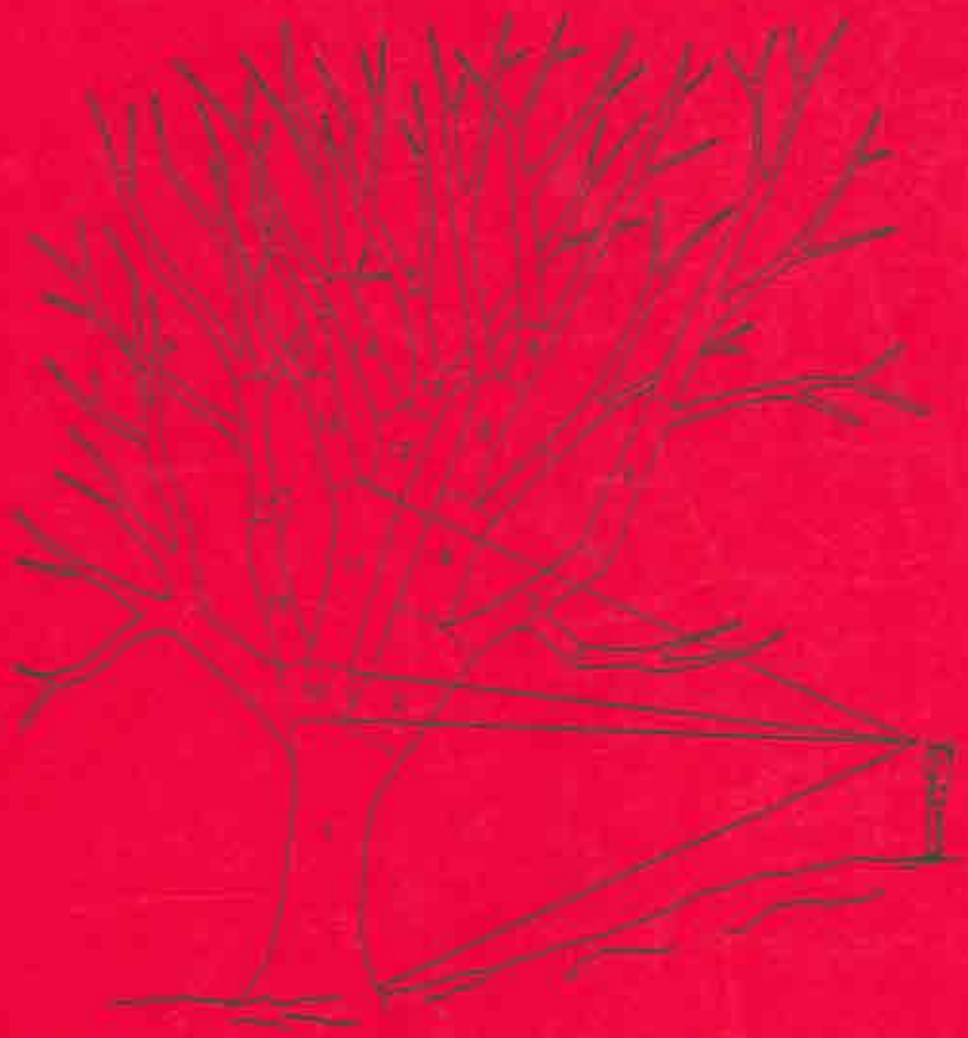
VOLUME EQUATIONS FOR YOUNG GROWTH SOFTWOOD AND HARDWOOD SPECIES AT BOGGS MOUNTAIN DEMONSTRATION STATE FOREST

by

Norman H. Pillsbury and Robert D. Fryer



September, 1979
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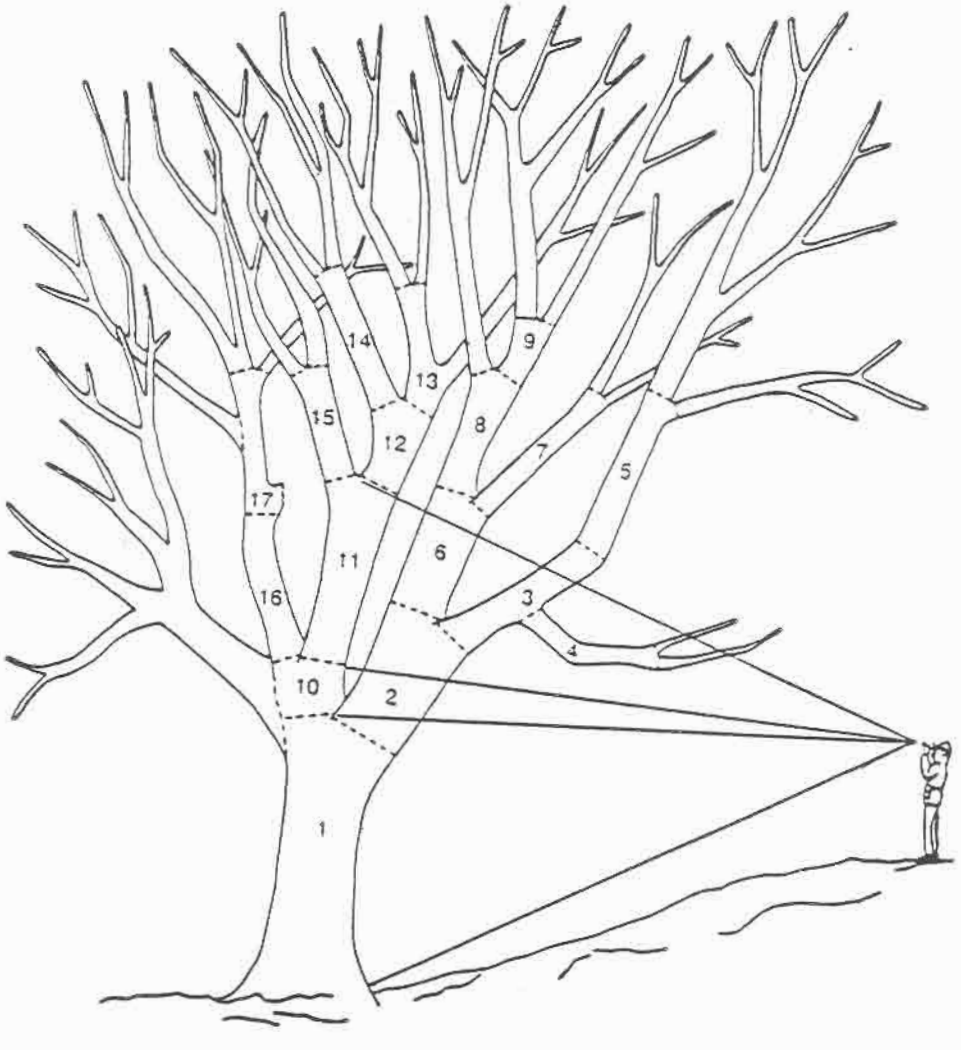

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ABSTRACT

Local and standard volume equations for Ponderosa pine (*Pinus ponderosa* Laws), sugar pine (*Pinus lambertiana* Dougl), Douglas-fir (*Pseudotsuga menziesii* Mirg), canyon live oak (*Quercus chrysolepis* Liemb), black oak (*Quercus kelloggii* Newb), and Pacific madrone (*Arbustus menziesii* Pursh) were developed for Boggs Mountain Demonstration State Forest. For the three softwood species local and standard equations were developed for total volume in cubic feet and cubic meters and Scribner and International 1/4 inch in board feet. For the three hardwood species equations were developed in both cubic feet and cubic meters for three utilization standards: 1) total volume (TVOL) of a tree includes all segment and terminal branch volume plus the volume of the stump and bark. It does not include the volume of the roots and foliage, 2) wood volume (WVOL) of a tree includes the volume of all segments from stump height to a 4 inch top (10 cm) minus the bark volume. As with total volume it does not include the volume of the roots and foliage, and 3) saw-log volume (SVOL) of a tree includes the volume of all segments for trees 11 inches (28 cm) and larger; volume was computed from stump height to a 9 inch (23 cm) top outside bark for straight sections 8 feet (2.5 meters) long or longer; excludes roots, bark and foliage

A total of between 36 and 51 trees were measured for each species from stands representing a broad range of environmental, topographic and site quality conditions. Additionally, sample trees were chosen to represent a broad range of sizes. For softwoods the diameters ranged from 10

inches (25 cm) to 45 inches (100 cm) and heights ranged from 30 feet (12 meters) to 110 feet (35 meters). For hardwoods diameters ranged from 4 inches (12 cm) to 40 inches (122 cm) and heights from 29 feet (9 meters) to 80 feet (35 meters).

KEYWORDS: Boggs Mountain Demonstration State Forest, Local Volume Equations, Local Volume Tables, Standard Volume Equations, Standard Volume Tables, Ponderosa pine, sugar pine, Douglas-fir, canyon live oak, black oak, Pacific madrone, hardwood volume tables, softwood volume tables.

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THE AUTHORS

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VOLUME EQUATIONS FOR YOUNG GROWTH SOFTWOOD AND HARDWOOD SPECIES AT BOGGS MOUNTAIN DEMONSTRATION STATE FOREST

I. Introduction

Ponderosa pine (*Pinus ponderosa* Laws), sugar pine (*Pinus lambertiana* Dougl), Douglas-fir (*Pseudotsuga menziesii* (Mirb) Franco), canyon live oak (*Quercus chrysolepis* Liemb.), black oak (*Quercus kelloggii* Newb), Pacific madrone (*Arbutus menziesii* Pursh) compose some of the most dominate forest types in California. These species most often grow in mixed softwood/hardwood compositions, frequently in association with each other. Ponderosa pine particularly, is the most widely distributed tree in North America. It is found in five major forest types in California principally associated with Douglas-fir and sugar pine (Fowells 1965). It grows well on good sites and has commercial importance for a wide variety of wood products including lumber, posts, and millwork. Sugar pine is the largest and most valuable of the western pine species. It is one of the major timber species in the Transition Zone in the Cascade-Sierra Nevada range and is represented in over 9 forest types, occurring singly or in small groups but rarely in pure stands (Fowell 1965). It is predominantly associated with ponderosa pine, red and white fir, Douglas-fir, black oak and Jeffrey pine depending on the site. Douglas-fir also grows extensively through North America. In California, Douglas-fir is largely restricted to forests west of the Cascade-Sierra Nevada crest where it is predominantly found in mixed softwood stands in association with ponderosa pine, sugar pine, black oak and madrone among others (Griffin and Critchfield 1972). Douglas-fir is of particular importance for use as construction grade lumber. The hardwood species, canyon live oak, black oak, and madrone, although limited in

their commercial value, are important for other uses. With the increasing demand for hardwoods for fuel, energy, and wood fiber effective management of these species has become essential.

Utilization of the mixed softwood/hardwood forest types at Boggs Mountain Demonstration State Forest (BMDSF) (see Figure 1) has occurred since 1880 (CDF&FP 1986). BMDSF was purchased by the State for experimental and demonstration purposes as a an example of a recently cutover forest from which all merchantable timber had been felled except for a few seed trees and scattered patches of other mature trees. This period of forest harvesting at Boggs Mountain has resulted in predominantly even-age stands of young growth ponderosa pine, sugar pine and Douglas-fir with scattered hardwoods. Present management of BMDSF, as in all State Forests, conforms to forest management practices designed to promote continuous forest production with regard to the preservation of soil, water, scenic, wildlife, and recreational values (CDF&FP 1986).

Intensive management for continuous production at BMDSF requires reliable methods for accurately estimating tree volumes. In the past, cubic feet and board feet volume tables (Scribner board-foot and International 1/4 inch) have been developed for ponderosa pine, sugar pine, Douglas-fir, and others (Wenzel 1983, MacLean and Berger 1976). Likewise, volume tables have been developed for many hardwoods (Pillsbury and Kirkley 1984, Pillsbury and Pryor 1988) including canyon live oak, black oak, and Pacific madrone. These equations (both those of Wenzel, MacLean and Berger and those of Pillsbury *et. al.*,) however, were developed from sample data intended to represent different conditions for these species than are found at BMDSF. They are not applicable under the set of conditions at Boggs Mountain without extensive field testing.

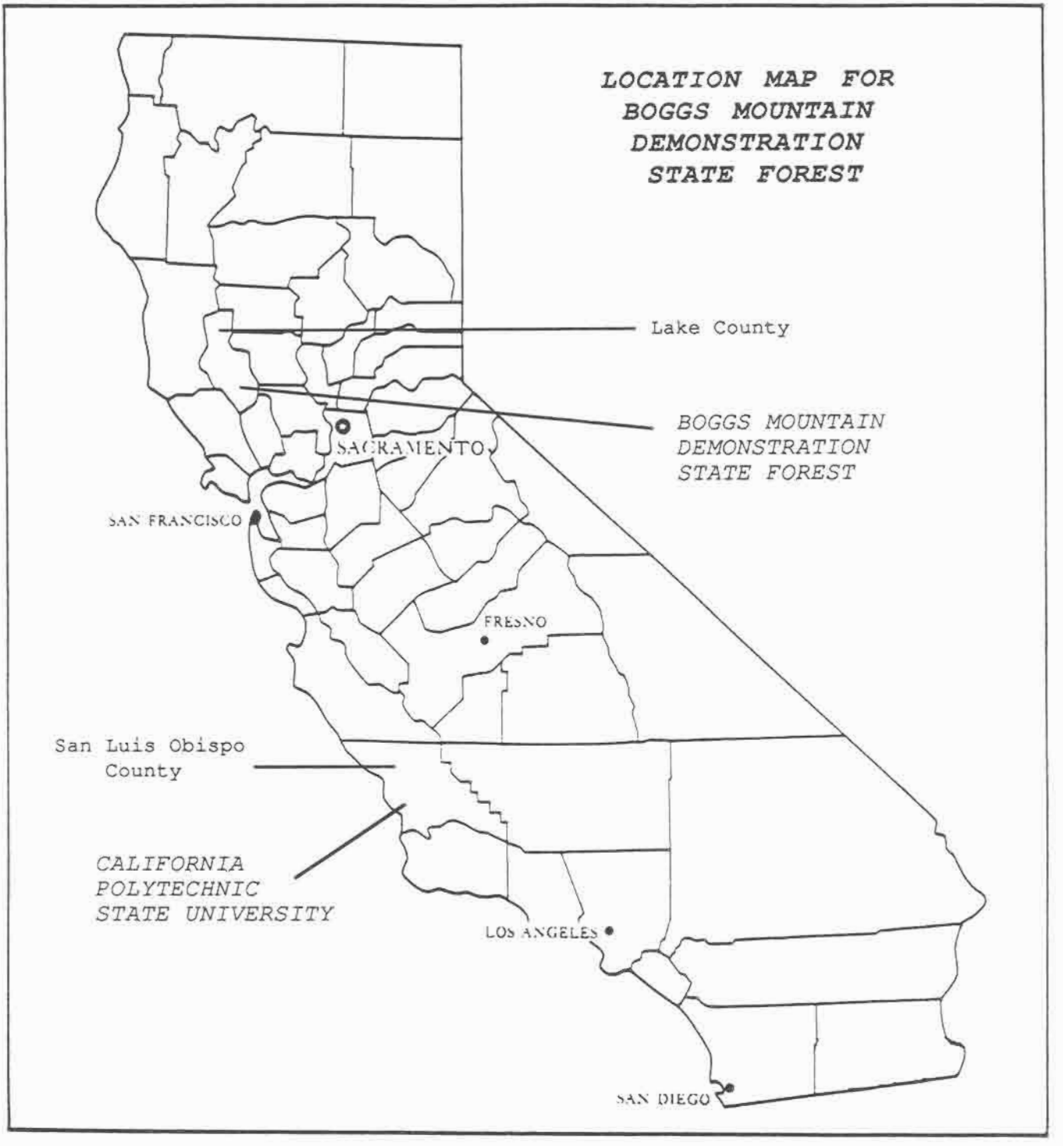

Figure 1. Map of California showing county boundaries and location of Boggs Mountain Demonstration State Forest (BMDSF).

The purpose of this study was to develop local and standard volume equations for six species at Boggs Mountain Demonstration State Forest. These equations are needed to accurately evaluate management decisions such as stand volume determination, stocking levels, thinning schedules, stand composition and others.

II. Background

Volume equations are mathematical equations used to estimate tree volume. A common volume prediction model (Husch *et. al.*, 1982) is:

$$V = aD^bH^c \qquad [1]$$

where V = tree volume
D = tree diameter
H = tree height
a,b,c = regression coefficients

Volume equations are usually developed for one species for a particular region. They are based on an established relationship between easily measured dimensions of the tree and its volume. Dimensions commonly used are diameter, height, and form class (Husch *et al.*, 1982). These dimensions are measured and recorded in the field by forestry personnel. This data is then entered into a computer and through multiple regression analysis developed volume equations are developed.

1. DEVELOPING VOLUME EQUATIONS:

Volume equations are developed through the multiple regression of sample tree data. They are used to predict individual tree volume based on tree diameter and height measurements. The most accurate means of gathering sample tree data is to fell the tree, cut it into segments, make measurements of each stem and branch segment, calculate stem

and segment volume, and finally, sum the volumes. However, due to the large amount of time involved in felling each sample tree, plus the lost dollar value of the tree if it cannot be utilized, a more expedient and less expensive method was developed.

In 1978, methodology for estimating standing tree volume was developed by Pillsbury and Stephens and used extensively by Pillsbury and Kirkley (1984) and Pillsbury and Pryor (1988). In this method, an optical dendrometer (Spiegel Relaskop) was used to calculate standing tree volume of sample trees. Standing sample trees were systematically divided into segments and numbered (see Figure 2). Each segment was measured with the relaskop for length and upper and lower segment diameters. To obtain total tree volume the volume of each segment was calculated and all segment volumes were summed.

In order to assess the accuracy of their method for calculating standing tree volume Pillsbury and Stephens felled and remeasured 63 of the 170 samples. They were remeasured based on the same criteria used to measure the sample trees when they were standing. The volumes from the 63 felled trees were considered to be more accurate (because they were based on direct measurements) than the corresponding volumes of the same trees measured when they were standing. The felled tree volumes were then regressed against the standing tree volumes to obtain a felled tree to standing tree volume regression equation. The equation indicated that volume calculated for standing trees correlated well to volume calculated for felled trees (R^2 = 0.99). The equation was:

$$\text{Volume } m^3 \text{ (felled)} = 1.166.\text{Volume } m^3 \text{ (standing)}^{0.9947} \quad [2]$$

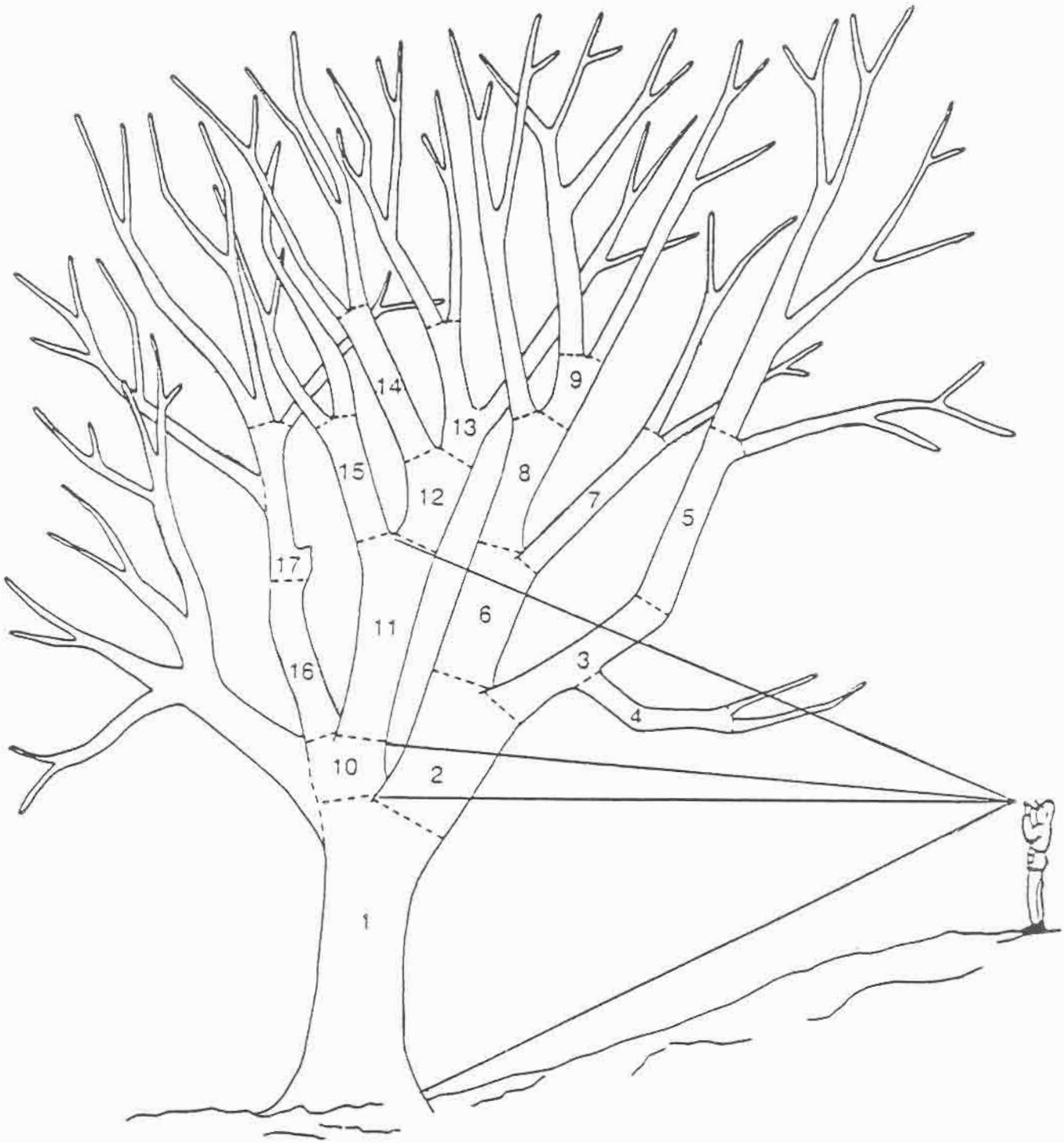

Figure 2. Standing tree measurement of sample trees (Pillsbury and Kirkley, 1984. Segments were measured to obtain tree volume.

which indicates that the standing tree measurement technique underestimates actual (felled) tree volume by about 15 percent. However, the high degree of correlation ($R^2 = 0.99$) between standing and felled tree volumes showed that volumes from standing trees could be adjusted by this equation to represent actual felled volumes. Equation [2] is species independent because it is primarily a measure of the measurement technique and utilization standard rather than of a particular species.

