factors in the survival of seedlings, although there is much to be learned in this field. He expressed preference for seedlings from plus or elite trees grown in areas similar to those they wish to plant. He also mentioned the problem of producing trees which would be distasteful to livestock.

Mr. Greathouse's paper follows:

THE PLANTING MAN'S IDEAL TREE

by
Thomas Greathouse
Forester, Olympic National Forest

My friends, whether Republican, Democrat, or Independent, I bring tidings from Mason Bruce, Supervisor of the Olympic, who was unable to attend. At his request, I will attempt to describe our concept of the ideal tree for planting.

The Olympic has now reforested about 43,000 acres. This is more than any other National Forest in the Pacific Northwest. During the last three years, due primarily to the salvage program on the approximately 19,000 acres of National Forest land which were covered by the Forks and Bear Creek Burns of 1951 and 1952, we have stepped up our planting activities considerably above normal.

Plans for the coming planting season call for reforesting about 4,800 acres; 3,700 of this is proposed for planting, the rest seeding. The program peaked last year with 5,500 acres being planted and 600 seeded, as compared to 3,200 planted and 1,100 seeded the year previously.

Before I get to the theme of this talk, I might say that I feel somewhat like a school boy trying to explain the 4th Dimension to Einstein. As nurserymen, you have been listening to the complaints and suggestions of tree planters for a number of years. I hope that I can add to the constructive suggestions that you have received.

My first preparation for this talk consisted of an interview with Walt Millo, a planting contractor, who last year reforested about 3,500 acres for the Olympic besides work that he did for other Forests and Rayonier Company. I thought that his comments were interesting enough to pass on to you, even though there may be some conflict between his idea of the perfect tree and those ideas developed by research. Millo stated that 2-0 trees, readily visible after planting, with a sturdy stem and healthy crown, were important for the morale of his crew. A good tree planter is like most other people; he wants to be able to see what he has accomplished. Most 1-0 trees have such small crowns that it is difficult for the planters to see their previous rows. Frost-damaged trees, such as we planted last year, sometimes present the same problem. A sturdy stem is easier to handle than a scrawny one. Millo's sample 2-0 tree measured about 1/8-inch in diameter. Since Crossitt, Rindt and Gunning listed 3/32-inch as a minimum for conifers, there is no conflict here.

A bulletin, entitled "How to Grade Yellow Poplar Planting Stock," which was issued October, 1953, by the Central States Experiment Station, confirms Millo's thoughts, but on a scientific basis. This paper stated that survival of a planted yellow poplar tree was significantly affected by two interrelated factors:

(1) seedling size, as expressed by stem diameter; and (2) degree of root pruning.

Top growth for poplar during the first two years after planting was believed to depend mainly on food stored in the thickened portion of the roots. Since top growth occurs in spring and early summer when moisture conditions are usually favorable, excessive root pruning does not seriously retard top growth during the first two seasons, unless a drouth occurs. During an unusually dry period, excessively pruned roots would not be sufficiently developed to supply the amount of water needed for survival, since water absorption is mainly a function of the smaller roots.

Thus Millo and his crew, instinctively or otherwise, want a tree which has a good chance for survival.

With reference to root pruning, there is possibly some conflict between the ideal tree for planting, using present tools and methods, and the ideal tree for survival. Eight inches is about the maximum root length if the roots are not to be curled up when planted. If the soil was of the right composition, possibly 9 inches would be permissible. Sometimes eight inches is too long - in rocky, shallow soils, for example.

Although I have been unable to find any information concerning the ideal top-root ratio, Crossitt, Rindt and Gunning stated in the U.S.D.A. Yearbook for 1949 that a 1:1 to 3:1 top to root ratio, by weight, were the minimum and maximum for conifers. Over 3:1 ratio resulted in poor survival. Perhaps we have been letting the tail wag the dog in pruning the roots to fit the present planting hoe. If 8-inch roots are not ideal for the average 2-0 top or crown, then it seems that we should consider the advisability of a planting tool with different dimensions. One experiment, which has been carried on for six years by the Puget Sound Research Center, shows a 13% greater survival by 1-0 stock, as compared to 2-0 and some jumbo 2-0. Perhaps this is because there is a better balance between top-root ratio with the 1-0 stock.

However, Wakely, in his book on Southern pines, states that top-root ratios have never proven useful in grading Southern pine nursery seedlings and were not used in his suggested grading rules. He also said that the complex problem of establishing satisfactory grades for Southern pines had not been solved. Maximum size of root collar and of seedlings was not as important as first believed, as intermediate seedlings showed better survival when planted than did the jumbo grade.

As I understand it, the root pruning which is done during the dormant season prior to the second growing season is designed to give a better balance to this ratio, based, of course, upon the limits of the planting hoe.

Although top-root ratio may be one of the major factors in the survival of seedlings which undergo the shock of being planted in a cutover area, much is yet to be learned in this field.

An experiment now in progress at Capital State Nursery will probably shed new light on this problem.

Width of roots is also important, if the trees are to be planted properly. Three to 3½ inches is satisfactory. If there is moist earth attached to the roots, they will droop somewhat and occupy less horizontal space, but this should not be counted on when pruning the trees. Noble fir, spruce, and cedar are generally less desirable for planting, as their roots maintain a more horizontal position. Pruning the roots of these species to a maximum of 3 inches width is important.

