ESTIMATING BOLE SPECIFIC GRAVITY FROM LIMBS OF MATURE BLACK CHERRY AND NORTHERN RED OAK TREES

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ABSTRACT

Specific gravity values were determined for the bole, and three locations in limbs were taken from the upper, middle, and lower crown of fifty 35-year-old trees of both northern red oak (*Quercus rubra* L.) and black cherry (*Prunus serotina* Ehrh.). Bole specific gravity varied from 0.469 to 0.605 with an average of 0.524 for black cherry; and varied from 0.549 to 0.656 with an average of 0.584 for northern red oak. Limb specific gravity was greater and more variable. At each crown position limb specific gravity decreased along the limb from the base to the terminus. The highest bole-limb correlation was with the middle section of the middle limb in black cherry ($r = 0.510$); and the middle section of the lowest limb in northern red oak ($r = 0.450$). The degree of correlation was low but statistically significant.

Additional keywords: *Quercus rubra, Prunus serotina,* stemwood, branchwood, correlations, prediction equations.

INTRODUCTION

The specific gravity of standing trees must frequently be assessed for both research and forest management purposes. Traditionally this has been done by removing a wood sample from some point near the base of the tree bole, usually at breast height. The resulting opening itself is not only a defect in the most valuable portion of the tree but may serve as an infection court for stain or decay-causing fungi. In small trees, seedlings and saplings, specific gravity determination often involves a process of destructive sampling. A relatively rapid, nondamaging, nondestructive means of assessing the specific gravity of standing trees is needed.

Tree improvement researchers have had a special interest in estimating the specific gravity of valuable and often small breeding stock. In order to preserve such material, their approach has been to examine the correlation between bole wood specific gravity and that of branches. Zobel and Rhodes (1956) conducted the pioneering research with sapling loblolly pine which indicated that the two were correlated. Subsequent research by Zobel and Rhodes (1957), McKimmy and Ching (1968), and Lee (1971) all with relatively young conifers have confirmed and amplified the conclusions reached in the initial study.

The research reported here expands the ideas reported in the literature to an examination of the relationship between the bole wood and limb wood specific gravity in older individuals of two hardwood species.

PROCEDURE

Field

Fifty northern red oak (*Quercus rubra* L.) and 50 black cherry (*Prunus serotina* Ehrh.) trees were selected from a 35-year-old, mixed northern hardwood stand located near Morgantown, West Virginia. Wood samples were taken from the bole and crown of each tree according to the plan depicted in Fig. 1. The boles were sampled by extracting two 1-inch-diameter increment cores at breast height. The first sampling point was located randomly,