Other studies have also shown that measurements of standing trees using optical dendrometers may give a biased estimate of tree volume. Bickell (1976) showed that the Barr and Stroud dendrometer over-estimated tree volumes by 5.4% and Pillsbury and DeLasaux (1988) found that measuring Sierra redwood with a tele-relaskop over-estimated volume by up to 9 percent.

For this study the same technique used by Pillsbury *et. al.*, (1978, 1984, 1988) of adjusting standing tree volumes to represent actual felled volumes was used.

III Problem Statement

The current lack of accurate volume equations for these species on both private and State owned lands precludes:

1) reliable estimates of harvest volume which can result in economic loss through underestimation of lump sum sales, and

2) efficient forest management activities such as inventory, thinning, stocking, and growth and yield studies.

For these reasons the development of accurate volume tables is considered essential for on-going management activities and planned future studies at Boggs Mountain Demonstration State Forest.

IV. Study Objectives

The objectives of this project were to develop local and standard volume equations and tables for young growth ponderosa pine, sugar pine, Douglas-fir, canyon live oak, black oak, and Pacific madrone that will:

1. represent the full range of diameters and corresponding heights

2. will be applicable to the various stand and site conditions at Boggs Mountain Demonstration State Forest.

V. Methodology

1. STAND AND SAMPLE TREE SELECTION:

Data collection was completed at Boggs Mountain Demonstration State Forest, Cobb, CA. To sample an accurate representation of the trees of BMDSF the forest was divided into six strata (see Figure 3); about the same number of trees were sampled in each strata. Stands were chosen from within each strata that represented the various site qualities, stand densities, and topography.

For each species trees were selected to represent the existing range of diameters, heights, and growth forms. Experience has shown that a carefully selected sample of about 40 trees is normally satisfactory for estimating volume regression coefficients and testing for adequacy of the equations (Pillsbury *et. al.*, 1978, 1984, 1988). Sound trees 5 inches (12.5 cm) DBH or larger for hardwoods and 10 inches (25 cm) DBH or larger for softwoods were selected. Decadent trees and trees with major defects were avoided.

2. SAMPLE TREE MEASUREMENT:

A total of between 36-51 trees were measured standing for each species. Also, approximately 10 standing trees of each species were felled and remeasured. The methodology used for measuring, both the standing and felled trees is similar to that developed by Pillsbury and Stephens (1978), and used by Pillsbury *et. al.*, (1984, 1988).

Standing Tree Measurement:

Standing trees were systematically divided into segments (see Figure 2). For each segment the length and the upper and lower diameter were measured.

For softwoods, standing trees were divided into 16 foot logs and the diameter was measured at the top of each log if

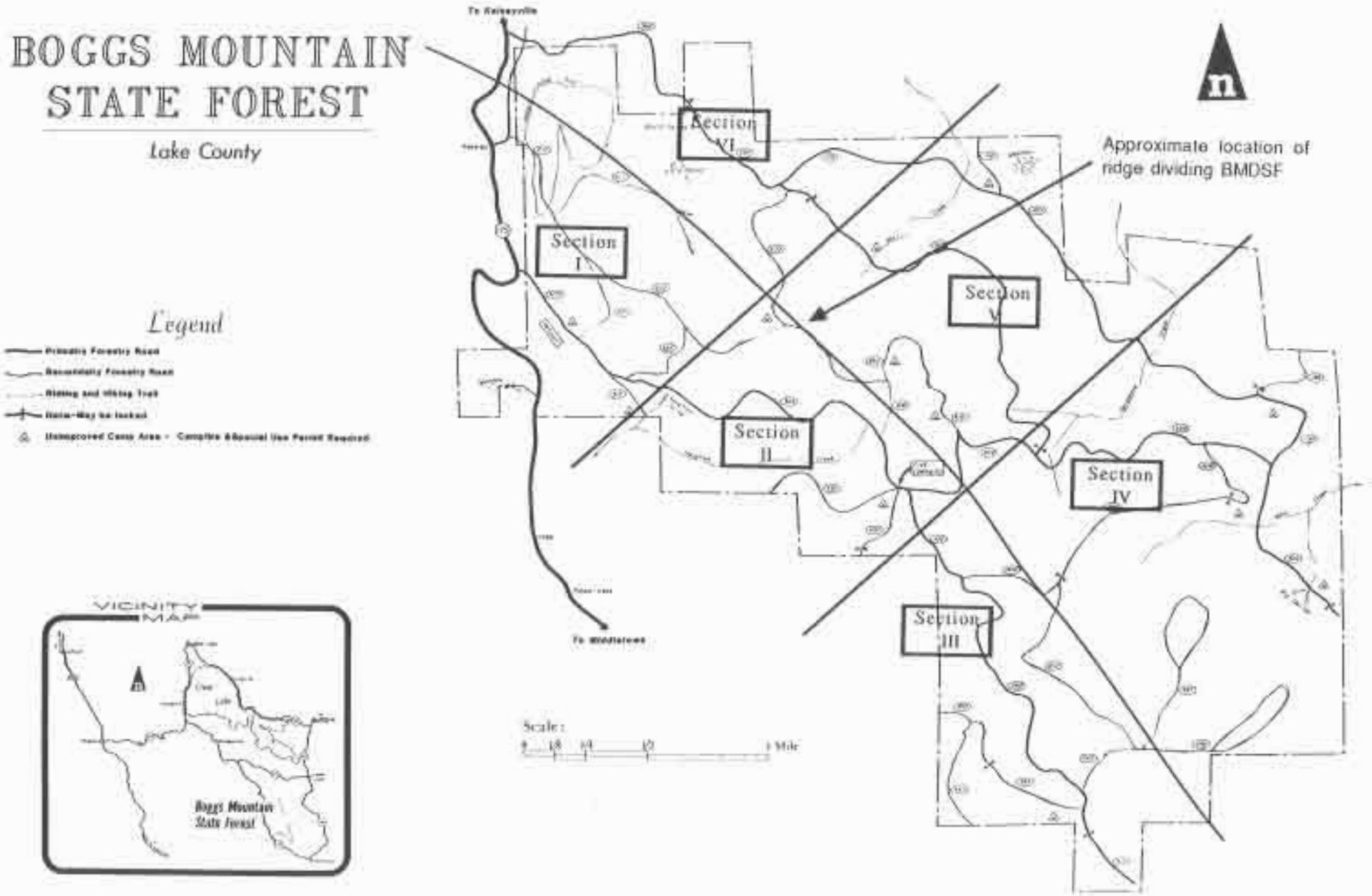

Figure 3. Map of Boggs Mountain Demonstration State Forest divided into six sections from which sample trees were selected and measured.

possible (most often it was visible). If the bole was not visible at each 16 foot point then a point either higher or lower (whatever was closer to the 16 ft log point) was selected in order that the bole be clearly seen to make the diameter measurement. Minimum diameter for softwoods was 8 inches (20 cm). All segments were measured to a 10 inch top.

For hardwoods the length of the segments were usually the distance between branch forks if the distance was less than 10 feet (3 meters). If a stem was straight for a greater distance, the stem was divided so that the maximum segment length was approximately 10 feet. Minimum diameter for hardwoods was 5 inches (12.5 cm). All segments were measured to a 4 inch top. Hardwood segments were defined based on the criteria stated below.

1. Segments were defined as the distance from fork to fork in trees with complex branching.

2. If a branch had sweep or crook, segment lengths were shortened to obtain a straight length.

3. Segments were also divided if abrupt changes in taper were apparent.

4. If a tree had an excurrent growth form the maximum segment length was approximately 10 feet.

For all species, standing tree measurements were made using a Spiegel Relaskop (see Figure 2). This instrument was used to measure segment lengths and upper and lower segment diameters. Diameter at breast height (dbh) was measured with a D-tape. Stump diameter (height of 1 ft) was also measured with a D-tape and used to help compute the volume of the first segment. Total height was measured from ground level on the uphill side to the tip of the tallest branch of the tree. Trees that were

leaning were measured as if they were a straight standing tree by determining their total stem length. Bark thickness was measured at breast height with an inch ruler and used in the development of Scribner, Int'l 1/4 inch volume equations for the softwoods and wood volume and saw-log volume equations for the hardwoods. A summary of the sample tree variables measured in the field is presented in Table 1.

Table 1. Tree variables measured, units, and method of measurement.

Tree Variables	Units and Precision	Method of Measurement
DBHob	1/2 inch	Diameter tape
AVERAGE BARK THICKNESS	0.1 inch	inch ruler
DIAMETER AT TOP OF FIRST (16')LOG	1/2 inch	optical dendrometer (Speigel relaskop)
INTERMEDIATE DIAMETERS ON STEM	1/2 inch	optical dendrometer (Speigel relaskop)
DIAMETER AT MERCHANTABLE HEIGHT	1/2 inch	optical dendrometer (Speigel relaskop)
TOTAL HEIGHT	1 foot	optical dendrometer (Speigel relaskop)
MERCHANTABLE HEIGHT	1 foot	optical dendrometer (Speigel relaskop)
INTERMEDIATE HEIGHTS	1 foot	optical dendrometer (Speigel relaskop)

Felled Tree Measurement:
A subsample of approximately 10 trees for each species were felled and remeasured. For both softwoods and hardwoods felled trees were divided into segments based on the same criteria used to define segments in the standing tree measurement technique. Each segment was measured for diameter at both ends with a D-tape; segment lengths were measured directly. Individual segment volumes were calculated and then summed to determine total tree volume. The volume from the felled tree technique, considered by Pillsbury and Stephens (1978) to be more accurate than the volume from the standing tree measurement technique, was based on measurements taken directly on the tree after it was felled.

3. UTILIZATION STANDARDS:
Sample tree volumes were calculated for four utilizations standards. For softwoods the utilization standards were total volume (in cubic feet and cubic meters) and merchantable volume (in board feet) using: Scribners log rule based on: a) dbh and total height and b) dbh and the number of 16 foot logs, and International 1/4 inch log rule. For hardwoods the utilization standards were: total volume (TVOL), wood volume (WVOL), and saw-log volume (SVOL) (see Figure 4). They were calculated in both cubic feet and cubic meters using Smalians volume equation. The four utilization standards are described below.

Total volume:
Total tree volume includes all segment and terminal branch volume plus the volume of the stump and bark. It does not include the volume of the roots and foliage.

Wood volume:
Wood volume of a tree is the volume of all segments from stump height to a 4 inch (10 cm) top <u>minus the bark volume</u>. As with total volume it does not include the volume of the roots and foliage.

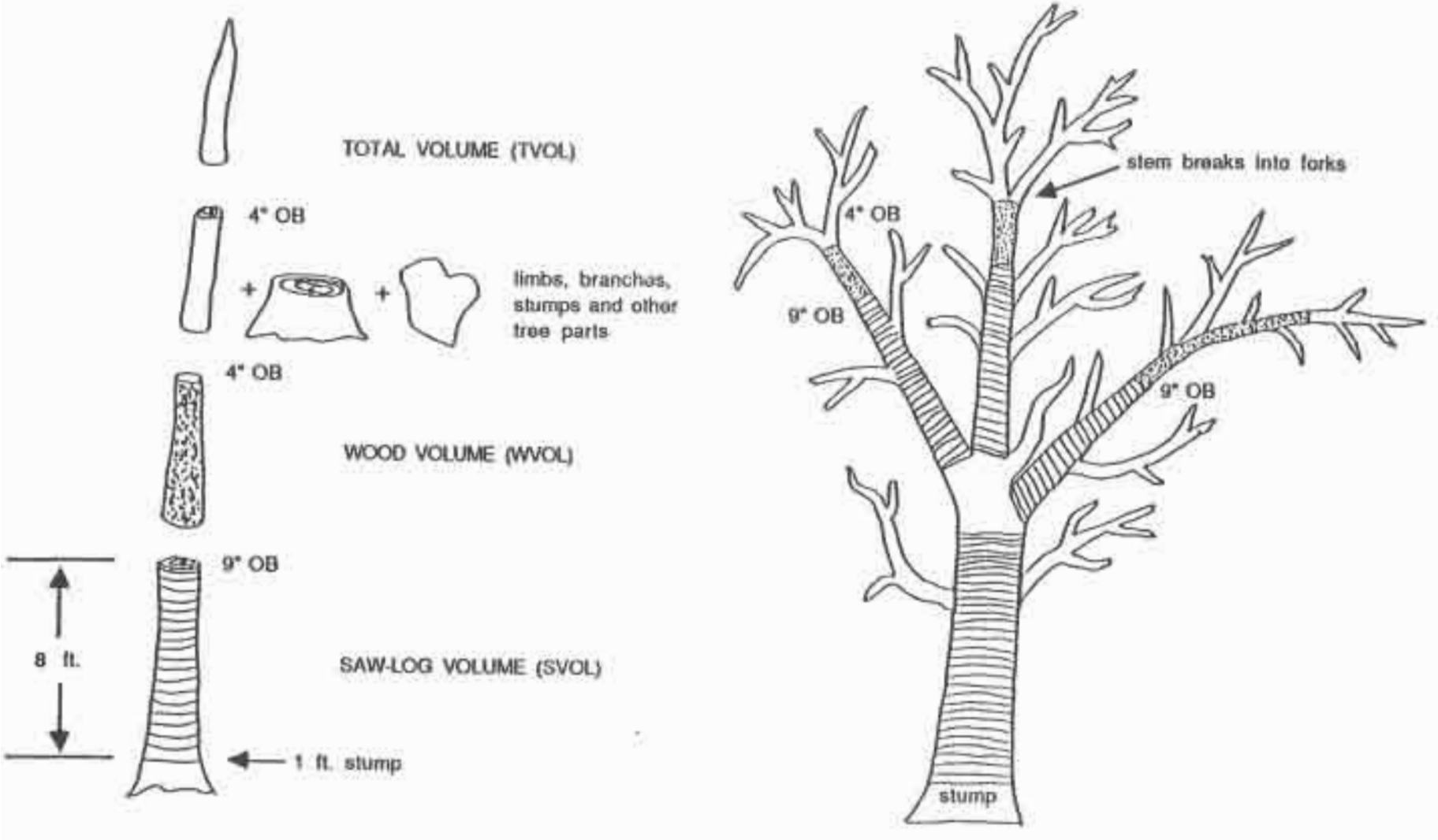

Figure 4. Hardwood utilization standards for volume assessment (Pillsbury and Kirkley 1984).

To obtain inside bark segment volume a regression equation estimating diameter inside bark (DIB) from diameter outside bark (DOB) was developed from bark thickness data. It was assumed, based on field observations, that the DIB vs. DOB relationship was constant at all heights. This step effectively deducts the bark volume from total volume of the segment. Next, segment volumes were calculated and finally the segments were summed to equal wood volume of the tree.

Saw-log volume:
Saw-log volume is the volume of all segments for trees 11 inches (28 cm) and larger; volume was computed from stump height to a 9 inch (23 cm) top outside bark for straight sections 8 feet (2.5 meters) long or longer; excludes roots, bark and foliage.

Merchantable Volume:
Merchantable volume is the volume of all segments from stump height to a 10 inch top calculated in board feet using two different log rules: Scribner and International 1/4 inch

1. Scribner volume (bd. ft.) = $(0.79D^2-2D-4) \times L/16$.
   (based on: a. total height and, b. number of 16 foot logs).
2. International 1/4" volume (bd. ft.) = $0.905(0.22D^2-.71D)$
   (for 4 foot sections)

4. SAMPLE TREE VOLUME COMPUTATION:
Tree volumes for the hardwood species were computed based on three utilization standards, total volume, wood volume, and saw-log volume, in both cubic feet and cubic meters. Volumes of the softwood species were computed for total volume in cubic feet and cubic meters and for merchantable volume in board feet. Volumes were computed from relaskop height coordinates and diameter measurements using Smalian's volume formula [3] for hardwoods and Smalian's, Scribner's,[4] and

International 1/4 inch [5] (Husch *et.al.*, 1982) for the softwoods.

$$\text{Smalian's Volume } (ft^3)^1 = (B + b)/2 \times L \quad [3]$$

$$\text{Scribner (bd. ft.)}^2 = (0.79D^2-2D-4) \times L/16 \quad [4]$$

$$\text{Int'l 1/4" (bd. ft.)}^3 = 0.905(0.22D^2-.71D) \quad [5]$$

[1]where B is the cross-sectional area at the large end of segment, b is the cross-sectional area at the small end of the segment, and L is length.

[2]where D is the DBH and L is the tree height to a 10 inch top.

[3]where D is the DBH, for 4 foot sections (one half inch is added to each 4 ft section).

For hardwoods total volume was calculated using Smalian's for all segments to a 4 inch (10 cm) top. Segments 4 inches in diameter or less were considered terminal branches and their volumes were computed separately as a paraboloid from (4 in. to 0 in.) based on the following equation.

$$\text{Terminal Branch Volume} = (B*L)/2 \quad [6]$$

where B is the cross-sectional area of the large end and L is the terminal branch length

For wood volume and saw-log volume of hardwoods volume was calculated using Smaian's equation but using different utilization standards.

5. ERROR AND OUTLIER ANALYSIS

Several checks were made to detect if measurement and recording errors exist in the data set. Height and diameter measurement errors were detected by checking to see if upper diameters were greater than lower diameters. Volume calculation errors as well as other tree measurement errors were detected by statistical outlier analysis. Careful

analysis of scatter plots of measured tree variables (e.g., DBH vs. total volume)(see Appendix B)evaluating standardized residuals, etc., was performed. This process identified errors resulting from either tree measurement, data recording or data entry. Statistical outlier analysis was based on methods outlined in Neter et. al.,1985. The error and outlier analysis usually resulted in 1 or 2 trees per species being removed from the data sets.

6. CORRECTION OF SAMPLE TREE VOLUMES:

As previously discussed earlier studies which used optical dendrometers have shown a bias by either under- or over-estimating tree volumes. For this reason, approximately 60 trees were felled and remeasured for height, dbh and upper and lower diameter for tree segments. Standing and felled tree volumes were then calculated and correction equations were developed by regressing the "felled tree volume" to "standing tree volume" relationship.

Hardwood volumes were under-estimated, on the average, by about 1.5 percent. No adjustments were made to hardwoods because of the generally large variation in volumes found in these species and because the adjustment would be so small.

Conifer volumes were under-estimated, on the average, by about 3 percent and their volumes were adjusted by the correction equations stated below.

Cubic Volume:

Total Vol (ft^3) = 1.82 + TVOL standing (ft^3) x 1.024662 [7]

Merchantable Volume:

Merch Vol (Scrib. bf) = 14.04 + MVOL standing (Scrib. bf) x 1.032273 [8a]

Merch Vol (Int'l. bf) = 13.93 + MVOL standing (Int'l. bf) x 1.033110 [8b]

VI. VOLUME EQUATION DEVELOPMENT:

For hardwood species local and standard volume equations were developed in cubic feet and cubic meters for both total and wood volume. For the softwoods local and standard equations were developed in cubic feet, cubic meters and Scribner board foot for total volume and saw-log volume.

1. Local and standard volume tables:

Local and standard volume tables were developed based on the following models.

$$\text{Local Volume:} \quad V = aD^b \qquad [9]$$

$$\text{Standard Volume:} \quad V = aD^bH^c \qquad [10]$$

where V is the volume in cubic meters, cubic feet, or board feet, D is the DBHob (diameter breast height outside Bark) in centimeters or inches, H is total height in meters, feet, or number of 16 ft. logs, and a, b, and c are regression coefficients.

Multiple regression analysis using the matrix approach was used to compute the volume equations. A $\log_{10}$ transformation of volume, DBH, and height was used to linearize the data and to equalize the variation about the regression line. The data were converted to the logarithmic form to compute the regression coefficients a, b, and c. This is the normal procedure when fitting nonlinear tree volume equations because the logarithmic form is more compatible with the assumption of homogeneity of variance (Husch *et. al.* 1982). From these equations local and standard volume tables were developed and are listed in the Appendix (see Appendix C).

