rather than

on level land, and good drainage is necessary. (*b*) The best soils for Douglas-fir growth are medium to deep loams with sandy or gravelly subsoils; poor soils are shallow loams or shallow sands with rock outcrops. (*c*) Douglas-fir very often grows better on bench lands and hill soils than on bottom lands generally considered most productive from an agricultural standpoint.

Powers (*4*) at the Oregon Agricultural Experiment Station studied some characteristics of several forest soils representing three major timber areas of Oregon. He found the maximum numbers of microorganisms and the maximum base exchange capacity generally occuring in nearly neutral fermenting (*F*) or largely humified (*H*) layers containing approximately 75 per cent organic matter. The feeding roots were observed to be massed just below this organic layer.

The effect of burning on forest soils was studied by Fowells and Stephenson (*5*). They concluded that the temporary effect of burning may be helpful in some respects but since the productivity of the forest soil depends upon gradual mineralization of the fallen litter it does not appear reasonable to expect continuous and often repeated burning to improve forest soil fertility.

A chemical and microbiological analysis of some Oregon forest soils was carried out by Powers and Bollen (*6*) furthering Powers' earlier work. The 1935 study found that the nutrient supply is greatest in the *F* and *H* layers, especially bases and nitrates, and that micro- and macroorganisms are important in humus–nitrogen generation.

A study made in Alaska, under conditions similar to those of the Pacific Northwest coastal forests, was published by Taylor (*7*). This investigator states that nitrate-nitrogen is an important factor in the occurrence of Sitka spruce and Western hemlock seedlings, the nitrifying power varying with the organic matter source of the seed-bed.

Wheeting (*8*) studied the shot clay soils found in western Washington. He concludes that shot clays are formed under forest vegetation only, that they are best developed where there is a condition of restricted drainage, and that shot are a normal development in soils of the area. The theory of precipitation and dehydration of soluble iron and aluminum compounds around nuclei during the dry season is supported as the method of formation.

Isaac and Hopkins (*9*), studying soil changes brought about by logging and slash burning in the Douglas-fir region, found evidence to support the

growing theory that burning did not, as so many landowners still believed, make for greater sustained productivity. These investigators state that the harmful effects of slash burning far outweigh the temporary beneficial effects of increased available nutrients in the fire remains. They warn that while a first-year effect of heightened growth of grass and other plants is evident, over a period of time burning results in lower productivity due to leaching of the increased nutrient supply into the deeper part of the soil profile.

Interest in the organic matter relationships of forest soils appears to have been predominant in this region. Besides the work done in Oregon, Wheeting (*10*) discussed the importance of forest humus layers to tree growth, remarking in conclusion that the forester and the soils man have a common denominator of interest—the soil organic matter represented by the forest humus layers.

Numerous references to the soil are made in the course of ecological, biological, and other scientific studies of flora and fauna of the Pacific Northwest, but from the standpoint of direct forest soils research, the few foregoing studies summarize the work in this region to date.

Proposed Program

THE WORK of the Pacific Northwest Forest and Range Experiment Station now includes the study of forest soils. Only problems directly concerned with land use will be considered in this new program. Fundamental research, such as that involved in forest soil microbiology, soil physics, and basic nutritional problems, is considered a function of the colleges and institutions devoted to such intensive work.

Based on the foregoing premise, the following program, listing studies in order of urgency, is proposed:

I. Primary studies
   - A. Soil and site factors in tree growth
     1. Douglas-fir
        - *a*) A study of the role played by plant nutrients in Douglas-fir growth
        - *b*) A study of physical factors of soil and site affecting growth
        - *c*) A study, utilizing data from *a* and *b*, to evolve a method of site evaluation for Douglas-fir by use of soil information in combination with physical site characteristics
     2. Other commercial species as opportunity arises

B. Soil and site factors in regeneration
   1. Artificial regeneration (planting)
      a) Determination of soil requirements of different tree species
      b) Determination of feasible planting areas from soil standpoint
      c) Determination of best planting methods to use for specific conditions of soil and site
   2. Natural regeneration
      a) Determination of soil factors affecting natural seedling establishment
      b) Assistance in evolution of timber-management methods designed to create optimum soil conditions for restocking and growth

C. Studies of man-caused soil deterioration
   1. Effects of fire, logging, and grazing on soil properties
   2. Methods of prevention or amelioration of damage

D. Watershed problems—run-off control

II. Secondary studies

A. Nursery practices
   1. Nursery site selection
   2. Nursery soil treatment practices
   3. Development of stock best suited to particular sites

