U. S. DEPARTMENT OF AGRICULTURE FOREST SERVICE
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
R. W. COWLIN, DIRECTOR

Research Note

Number 122 Portland, Oregon October 1955

TENTATIVE GUIDES FOR THE SELECTION OF PLUS TREES AND SUPERIOR STANDS IN DOUGLAS-FIR

By

Leo A. Isaac

Interest among foresters in forest tree improvement has increased rapidly in recent years. Geneticists have learned that some individual trees greatly excel their neighbors in desirable characteristics, and that some entire stands are superior to other stands of the same species in a general locality. They have learned that many of the desirable tree characteristics are hereditary in nature, and they have reasoned and shown that man may profit greatly by planned improvement of forest trees.

In the Pacific Northwest, early interest centered around the testing of strains and determination of climatic tolerance. Heredity studies[1/] started 40 years ago have shown that superior strains exist in our stands; also that our trees cannot be arbitrarily shifted from one climatic zone to another without adverse effect. Unusual trees have been noted in the region, but until very recently no effort has been made to study or propagate them.

Great gains may be expected over a long period of years through crossbreeding for the most desirable characteristics. Immediate, practical gains can also be attained through selection for better seed

---

1/ Munger, Thornton T., and Morris, William G. Growth of Douglas fir trees of known seed source. U. S. Dept. Agr. Tech. Bul. 537, 40 pp., illus. 1936.

sources--better seed sources, first, through the selection and perhaps the improvement of our best natural stands as designated seed-production areas; and, second, through the development of seed orchards with grafted stock from the finest individual trees in our natural stands.

When tree improvement starts with an undeveloped species, there are naturally no certified or so-called elite trees; therefore, work will start with the best individual trees and best natural strains or stands. These are known as plus trees and superior stands. This research note has been prepared to provide tentative guides for recognizing and selecting plus trees and superior stands of Douglas-fir. Plus trees will provide rooting and grafting scions for establishing seed orchards, pollen for controlled breeding, and in some instances seed for progeny testing. Superior stands, where preserved, will provide natural seed sources and seed-production areas that may either be improved or held in their natural condition.

With the rapid development of species-improvement work, there has been great variation in the use of forest genetic terms. To avoid confusion and misunderstanding, important terms used in this report are defined in conformity with the definitions proposed by the Society of American Foresters subcommittee on forest genetics:

> Elite tree.--A tree greatly superior to the average tree of the same species in some inherited characteristic or characteristics, as determined by progeny tests. Often growth form and growth rate are the main characteristics considered when classifying a tree as an elite; but a tree superior in other characteristics, such as resistance to disease, yield of oleoresin, or fiber length, may be termed an elite even though it is not superior in growth form or growth rate. [cf. plus tree, superior tree.]
>
> Plus tree.--A tree which, in its outward appearance, is superior to the average tree of the same species growing on a similar site. The selection of a plus tree is based entirely on visible characters. If, through testing of the offspring of the tree, it has been shown to possess inherent superiority, the tree may be termed an elite tree. Superiority may be expressed in form, vigor, resistance to pests, etc. [cf. elite tree, superior tree.]
>
> Seed orchard (seed plantation).--A plantation of trees, selected for their hereditary characters, so grown and treated as to produce abundant, easily harvested seed

crops. Commonly such an orchard is established by setting out clones (as grafts or cuttings) or progeny of selected trees or hybrids, treating them to stimulate abundant seed production. In its strict sense a seed orchard is established specifically for seed production with genetically proven (tested) stock. In practice seed orchards are often established while genetic tests are under way on the parent material used. Depending on the results of those tests, the undesirable material will then be removed from the already established orchard. [cf. seed production area, progeny, graft, clone.]

Seed production area.--A stand or group of stands of specially desirable trees, set aside and usually specially treated to enhance seed production. Such areas are composed of stands or plantations not originally established for seed production and much less intensively selected and treated than seed orchards. Their genetic worth is usually not known; the trees are merely good phenotypes. [cf. seed orchard, genotype, phenotype.]