VII. RESULTS OF STUDY:

1. LOCAL AND STANDARD VOLUME EQUATIONS:
Local and standard volume equations were developed for the six species at Boggs Mountain Demonstration State Forest. For the three hardwood species equations were developed in both English and metric units for three utilization standards: total volume, wood volume, and saw-log volume. For the softwoods species volume equations were developed in English units for total volume and board foot volume and metric units for total volume. All volume equations are listed in Tables 2-7.

2. LOCAL AND STANDARD VOLUME TABLES:
Local and standard volume tables were developed for the six species at BMDSF based on the same utilization standards previously described. All volume tables are listed in the Appendix (see Appendix C).

3. ROOT MEAN SQUARE ERROR AND AGGREGATE DIFFERENCE TESTS:
To check the reliability of the volume equations developed by this study two tests were performed: 1) root mean squared error (RMS) test, and 2) aggregate difference test. Both tests were based on the BMDSF volume equations and on volume equations of the same species developed for other regions. For softwoods the BMDSF equations were compared to equations developed by Wensel (USFS Bulletin 1883, 1977). Hardwood equations were compared to similar equations developed by Pillsbury and Kirkley (1984).

Root Mean Squared Error Test:
A measure of the reliability of an equation is the extent to which the individual observations of sample tree volume varies from the regression surface (Maclean and Berger 1976).

Table 2. Local and Standard volume equations for **young growth ponderosa pine** at Boggs Mountain Demonstration State Forest.

LOCAL VOLUME EQUATIONS

English Units (DBH in inches)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. ft.):	Volume = $0.0363331\ (DBH^{2.53035})$	0.965	48	0.05737
Scrib. 1 (bd. ft.):	Volume = $0.0199222\ (DBH^{3.22022})$	0.946	47	0.08856
Int'l 1/4" (bd. ft.):	Volume = $0.0290782\ (DBH^{3.13142})$	0.944	47	0.08838

Metric Units (DBH in centimeters)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. m):	Volume = $0.0000972\ (DBH^{2.53035})$	0.943	48	0.00162

STANDARD VOLUME EQUATIONS

English Units (DBH in inches, total HT in feet, and NL is number of 16 ft. logs and 1/2 logs)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. ft.):	Volume = $0.0106345\ (DBH^{2.22642})(HT^{0.46726})$	0.972	48	0.05104
Scrib. 1 (bd. ft.):	Volume = $0.0064579\ (DBH^{2.92149})(HT^{0.44199})$	0.949	47	0.08599
Scrib. 2 (bd. ft.):	Volume = $0.2795348\ (DBH^{2.06845})(NL^{0.71523})$	0.982	48	0.05557
Int'l 1/4" (bd. ft.):	Volume = $0.0087845\ (DBH^{2.81401})(HT^{0.46964})$	0.948	47	0.08533

Metric Units (DBH in centimeters, total HT in meters)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. m.):	Volume = $0.0000658\ (DBH^{2.22642})(HT^{0.46726})$	0.943	48	0.00144

NOTES:

Ponderosa Pine equations were developed from trees of dia. ranging from 10 in. to 36 in.

Smalians (cu. ft.) = Total tree volume including all stem and branch wood plus stump and bark; excludes foliage and roots. HT is total height.

Scrib. 1 (bd. ft.) = Scribner board foot volume based on dbh, and for standard volume equations, total tree height.

Scrib. 2 (bd. ft.) = Scribner board foot volume based on dbh and number of 16 foot logs and 1/2 logs to a 6" top (NL).

Int'l 1/4" (bd. ft.) = International 1/4 inch board foot volume based on dbh, and for standard volume equations, tree height to a 10" top.

R^2 = the multiple coefficient of determination.

N = the sample size.

SE = the standard error of the estimate in cubic feet or cubic meters.

Table 3. Local and Standard volume equations for **young growth sugar pine** at Boggs Mountain Demonstration State Forest.

LOCAL VOLUME EQUATIONS

English Units (DBH in inches)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. ft.):	Volume = 0.0481061 $(DBH^{2.39206})$	0.973	43	0.06079
Scrib. 1 (bd. ft.):	Volume = 0.0310249 $(DBH^{2.99864})$	0.947	42	0.15013
Int'l 1/4" (bd. ft.):	Volume = 0.0428598 $(DBH^{2.92738})$	0.946	22	0.10199

Metric Units (DBH in centimeters)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. m):	Volume = 0.00014635 $(DBH^{2.39206})$	0.943	43	0.00172

STANDARD VOLUME EQUATIONS

English Units (DBH in inches, total HT in feet, and NL is number of 16 ft. logs and 1/2 logs)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. ft.):	Volume = 0.0077648 $(DBH^{1.99122})(HT^{0.67964})$	0.983	42	0.04774
Scrib. 1 (bd. ft.):	Volume = 0.0007872 $(DBH^{2.32149})(HT^{1.27724})$	0.968	42	0.08087
Scrib. 2 (bd. ft.):	Volume = 0.4053815 $(DBH^{1.94896})(NL^{0.65602})$	0.979	42	0.63496
Int'l 1/4" (bd. ft.):	Volume = 0.0010155 $(DBH^{2.23760})(HT^{1.30106})$	0.966	42	0.08645

Metric Units (DBH in centimeters, total HT in meters)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. m.):	Volume = 0.000077 $(DBH^{1.99122})(HT^{0.67964})$	0.943	43	0.00135

NOTES:

Sugar Pine equations were developed from trees of dia. ranging from 10 in. to 38 in.

Smalians (cu. ft.) = Total tree volume including all stem and branch wood plus stump and bark; excludes foliage and roots. HT is total height.

Scrib. 1 (bd. ft.) = Scribner board foot volume based on dbh, and for standard volume equations, total tree height.

Scrib. 2 (bd. ft.) = Scribner board foot volume based on dbh and number of 16 foot logs and 1/2 logs to a 6" top (NL).

Int'l 1/4" (bd. ft.) = International 1/4 inch board foot volume based on dbh, and for standard volume equations, tree height to a 10" top.

R^2 = the multiple coefficient of determination.

N = the sample size.

SE = the standard error of the estimate in cubic feet or cubic meters.

Table 4. Local and Standard volume equations for **young growth Douglas-fir** at Boggs Mountain Demonstration State Forest.

LOCAL VOLUME EQUATIONS

English Units (DBH in inches)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. ft.):	Volume = 0.0667147 (DBH $^{2.27779}$)	0.943	50	0.06810
Scrib. 1 (bd. ft.):	Volume = 0.0836664 (DBH $^{2.68142}$)	0.908	48	0.10241
Int'l 1/4" (bd. ft.):	Volume = 0.1147305 (DBH $^{2.61362}$)	0.905	48	0.10157

Metric Units (DBH in centimeters)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. m):	Volume = 0.0002260 (DBH $^{2.27779}$)	0.943	50	0.00193

STANDARD VOLUME EQUATIONS

English Units (DBH in inches, total HT in feet, and NL is number of 16 ft. logs and 1/2 logs)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. ft.):	Volume = 0.0054341 (DBH $^{1.67288}$)(HT $^{0.96384}$)	0.972	50	0.04835
Scrib. 1 (bd. ft.):	Volume = 0.0009034 (DBH $^{2.07517}$)(HT $^{1.41405}$)	0.904	51	0.12542
Scrib. 2 (bd. ft.):	Volume = 1.7104012 (DBH $^{1.38889}$)(NL $^{0.86478}$)	0.969	49	0.06451
Int'l 1/4" (bd. ft.):	Volume = 0.0059975 (DBH $^{1.73017}$)(HT $^{1.25863}$)	0.948	47	0.07031

Metric Units (DBH in centimeters, total HT in meters)

LOG RULE	EQUATION	R^2	N	SE
Smalians (cu. m.):	Volume = 0.0001019 (DBH $^{1.67288}$)(HT $^{0.96384}$)	0.972	50	0.00137

NOTES:

Douglas-fir equations were developed from trees of dia. ranging from 10 in. to 46 in.

Smalians (cu. ft.) = Total tree volume including all stem and branch wood plus stump and bark; excludes foliage and roots. HT is total height.

Scrib. 1 (bd. ft.) = Scribner board foot volume based on dbh, and for standard volume equations, total tree height.

Scrib. 2 (bd. ft.) = Scribner board foot volume based on dbh and number of 16 foot logs and 1/2 logs to a 6" top (NL).

Int'l 1/4" (bd. ft.) = International 1/4 inch board foot volume based on dbh, and for standard volume equations, tree height to a 10" top.

R^2 = the multiple coefficient of determination.

N = the sample size.

SE = the standard error of the estimate in cubic feet or cubic meters.

Table 5. Local and Standard volume equations for **canyon live oak** at Boggs Mountain Demonstration State Forest.

LOCAL VOLUME EQUATIONS

English Units (volume in ft^3, DBH in inches)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0487933\ (DBH^{2.41617})$	0.946	34	0.09898
WOOD VOLUME:	$WVOL = 0.0197719\ (DBH^{2.64068})$	0.936	34	0.00427
SAW-LOG VOLUME:	$SVOL = 0.0199618\ (DBH^{2.54959})$	0.772	20	0.14005

Metric Units (volume in m^3, DBH in centimeters)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0001453\ (DBH^{2.41617})$	0.946	34	0.00280
WOOD VOLUME:	$WVOL = 0.0000477\ (DBH^{2.64068})$	0.936	34	0.00012
SAW-LOG VOLUME:	$SVOL = 0.0000524\ (DBH^{2.54959})$	0.772	20	0.00396

STANDARD VOLUME EQUATIONS

English Units (volume in ft^3, DBH in inches, HT is total height in feet)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0131571\ (DBH^{2.14573})(HT^{0.52009})$	0.952	34	0.09088
WOOD VOLUME:	$WVOL = 0.0038325\ (DBH^{2.30212})(HT^{0.65109})$	0.950	34	0.10689
SAW-LOG VOLUME:	$SVOL = 0.0031659\ (DBH^{2.08229})(HT^{0.79159})$	0.820	20	0.12513

Metric Units (volume in m^3, DBH in cm., HT is total height in meters)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0000935\ (DBH^{2.14573})(HT^{0.52009})$	0.952	34	0.00257
WOOD VOLUME:	$WVOL = 0.0000275\ (DBH^{2.30212})(HT^{0.65109})$	0.950	34	0.00302
SAW-LOG VOLUME:	$SVOL = 0.0000329\ (DBH^{2.08229})(HT^{0.79159})$	0.820	20	0.00345

NOTES:

TVOL = all stem and branch wood plus stump and bark; excludes foliage and roots.

WVOL = all stem and branch wood to a 4" (10 cm) top; excludes stump and bark; excludes foliage and roots.

SVOL = all wood inside bark to a 9" (23 cm) top for segments ≥ 8 ft. (2.5 m) for all trees 11" (28 cm) dbh and larger; excludes stump, foliage and roots.

R^2 = the multiple coefficient of determination.

N = the sample size.

SE = the standard error of the estimate in cubic feet or cubic meters.

Table 6. Local and Standard volume equations for **black oak** at Boggs Mountain Demonstration State Forest.

LOCAL VOLUME EQUATIONS

English Units (volume in ft^3, DBH in inches)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0799467\ (DBH^{2.26913})$	0.914	44	0.13211
WOOD VOLUME:	$WVOL = 0.0388177\ (DBH^{2.41445})$	0.900	44	0.01527
SAW-LOG VOLUME:	$SVOL = 0.0519914\ (DBH^{2.28068})$	0.836	26	0.13169

Metric Units (volume in m^3, DBH in centimeters)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0002730\ (DBH^{2.26913})$	0.914	44	0.00349
WOOD VOLUME:	$WVOL = 0.0001157\ (DBH^{2.41445})$	0.900	44	0.00043
SAW-LOG VOLUME:	$SVOL = 0.0001756\ (DBH^{2.28068})$	0.836	26	0.00373

STANDARD VOLUME EQUATIONS

English Units (volume in ft^3, DBH in inches, HT is total height in feet)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0099790\ (DBH^{1.67821})(HT^{0.91652})$	0.938	44	0.11193
WOOD VOLUME:	$WVOL = 0.0029447\ (DBH^{1.68211})(HT^{1.13585})$	0.932	44	0.12517
SAW-LOG VOLUME:	$SVOL = 0.0038666\ (DBH^{1.69402})(HT^{1.03846})$	0.893	26	0.06261

Metric Units (volume in m^3, DBH in centimeters, HT is total height in meters)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0001765\ (DBH^{1.67821})(HT^{0.91652})$	0.938	44	0.00317
WOOD VOLUME:	$WVOL = 0.0000670\ (DBH^{1.68211})(HT^{1.13585})$	0.932	44	0.00354
SAW-LOG VOLUME:	$SVOL = 0.0000775\ (DBH^{1.69402})(HT^{1.03846})$	0.893	26	0.00177

TVOL = all stem and branch wood plus stump and bark; excludes foliage and roots.
WVOL = all stem and branch wood to a 4" (10 cm) top; excludes stump and bark; excludes foliage and roots.
SVOL = all wood inside bark to a 9" (23 cm) top for segments ≥ 8 ft. (2.5 m) for all trees 11" (28 cm) dbh and larger; excludes stump, foliage and roots.
R^2 = the multiple coefficient of determination.
N = the sample size.
SE = the standard error of the estimate in cubic feet or cubic meters.

Table 7. Local and Standard volume equations for **Pacific madrone** at Boggs Mountain Demonstration State Forest.

LOCAL VOLUME EQUATIONS

English Units (volume in ft^3, DBH in inches)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0583740\ (DBH^{2.36581})$	0.898	35	0.15529
WOOD VOLUME:	$WVOL = 0.0310384\ (DBH^{2.53585})$	0.891	35	0.01527
SAW-LOG VOLUME:	$SVOL = 0.0143017\ (DBH^{2.72298})$	0.544	17	0.20169

Metric Units (volume in m^3, DBH in centimeters)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0001822\ (DBH^{2.36581})$	0.898	35	0.00439
WOOD VOLUME:	$WVOL = 0.0000827\ (DBH^{2.53585})$	0.891	35	0.00043
SAW-LOG VOLUME:	$SVOL = 0.0000320\ (DBH^{2.72298})$	0.544	17	0.00571

STANDARD VOLUME EQUATIONS

English Units (volume in ft^3, DBH in inches, HT is total height in feet)

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0061203\ (DBH^{1.86664})(HT^{0.90347})$	0.935	35	.11149
WOOD VOLUME:	$WVOL = 0.0022292\ (DBH^{1.95295})(HT^{1.05501})$	0.939	35	.11295
SAW-LOG VOLUME:	$SVOL = 0.0001304\ (DBH^{1.83452})(HT^{1.76666})$	0.722	17	.01576

Metric Units (volume in m^3, DBH in cm., HT is total height in meters))

UTILIZATION STANDARD	EQUATION	R^2	N	SE
TOTAL VOLUME:	$TVOL = 0.0000889\ (DBH^{1.86664})(HT^{0.90347})$	0.935	35	.00316
WOOD VOLUME:	$WVOL = 0.0000358\ (DBH^{1.95295})(HT^{1.05501})$	0.939	35	.00032
SAW-LOG VOLUME:	$SVOL = 0.0000055\ (DBH^{1.83452})(HT^{1.76666})$	0.722	17	.00045

NOTES:

TVOL = all stem and branch wood plus stump and bark; excludes foliage and roots.

WVOL = all stem and branch wood to a 4" (10 cm) top; excludes stump and bark; excludes foliage and roots.

SVOL = all wood inside bark to a 9" (23 cm) top for segments ≥ 8 ft. (2.5 m) for all trees 11" (28 cm) dbh and larger; excludes stump, foliage and roots.

R^2 = the multiple coefficient of determination.

N = the sample size.

SE = the standard error of the estimate in cubic feet or cubic meters.

The measure of the residual variation is the root mean squared error (Equation [10]), that is, the root of the mean squared difference between the predicted and actual volumes. The RMS test provides a percent error of variation which is useful for comparing volume equations to each other. This comparison is expressed as a percent of the average tree volume. The RMS equation is as follows:

$$\text{RMS } (\%) = \frac{\sqrt{\dfrac{\sum(\text{Est. Vol.} - \text{Act. Vol})^2}{N}}}{\dfrac{\sum \text{Act. Vol}}{N}} \times 100 \qquad [10]$$

Where: RMS = Percent root mean squared error,
Est. Vol. = Estimated tree volume based on volume estimation equations,
Act. Vol. = Actual tree volume, and
N = number of trees.

A summary of the comparison of test values for the BMDSF volume equations and volume equations of Wensel (1977) and Pillsbury and Kirkley (1984) is shown in Table 8.

Aggregate Difference Test:

The aggregate difference test is another measure of equation reliability. The aggregate difference is the difference between the sum of the predicted volumes and the sum of the actual volumes for sample trees. The test provides a percent error value based on the sum of the sample volumes.

Summary of the root mean squared error and the aggregate difference tests for the BMDSF volume equations and those of Wensels (for the softwoods) and Pillsbury and Kirkley (for the hardwoods) is shown in Table 8. Individual tree test values are presented in the Appendix (see Appendix E).

Table 8. Root mean squared error and aggregate difference tests comparing the BMDSF volume equations with equations developed by Wensel (1977 for softwoods in Northern California and Pillsbury and Kirkley (1984) for hardwoods statewide.

HARDWOODS

Local Volume Equations

Species	Util. Std.	Root Mean Square (%) BMDSF	Aggregate Diff. (%) BMDSF
CnLO	TVOL	26.02	-5.20
	WVOL	22.28	-5.04
	SVOL	14.58	-3.54
BO	TVOL	25.46	3.15
	WVOL	21.81	-1.18
	SVOL	17.06	32.70
PM	TVOL	25.50	-1.50
	WVOL	24.30	11.00
	SVOL	19.10	14.28

Standard Volume Equations

Species	Util. Std.	Root Mean Squared (%) BMDSF	Root Mean Squared (%) Statewide	Aggregate Difference (%) BMDSF	Aggregate Difference (%) Statewide
CnLO	TVOL	25.10	37.10	-4.94	19.93
	WVOL	21.30	40.20	-4.62	31.29
BO	TVOL	26.56	68.10	2.69	29.39
	WVOL	41.15	58.00	12.19	34.77
PM	TVOL	33.30	47.34	2.30	13.10
	WVOL	44.40	56.16	22.51	34.37

LEGEND

BMDSF: based on standards equations developed by Pillsbury and Pryor 1989.

Statewide: based on standard equations developed by Pillsbury and Kirkley 1984.

Wensels: based on standard equations developed by Wensel 1977.

PP = ponderosa pine
SP = sugar pine
DF = Douglas-fir
CnLO = canyon live oak
BO = black oak
PM = Pacific madrone

CONIFERS

Local Volume Equations

Species	Util. Std.	Root Mean Square (%) BMDSF	Aggregate Diff. (%) BMDSF
PP	Total Vol.	31.20	-0.38
	Scribner	211.93	-0.69
SP	Total Vol.	35.57	0.66
	Scribner	336.70	1.18
DF	Total Vol.	40.66	-17.97
	Scribner	304.13	-21.20

Standard Volume Equations

Species	Util. Std.	Root Mean Squared (%) BMDSF	Root Mean Squared (%) Wensels	Aggregate Difference (%) BMDSF	Aggregate Difference (%) Wensels
PP	Total Vol.	28.07	29.05	-0.32	3.89
	Scribner	193.24	339.89	-0.80	21.22
SP	Total Vol.	25.71	41.44	-0.26	4.40
	Scribner	215.19	498.11	-0.34	26.27
DF	Total Vol.	34.13	31.39	-20.17	16.40
	Scribner	236.71	295.00	-21.26	-1.59

NOTE:
No local volume equations from Wensel 1977 or Pillsbury and Kirkley 1984 were available for comparison with the BMDSF local volume equations.

Test Results:

Both tests, the root mean squared error and the aggregate difference showed smaller error values for the BMDSF equations, for all species except Douglas-fir when compared to errors of other equations. This suggests that equations developed for BMDSF will predict tree volume closer to the actual tree volume than equations previously developed.

VIII. SUMMARY

Local and standard volume equations were developed for three young growth softwood species and three hardwood species at Boggs Mountain Demonstration State Forest. The equations were compared to previously developed volume equations by Wensel (1977) for softwood species and Pillsbury and Kirkley (1984) for hardwood species. Based on two tests: 1) root mean square error test (RMS) and 2) the aggregate difference test, volume equations from this study gave lower values for all species except Douglas-fir when compared to errors of other equations. It is recommended that volume equations from this study be used for volume prediction for species at BMDSF.

These volume tables will allow accurate assessment of tree and stand volumes for the six species at Boggs Mountain Demonstration State Forest. Moreover, they will provide the volume information necessary for periodic inventories, and implementation of specific management programs such as thinning prescriptions and growth and yield studies.

In addition to the benefits this information will have to BMDSF, publication of the data by the California Department of Forestry and Fire Protection will aid managers of federal and county lands having these species as well as providing valuable baseline information to non-industrial private landowners involved in forest management.