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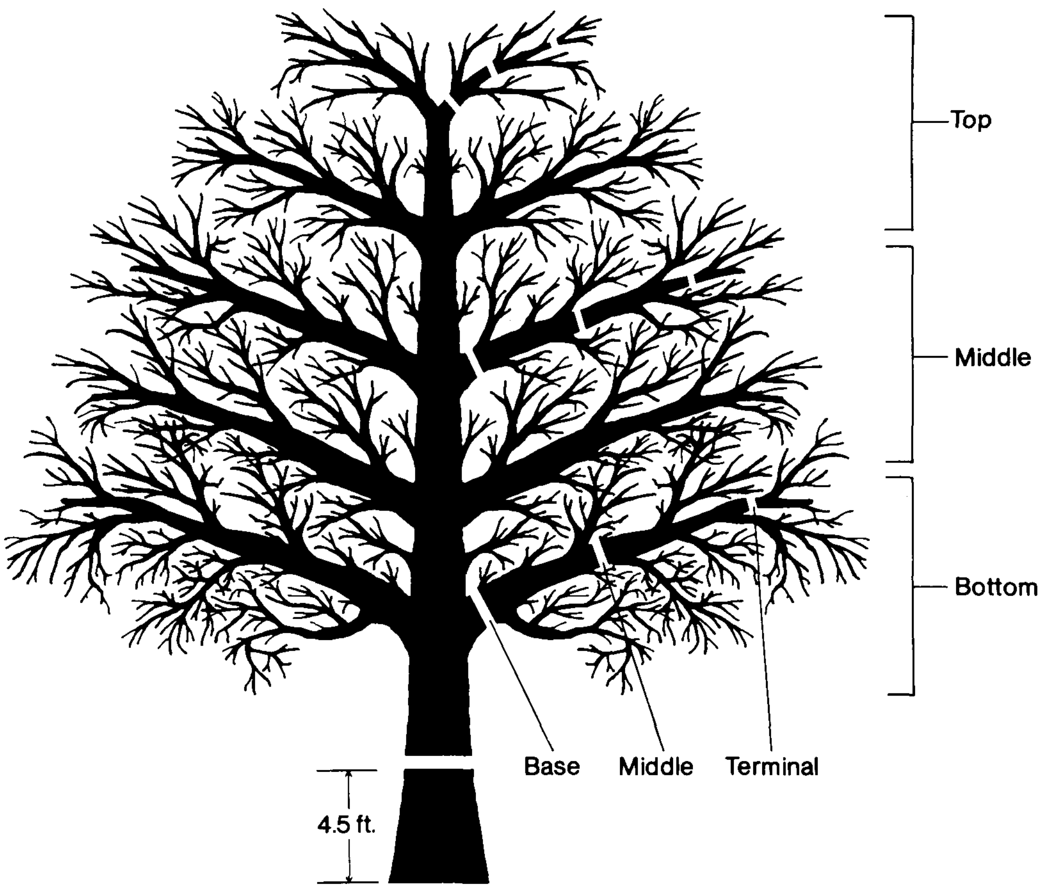

FIG. 1. The plan used for sampling the crowns and boles of black cherry and red oak trees. Three limbs, one each from the lower, middle, and upper parts of the crown were sampled by taking a sample from the base, middle, and terminal portions of each.

whereas the second was directly opposite the first. The crowns were sampled by cutting a limb from the upper, middle, and lowest portions of the live crown of each tree. Where major forks were encountered, limbs were selected from the larger of each pair and all limbs were from the same system of forks. Each limb was sampled by cutting 1-inch-thick discs from the basal portions near the main stem, near the outer extremity, and midway between the two.

Laboratory

In the laboratory, ½-inch-wide radial strips corresponding to the lower, upper, and two horizontal radii were cut from each limb. Five-year increment segments were excised from the radial limb samples and bole increment cores. The specific gravity of the unextracted wood of each of these samples was determined using the maximum moisture content method described by Smith (1954) with only a slight modification. Rather than beginning the infiltration process with the samples covered with water, an initial vacuum was employed for a twelve-hour period prior to introduction of deaeriated water into the closed system.

Analysis

In order to obtain specific gravity values that were more representative of the existing volume of bole and limb wood than