Seed orchards are sometimes established by grafting cuttings from plus or elite trees directly onto seedlings in young natural stands. Surplus, ungrafted seedlings are then removed from the stand. Exceptional seedlings selected directly from seedbeds in the nursery are also used to establish seed orchards, but little information is available to show the effectiveness of this method. Several plus trees or clones are needed to establish a seed orchard in order to prevent selfing or inbreeding; the minimum number is usually about 10. Contamination from outside pollen sources is prevented by locating seed orchards apart from other stands or screening them with a border plantation of other species.

Seed-production areas for Douglas-fir will usually consist of one or more selected portions of a superior stand or strain. A minimum size for a seed-production area has not been determined, but several acres will probably be needed to provide adequate pollination.

Selecting Plus Trees

A plus tree may have one or more desirable characteristics. For timber production in coniferous stands, the features most sought after are growth rate, bole form, and wood quality; characteristics such as

Christmas tree form, seed production, and resistance to insects and disease are often important as well. If plus trees are to be used for hybridization or crossbreeding alone, they may be selected for a single characteristic such as hardiness or resistance to disease. When plus trees are to be used primarily for seed-orchard cuttings, however, they should, if possible, be outstanding in several of the characteristics desired in the new forest.

In Europe, criteria extensively used in the selection of plus trees[2/ 3/ 4/] of Scotch pine, Norway spruce, and several other conifers are based largely on growth rate, bole form, crown shape, crown thrift, and branch angle. These same characteristics appear to provide a good starting point for the recognition of plus trees in Douglas-fir.

In a mature stand, trees of exceptional form and quality can be easily recognized, but longtime progeny tests will be required to determine if the tree is inherently good or if its good looks are the result of environmental conditions during early life. But when a tree is selected at an early age before crown development, bole clearing, and growth have been strongly influenced by competition, its selection is far more dependable. In our quest for plus trees of Douglas-fir, it therefore appears logical to concentrate on young, open-grown trees that are at or approaching seed-bearing age. This does not imply, of course, that older trees with outstanding characteristics should be overlooked or bypassed.

In seeking plus trees, the forester should, above all, keep in mind that he is looking for a tree that is really outstanding. In a stand of many thousand Douglas-firs, there may be several trees, one, or even no trees that merit consideration. Within these broad guidelines, the following tentative specifications may prove helpful in selecting plus

---

2/ Arnborg, Tore, and Hadders, Gustaf. The society for practical forest improvement. Society for Practical Forest Improvement, Report No. 59. Uppsala, Sweden. 1953.

3/ Jensen, Holger. The establishment of forest tree seed orchards at Ramlosa 1941-54. Acta Horti Gotoburgensis 19 (5): 157-192, illus. August 1954.

4/ Lindquist, Bertil. Genetics in Swedish forestry practice. Stockholm, Sweden. 173 pp. 1948.

trees of Douglas-fir for timber production; selection for characteristics such as resistance to insects, disease, and drought will require special guides:

(a) A plus tree should be one of the fastest growing trees in a given stand.

(b) The crown should be thrifty but not overly dense or limby in comparison with its neighbors. It should have high vigor in the upper third of the crown and low vigor from there downward.

(c) The plus tree's crown should be narrow. It should retain a wedge-shaped, well-pointed top, but from the upper third downward the outer edge of the crown should remain somewhat parallel to the stem.