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APPENDIX A

SAMPLE TREE DATA VOLUME
COMPUTATION SPREADSHEETS

SAMPLE TREE CUBIC AND BOARD FOOT VOLUME COMPUTATION SPREADSHEET (softwoods)

Species: Ponderosa Pine

Tree Number: 2

Basal area = D^2 (in inches) x 0.005454

Regression coefficients for Dib vs. Dob:
a = -0.44331
b = 0.99005

	English	METRIC
Dbhob (in) =	28.0	71
Total Ht (ft) =	130.6	39.8
Horiz Dist (ft) =	66.0	
Dob at 1' (in) =	35.4	90
SBT (in) =	3.0	7.7

(1)				(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Tree Height	Lower Dob (cm)	Upper Dob (cm)	Hor. Dist (m)	Relascope Height Reading	Dob (in)	Cumul. Height (feet)	Angle (deg.)	Segment Number	Segment Length (ft)	Dib (in)	Average Seg. B/Ab (sq.ft.)	Gross Vol (lb) (cu. ft.)	Segment Length (ft)	Rate of Segment Taper (in/ft)	Log #	Upper Dib (in)	Scale Length (even feet)	Scale Dib (in)	Board foot Volume (Scribner)	Board foot Volume (Int'l 1/4")
Base	x	x	x	0.0	x	0.0		x	x	31.1	x	x	x	x	x	x	x	x	x	x
4.5'	x	x	x	x	28.0	4.5		x	x	21.9	x	x	x	x	x	x	x	x	x	x
17.3	90	67	5	17.4	22.4	17.4		1	17.4	19.5	3.677	63.99	17.4	0.16	1.0	19.6	16.0	20	272	289
MP1	67	62	5	33.8	20.5	33.8		2	16.4	17.8	1.902	31.20	16.4	0.11	2.0	17.8	16.0	18	215	232
MP2	52	47	5	50.2	18.5	50.2		3	16.4	16.0	1.562	25.63	16.4	0.11	3.0	16.0	16.0	16	166	180
MP3	47	40	5	66.6	15.7	66.6		4	16.4	13.6	1.203	19.73	16.4	0.15	4.0	13.5	16.0	13	103	115
MP4	40	30	5	83.0	11.6	83.0		5	16.4	10.1	0.779	12.78	16.4	0.21	5.0	9.9	16.0	10	55	64
MP5	30	25	2	89.6	9.8	89.6		6	6.6	8.3	0.465	3.05	6.6	0.27	0.0	0.0	0.0	0	–	–
MP6				0.0	0.0	–		0	–	–	–	–	–	–	0.0	0.0	0.0	0	–	–
MP7				0.0	0.0	–		0	–	–	–	–	–	–	0.0	0.0	0.0	0	–	–
MP8				0.0	0.0	–		0	–	–	–	–	–	–	0.0	0.0	0.0	0	–	–
MP9				0.0	0.0	–		0	–	–	–	–	–	–	0.0	0.0	0.0	0	–	–
Tip	25	0		130.6	0.0	130.6		7	41.0	0.0	0.126	5.16	89.6				80.0		811	860
								Tot. Ht (ft) =	130.6			Cubic feet =	161.53							
												Cubic meters =	4.57							

Notes:

Col. 5: Used for leaning trees; angle from vertical

Col. 8: a) Base Dib is computed one of two ways:
1) the Dob at 1-foot and regression relationship; or,
2) by calculating the rate of taper between 4.5' & 17.3' and extrapolating to ground level.
b) DBHib = DBHob - 2(SBT). E.g., 33.5-2(2.5) = 28.5"
c) Other Dib values are calculated from the species Dib vs. Dob regression coefficients.

Col. 10: a) Volume is computed by Smalians formula, V=((b+B)/2)xL, where b & B are basal area at the small & large ends, and L is the segment length.
b) Volume of the tip is computed as a cone; V = (B x L)/3. c) Volume is cubic feet to a 0-inch top, excluding bark.

Col. 14: Upper Dib is calculated by interpolating diameters to specified stem lengths (17.5, 34, 50.5, 67, 83.5, 100, 116.5, 133, etc.).

Col. 15: Logs are calculated to even 2-foot lengths; minimum length of 6'. Trim is prorated at 6" per 16' length.

Col. 16: Scale diameters are small end, inside bark to nearest inch.

Col. 17: Scribner board foot volume to a 6" top calculated by: V = (0.79D^2-2D-4) x L/16, or by using Scribner log rule (table form).

Col. 18: International 1/4" board foot volume to a 10" top. Log length calculated by Col. 15. Volume = 0.905(0.22D^2-.71D) for 4 foot sections.

Table A1. Sample tree data volume computation spreadsheet for softwood species.

SAMPLE TREE CUBIC FOOT VOLUME COMPUTATION SPREADSHEET (hardwoods)

Species = Canyon Live Oak
Tree Number = 2

Base Sight 1 = -1.3	Base Sight 2 =	Base Sight 3 =	Dbhob (cm) = 40	Dib vs. Dob
Rel Scale = 20	Rel Scale =	Rel Scale =	Total Ht (m) = 18.3	-0.64865
Horiz Dist = 20	Horiz Dist =	Horiz Dist =	Dia. at 1 foot = 43	0.94838
Base Sight 1 = -1.3	Base Sight 2 = 0	Base Sight 3 = 0	SBT = 1.5	7.85E-05

BS No.	Seg No.	Lower Sight	Lower DOB	Upper Sight	Upper DOB	Direct Horiz. Dist (m)	Angle (deg.)	Average Seg. BAob (sq. m.)	Segment Length (m)	Total Volume (cu. m.)	Average Seg. BAib (sq. m.)	Wood volume (cu. m.)	Sawlog volume (cu. m.)
1	1		43.0		43.0	0.3		0.145	0.3	0.04	0.126	0.04	
1	2	-1.3	43.0	2.0	34.0			0.116	3.3	0.39	0.102	0.34	0.33809
1	3		14.0		10.0	1.2		0.012	1.2	0.01	0.009	0.01	
1	4	2.0	24.0	5.8	27.0			0.051	3.8	0.19	0.044	0.17	0.16592
1	5	5.8	23.0	11.5	10.0			0.025	5.7	0.14	0.021	0.12	
1	6		14.0		10.0	1.3		0.012	1.3	0.02	0.009	0.01	
1	7							0.000	0.0	0.00	0.000	0.00	
1	8							0.000	0.0	0.00	0.000	0.00	
1	9							0.000	0.0	0.00	0.000	0.00	
1	10							0.000	0.0	0.00	0.000	0.00	
1	11							0.000	0.0	0.00	0.000	0.00	
1	12							0.000	0.0	0.00	0.000	0.00	
1	13							0.000	0.0	0.00	0.000	0.00	
1	14							0.000	0.0	0.00	0.000	0.00	
1	15							0.000	0.0	0.00	0.000	0.00	
1	16							0.000	0.0	0.00	0.000	0.00	
1	17							0.000	0.0	0.00	0.000	0.00	
1	18							0.000	0.0	0.00	0.000	0.00	
1	19							0.000	0.0	0.00	0.000	0.00	
									Segment volume =	0.80		0.68	0.50
									Branch volume =	0.07			
									Cu. m. =	0.87	Cu. m. =	0.64	
									Cu. feet =	30.75	Cu. feet =	22.56	

Number of small branches = 7
Average branch length (m) = 4

Table A2. Sample tree data volume computation spreadsheet for hardwood species.

APPENDIX B

Volume Equation Scatter Plots

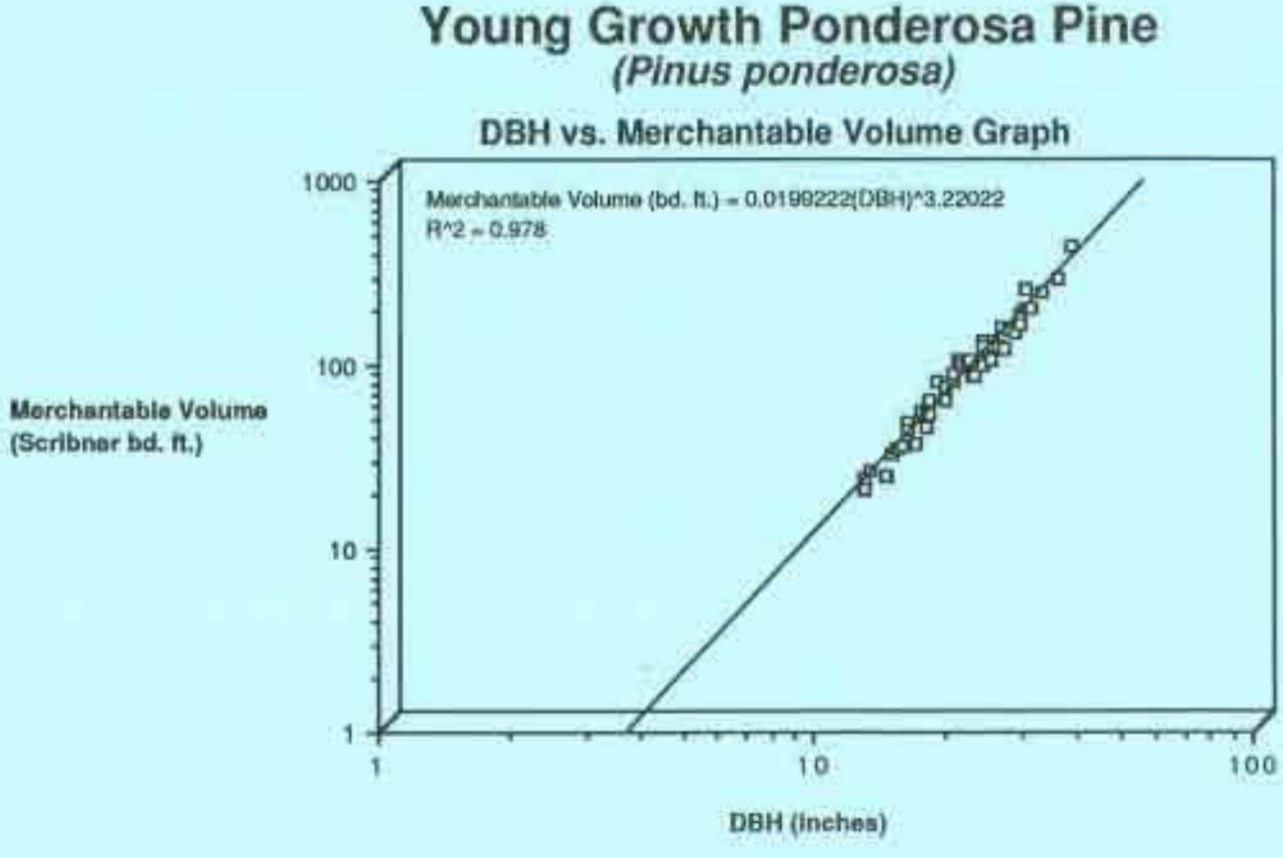

Figure B1. Scatterplot of DBH vs. merchantable volume (board feet) for young growth ponderosa pine at Boggs Mountain Demonstration State Forest.

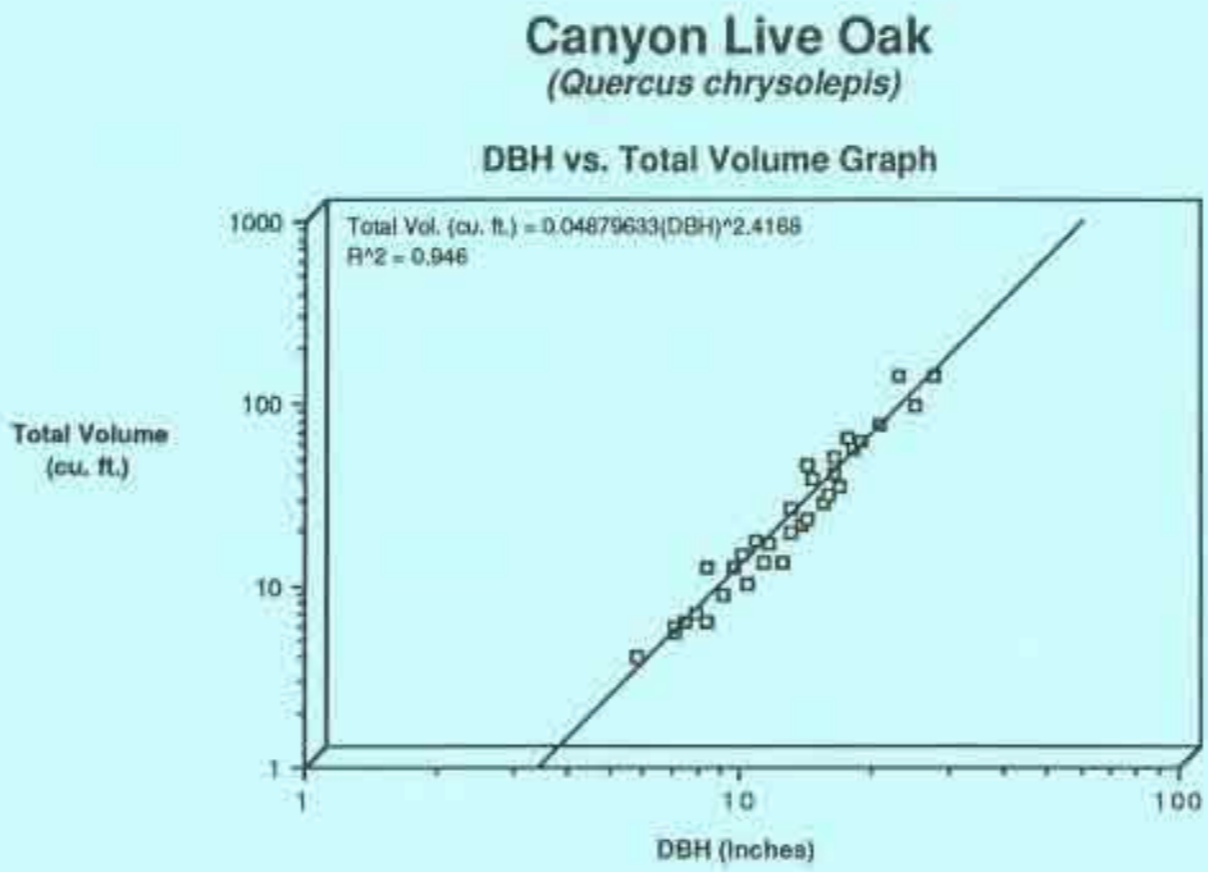

Figure B2. Scatterplot of DBH vs. total volume (cubic feet) for canyon live oak at Boggs Mountain Demonstration State Forest.

APPENDIX C

Local and Standard Volume Tables

YOUNG GROWTH PONDEROSA PINE
Bogus Mountain Demonstration State Forest

LOCAL VOLUME TABLES

Table C1a. ENGLISH

DBH (in)	Smallans TVOL (ft^3)	Log Rules* Scribner (bd. ft.)	Log Rules* Int'l 1/4" (bd. ft.)
10	12	33	39
12	20	60	70
14	29	98	113
16	40	150	171
18	55	220	248
20	71	308	345
22	91	419	465
24	113	555	610
26	138	718	784
28	167	911	988
30	199	1138	1228
32	234	1400	1503
34	273	1702	1811
36	315	2046	2173
38	361	2435	2574
40	411	2873	3022
42	465	3362	3521

Table C1b. METRIC

DBH (cm)	Smallans TVOL (m^3)
25	0.33
30	0.53
35	0.78
40	1.10
45	1.48
50	1.93
55	2.46
60	3.07
65	3.76
70	4.53
75	5.40
80	6.36
85	7.41
90	8.56
95	9.82
100	11.18
105	12.65

*** Log Rules:**
Smallans TVOL (ft^3) = Total Volume in cubic feet; includes all stem and branch wood plus stump and bark; excludes foliage and roots; Volume = 0.0383331 * (DBH^2.53035).
Scribner (bd. ft.) = Scribner board foot volume based on DBH; Volume = 0.0199222 * (DBH^3.22022).
Int'l 1/4" (bd. ft.) = International 1/4 inch board foot volume based on DBH; Volume = 0.0290782 * (DBH^3.1314)
Smallans TVOL (m^3) = Total volume in cubic meters based on DBH; Volume = 0.0800972 * (DBH^2.53035).

Table C1. Local Volume tables for young growth ponderosa pine for Total Volume (cu. ft.), Scribner (bd. ft.), International 1/4" (bd. ft.), and Total Volume (cu. m.).

YOUNG GROWTH PONDEROSA PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Total Volume (cu. ft.) **

DBH	Total Height (feet)														
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
10	9	10	11	12	13	14	15								
12	13	15	17	18	20	21	22								
14	19	21	24	26	28	29	31	33							
16	25	29	32	35	37	40	42	44	46	48	50				
18	32	37	41	45	48	51	54	57	60	62	64	67	69		
20	41	47	52	57	61	65	69	72	75	79	81	84	87		
22	51	58	64	70	75	80	85	89	93	97	101	104	108	111	114
24	62	71	78	85	92	97	103	108	113	118	122	127	131	135	139
26		84	94	102	109	116	123	129	135	141	146	151	156	161	166
28			110	120	129	137	145	152	159	166	172	178	184	190	195
30				140	151	160	169	178	186	194	201	208	215	221	228
32					174	185	195	205	215	224	232	240	248	256	263
34						212	224	235	246	256	266	275	284	293	301
36							254	267	279	291	302	312	322	332	342
38								301	315	328	340	352	364	375	386
40									353	367	381	395	408	420	432
42											425	440	455	468	482

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0106345 * (DBH^2.22642) * (HT^0.467261).
** Total Volume (cu. ft.) = Total volume in cubic feet based on DBH and total tree height.

Table C2. Young growth ponderosa pine standard volume table for total volume in cubic feet based on DBH and total tree height.

YOUNG GROWTH PONDEROSA PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Scribner (bd. ft.) **

DBH	Total Height (feet)														
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
10	24	28	30	33	35	37	39								
12	41	47	52	56	60	64	67								
14	65	74	81	88	94	100	105	110							
16	96	109	120	130	139	148	155	163	170	177	183				
18	135	153	169	183	196	208	219	230	240	249	258	267	275		
20	184	208	230	249	267	283	298	313	326	339	351	363	374		
22	243	275	304	330	353	374	394	413	431	448	464	479	494	508	522
24	313	355	392	425	455	483	508	533	555	577	598	618	637	655	673
26		449	495	537	579	610	642	673	702	729	756	781	805	828	851
28			615	667	714	757	797	835	871	906	938	969	999	1028	1056
30				815	873	926	976	1022	1066	1108	1148	1186	1223	1258	1292
32					1054	1118	1178	1234	1287	1338	1386	1432	1476	1519	1560
34						1335	1406	1473	1537	1597	1654	1709	1762	1813	1863
36							1662	1741	1816	1887	1955	2020	2083	2143	2201
38								2039	2127	2210	2290	2366	2439	2510	2578
40									2470	2567	2660	2748	2833	2915	2995
42											3067	3169	3263	3362	3453

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0064579 * (DBH^2.92149) * (HT^0.44199).
** Scribner (bd. ft.) = Scribner board foot volume based on DBH and total tree height.

Table C3. Young growth ponderosa pine standard volume table for Scribner board foot volume based on DBH and total tree height.

YOUNG GROWTH PONDEROSA PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Scribner (bd. ft.) **

DBH	Number of 16 foot logs														
(in)	1	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
10	33	44	54	63	72	80	88								
12	48	64	78	92	105	117	129								
14	66	88	108	126	144	161	177	192							
16	87	116	142	167	190	212	233	254	274	293	312				
18	110	149	181	213	242	270	298	324	349	374	398	421	444		
20	137	183	225	264	301	336	370	402	434	465	494	524	552		
22	167	223	274	322	367	410	451	490	529	566	602	638	672	706	740
24	200	267	329	385	439	490	539	587	633	677	721	763	805	846	886
26		316	388	455	518	579	637	693	747	799	851	901	950	998	1045
28			452	530	604	674	742	807	870	932	992	1050	1107	1163	1218
30				612	697	778	856	931	1004	1075	1144	1211	1277	1342	1405
32					796	889	978	1064	1147	1228	1307	1384	1459	1533	1606
34						1008	1109	1206	1301	1392	1482	1569	1654	1738	1820
36							1248	1358	1464	1567	1668	1766	1862	1956	2049
38								1518	1633	1753	1865	1975	2082	2188	2291
40									1820	1949	2074	2196	2314	2433	2548
42											2294	2429	2561	2691	2818

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.2795348 * (DBH^2.06845) * (HT^0.71523).
** Scribner (bd. ft.) = Scribner board foot volume based on DBH and number of 16 ft. logs to a 6 inch top.

Table C4. Young growth ponderosa pine standard volume table for Scribner board foot volume based on DBH and number of 16 foot logs to a 6 inch top.

YOUNG GROWTH PONDEROSA PINE
Buggs Mountain Demonstration State Forest

Standard Volume Table *
International 1/4" (bd. ft.) **

DBH	Total Height (feet)														
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
10	28	32	36	39	42	45	47								
12	47	54	60	65	70	35	79								
14	73	83	91	101	109	116	122	128							
16	106	121	135	147	158	168	178	187	195	204	211				
18	148	169	188	205	220	234	248	260	272	283	294	305	315		
20	199	228	253	275	296	315	333	350	366	381	396	410	423		
22	260	298	331	360	387	412	436	458	479	499	518	536	554	571	587
24	332	380	422	460	495	527	556	585	611	637	661	685	707	729	750
26		476	529	576	618	660	697	732	766	798	828	858	886	913	940
28			652	710	763	812	859	902	944	983	1021	1057	1091	1125	1158
30				862	927	987	1043	1096	1146	1193	1239	1283	1325	1366	1406
32					1111	1183	1250	1314	1374	1431	1486	1539	1589	1638	1686
34						1403	1483	1558	1629	1697	1762	1825	1885	1943	1999
36							1742	1830	1914	1994	2070	2143	2214	2282	2348
38								2133	2228	2321	2410	2495	2578	2657	2734
40									2574	2682	2784	2883	2978	3070	3158
42											3194	3307	3416	3521	3623

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0087845 * (DBH^2.81401) * (HT^0.46964).
** International 1/4" (bd. ft.) = International 1/4 inch board foot volume based on DBH and total tree height.