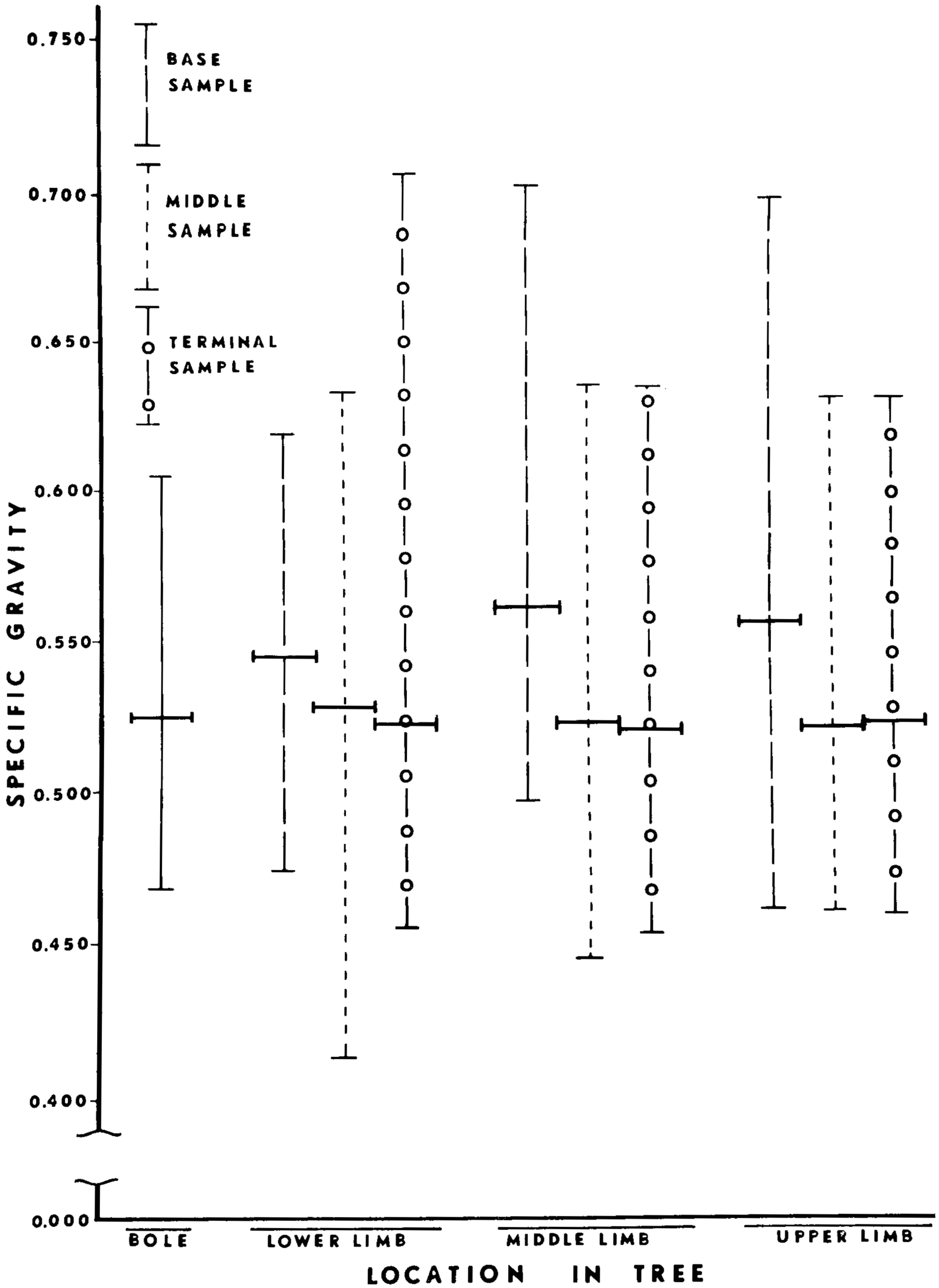

FIG. 2. The means, represented by horizontal bars, and the ranges for the specific gravity of bole wood and limb wood in black cherry. Each mean represents fifty trees.

TABLE 1. *The mean specific gravities and their ranges for black cherry and red oak bole wood and limb wood*

Location in tree	Black cherry		Red Oak	
	Mean specific gravity	Range	Mean specific gravity	Range
Bole	0.525	0.469-0.605	0.584	0.549-0.656
Lower Limb	0.532	0.414-0.705	0.613	0.502-0.702
Base	0.545	0.475-0.619	0.635	0.568-0.702
Middle	0.529	0.414-0.633	0.605	0.530-0.687
Terminal	0.523	0.456-0.705	0.599	0.502-0.675
Middle Limb	0.536	0.446-0.701	0.636	0.537-0.729
Base	0.562	0.498-0.701	0.653	0.589-0.715
Middle	0.524	0.446-0.636	0.631	0.561-0.729
Terminal	0.521	0.454-0.635	0.624	0.537-0.706
Upper Limb	0.534	0.460-0.698	0.652	0.394-0.756
Base	0.556	0.462-0.698	0.673	0.605-0.756
Middle	0.522	0.461-0.631	0.644	0.540-0.718
Terminal	0.523	0.460-0.631	0.640	0.394-0.723

radial strips of increment cores alone would yield, the value for each segment was weighted according to its relative position along the radius and a composite value for each location was computed.