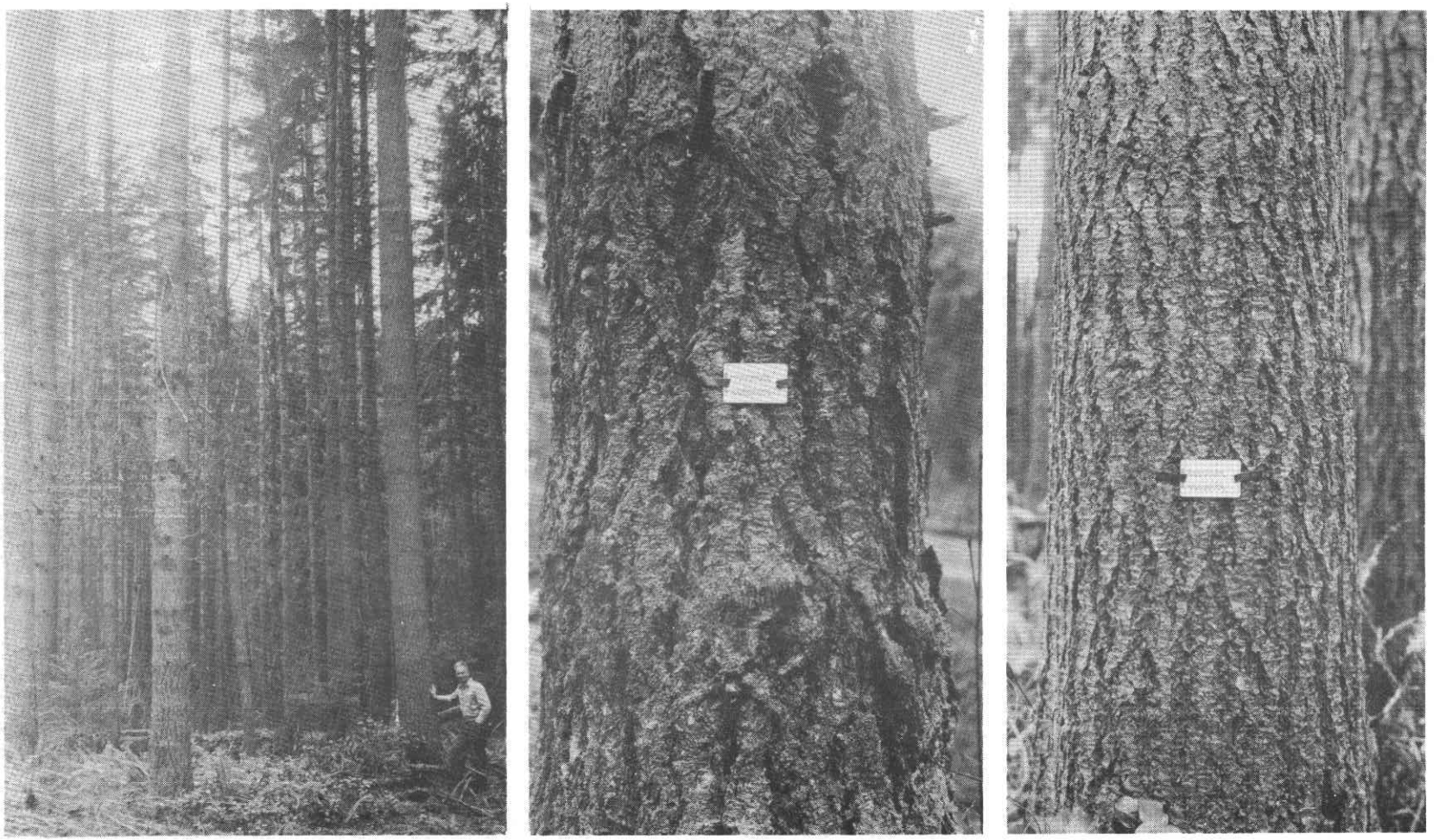
(d) The bole should be straight, have a high form factor, and be reasonably clear of branches between nodes and on the lower bole as trees approach maturity.

(e) Limbs in the upper third of the crown should not make a sharper, upward angle with the stem than 60°--more nearly horizontal or drooping branches are better. (European authorities believe that limbs pointing sharply upward compete with the main stem for growth, do not shed at an early date, and often form double leaders and forked trees.)