Table C5. Young growth ponderosa pine standard volume table for International 1/4 inch board foot volume based on DBH and tree height to a 6 inch top.

YOUNG GROWTH PONDEROSA PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Total Volume (cu. m.) **

DBH	Total Height (meters)														
(cm.)	10	13	16	19	22	25	28	31	34	37	40	43	46	49	52
5	0.01	0.01	0.01	0.03	0.01	0.01	0.01								
10	0.03	0.04	0.04	0.04	0.05	0.05	0.05								
15	0.08	0.09	0.10	0.11	0.12	0.12	0.13	0.14							
20	0.15	0.17	0.19	0.21	0.22	0.23	0.25	0.26	0.27	0.28	0.29				
25	0.25	0.28	0.31	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.49	0.51		
30	0.38	0.42	0.47	0.51	0.54	0.58	0.61	0.64	0.66	0.69	0.72	0.74	0.77		
35	0.53	0.60	0.66	0.71	0.76	0.81	0.86	0.90	0.94	0.97	1.01	1.05	1.08	1.11	1.14
40	0.71	0.80	0.89	0.96	1.03	1.09	1.15	1.21	1.26	1.31	1.36	1.41	1.45	1.50	1.54
45		1.05	1.15	1.25	1.34	1.42	1.50	1.57	1.64	1.71	1.77	1.83	1.89	1.94	2.00
50			1.46	1.58	1.69	1.79	1.89	1.98	2.07	2.16	2.24	2.31	2.39	2.46	2.53
55				1.95	2.09	2.22	2.34	2.45	2.56	2.67	2.76	2.86	2.95	3.04	3.12
60					2.54	2.69	2.84	2.98	3.11	3.24	3.36	3.47	3.58	3.69	3.79
65						3.22	3.39	3.56	3.72	3.87	4.01	4.15	4.28	4.41	4.53
70							4.00	4.20	4.38	4.56	4.73	4.89	5.05	5.20	5.35
75								4.90	5.11	5.32	5.51	5.70	5.89	6.06	6.23
80									5.90	6.14	6.37	6.59	6.80	7.00	7.20
85											7.29	7.54	7.78	8.01	8.24

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0000658 * (DBH^2.22642) * (HT^0.46726).
** Total Volume (cu. m.) = Total volume in cubic meters based on DBH and total tree height.

Table C6. Young growth ponderosa pine standard volume table for total volume in cubic meters based on DBH and total tree height.

YOUNG GROWTH SUGAR PINE
Boggs Mountain Demonstration State Forest

LOCAL VOLUME TABLES

ENGLISH

DBH (in)	Smaliana TVOL (ft^3)	Log Rules* Scribner (bd. ft.)	Log Rules* Int'l 1/4" (bd. ft.)
10	12	31	36
12	18	53	62
14	27	85	97
16	37	127	144
18	48	180	203
20	62	247	276
22	78	329	365
24	96	427	470
26	117	543	595
28	139	678	739
30	164	834	904
32	192	1012	1092
34	222	1214	1304
36	254	1440	1541
38	289	1694	1806
40	327	1976	2098
42	367	2287	2421

METRIC

DBH (cm)	Smaliana TVOL (m^3)
25	0.32
30	0.50
35	0.72
40	0.99
45	1.32
50	1.70
55	2.13
60	2.62
65	3.18
70	3.79
75	4.47
80	5.22
85	6.04
90	6.92
95	7.87
100	8.90
105	10.00

*** Log Rules:**
Smaliana TVOL (ft^3) = Total Volume in cubic feet; includes all stem and branch wood plus stump and bark; excludes foliage and roots; Volume = 0.0481061 * (DBH^2.39206).
Scribner (bd. ft.) = Scribner board foot volume based on DBH; Volume = 0.0310269 * (DBH^2.99864).
Int'l 1/4" (bd. ft.) = International 1/4 inch board foot vol. based on DBH; Vol. = 0.0428598 * (DBH^2.927381).
Smaliana TVOL (m^3) = Total volume in cubic meters based on DBH; Volume = 0.00014835 * (DBH^2.39206).

Table C7. Local Volume tables for young growth sugar pine for Total Volume (cu. ft.), Scribner (bd. ft.), International 1/4" (bd. ft.), and Total Volume (cu. m.).

YOUNG GROWTH SUGAR PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Total Volume (cu. ft.) **

DBH	Total Height (feet)												
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150
10	8	9	11	12	14	15	16						
12	11	13	16	18	20	21	23						
14	15	18	21	24	27	29	32	34					
16	20	24	28	31	35	38	41	44	47	50			
18	25	30	35	40	44	48	52	56	60	63			
20	31	37	43	49	54	59	64	69	74	78			
22	37	45	52	59	66	72	78	84	89	95			
24	44	53	62	70	78	85	93	99	106	113	119		
26			73	82	92	100	109	117	124	132	139		
28			84	96	106	116	126	135	144	153	162	170	
30				110	122	133	144	155	166	176	185	195	
32					138	152	164	176	188	200	211	222	232
34					156	171	185	199	212	225	238	250	262
36						192	208	223	238	252	267	280	294
38							233	248	265	281	297	312	327
40							256	275	293	311	329	344	362
42								303	323	343	362	381	399
44									355	376	397	418	438
46									388	411	434	457	479
48										448	473	497	521

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0077648 * (DBH^1.99122) * (HT^0.87964).
** Total Volume (cu. ft.) = Total volume in cubic feet based on DBH and total tree height.

Table C8. Young growth sugar pine standard volume table for total volume in cubic feet based on DBH and total tree height.

YOUNG GROWTH SUGAR PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Scribner (bd. ft.) **

DBH	Total Height (feet)												
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150
10	13	18	24	31	38	44	52						
12	19	28	37	47	57	68	79						
14	28	40	53	67	82	97	113	129					
16	38	55	73	92	112	132	154	176	199	222			
18	50	72	96	121	147	174	202	232	262	292			
20	64	92	122	154	188	222	258	296	334	373			
22	79	114	152	192	234	277	323	369	417	466			
24	97	140	186	235	286	340	395	452	510	570	631		
26			224	283	345	409	475	544	614	686	760		
28			266	336	410	486	565	646	729	815	903	993	
30				395	481	570	663	758	856	957	1060	1165	
32					558	662	770	881	995	1111	1231	1353	1478
34					643	762	886	1014	1145	1279	1417	1558	1701
36						870	1012	1157	1307	1461	1618	1779	1943
38							1147	1312	1482	1656	1835	2017	2203
40							1292	1478	1670	1866	2067	2272	2481
42								1655	1870	2090	2314	2544	2779
44									2083	2328	2578	2834	3096
46									2309	2581	2859	3143	3432
48										2849	3156	3469	3788

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0007872 * (DBH^2.32149) * (HT^1.27724).
** Scribner (bd. ft.) = Scribner board foot volume based on DBH and total tree height.

Table C9. Young growth sugar pine standard volume table for Scribner board foot based on DBH and total tree height.

YOUNG GROWTH SUGAR PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Scribner (bd. ft.) **

DBH	Number of 16 foot logs														
(in)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
10	36	47	57	66	74	82	89								
12	51	67	81	94	106	117	128	138	148	157					
14	69	91	109	127	143	158	172	186	200	212					
16	90	118	142	164	185	205	224	242	259	276					
18	113	148	179	207	233	258	281	304	326	347	367	387	406	425	443
20	139	182	219	254	286	317	346	373	400	426	451	476	499	522	544
22	168	219	264	306	345	381	416	449	482	513	543	572	601	628	656
24	199	259	313	362	408	452	493	533	571	607	643	678	712	745	777
26			366	423	473	528	576	622	667	710	752	792	832	870	908
28			422	489	551	610	666	719	771	820	869	915	961	1005	1049
30				559	631	698	762	823	882	938	994	1047	1099	1150	1200
32					715	791	864	933	1000	1064	1127	1187	1247	1304	1361
34					800	880	972	1050	1125	1198	1268	1334	1401	1468	1531
36						985	1086	1176	1258	1339	1417	1494	1568	1641	1712
38							1207	1304	1397	1488	1575	1660	1743	1823	1902
40							1334	1441	1544	1644	1741	1834	1926	2015	2102
42								1585	1698	1808	1914	2017	2118	2216	2312
44															

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.48538157 * (DBH^1.94896) * (HT^0.65602).
** Scribner (bd. ft.) = Scribner board foot volume based on DBH and number of 16 foot logs to a 6 inch top.

Table C10. Young growth sugar pine standard volume table for Scribner board foot based on DBH and number of 16 foot logs to 6 inch top.

YOUNG GROWTH SUGAR PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
International 1/4" (bd. ft.)

DBH	Total Height (feet)												
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150
10	15	21	28	36	44	53	61						
12	22	32	43	54	66	79	92						
14	31	45	60	77	94	112	130	149					
16	42	61	82	103	126	150	175	201	228	255			
18	55	79	106	135	164	196	228	262	296	332			
20	69	101	134	170	208	248	289	331	375	420			
22	86	124	166	211	258	307	357	410	464	520			
24	104	151	202	256	313	372	434	498	564	631	700		
26			242	306	374	446	519	596	674	755	838		
28				362	442	526	613	703	796	891	989	1089	
30				422	516	614	715	820	929	1040	1154	1271	
32					596	709	826	948	1073	1202	1333	1468	1606
34					682	812	946	1086	1229	1376	1527	1682	1840
36						923	1076	1234	1396	1564	1736	1911	2091
38							1214	1392	1576	1765	1959	2157	2360
40							1362	1562	1768	1980	2197	2419	2643
42								1742	1972	2208	2450	2698	2952
44									2188	2450	2719	2994	3276
46									2411	2706	3004	3308	3618
48										2977	3304	3638	3980

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0010155 * (DBH^2.23760) * (HT^1.30106).
** International 1/4" (bd. ft.) = International 1/4 inch board foot volume based on DBH and total tree height.

Table C11. Young growth sugar pine standard volume table for International 1/4 inch board foot volume based on DBH and total tree height.

YOUNG GROWTH SUGAR PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Total Volume (cu. m.)**

DBH	Total Height (meters)												
(cm)	10	13	16	19	22	25	28	31	34	37	40	43	46
25	0.22	0.27	0.31	0.35	0.38	0.42	0.45						
30	0.32	0.38	0.44	0.50	0.55	0.60	0.65						
35	0.44	0.52	0.60	0.68	0.75	0.82	0.88	0.94					
40	0.57	0.68	0.79	0.88	0.98	1.06	1.15	1.23	1.31	1.39			
45	0.72	0.86	0.99	1.12	1.23	1.34	1.45	1.56	1.66	1.76			
50	0.89	1.06	1.22	1.38	1.52	1.66	1.79	1.92	2.04	2.17			
55	1.08	1.29	1.48	1.66	1.84	2.01	2.17	2.32	2.47	2.62			
60	1.28	1.53	1.76	1.98	2.19	2.39	2.58	2.76	2.94	3.11	3.28		
65			2.07	2.32	2.56	2.80	3.02	3.24	3.45	3.65	3.85		
70			2.39	2.69	2.97	3.24	3.50	3.75	4.00	4.23	4.46	4.69	
75				3.08	3.41	3.72	4.02	4.30	4.58	4.85	5.12	5.38	
80					3.88	4.23	4.57	4.90	5.21	5.52	5.82	6.11	6.40
85					4.37	4.77	5.15	5.52	5.88	6.23	6.57	6.90	7.22
90						5.35	5.78	6.19	6.59	6.98	7.36	7.73	8.09
95							6.43	6.89	7.34	7.77	8.20	8.61	9.01
100							7.12	7.63	8.13	8.61	9.08	9.54	9.98
105								8.41	8.96	9.49	10.00	10.51	11.00
110									9.83	10.41	10.97	11.53	12.07
115									10.74	11.37	11.99	12.59	13.18
120										12.38	13.05	13.71	14.35

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.00007704 * (DBH^1.99122) * (HT^0.67964).
** Total Volume (cu. m.) = Total volume in cubic meters based on DBH and total tree height.

Table C12. Young growth sugar pine standard volume table for total volume in cubic meters based on DBH and total tree height.

YOUNG GROWTH DOUGLAS FIR
Boggs Mountain Demonstration State Forest

LOCAL VOLUME TABLES

ENGLISH

DBH (in)	Smaliana TVOL (ft^3)	Log Rules* Scribner (bd. ft.)	Log Rules* Int'l 1/4" (bd. ft.)
10	13	40	47
12	19	66	76
14	27	99	114
16	37	142	161
18	48	194	219
20	61	258	288
22	76	333	370
24	93	420	465
26	111	521	573
28	132	635	695
30	154	764	832
32	179	909	985
34	205	1069	1154
36	234	1246	1340
38	265	1441	1544
40	297	1653	1765
42	332	1884	2006

METRIC

DBH (cm)	Smaliana TVOL (m^3)
25	0.35
30	0.52
35	0.74
40	1.01
45	1.32
50	1.67
55	2.08
60	2.54
65	3.04
70	3.60
75	4.22
80	4.89
85	5.61
90	6.39
95	7.23
100	8.12
105	9.08

*** Log Rules:**
Smaliana TVOL (ft^3) = Total Volume in cubic feet; Includes all stem and branch wood plus stump and bark; excludes foliage and roots; Volume = 0.0667147 * (DBH^2.27779).
Scribner (bd. ft.) = Scribner board foot volume based on DBH; Volume = 0.0836664 * (DBH^2.68142).
Int'l 1/4" (bd. ft.) = International 1/4 inch board foot volume based on DBH; Volume = 0.1147305 * (DBH^2.61
Smaliana TVOL (m^3) = Total volume in cubic meters based on DBH; Volume = 0.000226 * (DBH^2.27779).

Table C13. Local Volume tables for young growth Douglas-fir for Total Volume (cu. ft.), Scribner (bd. ft.), International 1/4" (bd. ft.), and Total Volume (cu. m.).

YOUNG GROWTH DOUGLAS FIR
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Total Volume (cu. ft.) **

DBH (in)	Total Height (feet)												
	30	40	50	60	70	80	90	100	110	120	130	140	150
10	7	9	11	13	15	17	20						
12	9	12	15	18	21	24	27	29	32				
14	12	16	19	23	27	31	34	38	42	45			
16	15	20	24	29	34	38	43	48	52	57	61		
18	18	24	30	35	41	47	52	58	63	69	75		
20		29	35	42	49	56	62	69	76	82	89	96	
22			42	50	57	65	73	81	89	97	104	112	
24			48	57	66	76	85	94	103	112	121	130	139
26				65	76	86	97	107	117	128	138	148	158
28				74	86	98	110	121	133	145	156	168	179
30				83	97	110	123	136	149	162	175	188	201
32						122	137	152	166	181	195	210	224
34						135	152	168	184	200	216	232	248
36							167	185	202	220	238	255	273
38							183	202	222	241	260	280	299
40										263	284	305	326
42										285	308	330	353

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0054341 * (DBH^1.67288) * (HT^0.96348).
** Total Volume (cu. ft.) = Total volume in cubic feet based on DBH and total tree height.

Table C14. Young growth Douglas-fir standard volume table for total volume in cubic feet based on DBH and total tree height.

YOUNG GROWTH DOUGLAS FIR
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Scribner (bd. ft.) **

DBH	Total Height (feet)												
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150
10	13	20	27	35	44	53	62						
12	19	29	40	51	64	77	91	106	121				
14	26	40	55	71	88	106	125	145	166	188			
16	35	52	72	93	116	140	165	192	219	248	278		
18	45	67	92	119	148	179	211	245	280	317	355		
20		83	114	148	184	222	263	305	349	394	442	490	
22			139	180	224	271	320	371	425	481	538	598	
24			167	216	269	324	383	445	509	576	645	716	789
26				255	317	383	452	525	601	680	761	845	932
28				297	370	447	528	612	701	793	888	986	1087
30				343	427	515	609	707	809	915	1024	1137	1254
32						589	696	808	925	1046	1171	1300	1434
34						668	790	916	1049	1186	1328	1475	1626
36							889	1032	1181	1335	1495	1660	1831
38							994	1154	1321	1494	1673	1858	2048
40										1661	1861	2066	2278
42										1839	2059	2286	2521

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0009034 * (DBH^2.07517) * (HT^1.41495).
** Scribner (bd. ft.) = Scribner board foot volume based on DBH and total tree height.

Table C15. Young growth Douglas-fir standard volume table for Scribner board foot volume based on DBH and total tree height.

YOUNG GROWTH DOUGLAS FIR

Boggs Mountain Demonstration State Forest

Standard Volume Table *

Scribner (bd. ft.) **

DBH	Number of 16 foot to a 6" top														
(in)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
10	42	59	76	92	108	124	139								
12	54	71	88	119	139	159	179	198	217	236					
14	67	95	122	148	173	197	222	245	269	292	315	337	360		
16	80	114	146	178	208	238	267	295	324	351	379	406	433		
18	95	135	173	209	245	280	314	348	381	414	446	478	510	541	572
20		156	200	242	284	324	364	403	441	479	516	553	590	626	662
22			228	277	324	370	415	460	504	547	590	632	674	715	756
24			257	312	365	417	468	519	568	617	665	713	760	807	853
26				349	408	466	524	580	635	690	743	797	850	850	953
28				387	453	517	580	643	704	764	824	883	942	942	1057
30				425	498	569	639	707	775	841	907	972	1036	1036	1163
32						622	699	774	847	920	992	1063	1133	1133	1272
34						677	760	841	922	1001	1079	1156	1233	1233	1384
36							823	911	998	1084	1168	1252	1335	1335	1498
38							887	982	1076	1168	1259	1350	1439	1439	1615

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 1.7104812 * (DBH^1.38889) * (HT^0.86470).

** Scribner (bd. ft.) = Scribner board foot volume based on DBH and number of 16 foot logs to a 6" top.

Table C16. Young growth Douglas-fir standard volume table for Scribner board foot volume based on DBH and number of 16 foot logs to a 6" top.

YOUNG GROWTH DOUGLAS FIR
Boggs Mountain Demonstration State Forest

Standard Volume Table *
International 1/4" (bd. ft.) **

DBH	Total Height (feet)												
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150
10	23	33	44	56	68	80	93						
12	32	46	61	76	93	110	127	145	164				
14	42	60	79	100	121	143	166	190	214	239			
16	53	75	100	126	153	181	209	239	270	301	333		
18	64	93	123	154	187	221	257	293	330	369	408		
20		111	147	185	225	266	308	352	397	442	489	537	
22			175	218	265	313	363	415	468	522	577	634	
24			202	254	308	364	422	482	544	607	671	736	803
26				291	354	418	485	554	624	697	771	846	923
28				331	402	475	551	630	710	792	876	962	1049
30				373	453	536	621	709	800	892	987	1083	1182
32						599	695	793	894	998	1104	1211	1321
34						665	772	881	993	1108	1226	1345	1468
36							852	973	1096	1223	1353	1485	1620
38							935	1068	1204	1343	1486	1631	1779
40										1468	1624	1782	1944
42										1597	1767	1939	2115

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0059975 * (DBH^1.73017) * (HT^1.25863).
** International 1/4" (bd. ft.) = International 1/4 inch board foot volume based on DBH and total tree height.

Table C17. Young growth Douglas-fir standard volume table for International 1/4" board foot volume based on DBH and total tree height.

YOUNG GROWTH DOUGLAS FIR
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Total Volume (cu. m.) **

DBH	Total Height (meters)												
(cm)	10	13	16	19	22	25	28	31	34	37	40	43	46
25	0.20	0.26	0.32	0.38	0.44	0.49	0.55						
30	0.28	0.36	0.44	0.51	0.59	0.67	0.75	0.83	0.90				
35	0.36	0.46	0.56	0.67	0.77	0.87	0.97	1.07	1.17	1.27			
40	0.45	0.58	0.71	0.83	0.96	1.09	1.21	1.34	1.46	1.58	1.71		
45	0.55	0.70	0.86	1.01	1.17	1.32	1.47	1.63	1.78	1.93	2.08		
50		0.84	1.03	1.21	1.39	1.58	1.76	1.94	2.12	2.30	2.48	2.66	
55			1.20	1.42	1.63	1.85	2.06	2.28	2.49	2.70	2.91	3.12	
60			1.39	1.64	1.89	2.14	2.39	2.63	2.88	3.12	3.36	3.61	3.85
65				1.88	2.16	2.45	2.73	3.01	3.29	3.57	3.85	4.12	4.40
70				2.12	2.45	2.77	3.09	3.41	3.72	4.04	4.35	4.67	4.98
75				2.38	2.75	3.11	3.47	3.82	4.18	4.53	4.89	5.24	5.59
80						3.46	3.86	4.26	4.65	5.05	5.44	5.84	6.23
85						3.83	4.27	4.71	5.15	5.59	6.03	6.46	6.89
90							4.70	5.19	5.67	6.15	6.63	7.11	7.59
95							5.15	5.68	6.21	6.73	7.26	7.78	8.30
100										7.34	7.91	8.48	9.05
105										7.96	8.58	9.20	9.82

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0001019 * (DBH^1.67288) * (HT^0.963481).
** Total Volume (cu. m.) = Total volume in cubic meters based on DBH and total tree height.

