# Correlating Specific Gravities

## of Branch and Bole Wood in Young Douglas Fir

By Milford D. McKimmy
Kim K. Ching



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Forest Research Laboratory
School of Forestry
OREGON STATE UNIVERSITY
Corvallis

# CORRELATING SPECIFIC GRAVITIES OF BRANCH AND BOLE WOOD IN YOUNG DOUGLAS FIR

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We came to the following conclusions for the samples analyzed:

A very high degree of correlation does seem to exist between the specific gravities of branch wood and stem wood near the top of young Douglas fir stems.

A sampling technique that selects branch and bole wood from more than one location in the stem does not seem to be necessary in the young trees sampled.

A random sample of two branches from two different quadrants appears sufficient to determine average specific gravity of a branch whorl.

Ability to predict quality of wood without damaging young trees, from five to twenty years old, would be helpful to forest research and field personnel. In our study, we attempted to find a relation between juvenile stem wood and branch wood in young Douglas fir that would make possible an evaluation of wood quality without either destroying the young stem or requiring a large, old stem. If such an evaluation were possible, forest managers could more easily decide which trees to remove by thinning and which to save. They could also decide which timber stands might be managed more profitably on a pulpwood rotation, and which should be managed on a sawtimber rotation. Forest geneticists could determine the results of tree-breeding programs when the trees are still young.

This report describes the results of a study to establish a correlation between the specific gravity of juvenile stem wood and that of branch wood in young Douglas fir saplings, similar to the work reported for southern pine by Zobel and Rhodes (9).* We selected specific gravity as the characteristic to evaluate because it has been studied widely by other workers (5, 6, 7), because it seems to be related to other properties that may influence the quality of wood (1, 3, 8), and because it was convenient to study with the small specimens available.

*Numbers in parentheses refer to literature cited.

## PROCEDURE

We selected nine Douglas fir 8-14 years old from the school forest at Oregon State University. The growth rate of these trees varied from 4 to 8 growth rings per inch at the basal cut. They were growing on high site III land along a forest road in a Douglas fir stand from 110 to 125 years old. At the laboratory, the basal whorl and the branch whorl third from the top were separated from each tree for analyses of branch wood. Samples of branch wood were taken midway between the bole and the first secondary branch. Samples of bole wood were taken midway between the whorls that were third and fourth from the top, and between the basal whorl and the ground. Each cross section of the tree stem was divided into four quadrants, as diagrammed in Figure 1.

Specific gravities of branch and stem wood were determined by the maximum-moisture-content method described by Smith (4). Unextracted sample weights were used in this analysis because preliminary studies had demonstrated no significant differences in specific gravity attributable to extractives. Values for specific gravity were obtained for wood in all four quadrants of the bole in each section. Values for specific gravity of branch wood were obtained from one branch from each quadrant at each whorl, whenever four branches were present. Three of the whorls had only three branches; all others had four or more. The mean specific gravity of two branches from two quadrants selected randomly at each whorl also was obtained to test the feasibility of using two branches from a whorl rather than four, in analyzing correlation. In this instance, only two randomly selected quadrants were used to determine the corresponding mean specific gravity of the bole.

## RESULTS

Specific gravity of the branches always was higher than specific gravity of the corresponding bole samples. Very high correlation coefficients (beyond the one percent level of significance) were obtained from linear regression analyses of specific gravity of bole wood with specific gravity of branch wood for only the fourth internode and third branch whorl by both sampling techniques (Figure 2, correlations 3 and 6 in Table 1). The correlation coefficients, in this instance, for predicting specific gravity of the bole by use of two branches randomly selected from two quadrants ($r = 0.8755$), or of four branches or more from all four quadrants ($r = 0.9515$), were both highly significant, so either sampling procedure appears adequate. When analyses of bole and branch wood at both heights in the stem were combined (Figure 3, correlations 1 and 4 in Table 1), no significant correlation occurred. Similarly, there was no significant correlation of specific gravity of bole wood with specific gravity of branch wood at the basal bole and basal branch whorl in either sampling technique (correlations 2 and 5 in Table 1).