Bark characteristics may also be helpful. In many young-growth Douglas-fir stands, trees with flaky, fine-fissured, reddish-brown bark have been noted to be faster growing, finer branched, and cleaner boled than trees with hard, coarse-fissured, greyish bark. This difference was found to be pronounced on the McCleary Experimental Forest in northwestern Washington (fig. 1). This characteristic needs further study before it can be widely used with confidence.

Once plus trees are selected from visual characteristics, they can be further evaluated for wood quality by a measure of specific gravity, fibril angle, and percent of summerwood. The use of ordinary increment cores for these evaluations is currently being investigated by the Forest Products Laboratory at Madison, Wisconsin.

Figure 2, showing common forms of young Douglas-fir, is presented as a visual aid for selecting plus trees in young stands.



A. B. C.

Figure 1.--A. Clean-boled, fast-growing Douglas-fir tree (on right) with fine-grained, brownish bark, characteristic of good trees in the stand. Rough-boled tree (on left) has coarse-grained, greyish bark. B. Closeup of coarse-barked tree. C. Closeup of fine-barked tree.

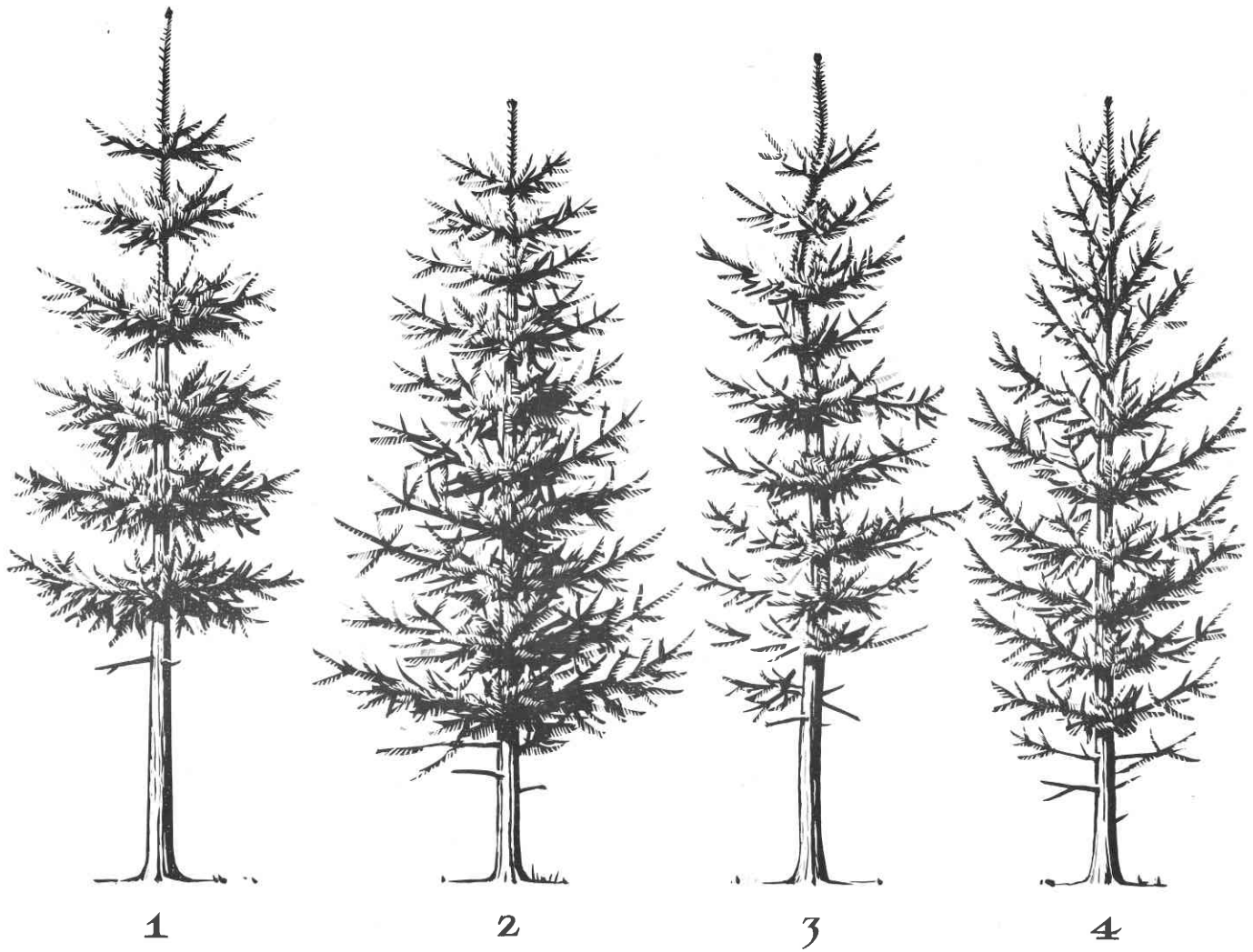


Figure 2.--Tree diagrams showing (1) ideal tree; (2) large, wedge-shaped crown; (3) crooked bole; and (4) limbs pointing too sharply upward.

Tree number 1 represents an ideal plus tree, larger than its neighbors, with vigorous pointed top, flat-sided crown, limbs dropping off early, and a straight bole clear between nodes.

Number 2 represents a slower growing tree with dense, wide, wedge-shaped crown and limbs retained longer than desired for timber production. Such trees would be ideal for Christmas tree purposes.

Number 3 represents a tree that has acceptable crown features but has a crooked, rough bole.

Number 4 represents a tree with limbs in upper third of crown at too sharp an upward angle (60° or less) with the stem.

Selecting Superior Stands

A superior stand is one that is better than surrounding stands or better than one would expect to find in a general locality or elevation. The existence of superior stands or strains is well established, but just how they develop in wild forests has never been clearly explained.