Table C18. Young growth Douglas-fir standard volume table for total volume in cubic meters based on DBH and total tree height.

CANYON LIVE OAK
Boggs Mountain Demonstration State Forest

LOCAL VOLUME TABLES

ENGLISH

DBH (in)	Utilization Standards* TVOL (cu. ft.)	WVOL (cu. ft.)	SVOL (cu. ft.)
5	1	0	0
6	2	1	1
7	5	3	3
9	10	7	5
11	16	11	9
13	24	17	14
15	34	25	20
17	46	35	27
19	60	47	36
21	76	61	47
23	95	78	59
25	116	97	73
27	140	118	89
29	167	144	107
31	196	171	127
33	228	202	149
35	262	236	173

METRIC

DBH (cm)	Utilization Standards* TVOL (cu. m.)	WVOL (cu. m.)	SVOL (cu. m.)
10	0.04	0.02	0.02
15	0.10	0.06	0.05
20	0.20	0.13	0.11
25	0.35	0.23	0.19
30	0.54	0.38	0.31
35	0.78	0.57	0.45
40	1.08	0.81	0.64
45	1.43	1.11	0.86
50	1.85	1.46	1.12
55	2.33	1.88	1.43
60	2.87	2.37	1.79
65	3.49	2.92	2.20
70	4.17	3.55	2.65
75	4.93	4.27	3.16
80	5.76	5.06	3.73
85	6.67	5.94	4.35
90	7.66	6.90	5.03

*** Utilization Standards:**

TVOL = Total Volume: all stem and branch wood plus stump and bark; excludes foliage and roots.
Volume (cu. ft.) = 0.0487933 * (DBH^2.41617); Volume (cu. m.) = 0.0001453 * (DBH^2.41617).

WVOL = Wood Volume: all stem and branch wood to a 4" top (10 cm); excludes stump, bark, foliage and roots
Volume (cu. ft.) = 0.0197719 * (DBH^2.64068); Volume (cu. m.) = 0.0000477 * (DBH^2.64068).

SVOL = Saw-log Volume: all wood inside bark to a 9" (23 cm) top for segments > 8 ft. (2.5 m) for all tree 11" (28 cm) dbh and larger; excludes stump foliage and roots.
Volume (cu. ft.) = 0.0199618 * (DBH^2.54959); Volume (cu. m.) = 0.0000524 * (DBH^2.54959).

Table C19. Canyon live oak local volume tables for Total Volume, Wood Volume, and Saw-log Volume in both cubic feet and cubic meters.

CANYON LIVE OAK
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Total Volume (cu. ft.) **

DBH (in)	Total Height (feet) 10	20	30	40	50	60	70	80	90	100	110
3	0	1	1	1	1	1	1				
5	1	2	2	3	3	3	4				
7	3	4	5	6	7	7	8	8			
9	5	7	9	10	11	12	13	14	15		
11	7	11	13	15	17	19	21	22	23	25	
13	11	15	19	22	25	27	29	32	34	35	
15		21	26	30	34	37	40	43	46	48	
17		27	34	39	44	48	52	56	60	63	66
19		35	43	50	56	61	66	71	76	80	84
21			53	62	69	76	82	88	94	99	104
23			64	75	84	92	100	107	114	121	127
25					101	111	120	128	136	144	151
27					119	130	141	151	161	170	179
29					138	152	165	177	188	198	208
31					160	175	190	204	217	229	240
33					182	201	217	233	248	262	275
35						229	247	264	281	297	312

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0131571 * (DBH^2.14573) * (HT^0.52009).
** Total Volume (cu. ft.) = all stem and branch wood plus stump and bark; excludes foliage and roots.

Table C20. Canyon live oak standard volume table for total volume in cubic feet based on DBH and total tree height.

CANYON LIVE OAK

Boggs Mountain Demonstration State Forest

Standard Volume Table *

Wood Volume (cu. ft.) **

DBH (in)	Tree Height (feet)										
	10	20	30	40	50	60	70	80	90	100	110
3	0	0	0	1	1	1	1				
5	1	1	1	2	2	2	2				
7	2	2	3	4	4	5	5	6			
9	3	4	6	7	8	9	10	10	11		
11	4	7	9	11	12	14	15	17	18	19	
13	6	10	13	16	18	20	22	24	26	28	
15		14	18	22	25	28	31	34	37	39	
17		18	24	29	33	37	41	45	49	52	56
19		24	31	37	43	48	54	58	63	68	72
21			39	47	54	61	67	74	79	85	90
23			48	58	67	75	83	91	98	105	112
25					81	91	101	110	119	127	135
27					97	109	120	131	142	152	161
29					114	128	142	155	167	179	190
31					133	149	165	180	195	208	222
33					153	173	191	208	225	241	256
35						198	218	238	257	276	293

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 0.0038325 * (DBH^2.30212) * (HT^0.45109).

** Wood Volume (cu. ft.) = all stem and branch wood to a 4" (10 cm) top, excludes stump and bark; excludes foliage and roots.

Table C21. Canyon live oak standard volume table for wood volume in cubic feet based on DBH and total tree height.

CANYON LIVE OAK
Boggs Mountain Demonstration State Forest

***Standard* Volume Table ***
Saw-log Volume (cu. ft.) **

DBH	Tree Height (feet)										
(in)	10	20	30	40	50	60	70	80	90	100	110
3	0	0	0	1	1	1	1				
5	1	1	1	2	2	2	3				
7	1	2	3	3	4	5	5	6			
9	2	3	5	6	7	8	9	10	11		
11	3	5	7	9	10	12	13	15	16	18	
13	4	7	10	12	15	17	19	21	23	25	
15		10	13	17	20	23	26	29	31	34	
17		12	17	21	26	30	33	37	41	44	48
19		16	22	27	32	37	42	47	51	56	60
21			26	33	40	46	52	58	63	69	74
23			32	40	48	55	63	70	76	83	90
25					57	66	74	83	91	99	107
27					67	77	87	97	107	116	125
29					78	90	101	113	124	135	145
31					89	103	117	130	142	155	167
33					102	118	133	148	162	176	190
35						133	150	167	183	199	215

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0031659 * (DBH^2.08229) * (HT^0.79159).
** Saw-log Volume (cu. ft.) = all wood inside bark to a 9" (23 cm) top for segments > 8 ft. (2.5 m) for all trees 11" (28 cm) dbh and larger; excludes stump foliage and roots.

Table C22. Canyon live oak standard volume table for saw-log volume in cubic feet based on DBH and total tree height.

CANYON LIVE OAK
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Total Volume (cu. m.) **

DBH (cm)	Total Height (meters)										
	3	6	9	12	15	18	21	24	27	30	33
10	0.02	0.03	0.04	0.05	0.05	0.06	0.06				
15	0.06	0.08	0.10	0.11	0.13	0.14	0.15				
20	0.10	0.15	0.18	0.21	0.24	0.26	0.28	0.30			
25	0.17	0.24	0.29	0.34	0.38	0.42	0.46	0.49	0.52		
30	0.24	0.35	0.43	0.50	0.56	0.62	0.67	0.72	0.77	0.81	
35	0.34	0.49	0.60	0.70	0.79	0.86	0.94	1.00	1.07	1.13	
40		0.65	0.80	0.93	1.05	1.15	1.25	1.34	1.42	1.50	
45		0.84	1.03	1.20	1.35	1.48	1.61	1.72	1.83	1.93	2.03
50		1.06	1.30	1.51	1.69	1.86	2.01	2.16	2.29	2.42	2.55
55			1.59	1.85	2.07	2.28	2.47	2.65	2.82	2.97	3.13
60			1.92	2.23	2.50	2.75	2.98	3.18	3.39	3.58	3.77
65					2.97	3.26	3.54	3.79	4.03	4.26	4.47
70					3.48	3.83	4.15	4.44	4.72	4.99	5.24
75					4.03	4.44	4.81	5.15	5.48	5.79	6.08
80					4.63	5.10	5.52	5.92	6.29	6.65	6.98
85					5.28	5.80	6.29	6.74	7.17	7.57	7.95
90						6.56	7.11	7.62	8.10	8.56	8.99

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0000935 * (DBH^2.145731 * HT^0.520009).
** Total Volume (cu. m.) = all stem and branch wood plus stump and bark; excludes foliage and roots.

Table C23. Canyon live oak standard volume table for total volume in cubic meters based on DBH and total tree height.

CANYON LIVE OAK

Boggs Mountain Demonstration State Forest

Standard Volume Table *

Wood Volume (cu. m.) **

DBH (cm)	Tree Height (meters) 3	6	9	12	15	18	21	24	27	30	33
10	0.01	0.02	0.02	0.03	0.03	0.04	0.04				
15	0.03	0.05	0.06	0.07	0.08	0.09	0.10				
20	0.06	0.09	0.11	0.14	0.16	0.18	0.20	0.22			
25	0.09	0.15	0.19	0.23	0.27	0.30	0.33	0.36	0.39		
30	0.14	0.22	0.29	0.35	0.40	0.45	0.50	0.55	0.59	0.63	
35	0.20	0.32	0.41	0.50	0.58	0.65	0.72	0.78	0.84	0.90	
40		0.43	0.56	0.68	0.78	0.88	0.97	1.06	1.15	1.23	
45		0.56	0.74	0.89	1.03	1.15	1.28	1.39	1.50	1.61	1.71
50		0.72	0.94	1.13	1.31	1.47	1.63	1.78	1.92	2.05	2.18
55			1.17	1.41	1.63	1.83	2.03	2.21	2.39	2.56	2.72
60			1.43	1.72	1.99	2.24	2.48	2.70	2.92	3.12	3.32
65					2.39	2.69	2.98	3.25	3.51	3.76	4.00
70					2.84	3.19	3.53	3.85	4.16	4.45	4.74
75					3.32	3.74	4.14	4.51	4.87	5.22	5.55
80					3.86	4.34	4.80	5.24	5.65	6.06	6.44
85					4.43	4.99	5.52	6.02	6.50	6.96	7.41
90						5.70	6.30	6.87	7.42	7.94	8.45

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 0.0000275 * (DBH^2.30212) * (HT^0.651091).

** Wood Volume (cu. m.) = all stem and branch wood to 10 cm (4") top, excludes stump and bark; excludes foliage and roots.

Table C24. Canyon live oak standard volume table for wood volume in cubic meters based on DBH and total tree height.

CANYON LIVE OAK
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Saw-log Volume (cu. m.) **

DBH	Tree Height (meters)										
(cm)	3	6	9	12	15	18	21	24	27	30	33
10	0.01	0.02	0.02	0.03	0.03	0.04	0.04				
15	0.02	0.04	0.05	0.07	0.08	0.09	0.10				
20	0.04	0.07	0.10	0.12	0.14	0.17	0.19	0.21			
25	0.06	0.11	0.15	0.19	0.23	0.26	0.30	0.33	0.36		
30	0.09	0.16	0.22	0.28	0.33	0.39	0.44	0.49	0.53	0.58	
35	0.13	0.22	0.31	0.39	0.46	0.53	0.60	0.67	0.73	0.80	
40		0.30	0.41	0.51	0.61	0.70	0.80	0.88	0.97	1.05	
45		0.38	0.52	0.65	0.78	0.90	1.02	1.13	1.24	1.35	1.45
50		0.47	0.65	0.81	0.97	1.12	1.27	1.41	1.54	1.68	1.81
55			0.79	0.99	1.18	1.37	1.54	1.72	1.88	2.05	2.21
60			0.95	1.19	1.42	1.64	1.85	2.06	2.26	2.45	2.65
65					1.67	1.93	2.19	2.43	2.67	2.90	3.13
70					1.95	2.26	2.55	2.84	3.11	3.38	3.65
75					2.26	2.61	2.94	3.27	3.59	3.91	4.21
80					2.58	2.98	3.37	3.74	4.11	4.47	4.82
85					2.93	3.38	3.82	4.25	4.66	5.07	5.47
90						3.81	4.30	4.78	5.25	5.71	6.16

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0000329 * (DBH^2.08229) * (HT^0.79159).
** Saw-log Volume (cu. m.) = all wood inside bark to a 23 cm (9") top for segments > 2.5 m (8 ft.) for all trees 28 cm (11") dbh and larger; excludes stump foliage and roots.

Table C25. Canyon live oak standard volume table for saw-log volume in cubic meters based on DBH and total tree height.

BLACK OAK

Boggs Mountain Demonstration State Forest

LOCAL VOLUME TABLES

ENGLISH

DBH (in)	TVOL (cu. ft.)	WVOL (cu. ft.)	SVOL (cu. ft.)
	Utilization Standards*		
3	1	1	1
5	3	2	2
7	7	4	4
9	12	8	8
11	18	13	12
13	27	19	18
15	37	27	25
17	50	36	33
19	64	47	43
21	80	60	54
23	98	75	66
25	119	92	80
27	141	111	96
29	168	132	113
31	194	155	131
33	223	180	151
35	255	208	173

METRIC

DBH (cm)	TVOL (cu. m.)	WVOL (cu. m.)	SVOL (cu. m.)
	Utilization Standards*		
10	0.05	0.03	0.03
15	0.13	0.08	0.08
20	0.24	0.16	0.16
25	0.41	0.27	0.27
30	0.61	0.43	0.41
35	0.87	0.62	0.58
40	1.18	0.85	0.79
45	1.54	1.13	1.04
50	1.96	1.46	1.32
55	2.43	1.84	1.64
60	2.96	2.27	1.99
65	3.55	2.76	2.39
70	4.20	3.30	2.84
75	4.91	3.90	3.32
80	5.68	4.55	3.84
85	6.52	5.27	4.41
90	7.42	6.05	5.03

*** Utilization Standards:**

TVOL = Total Volume: all stem and branch wood plus stump and bark; excludes foliage and roots.
Volume (cu. ft.) = 0.0799467 * (DBH^2.26913); Volume (cu. m.) = 0.0002730 * (DBH^2.26913).

WVOL = Wood Volume: all stem and branch wood to a 4" top (10 cm); excludes stump, bark, foliage and roots
Volume (cu. ft.) = 0.0388177 * (DBH^2.41465); Volume (cu. m.) = 0.0001157 * (DBH^2.41465).

SVOL = Saw-log Volume: all wood inside bark to a 9" (23 cm) top for segments > 8 ft. (2.5 m) for all tree 11" (28 cm) dbh and larger; excludes stump foliage and roots.
Volume (cu. ft.) = 0.0519914 * (DBH^2.28068); Volume (cu. m.) = 0.0001756* (DBH^2.28068).

Table C26. Black oak local volume tables for Total Volume, Wood Volume, and Saw-log Volume in both cubic feet and cubic meters.

BLACK OAK
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Total Volume (cu. ft.) **

DBH	Total Height (feet)											
(in)	10	20	30	40	50	60	70	80	90	100	110	120
3	1	1	1	2	2	3						
5	1	2	3	4	5	6	7					
7	2	4	6	8	9	11	13	15				
9	3	6	9	12	14	17	20	22	25			
11	5	9	13	16	20	24	27	31	35			
13	6	12	17	22	27	31	36	41	46			
15		15	21	28	34	40	46	52	58			
17		18	26	34	42	49	57	64	72	79		
19		22	32	41	50	60	69	78	86	95		
21			37	49	60	70	81	92	102	112	123	133
23			43	57	69	82	94	107	119	131	143	155
25				65	80	94	109	123	137	151	164	178
27					91	107	124	140	156	171	187	203
29					102	121	139	158	176	193	211	229
31					115	135	156	176	196	216	236	256
33					127	150	173	196	218	240	262	284
35							191	216	241	265	289	313
37							210	237	264	291	318	344

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0099790 * (DBH^1.67821) * (HT^0.91852).
** Total Volume (cu. ft.) = all stem and branch wood plus stump and bark; excludes foliage and roots.

Table C27. Black oak standard volume table for total volume in cubic feet based on DBH and total tree height.

BLACK OAK
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Wood Volume (cu. ft.) **

DBH (in)	Tree Height (feet) 10	20	30	40	50	60	70	80	90	100	110	120
3	0	1	1	1	2	2						
5	1	1	2	3	4	5	6					
7	1	2	4	5	7	8	10	11				
9	2	4	6	8	10	12	15	17	20			
11	2	5	8	11	14	17	21	24	28			
13	3	7	10	15	19	23	27	32	37			
15		8	13	18	24	29	35	41	46			
17		10	16	23	29	36	43	50	57	65		
19		13	20	28	35	44	52	60	69	78		
21			23	33	42	52	62	72	82	92	103	114
23			27	38	49	60	72	83	95	107	120	132
25				44	56	69	82	96	110	124	138	152
27					64	79	94	109	125	141	157	173
29					72	89	106	123	141	159	177	195
31					81	99	118	138	158	178	198	218
33					90	110	132	153	175	197	220	243
35							145	169	193	218	243	268
37							159	184	212	239	266	294

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0029447 * (DBH^1.68211) * (HT^1.13585).
** Wood Volume (cu. ft.) = all stem and branch wood to a 4" top (10 cm); excludes stump, bark, foliage and roots.

Table C28. Black oak standard volume table for wood volume in cubic feet based on DBH and total tree height.

BLACK OAK
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Saw-log Volume (cu. ft.) **

DBH	Tree Height (feet)											
(in)	10	20	30	40	50	60	70	80	90	100	110	120
3	0	1	1	1	1	2						
5	1	1	2	3	3	4	5					
7	1	2	4	5	6	7	9	10				
9	2	4	5	7	9	11	13	15	17			
11	2	5	8	10	13	16	19	21	24			
13	3	7	10	14	17	21	25	28	32			
15		9	13	18	22	27	31	36	41			
17		11	16	22	27	33	39	44	50	56		
19		13	19	26	33	40	47	54	61	68		
21			23	31	39	47	55	64	72	80	89	97
23			27	36	46	55	65	74	84	94	103	113
25				42	52	63	74	85	97	108	119	130
27					60	72	85	97	110	123	136	148
29					67	82	96	110	124	139	153	167
31					76	91	107	123	139	155	171	187
33					84	101	119	137	155	172	190	208
35							132	151	171	191	210	230
37							145	166	188	209	231	253

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0038666 * (DBH^1.69402) * (HT^1.03846).
** Saw-log Volume (cu. ft.) = all wood inside bark to a 9" (23 cm) top for segments > 8 ft. (2.5 m) for all trees 11" (28 cm) dbh and larger; excludes stump foliage and roots.

Table C29. Black oak standard volume table for saw-log volume in cubic feet based on DBH and total tree height.

BLACK OAK

Boggs Mountain Demonstration State Forest

Standard Volume Table *

Total Volume (cu. m.) **

DBH	Total Height (meters)											
(cm)	3	6	9	12	15	18	21	24	27	30	33	36
10	0.02	0.04	0.06	0.08	0.10	0.12						
15	0.05	0.09	0.12	0.16	0.20	0.23	0.27					
20	0.07	0.14	0.20	0.26	0.32	0.38	0.44	0.50				
25	0.11	0.20	0.29	0.38	0.47	0.55	0.64	0.72	0.80			
30	0.15	0.27	0.40	0.52	0.64	0.75	0.87	0.98	1.09			
35	0.19	0.36	0.52	0.67	0.82	0.97	1.12	1.27	1.41			
40		0.45	0.65	0.84	1.03	1.22	1.40	1.59	1.77			
45		0.54	0.79	1.02	1.26	1.48	1.71	1.93	2.15	2.37		
50		0.63	0.94	1.22	1.50	1.77	2.04	2.31	2.57	2.83		
55			1.10	1.43	1.76	2.08	2.39	2.71	3.02	3.32	3.62	3.92
60			1.27	1.66	2.04	2.41	2.77	3.13	3.49	3.84	4.19	4.54
65				1.90	2.33	2.75	3.17	3.58	3.99	4.40	4.80	5.19
70					2.64	3.12	3.59	4.06	4.52	4.98	5.43	5.88
75					2.96	3.50	4.03	4.55	5.07	5.59	6.10	6.61
80					3.30	3.90	4.49	5.08	5.65	6.23	6.80	7.36
85					3.65	4.32	4.97	5.62	6.26	6.89	7.52	8.15
90							5.47	6.19	6.89	7.59	8.28	8.97
95							5.99	6.77	7.54	8.31	9.07	9.82

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 0.0001765 * (DBH^1.67821) * (HT^0.91652).

** Total Volume (cu. m.) = all stem and branch wood plus stump and bark; excludes foliage and roots.

Table C30. Black oak standard volume table for total volume in cubic meters based on DBH and total tree height.