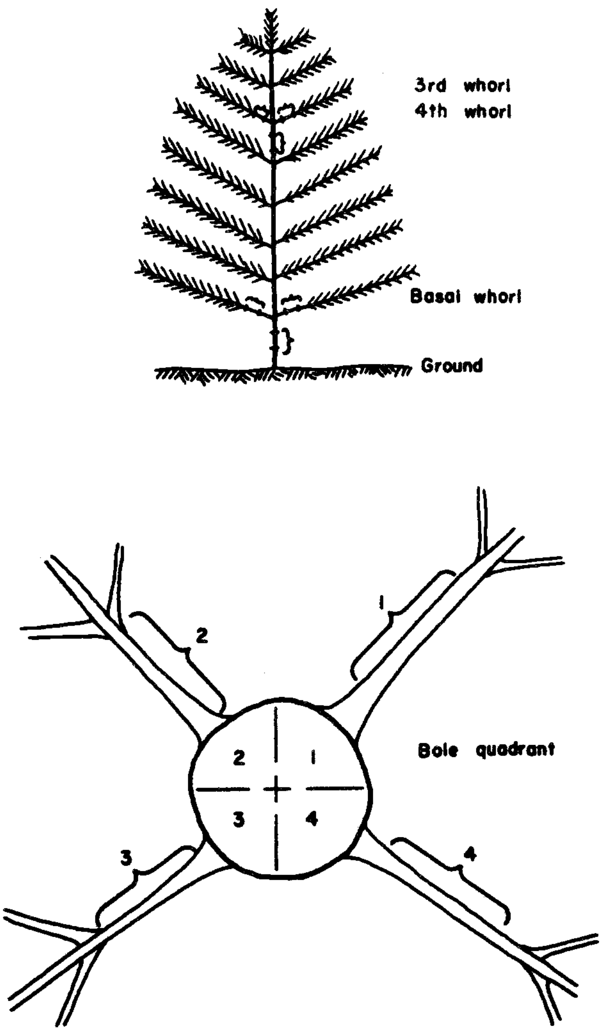


Figure 1. Schematic diagrams showing locations on bole and branches from which samples were taken.

Table 1. Correlations Made from Linear Regression Analysis of Specific Gravity of Bole Wood with Specific Gravity of Branch Wood in Young Douglas fir.

| Correlations | Regression equations | r* | $r^2$ | d.f. | Std. error of estimate |
|---|---|---|---|---|---|
| 1. Bole wood with branch wood (both whorls combined) | $\hat{Y} = -0.1319 + 0.9461X$ | 0.6201 | 0.3845 | 7 | 0.0482 |
| 2. Basal bole with basal whorl | $\hat{Y} = 0.4991 - 0.0276X$ | 0.0287 | 0.0008 | 7 | 0.0330 |
| 3. Bole at fourth internode with third whorl | $\hat{Y} = -1.0640 + 2.4980X$ | 0.9515** | 0.9053 | 7 | 0.0716 |
| 4. Bole wood with branch wood (both whorls combined, random sample, two branches at each whorl) | $\hat{Y} = 0.0169 + 0.7061X$ | 0.5061 | 0.2561 | 7 | 0.0540 |
| 5. Basal bole wood with basal branch whorl (random sample, two branches at each whorl) | $\hat{Y} = 0.4927 - 0.0205X$ | 0.0457 | 0.0021 | 7 | 0.0376 |
| 6. Bole at fourth internode with third whorl (random sample, two branches at each whorl) | $\hat{Y} = -0.7568 + 1.9726X$ | 0.8755** | 0.7664 | 7 | 0.0364 |

*r = Correlation coefficient.

**Beyond 1% level of significance.

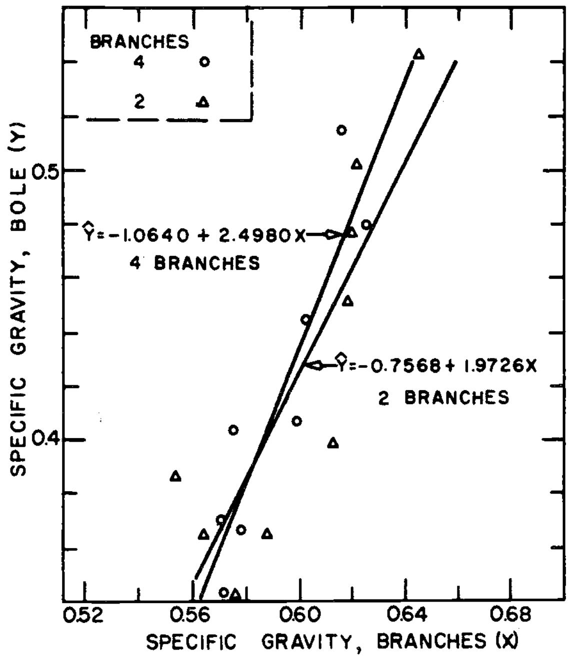


Figure 2. Regressions of bole wood on branch wood at top of tree based on specific gravity of four or more branches representing each quadrant and of two randomly selected branches from two different quadrants.