A regression analysis and a simple product moment correlation were computed for the data. Initially, the most descriptive exponent was determined by analysis of the significance of the regression coefficients. As a result, linear regressions and their correlation coefficients were computed for all possible combinations of the data.

RESULTS AND DISCUSSION

The specific gravity values for the boles, three limbs, and three limb locations averaged over all trees are given in Table 1 and Figs. 2 and 3. For both species, the specific gravity of the limb sample nearest the bole was always greater than the bole specific gravity. The specific gravity of samples taken at greater distances from the bole was always less than the closest sample regardless of the limb being sampled. In cherry, but not in oak, the reduction is sufficiently large to result in values in the terminal limb sections that were lower than those measured in the bole. In oak, mean limb specific gravity, obtained by averaging the three values from each limb, exhibited a strong trend of increasing specific gravity with increasing height in the crown, the largest specific gravity being in the upper limb. In cherry, the largest specific gravity occurred in the middle limb and the differences were smaller than in oak.

Table 1 also lists the ranges of values observed. The variability encountered was large. For example, the average cherry bole specific gravity was 0.525 and ranged between 0.469 and 0.605. For oak, the range was from 0.549 to 0.656 with a mean of 0.584.

The first examination of the data consisted of a comparison of bole specific gravity and aggregate crown specific gravity. Rather low, but significant, correlation co-