Better growth than one would expect in a given locality is a first requirement. Climate is perhaps the greatest factor affecting tree growth; altitude, insofar as it affects climate, also affects growth. When the entire region was sampled in the preparation of the yield bulletin,[5/] 89 percent of site I growth was found below 1,500 feet elevation, and none was found above 2,000 feet. Yet in recent years, three areas of site I growth have been found above 3,000 feet elevation. These are very likely superior stands. A second requirement is that a superior stand should contain an above-average number of high quality (good looking) trees. High quality trees in a superior stand should approach the plus tree in desirable characteristics but in most instances would be farther down the scale of superiority.

When portions of superior natural stands are selected and set aside as seed-production areas, they can then be further improved by the removal of slow growing, badly formed, and diseased trees (bad pollen parents). Thinning and the mulching effect of the resulting slash can be expected to stimulate crown growth and possibly seed production. In thinning a seed-collection area, high quality trees should not be removed simply because they do not produce cones. They may provide

---

5/ McArdle, Richard E. The yield of Douglas fir in the Pacific Northwest. U. S. Dept. Agr. Tech. Bul. 201, 74 pp., illus. 1930, Rev. 1949.

pollen for other reserved trees. Once seed areas are selected and thinned, many other steps may be undertaken to stimulate seed production such as pruning, topping, watering, fertilization, and insect and disease control.

Further Work

The specifications given for both plus trees and superior stands are preliminary. They should serve as interim guides but will need to be field tested in young-growth stands of different ages and periodically revised.

One immediate need is the determination of the normal variation in height growth, diameter growth, bark thickness, crown width, branch angle, percent of summerwood, and other key characteristics of Douglas-fir. When this needed background information is available, a start can then be made toward the substitution of measurement data for the broad adjectives used in the present specifications. Meanwhile, foresters in all parts of the Douglas-fir region should diligently search for candidate plus trees and superior stands using the best information now available. Once identified and located, these selected trees and stands will provide the raw material for real gains through planned species improvement.