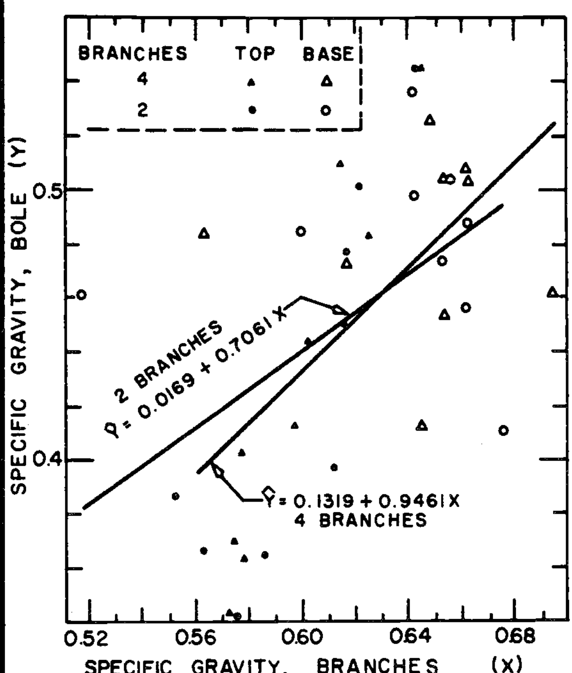


Figure 3. Regressions of bole wood on branch wood at base and top of stem based on specific gravity of four or more branches representing each quadrant and of two randomly selected branches from two different quadrants.

## DISCUSSION

The contrast in significance of correlation coefficients for specific gravity between bole and branch wood at the two different heights in the stem is probably attributable to increasing maturity of the stem wood and declining vigor of the lower branches. Although no data are presented as verification, most likely the declining vigor of older branches would tend to cause production of lower specific gravity in branch wood in contrast to the increasing specific gravity in the older bole wood. Thus, the relationship between age and specific gravity in the stem and in branches would differ with increasing age, which would cause the lack of correlation found. The various ages of the stems analyzed would also tend to cause additional variation in specific gravity in the analysis of basal bole wood and basal branch wood. Furthermore, only a few branch whorls contribute nutrients and growth hormones to wood formed in the uppermost part of the stem, while many branch whorls contribute to wood formed at the base.

Even though the present study has indicated that specific gravity of young stem wood can be predicted from the specific gravity of branch wood, a correlation between juvenile wood and mature wood of the stem may show a different relation, as indicated by a preliminary study in Douglas fir (2). Clearly, more information of this nature is needed for a particular species at a given site to help the forest manager make valid and reliable decisions that would enable him to grow trees with wood of high specific gravity.

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## PROGRAM AND PURPOSE

The program of the Forest Research Laboratory is designed to provide information that will improve techniques of forest management and promote full utilization of forest products. Able specialists with well-equipped laboratories study Oregon's forest resources, supported by the forest industry and by state and federal funds.

Research in this field by wood scientists and technologists, chemists, and engineers includes studies of properties, processing, utilization, and marketing of wood and of timber by-products. Technical principles derived through this research can be applied to the operation of Oregon's forest industry.

The PROGRAM of research includes

- identifying and developing chemicals from wood,
- improving pulping of wood and wood residues,
- investigating and improving manufacturing techniques,
- extending life of wood by treating,
- developing better methods of seasoning wood for higher quality and reduced costs,
- cooperating with forest scientists to determine effects of growing conditions on wood properties, and
- evaluating engineering properties of wood and wood-based materials and structures.

The PURPOSE of research on forest products is to provide information that will enable the forest industry to expand markets, create new jobs, and bring more dollar returns by

> developing products from residues and timber now wasted, and

> improving treatment and design of present wood products.