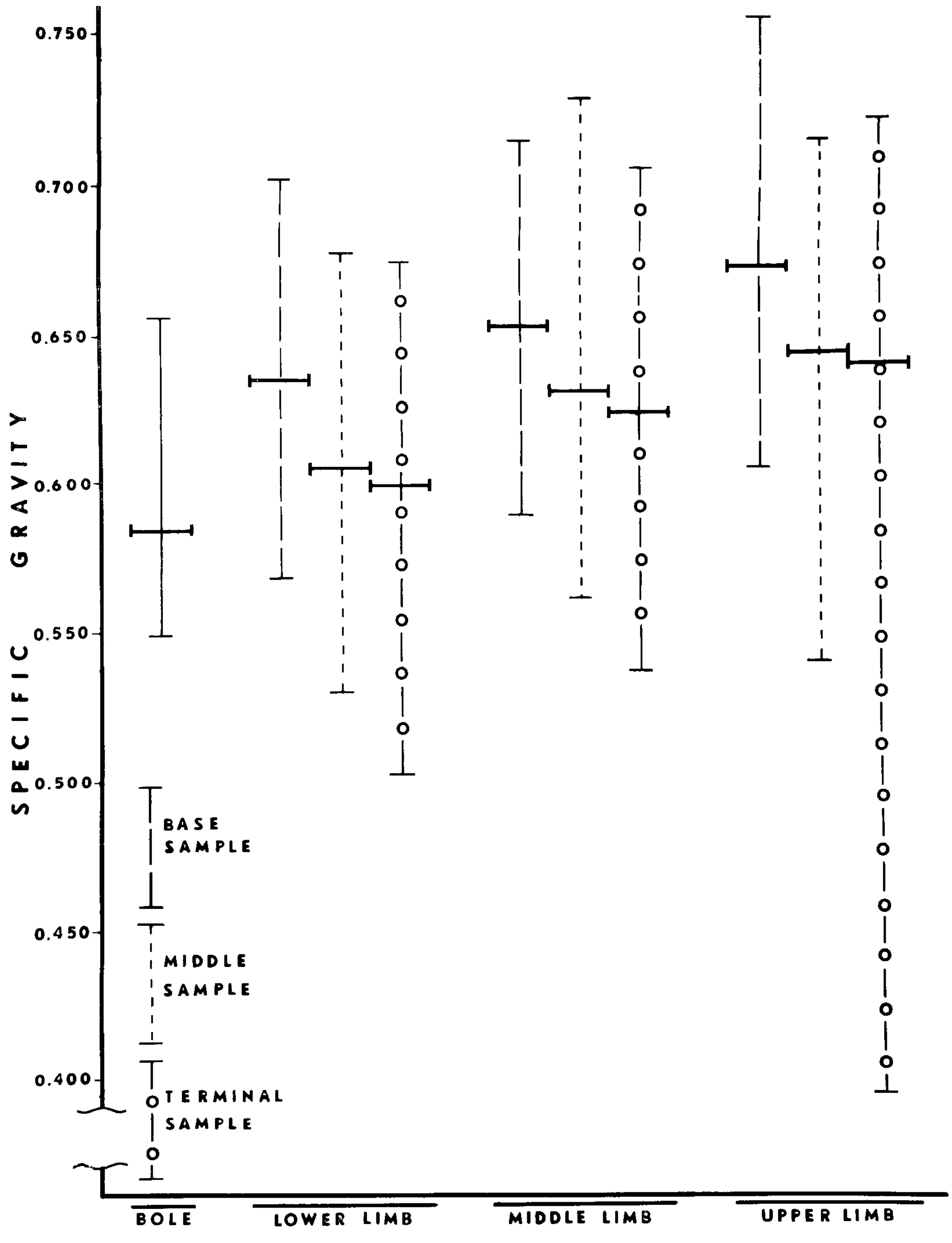

FIG. 3. The means, represented by horizontal bars, and the ranges for the specific gravity of bole wood and limb wood in northern red oak. Each mean represents fifty trees.

efficients were obtained with these regressions for both species (cherry = 0.403; oak = 0.215).

In an attempt to improve the degree of correlation, and thus the ability to successfully predict bole specific gravity from limb specific gravity, successively smaller combinations of limb samples were analyzed. The highest degree of correlation obtained for cherry was with the sample from the midpoint of the middle limb. For oak, the highest degree of correlation obtained was with the sample taken from the midpoint of the lowest limb. The regression equations associated with these two sampling points and their correlation coefficients are,

$$\text{cherry: } Y = 0.351 + 0.333\,X \quad r = 0.510 \quad (1)$$

$$\text{oak: } Y = 0.350 + 0.390\,X \quad r = 0.450. \quad (2)$$

Again the degree of correlation was relatively low but significant.

The assumption may be made that wood with similar characteristics is formed in the boles and crowns of trees and that the specific gravity of the two locations should be highly correlated even though possibly of a different order of magnitude. It appears that the variability associated with the relative amounts of abnormal wood and other unknown factors negate such a relationship.

Because of the large amount of variability and consequent low correlations, the data suggest that only rough approximations of bole specific gravity of an individual tree may be obtained from limb samples. However, where population values are of interest, this technique should be useful, as in assessing the relative specific gravity of stands and/or large forest units. It should be especially useful where comparisons are of interest rather than specific values.

SUMMARY

In black cherry and northern red oak, the mean specific gravity of limb wood is higher than that of the bole wood. There is a significant positive linear relationship between the two. If sample locations are disregarded and aggregate crown specific gravity is considered, the degree of correlation in cherry trees is 0.403 and in oak trees is 0.215.

Mean specific gravity of limb wood decreases as the distance from the bole increases and generally increases with height in the tree.

The location in the crown where limb specific gravity is most strongly correlated with bole specific gravity in black cherry is the middle section of the middle limb (r = 0.510), and in oak the middle section of the lowest limb (r = 0.450).

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