BLACK OAK

Boggs Mountain Demonstration State Forest

Standard Volume Table *

Wood Volume (cu. m.) **

DBH	Tree Height (meters)											
(cm)	3	6	9	12	15	18	21	24	27	30	33	36
10	0.01	0.02	0.04	0.05	0.07	0.09						
15	0.02	0.05	0.08	0.11	0.14	0.17	0.20					
17	0.03	0.06	0.10	0.13	0.17	0.21	0.25	0.29				
19	0.03	0.07	0.12	0.16	0.21	0.25	0.30	0.35	0.40			
21	0.04	0.09	0.14	0.19	0.24	0.30	0.36	0.41	0.47			
23	0.05	0.10	0.16	0.22	0.28	0.35	0.42	0.48	0.55			
25		0.12	0.18	0.25	0.33	0.40	0.48	0.56	0.64			
27		0.13	0.21	0.29	0.37	0.46	0.54	0.63	0.72	0.82		
29		0.15	0.23	0.32	0.42	0.51	0.61	0.71	0.82	0.92		
31			0.26	0.36	0.47	0.58	0.69	0.80	0.91	1.03	1.15	1.27
33			0.29	0.40	0.52	0.64	0.76	0.89	1.01	1.14	1.27	1.41
35				0.45	0.57	0.71	0.84	0.98	1.12	1.26	1.41	1.55
37					0.63	0.78	0.92	1.08	1.23	1.39	1.54	1.70
39					0.69	0.85	1.01	1.18	1.34	1.51	1.69	1.86
41					0.75	0.92	1.10	1.28	1.46	1.65	1.84	2.03
43					0.81	1.00	1.19	1.39	1.58	1.78	1.99	2.20
45							1.28	1.50	1.71	1.93	2.15	2.37
47							1.38	1.61	1.84	2.07	2.31	2.55

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 0.0000670 * (DBH^1.68211) * (HT^1.13589).

** Wood Volume (cu. m.) = all stem and branch wood to a 10 cm top (4"); excludes stump, bark, foliage and roots.

Table C31. Black oak standard volume table for wood volume in cubic meters based on DBH and tree height.

BLACK OAK

Boggy Mountain Demonstration State Forest

Standard Volume Table *

Saw-log Volume (cu. m.) **

DBH	Tree Height (meters)											
(cm)	3	6	9	12	15	18	21	24	27	30	33	36
10	0.01	0.02	0.04	0.05	0.06	0.08						
15	0.02	0.05	0.07	0.10	0.13	0.15	0.18					
20	0.04	0.08	0.12	0.16	0.21	0.25	0.29	0.34				
25	0.06	0.12	0.18	0.24	0.30	0.36	0.43	0.49	0.55			
30	0.08	0.16	0.24	0.33	0.41	0.50	0.58	0.67	0.76			
35	0.10	0.21	0.31	0.42	0.53	0.64	0.76	0.87	0.98			
40		0.26	0.39	0.53	0.67	0.81	0.95	1.09	1.23			
45		0.31	0.48	0.65	0.82	0.99	1.16	1.33	1.50	1.67		
50		0.38	0.57	0.77	0.97	1.18	1.38	1.59	1.79	2.00		
55			0.67	0.91	1.15	1.38	1.62	1.87	2.11	2.35	2.60	2.84
60			0.78	1.05	1.33	1.60	1.88	2.16	2.44	2.73	3.01	3.29
65				1.21	1.52	1.84	2.16	2.48	2.80	3.12	3.45	3.77
70					1.72	2.08	2.44	2.81	3.17	3.54	3.91	4.28
75					1.94	2.34	2.75	3.16	3.57	3.98	4.39	4.81
80					2.16	2.61	3.06	3.52	3.98	4.44	4.90	5.36
85					2.39	2.89	3.40	3.90	4.41	4.92	5.43	5.94
90							3.74	4.30	4.86	5.42	5.98	6.55
95							4.10	4.71	5.32	5.94	6.56	7.18

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 0.00007752 * (DBH^1.69402) * (HT^1.03046).

** Saw-log Volume (cu. m.) = all wood inside bark to a 23 cm (9") top for segments > 2.5 m (8 ft.) for all trees 28 cm (11") dbh and larger; excludes stump foliage and roots.

Table C32. Black oak standard volume table for saw-log volume in cubic meters based on DBH and total tree height.

PACIFIC MADRONE
Boggs Mountain Demonstration State Forest

LOCAL VOLUME TABLES

ENGLISH

DBH (in)	TVOL (cu. ft.)	WVOL (cu. ft.)	SVOL (cu. ft.)
	Utilization Standards*		
3	1	1	0
5	3	2	1
7	6	4	3
9	11	8	6
11	17	14	10
13	25	21	15
15	35	30	23
17	48	41	32
19	62	54	43
21	78	70	57
23	97	88	73
25	118	109	92
27	142	132	113
29	168	159	137
31	197	188	165
33	228	220	195
35	263	256	229

METRIC

DBH (cm)	TVOL (cu. m.)	WVOL (cu. m.)	SVOL (cu. m.)
	Utilization Standards*		
10	0.04	0.03	0.02
15	0.11	0.08	0.05
20	0.22	0.16	0.11
25	0.37	0.29	0.20
30	0.57	0.46	0.34
35	0.82	0.68	0.51
40	1.12	0.96	0.74
45	1.49	1.29	1.02
50	1.91	1.68	1.35
55	2.38	2.14	1.75
60	2.93	2.67	2.22
65	3.54	3.27	2.76
70	4.22	3.95	3.38
75	4.97	4.70	4.08
80	5.79	5.54	4.87
85	6.69	6.46	5.74
90	7.65	7.47	6.71

*** Utilization Standards:**

TVOL = Total Volume: all stem and branch wood plus stump and bark; excludes foliage and roots.
Volume (cu. ft.) = 0.0583740 * (DBH^2.36581); Volume (cu. m.) = 0.0001822 * (DBH^2.36581).

WVOL = Wood Volume: all stem and branch wood to a 4" top (10 cm); excludes stump, bark, foliage and roots
Volume (cu. ft.) = 0.0310384 * (DBH^2.53585); Volume (cu. m.) = 0.0000827 * (DBH^2.53585)).

SVOL = Saw-log Volume: all wood inside bark to a 9" (23 cm) top for segments > 8 ft. (2.5 m) for all tree 11" (28 cm) dbh and larger; excludes stump foliage and roots.
Volume (cu. ft.) = 0.0143017 * (DBH^2.72298); Volume (cu. m.) = 0.0000320 * (DBH^2.72298).

Table C33. Pacific madrone local volume tables for Total Volume, Wood Volume, and Saw-log Volume in both cubic feet and cubic meters.

PACIFIC MADRONE

Boggs Mountain Demonstration State Forest

Standard Volume Table *

Total Volume (cu. ft.) **

DBH (in)	Total Height (feet)										
	10	20	30	40	50	60	70	80	90	100	110
3	0	1	1	1	2						
5	1	2	3	3	4	5	6				
7	2	3	5	6	8	9	11	12			
9	3	6	8	10	13	15	17	19	22		
11	4	8	12	15	18	22	25	28	31	34	
13		11	16	21	25	30	34	39	43	47	
15		14	21	27	33	39	45	50	56	62	
17		18	26	34	42	49	56	64	71	78	
19		22	32	42	51	60	69	78	87	96	
21			39	50	62	73	84	94	105	115	126
23			46	60	73	86	99	112	124	137	149
25				70	85	101	116	130	145	160	174
27					99	116	134	151	168	184	201
29					113	133	153	172	191	211	230

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 0.0061203 * (DBH^1.86664) * (HT^0.90347).

** Total Volume (cu. ft.) = all stem and branch wood plus stump and bark; excludes foliage and roots.

Table C34. Pacific madrone standard volume table for total volume in cubic feet based on DBH and total tree height.

PACIFIC MADRONE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Wood Volume (cu. ft.) **

DBH (in)	Tree Height (feet) 10	20	30	40	50	60	70	80	90	100	110
3	0	0	1	1	1						
5	1	1	2	3	3	4	5				
7	1	2	4	5	6	7	9	10			
9	2	4	6	8	10	12	14	17	19		
11	3	6	9	12	15	18	21	25	28	31	
13		8	12	16	21	25	30	34	38	43	
15		10	16	22	27	33	39	45	51	57	
17		13	20	28	35	42	50	57	65	73	
19		17	25	34	43	53	62	71	81	90	
21			31	42	53	64	75	87	98	110	121
23			37	50	63	76	90	104	117	131	145
25				59	74	90	106	122	138	154	171
27					86	105	123	142	160	179	198
29					99	120	141	163	184	206	228

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0022292 * (DBH^1.95295) * (HT^1.05581).
** Wood Volume (cu. ft.) = all stem and branch wood to a 4" (10 cm) top; excludes stump, bark, foliage and roots.

Table C35. Pacific madrone standard volume table for wood volume in cubic feet based on DBH and total tree height.

PACIFIC MADRONE

Boggs Mountain Demonstration State Forest

***Standard* Volume Table ***

Saw-log Volume (cu. ft.) **

DBH (in)	Tree Height (feet)										
	10	20	30	40	50	60	70	80	90	100	110
3	0	0	0	1	1						
5	0	0	1	2	3	3	5				
7	0	1	2	3	5	6	8	11			
9	0	1	3	5	7	10	13	17	21		
11	1	2	4	7	11	15	19	24	30	36	
13		3	6	10	14	20	26	33	41	49	
15		4	8	13	19	26	34	43	53	64	
17		5	10	16	24	33	43	54	67	81	
19		6	12	20	29	40	53	67	82	99	
21			14	24	35	48	63	80	98	119	140
23			17	28	41	57	75	95	116	140	166
25				32	48	66	87	110	136	163	193
27					55	76	100	127	156	188	223
29					63	87	114	145	178	214	254

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 0.0001304 * (DBH^1.83452) * (HT^1.76666).

** Saw-log Volume (cu. ft.) = all wood inside bark to a 9" (23 cm) top for segments > 8 ft. (2.5 m) for all trees 11" (28 cm) dbh and larger; excludes stump, foliage and roots.

Table C36. Pacific madrone standard volume table for saw-log volume in cubic feet based on DBH and total tree height.

PACIFIC MADRONE

Boggs Mountain Demonstration State Forest

Standard Volume Table *

Total Volume (cu. m.) **

DBH (cm)	Total Height (meters) 3	6	9	12	15	18	21	24	27	30	33
10	0.02	0.03	0.05	0.06	0.08						
15	0.04	0.07	0.10	0.13	0.16	0.19	0.22				
20	0.06	0.12	0.17	0.23	0.28	0.32	0.37	0.42			
25	0.10	0.18	0.26	0.34	0.42	0.49	0.57	0.64	0.71		
30	0.14	0.26	0.37	0.48	0.59	0.69	0.80	0.90	1.00	1.10	
35		0.34	0.49	0.64	0.78	0.92	1.06	1.20	1.33	1.46	
40		0.44	0.63	0.82	1.00	1.18	1.36	1.54	1.71	1.88	
45		0.55	0.79	1.02	1.25	1.48	1.70	1.91	2.13	2.34	
50		0.67	0.96	1.25	1.52	1.80	2.06	2.33	2.59	2.85	
55			1.15	1.49	1.82	2.15	2.47	2.78	3.10	3.40	3.71
60			1.35	1.75	2.14	2.52	2.90	3.27	3.64	4.01	4.37
65				2.03	2.49	2.93	3.37	3.80	4.23	4.65	5.07
70					2.85	3.37	3.87	4.37	4.86	5.34	5.82
75					3.25	3.83	4.40	4.97	5.52	6.07	6.62

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 0.0000889 * (DBH^1.86664) * (HT^0.90147).

** Total Volume (cu. m.) = all stem and branch wood plus stump and bark; excludes foliage and roots.

Table C37. Pacific madrone standard volume table for total volume in cubic meters based on DBH and total tree height.

PACIFIC MADRONE

Boggs Mountain Demonstration State Forest

Standard Volume Table *

Wood Volume (cu. m.) **

DBH (cm)	Tree Height (meters) 3	6	9	12	15	18	21	24	27	30	33
10	0.01	0.02	0.03	0.04	0.06						
15	0.02	0.05	0.07	0.10	0.12	0.15	0.18				
20	0.04	0.08	0.13	0.17	0.22	0.26	0.31	0.36			
25	0.06	0.13	0.20	0.26	0.33	0.41	0.48	0.55	0.62		
30	0.09	0.18	0.28	0.38	0.48	0.58	0.68	0.78	0.89	0.99	
35		0.25	0.38	0.51	0.65	0.78	0.92	1.06	1.20	1.34	
40		0.32	0.49	0.66	0.84	1.02	1.20	1.38	1.56	1.74	
45		0.40	0.62	0.83	1.06	1.28	1.50	1.73	1.96	2.19	
50		0.49	0.76	1.02	1.30	1.57	1.85	2.13	2.41	2.69	
55			0.91	1.23	1.56	1.89	2.23	2.56	2.90	3.24	3.59
60			1.08	1.46	1.89	2.24	2.64	3.04	3.44	3.85	4.25
65				1.71	2.16	2.62	3.09	3.55	4.02	4.50	4.97
70					2.50	3.03	3.57	4.11	4.65	5.20	5.75
75					2.86	3.47	4.08	4.70	5.32	5.95	6.57

NOTES:

Black line indicates range of data.

* Standard Volume Table developed from the following equation: Volume = 0.0000358* (DBH^1.95295) * (HT^1.05501).

** Wood Volume (cu. m.) - all stem and branch wood to a 10 cm (4") top; excludes stump, bark, foliage and roots.

Table C38. Pacific madrone standard volume table for wood volume in cubic meters based on DBH and total tree height.

PACIFIC MADRONE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Saw-log Volume (cu. m.) **

DBH (cm)	Tree Height (feet) 3	6	9	12	15	18	21	24	27	30	33
10	0.00	0.01	0.02	0.03	0.04						
15	0.01	0.02	0.04	0.06	0.09	0.13	0.17				
20	0.01	0.03	0.07	0.11	0.16	0.22	0.29	0.37			
25	0.01	0.05	0.10	0.16	0.24	0.33	0.44	0.55	0.68		
30	0.02	0.07	0.14	0.23	0.34	0.47	0.61	0.77	0.95	1.15	
35		0.09	0.18	0.30	0.45	0.62	0.81	1.03	1.26	1.52	
40		0.11	0.23	0.39	0.57	0.79	1.04	1.31	1.61	1.95	
45		0.14	0.29	0.48	0.71	0.98	1.29	1.63	2.00	2.41	
50		0.17	0.35	0.58	0.86	1.19	1.56	1.97	2.43	2.93	
55			0.42	0.69	1.03	1.41	1.86	2.35	2.90	3.49	4.13
60			0.49	0.81	1.20	1.66	2.18	2.76	3.40	4.09	4.84
65				0.94	1.39	1.92	2.52	3.20	3.93	4.74	5.61
70					1.60	2.20	2.89	3.66	4.51	5.43	6.43
75					1.81	2.50	3.28	4.15	5.12	6.16	7.29

NOTES:
Black line indicates range of data.
* Standard Volume Table developed from the following equation: Volume = 0.0000055 * (DBH^1.83452) * (HT^1.76666).
** Saw-log Volume (cu. m.) = all wood inside bark to a 23 cm (9") top for segments > 2.5 m (8 ft.) for all trees 11" (28 cm) dbh and larger; excludes stump foliage and roots.

Table C39. Pacific madrone standard volume table for saw-log volume in cubic feet based on DBH and total tree height.

APPENDIX D

Summary of Sample Tree Data

Tree Number	Dbhob (inches)	Total Height (feet)	Smalians Volume (cu. ft.)	Scribners Volume (bd. ft.)	Int'l 1/4" Volume (bd. ft.)
1	22.0	119.7	76.83	310.30	343.49
2	28.0	130.6	167.34	851.21	923.07
3	16.9	83.0	40.45	139.98	164.76
4	12.2	72.5	20.85	56.00	66.00
5	15.4	99.1	42.40	166.00	192.00
6	27.2	128.3	130.77	632.37	694.75
7	17.3	92.8	56.59	263.00	297.00
9	22.8	124.7	117.93	638.00	702.00
10	23.6	106.0	98.38	471.34	521.19
11	12.6	86.6	23.66	56.00	66.00
12	12.2	82.3	18.43	29.52	30.46
13	21.7	97.8	75.54	308.24	344.52
14	25.6	109.6	107.83	520.89	573.88
15	16.5	79.4	48.32	184.36	214.35
16	28.0	120.7	143.51	731.47	791.86
17	33.9	121.7	259.91	1558.32	1654.51
18	29.1	128.0	178.69	975.09	1061.50
19	14.2	89.2	28.81	71.85	82.11
20	31.5	128.0	220.75	1272.38	1368.34
21	18.9	113.2	66.54	315.46	357.96
22	19.7	90.6	70.49	315.46	350.72
23	16.1	69.9	32.81	117.27	132.74
24	24.0	93.2	92.64	434.17	476.76
25	13.8	46.6	21.81	82.17	92.45
26	15.0	81.4	31.71	112.11	125.51
27	21.3	107.3	92.56	454.82	504.66
28	17.3	87.9	46.96	179.20	201.96
29	12.2	52.8	12.72	25.39	30.46
30	19.7	83.7	79.85	365.01	404.45
31	14.6	66.6	30.45	117.27	132.74
32	16.9	92.8	49.20	195.72	223.65
33	28.7	126.0	178.91	978.18	1063.57
34	18.9	97.1	56.62	223.59	248.45
35	15.4	71.5	38.19	135.85	158.57
36	25.2	99.4	141.84	726.31	789.80
37	36.6	150.3	385.55	2445.04	2593.61
38	20.5	106.3	88.63	444.50	492.26
39	18.1	93.2	70.81	319.59	357.96
40	20.9	93.8	90.49	421.79	469.53
41	29.5	111.9	179.82	1007.09	1084.23
42	26.4	107.6	133.98	708.76	769.13
43	24.4	107.0	117.15	592.11	654.46
44	24.8	109.9	112.31	537.40	592.47
45	22.8	100.4	87.00	398.05	438.54
46	24.4	106.6	111.24	573.00	628.00
47	28.7	139.8	223.33	1313.00	1411.00
48	18.9	97.4	67.64	330.00	373.00
49	20.1	116.1	94.63	478.00	537.00
50	22.8	130.6	109.09	559.08	621.40

Notes:
Tree number 8 not used.
Standard Volume Table Outliers - Smalians, tree 29; Scribners and Int'l 1/4", trees 12 and 29.
Local Volume Table Outliers - Smalians, tree 12; Scribners and Int'l 1/4", trees 12 and 29.

Table D1. Sample tree data for ponderosa pine at Boggs Mountain Demonstration State Forest.

YOUNG GROWTH SUGAR PINE
Sample Tree data

Tree Number	Dbhob (inches)	Total Height (feet)	Number of logs and 1/2 log	Smalians Volume (cu. ft.)	Scribners Volume (bd. ft.)	Int'l 1/4" Volume (bd. ft.)
1	15.8	68	1.5	28.4	86	97
2	14.2	80	2.0	31.7	107	126
3	11.0	65	1.0	17.2	45	53
4	13.4	81	1.0	25.9	72	82
5	33.1	107	4.5	166.4	883	951
6	25.6	113	4.5	123.0	611	668
7	24.0	105	4.0	97.4	414	461
8	18.9	110	3.0		277	311
9	20.5	87	2.5	56.5	227	257
10	26.8	97	4.0	128.3	605	660
11	18.9	76	1.0	36.8	120	133
12	26.0	97	3.5	105.2	470	520
13	29.5	105	4.0	171.1	844	909
14	19.7	94	2.5	65.1	287	320
15	16.1	83	2.0	45.6	197	220
16	33.9	130	6.0	236.5	1323	1421
17	21.3	80	2.5	59.7	224	248
18	39.0	108	5.5	291.4	1711	1814
19	11.0	53	0.5	11.7		
20	18.1	75	2.0	44.7	163	184
21	24.0	97	3.5	85.3	331	367
22	15.0	61	1.5	31.8	112	126
23	18.9	69	2.0	49.5	193	215
24	31.5	99	4.0	167.9	902	969
25	29.1	116	4.5	191.9	1059	1137
26	13.0	45	1.0	21.3		
27	14.6	72	1.5	29.8	106	119
28	18.9	85	1.5	44.2	158	177
29	16.5	77	2.5	41.8	164	186
30	11.8	59	0.5	16.7	37	41
31	20.9	99	4.0	84.0	394	441
32	13.8	69	1.5	26.8	98	113
33	24.8	90	3.5	121.1	581	631
34	47.6	125	6.0	435.3	2579	2710
35	30.3	113	5.5	204.2	1147	1230
36	24.8	113	4.5	108.1	538	595
37	28.0	118	4.5	142.6	690	750
38	14.2	74	1.0	26.5	68	78
39	17.3	66	1.5	34.8	121	139
40	22.8	109	4.5	103.2	515	570
41	20.5	107	4.0	84.5	372	418
42	29.9	103	4.5	163.2	842	907
43	24.4	89	3.5	90.5	377	417
44	26.0	97	4.0	106.6	484	535

Notes:
Standard Volume Table Outliers - Smalians, tree 8; Scribners and Int'l 1/4", trees 19 and 26.
Local Volume Table Outliers - Smalians, tree 8; Scribners and Int'l 1/4", trees 19 and 26.

Table D2. Sample tree data for sugar pine at Boggs Mountain Demonstration State Forest.