B. Incidental studies
   1. Forest soil survey techniques and promotion
   2. Localized problems

Soil and Site Investigations

CONSIDERED THE MOST URGENT forest soil problem for the Northwest is that of learning the nature of soil and site conditions which influence the rate of tree growth. There are two very important applications of such knowledge to practical forestry. First, in attempting reforestation of unstocked lands, the cost of planting in relation to expected return on the investment is of great importance. Concentration of first planting effort on best sites is obviously the desired practice, but without trees present to indicate capability of the land to produce good forests, the task of appraisal is difficult. Second, permanent enterprises dealing with forest lands must forecast yields of timber at future harvest dates. A logging investment of thousands of dollars

must be founded upon rather accurate figures of expected future yields. Other applications of such a method of evaluation of lands for timber production lie in the fields of appraisal for tax or sale purposes and determination of best land use for a given site.

A method of site-class evaluation based on features of soil and site is greatly needed in the Douglas-fir region, but it cannot be determined until fundamental knowledge is obtained through soil-site study.

Douglas-fir, being the most valuable commercial tree species in the region, has been selected for initial work, with studies in other commercial species being planned for the near future. As a first step, the role of soil fertility in tree growth has been studied. Soil-nutrient level and site quality correlation were investigated through laboratory determinations made on a series of soil samples collected in Oregon and Washington Douglas-fir forests of known site class. Determinations of total nitrogen, available phosphorous, available potash, total organic matter, base exchange capacity, and replaceable calcium and magnesium were made in the laboratory. When the results from these analyses were statistically treated, it was found that there was no correlation between these measurable soil fertility values and site class (*11*).

A study of physical factors of soil and site will complement the nutrient availability investigation. All observable characteristics of the soil profile and physical features of the site will be studied over a wide range of conditions under all site classes and the data statistically compared with tree-growth rate. Many permanent growth plots in Douglas-fir forests are available for sampling in connection with this work. Some of these plots have been established for as long as 35 years, and afford very accurate site and growth data. The Douglas-fir region will be thoroughly covered outside these plots as well, to assure adequate sampling. As data are accumulated and tested, significant factors of soil and site will be further developed as criteria by which site quality may be evaluated.

Soil and Site Factors in Regeneration

THE SECOND PHASE of the program, soil and site factors in regeneration, is intended primarily to assist in the task of planting or seeding logged or other unstocked lands. In view of a large investment in labor, equipment, and planting stock or seed, any areas to be artificially restocked should be studied for

feasibility of planting. One of the most important parts of such a study is a soil survey to define the soil differences encountered on the site. This will aid in planning the job, including determination of methods of planting to be used, and planting the most feasible areas first.

Considering natural regeneration, we should have information as to the soil conditions affecting seedling establishments. This will have practical application in planning timber-management operations and logging in order to create optimum conditions for restocking and growth.

Soil Deterioration

As the third basic study in this program, the problems of soil deterioration will be studied. The actual extent of soil damage caused by slash burning is still a source of controversy. Some answers have been found but more work remains to be done before conclusions applicable to the entire region can be reached. The study will be extended over a number of years after burning to learn the length of time required for restoration of soil to its original condition before logging and burning. The effects of logging and grazing on soil condition will also be observed, as a step toward solving some of the land-use problems arising from those activities.

Watershed Problems

Watershed Problems are always closely connected with forest management. Again, the soil, acting as a reservoir, is the fundamental point of attack. The subject will be approached from the standpoint of the effects of soil damage and corrections therefor.

Several studies taking a place secondary to those described above should be mentioned. Nursery practices will become more intensified as planting programs are established, and the selection of sites for new nurseries, as well as the treatment of the soils growing seedlings in these nurseries, will be important.

As work progresses, incidentals to the major studies will of course arise. All of these cannot be foreseen at the beginning, but one important example lies in improving methods and increasing the extent of forest soil surveys. Extension of soil surveys onto forest lands would provide an invaluable tool for practical foresters just as such surveys have benefited agriculturists. Work

with pathologists, entomologists, and forest administrators will uncover localized problems, the solutions of which may be aided by soil study.

If the foregoing statement of studies and aims seems rather all-inclusive, it is because potentialities for forest soils research in the Pacific Northwest are great. Now that forests are being raised as a crop in this region, knowledge must be built up rapidly to keep abreast of land use problems. It is hoped that this program planned by the Pacific Northwest Forest and Range Experiment Station will stimulate increasing thought and research by other organizations into various phases of the forest soils field.

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