Fresh, healthy appearing trees are much simpler to handle. Most of the planters cannot be trusted to discard the poorer trees. The cull percentage would have been even higher this year, due to frost damage, if the planters had selected only the best trees. We realize that there are many uncontrollable factors - weather, labor, etc. - which affect the quality of the trees that you produce, but I am attempting to outline the ideal tree.

We prefer 2-0 trees on the Olympic. Even though the experiment carried on by the Puget Sound Research Center indicated better survival of 1-0 stock after 6 years, there are other factors in favor of 2-0 seedlings. The major considerations are: Elimination of weak trees in the nursery; facility in planting; crew morale; and more adequate preparation to compete with the brush and the shock of being transplanted to sometimes severe sites in cutover areas.

There are also economic considerations to be weighed in producing seedlings which must be mentioned when contemplating the ideal tree. Our trees (about 2/3 of which came from the Capitol State Nursery just south of Olympia) cost an average of about $6.00 per thousand last year. These were all 2-0 stock. Our total planting cost was about $46.00 per thousand. Thus the trees cost about 13% of the total. Costs of producing 1-0 stock would be a saving of only 4% of the total cost. This saving, balanced against what we believe to be much better survival by 2-0 stock, is not believed to be a net saving.

Genetic qualities are receiving more consideration each year. We would like to know that our trees were resistant to frost and to disease, and that they would be fast-growing with straight, clean boles.

Geneticists tell us that resistance to frost damage is greater in trees that are native to the higher elevations. Thus if we plant trees at high elevations, which were grown from seed collected at sea level, we should not be surprised if there is annual frost damage. Past observations have shown that Douglas fir seed, moved from Colorado to the Pacific Coast, produced seedlings which were more susceptible to disease then indigenous trees.

Our goal is to obtain progeny from plus or elite trees growing at equivalent elevations and on areas with site and climate similar to that of the areas which we wish to plant. This can be done to some extent by selective cone collection or by establishing seed orchards using graftings from the plus trees to produce the desired seed. The latter is believed to give more certain results.

In my research for this paper I read that wildlife prefers nursery-grown stock to natural reproduction. Since animals seem to have a natural selectivity in browsing, which permits them to distinguish foliage containing the elements they need for survival, the more succulent nursery stock, which has been fertilized, is heavily browsed. It would be very desirable, from our viewpoint, for you to produce trees which would be distasteful to wildlife.

I realize that you have given much thought to this problem and have experimented with both external repellents and with those which can be built-in to the trees, as is done with fertilizer. Harry Hartwell of the Fish and Wildlife Service said that the problem is still a baffling one. Since the trees live largely on the food stored in the thickened portion of the roots for the first two years after planting, any such built-in repellent should be good for at least that period.

In summation, we believe the ideal tree would have the following:

1. Be 2-0 stock with sturdy stem and healthy, well-developed crown.

2. Be resistant to disease, frost damage, and wildlife.

3. Be of fast-growing, plus-tree stock.

(End of Paper)

As the last speaker of the day, Chairman Deffenbacher introduced Dr. Ernest Wright, Pathologist, Division of Forest Disease Research, U.S. Forest Service.

Dr. Wright explained the work of the pathologist, who is called in when seedling losses occur in the nursery. He stressed the careful examination what is made on the site to determine the exact cause of the losses. A number of cultures are then taken to be certain the ocular observations are correct. Re-isolation of the same fungi from artificially infected seedlings is final proof of pathogenicity. He said that the pathologist cannot do much about the damping off while it is in progress, but he can do research on the active disease, and plan for the future.

Dr. Wright's paper follows:

PATHOLOGICAL RESEARCH IN THE FOREST NURSERY

by

Ernest Wright, Pathologist
Pacific Northwest Forest and Range Experiment Station

It is the purpose of this paper to dispel the mystic halo which sometimes surrounds the nursery pathologist and to explain his curious antics, as well as his unusual aroma at times.

The nursery pathologist is essentially a soil biologist. The diseases which infect nursery seedlings are primarily fungi that live in the soil and are dealt with accordingly. The essential part of the problem is to determine the cause of the loss. This may appear to be a simple matter. Unfortunately such is not the case. Let us assume a not-too-hypothetical situation.

A forest nursery, which our pathologist has had under surveillance for some time and which has had no alarming seedling losses, suddenly develops an acute case of what appears to be damping-off. Now the pathologist is in his glory as well as in a state of anxiety. He arrives at the nursery and immediately gets down on all fours and starts crawling thither and yon among the seedbeds like a bloodhound with his nose close to the ground. He carefully digs out a number of seedlings, whips out a hand lens, and examines each seedling very intently. Yes, this fellow is a queer egg to the casual observer, but he is not as daffy as he appears. What is he looking for? Surely he should be able to determine damping-off without such peculiar activity. He would be unwise and foolish if he did not make these careful examinations because what appears to be damping-off could easily be chemical injury, insect, or mechanical damage, sunscald, frost, drought, or a combination of more than one factor. Each shows specific symptoms.