YOUNG GROWTH DOUGLAS-FIR
Sample Tree data

Tree Number	Dbhob (inches)	Total Height (feet)	Number of logs and 1/2 logs	Smalians Volume (cu. ft.)	Scribners Volume (bd. ft.)	Int'l 1/4" Volume (bd. ft.)
1	20	101	3.0	60.7	236	269
2	25	101	4.0	96.0	441	490
3	29	93	3.5	102.7	434	481
4	33	107	4.0	149.8	763	825
5	28	95	4.0	108.6	514	567
6	14	68	1.5	28.7	106	119
7	15	67	1.0	24.2	41	
8	12	61	0.5	13.1	19	
9	20	85	2.5	57.7	255	282
10	13	67	0.5	17.8	41	
11	28	95	3.0	108.5	456	498
12	24	119	4.5	104.1	499	550
13	25	118	4.5	123.4	637	698
14	22	110	4.0	89.3	430	479
15	15	75	2.5	32.5	129	148
16	17	87	2.5	44.7	185	212
17	32	125	4.5	158.5	782	852
18	21	91	3.5	80.7	382	420
19	13	61	1.5	27.5	112	126
20	22	80	3.0	67.9	292	327
21	20	78	2.5	52.3	238	265
22	16	57	1.0	27.0	86	97
23	35	109	5.5	213.7	1159	1242
24	27	98	4.0	119.0	577	630
25	19	84	3.5	57.9	267	302
26	15	71	1.5	28.2	90	102
27	14	73	1.5	29.3	117	133
28	28	105	4.0	137.7	716	776
29	23	98	4.0	90.2	391	436
30	24	102	4.5	109.8	529	582
31	12	64	1.5	22.4	83	99
32	20	95	3.5	68.1	311	348
33	19	88	2.5	50.9	185	212
34	19	91	3.0	62.4	287	323
35	15	67	1.5	27.1	83	99
36	20	88	3.0	59.5	254	288
37	34	129	6.0	322.1	1959	2075
38	23	91	3.5	78.9	386	427
39	14	66	1.5	31.0	122	141
40	14	81	1.5	26.7	86	99
41	22	106	4.0	90.5	456	505
42	18	68	1.5	36.8	139	158
43	16	62	1.5	31.0	112	126
44	19	64	2.0	43.9	188	211
45	17	80	2.0	46.9	207	232
46	25	92	3.5	83.5	350	387
47	31	122	5.5	178.6	949	1026
48	22	104	4.5	100.5	531	585
49	30	114	4.5	152.2	756	822
50	20	105	3.5	70.1	298	338
51	22	101	4.0	91.5	441	490

Notes:
Standard Volume Table Outliers - Smalians, tree 37; Int'l 1/4", trees 7, 8, 10, and 37.
Local Volume Table Outliers - Smalians, tree 37; Int'l 1/4", trees 7, 8, & 10.

Table D3. Sample tree data for Douglas-fir at Boggs Mountain Demonstration State Forest.

CANYON LIVE OAK
Sample Tree Data

Tree No.	DBHob (inches)	Total Height (feet)	Total Volume (cu. ft.)	Wood Volume (cu. ft.)	Saw-log Volume (cu. ft.)
1	11.8	33	11.8	7.1	0.0
2	15.8	60	30.8	22.6	17.7
3	13.0	46	18.7	13.8	12.7
4	4.7	31			
5	5.5	26	3.5	1.8	0.0
6	9.1	38	10.8	7.1	0.0
7	7.9	32	5.5	3.2	0.0
8	6.7	39	4.8	2.8	0.0
9	10.6	44	11.8	8.5	0.0
10	16.9	45	48.7	36.4	26.5
11	6.7	35	5.2	3.2	0.0
12	17.7	48	55.4	44.1	27.2
13	12.2	35	23.5	18.2	12.1
14	8.7	32	7.7	5.3	0.0
15	15.0	42	27.8	19.4	13.4
16	19.7	56	67.2	50.2	37.4
17	12.2	45	17.3	12.4	7.4
18	23.6	65	84.9	67.1	49.8
19	13.4	35	20.3	15.2	10.2
20	6.7	30	5.2	3.2	0.0
21	7.1	37	5.6	3.5	0.0
22	9.5	38	13.2	9.5	0.0
23	11.0	38	14.7	10.6	7.1
24	9.8	50	9.0	5.7	0.0
25	11.4	42			17.7
26	13.8	47	34.3	26.1	22.6
27	7.9	53	11.1	8.5	0.0
28	14.6	50	25.1	18.4	13.4
29	13.4	72	40.2	31.8	27.6
30	16.5	57	56.9	44.5	34.6
31	10.2	39	15.6	11.3	0.0
32	15.4	68	36.2	25.8	22.3
33	15.4	80	45.0	35.7	28.3
34	21.7	63	123.8	100.3	63.6
35	7.5	38	6.1	4.2	0.0
36	26.0	65	123.1	99.2	90.4

NOTES:
Standard Volume Table Outliers - Total and Wood Volumes, Trees 4 and 25.
Local Volume Table Oultiers - Total and Wood Volumes, Trees 4 and 25.

Table D4. Sample tree data for canyon live oak at Boggs Mountain Demonstration State Forest.

BLACK OAK
Sample Tree Data

Tree No.	DBHob (inches)	Total Height (feet)	Total Volume (cu. ft.)	Wood Volume (cu. ft.)	Saw-log Volume (cu. ft.)
1	9.8	41	22.5	17.0	0.0
2	12.6	58	29.8	20.6	19.1
3	13.0	47	21.9	14.8	12.4
4	13.4	59	36.6	27.1	26.5
5	17.3	67	57.5	40.5	26.5
6	9.1	37			0.0
7	12.2	56	22.5	16.4	14.5
8	9.1	44	10.1	6.9	0.0
9	7.5	33	6.5	4.4	0.0
10	15.7	50	29.3	21.1	19.8
11	17.3	51	48.3	36.0	33.2
12	14.6	42	25.7	17.8	13.8
13	12.6	75	34.7	25.2	20.1
14	11.0	52	25.1	19.0	17.3
15	13.8	47	30.2	22.2	17.0
16	7.5	23			0.0
17	8.7	39	11.8	7.2	0.0
18	6.7	26	5.3	2.7	0.0
19	9.8	60	19.9	14.5	0.0
20	13.8	46	33.2	24.4	21.2
21	5.5	34	6.8	4.5	0.0
22	11.4	39	13.1	8.9	8.5
23	12.6	45	27.6	19.6	16.6
24	7.5	23	5.8	3.1	0.0
25	9.8	40	14.0	9.7	0.0
26	16.5	49	67.7	51.4	38.5
27	8.3	33			0.0
28	15.0	59	43.0	32.5	27.2
29	9.8	40	10.3	7.3	0.0
30	11.4	61	28.1	20.2	16.6
31	26.4	63	87.1	61.8	51.6
32	15.4	43	20.8	13.5	0.0
33	18.9	68	42.0	28.8	16.2
34	32.3	88	187.4	145.7	139.1
35	20.9	66	57.5	43.9	40.3
36	5.5	28	2.0	1.1	0.0
37	5.9	28	5.2	3.5	0.0
38	7.1	36	6.9	4.8	0.0
39	19.3	67	75.2	57.5	51.2
40	23.2	80	169.2	131.2	122.5
41	18.5	71	57.2	42.8	39.6
42	27.2	92	186.5	145.4	129.6
43	15.0	77	49.3	38.0	37.4
44	8.3	45	7.5	5.1	0.0
45	9.4	49	15.5	11.0	0.0
46	14.2	44	39.7	28.7	26.8
47	27.6	87	155.0	119.4	109.8

NOTES:
Standard Volume Table Outliers - Total and Wood Volumes, Trees 6, 16, 27.
Local Volume Table Oultiers - Total and Wood Volumes, Trees 6, 16, 27.

Table D5. Sample tree data for black oak at Boggs Mountain Demonstration State Forest.

PACIFIC MADRONE
Sample Tree Data

Tree No.	DBHob (inches)	Total Height (feet)	Total Volume (cu. ft.)	Wood Volume (cu. ft.)	Saw-log Volume (cu. ft.)
1	16.9	53.8	50.3	41.6	31.8
2	14.2	44.6	29.4	24.2	17.7
3	15.4	43.0	28.6	24.0	13.8
4	11.4	26.3	10.8	8.2	0.0
5	10.6	27.2	11.8	8.9	0.0
6	11.8	40.7	11.5	8.9	5.7
7	7.5	39.0	12.7	9.3	0.0
8	9.1	38.4	10.4	7.5	0.0
9	4.3	21.3	1.7	1.0	0.0
10	10.6	41.3	16.7	12.9	0.0
11	13.0	48.9	34.5	29.3	22.3
12	7.1	36.4	5.7	4.2	0.0
13	8.3	37.1	7.7	6.3	0.0
14	19.7	59.7	51.7	43.3	36.7
15	17.3	62.0	57.0	49.8	40.3
16	14.6	71.9	47.6	41.8	28.6
17	11.0	65.0	26.8	23.4	18.0
18	6.7	48.9	4.7	3.6	0.0
19	9.1	58.4	16.9	14.7	0.0
20	11.8	44.3	28.8	25.2	17.3
21	15.8	64.6	26.2	22.3	15.5
22	20.9	70.5	81.4	71.1	65.0
23	12.2	48.2	16.1	12.8	7.1
24	9.1	37.1	9.1	6.4	0.0
25	15.0	73.8	68.8	61.3	49.1
26	18.5	65.9	57.9	50.5	45.9
27	9.8	37.7	13.5	10.7	0.0
28	5.9	36.4	3.3	2.1	0.0
29	6.3	26.9	3.3	2.5	0.0
30	10.2	52.2	13.8	11.3	0.0
31	7.9	49.5	10.9	9.0	0.0
32	5.5	36.1	3.5	2.7	0.0
33	16.1	53.8	32.7	27.8	22.6
34	17.7	54.5	36.0	29.9	24.4
35	18.9	66.9	90.7	80.5	71.3

NOTES:
Standard Volume Table Outliers - No outliers.
Local Volume Table Oultiers - No outliers.

Table D6. Sample tree data for Pacific madrone at Boggs Mountain Demonstration State Forest.

APPENDIX E

Root Mean Squared Error and
Aggregate Difference Tests

PONDEROSA PINE
Boggs Mtn. Demonstration State Forest

Tree No.	DBH (inches)	Total Ht (feet)	Local (cubic feet) Estimated (cu. ft.)	Local (cubic feet) Actual (cu. ft.)	Local (cubic feet) Squared Difference	Local (Scribner board feet) Estimated (cu. ft.)	Local (Scribner board feet) Actual (cu. ft.)	Local (Scribner board feet) Squared Difference	Standard (cubic feet) Estimated (cu. ft.)	Standard (cubic feet) Actual (cu. ft.)	Standard (cubic feet) Squared Difference	Standard (Scribner board feet) Estimated (cu. ft.)	Standard (Scribner board feet) Actual (cu. ft.)	Standard (Scribner board feet) Squared Difference
1	22.0	118.7	81.99	77.01	188.13	421.02	310.87	12311.30	87.43	77.03	416.83	450.57	310.87	19348.32
2	28.0	130.8	146.04	167.72	3.75	904.53	855.53	2550.63	172.38	167.72	19.09	890.43	855.53	6364.13
3	16.8	82.6	46.69	40.56	37.58	180.22	139.69	1656.83	45.59	40.56	25.38	178.92	139.69	1402.54
4	12.2	72.5	22.40	20.85	6.22	63.83	56.00	46.71	20.46	20.05	0.06	64.07	56.00	65.11
5	15.4	99.1	36.81	42.40	35.21	131.60	164.00	1183.21	39.85	42.48	4.50	143.84	166.00	491.17
6	27.2	128.3	134.48	131.27	340.04	826.38	635.22	38046.40	140.14	131.87	849.32	853.79	636.22	47377.40
7	17.3	92.9	48.48	56.59	50.53	194.07	263.00	4751.80	50.51	56.59	36.26	198.82	263.00	4119.60
8	22.9	124.7	99.55	117.93	337.91	472.40	638.00	27433.92	107.35	117.93	111.64	507.63	638.00	17001.02
10	23.6	106.0	108.46	98.45	97.13	526.89	473.09	2894.89	107.30	98.45	75.55	521.43	473.09	2354.61
11	12.6	86.6	22.11	23.66	2.42	68.60	56.00	184.91	24.05	23.66	0.15	76.04	56.00	401.33
12	12.2	82.3	20.48	18.49	3.95	62.59	28.38	1192.97	21.82	18.49	11.11	67.78	28.38	1506.81
13	21.7	97.9	87.03	75.72	127.95	398.14	404.89	7965.58	85.14	75.72	88.73	395.38	308.89	6640.46
14	25.4	109.4	132.41	108.99	611.45	681.81	522.97	25329.88	130.25	108.99	891.36	668.86	522.97	21282.80
15	18.5	79.4	43.98	48.44	19.85	167.57	184.18	382.72	42.28	48.44	38.79	161.95	184.18	494.13
16	28.0	120.7	168.86	143.85	489.44	908.03	734.88	28359.98	165.80	143.85	488.24	893.58	734.88	38827.88
17	23.8	121.7	269.71	268.49	84.96	1879.56	1547.41	12538.20	256.14	268.49	38.46	1887.49	1547.41	403.42
18	28.1	138.0	184.40	178.10	28.05	1035.20	980.24	3020.31	186.91	178.10	61.93	1046.32	980.24	4353.53
19	14.2	88.2	26.78	28.89	0.79	101.70	70.98	948.38	31.75	28.89	8.20	108.70	70.98	1428.56
20	31.5	128.0	224.42	221.26	11.14	1336.42	1279.54	2699.10	222.34	221.26	1.16	1333.83	1279.54	1176.94
21	18.8	113.2	61.81	66.70	25.33	258.83	314.16	3020.03	67.38	66.70	0.38	279.82	326.16	1301.68
22	18.7	90.4	68.38	75.60	5.18	292.92	316.16	568.53	66.84	70.86	17.81	285.65	326.16	831.06
23	16.1	89.9	41.35	52.90	72.08	154.60	116.63	1441.50	37.84	32.90	24.43	142.66	116.63	677.60
24	24.0	93.2	113.16	92.86	489.62	555.70	435.48	14406.31	106.93	92.86	143.25	517.16	435.48	6438.68
25	13.8	46.6	27.73	21.88	96.28	83.88	81.30	134.18	22.01	21.88	0.02	72.13	81.30	38.32
26	15.0	97.8	34.15	31.80	5.52	121.64	111.49	92.32	37.38	31.88	31.14	130.54	111.49	445.55
27	21.3	107.0	83.08	92.78	93.98	375.30	456.46	6387.80	85.35	82.78	55.08	389.51	456.46	5834.68
28	12.2	52.8	20.46	12.76	58.40	63.83	24.14	1487.37	17.82	12.76	25.58	55.70	24.14	896.06
30	18.7	83.7	68.38	80.04	136.09	292.92	366.05	5348.41	84.00	80.04	256.38	275.83	366.05	8138.85
31	14.8	68.8	31.82	30.53	1.52	111.08	118.83	30.80	29.84	30.53	1.20	103.47	118.83	173.11
32	16.8	92.8	46.69	38.33	8.87	180.22	195.41	236.82	48.05	49.33	1.46	185.90	195.41	94.32
33	28.7	134.0	178.16	176.32	1.34	990.82	983.36	55.71	180.03	178.32	0.50	998.58	983.36	231.85
34	18.9	97.1	81.83	84.76	24.09	356.83	223.67	1099.83	82.68	84.76	35.23	361.58	223.67	1436.89
35	10.4	71.0	36.81	38.29	3.31	131.60	130.34	15.96	36.28	38.28	16.58	124.54	130.34	116.38
36	25.2	99.4	127.72	142.17	209.26	648.41	789.78	8589.28	120.24	142.17	881.16	613.90	789.78	13801.44
37	36.6	150.3	338.71	386.42	2323.08	2149.89	2460.11	89533.30	325.14	386.42	3629.26	2189.96	2460.11	72983.35
38	25.5	106.3	75.51	68.30	51.98	332.35	446.07	12832.57	78.14	68.30	96.71	343.88	446.07	10447.59
39	18.1	99.2	86.91	78.98	243.78	223.98	320.32	8589.50	55.92	70.98	226.90	224.74	320.32	8757.57
40	20.8	83.8	79.24	88.70	131.29	353.37	423.21	4836.18	76.91	80.78	199.29	344.83	423.21	6068.52
41	29.5	111.8	190.37	182.23	111.04	1092.92	1022.45	4687.98	180.87	180.23	0.41	1025.37	1017.45	146.83
42	24.4	167.6	143.78	134.29	88.53	753.73	708.76	2021.35	138.42	134.29	17.04	726.69	712.11	212.58
43	24.4	107.0	117.75	117.42	0.10	584.84	589.11	32.81	115.45	117.42	2.47	575.86	594.68	304.14
44	24.0	108.8	122.84	112.57	103.06	614.38	537.46	6222.46	121.69	112.57	83.22	611.06	538.60	5106.18
45	22.8	100.4	98.13	87.21	142.35	476.10	398.05	5190.78	94.68	87.21	68.84	459.25	399.38	5893.98
46	24.4	106.6	133.72	111.14	43.45	584.84	573.08	140.26	115.45	111.14	20.32	574.51	573.00	3.46
47	28.7	138.8	173.53	223.33	2087.93	984.37	1312.08	106488.14	188.42	223.33	1219.46	1041.33	1313.00	73807.03
48	15.8	93.6	61.89	67.44	30.42	254.84	330.08	5334.22	62.78	67.44	22.58	241.04	330.00	4632.42
49	20.1	114.1	72.08	84.63	308.21	313.27	478.08	27134.30	78.14	84.63	271.12	338.86	478.00	19361.09
50	22.8	130.8	99.17	108.38	103.52	472.12	581.83	8240.80	103.34	108.38	2.80	510.82	581.83	5176.95
Sum			4655.6	4713.7	10742.1	23467.1	24539.6	496696.97	4698.40	4713.69	8710.86	23648.97	24041.40	412949.91
Count			48.0	48.0	48.0	48.0	48.0	48.00	48.00	48.00	48.00	48.00	48.00	48.00
Average					223.8			10347.89			181.48			8603.12
Root					15.2			101.72			13.47			92.75
RMS (%)					31.2			317.53			28.07			193.24
Aggregate Difference (%)					-0.38			-3.48			-0.32			-3.84

Table B1. Root mean squared error and aggregate difference tests for ponderosa pine using volume equations developed at BMDSF (Willsbury and Pryor 1989).

PONDEROSA PINE
Northern California

			Standard (cubic feet)			Standard (Scribner board feet)		
Tree No.	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	22.0	119.7	108	77	965	626	311	99197
2	28.0	130.6	191	168	520	1218	856	131143
3	16.9	83.0	43	41	7	206	139	4445
4	12.2	72.5	19	21	2	81	56	605
5	15.4	99.1	43	42	0	210	166	1916
6	27.2	128.3	177	131	2070	1113	635	227998
7	17.3	92.8	51	57	32	253	263	92
9	22.8	124.7	121	118	9	717	638	6259
10	23.6	106.0	109	99	108	621	473	21795
11	12.6	86.6	25	24	2	111	56	2982
12	12.2	82.3	22	18	14	96	28	4575
13	21.7	97.8	84	76	70	455	309	21317
14	25.6	109.6	133	108	600	781	523	66831
15	16.5	79.4	39	48	84	184	184	0
16	28.0	120.7	175	144	992	1094	735	128746
17	33.9	121.7	260	260	1	1720	1567	23377
18	29.1	128.0	203	179	551	1303	980	104049
19	14.2	89.2	33	29	14	151	71	6441
20	31.5	128.0	237	221	241	1559	1280	78231
21	18.9	113.2	75	67	65	406	316	8104
22	19.7	90.6	64	71	44	329	316	159
23	16.1	69.9	33	33	0	146	117	860
24	24.0	93.2	98	93	30	541	436	11024
25	13.8	46.6	16	22	41	58	81	534
26	15.0	97.8	40	32	69	194	111	6819
27	21.3	107.3	89	93	11	495	456	1499
29	12.2	52.8	14	13	1	52	24	790
30	19.7	83.7	59	80	447	295	366	5044
31	14.6	66.6	25	31	27	108	117	77
32	16.9	92.8	49	49	0	240	196	2001
33	28.7	126.0	194	179	213	1236	983	63864
34	18.9	97.1	64	57	46	329	224	11166
35	15.4	71.5	30	38	63	134	135	1
36	25.2	99.4	116	142	689	660	730	4881
37	36.6	150.3	380	386	47	2749	2460	83477
38	20.5	106.3	82	68	191	448	446	5
39	18.1	93.2	56	71	228	282	320	1459
40	20.9	93.8	75	91	255	395	423	806
41	29.5	111.9	180	180	0	1118	1012	11165
42	26.4	107.6	138	134	17	819	712	11414
43	24.4	107.0	118	117	0	678	595	6904
44	24.8	109.9	125	113	152	730	540	36209
45	22.8	100.4	96	87	75	531	399	17424
46	24.4	106.6	117	111	35	674	573	10262
47	28.7	139.8	216	223	55	1421	1313	11610
48	18.9	97.4	64	68	15	331	330	1
49	20.1	116.1	87	95	60	485	478	46
50	22.8	130.6	127	109	302	762	561	40048

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	4896.97	4713.69	9460.62	29144.5	24042.4	1277652.08
Count	48.00	48.00	48.00	48.0	48.0	48.00
Average			197.10			26617.75
Root			14.04			163.15
RMS (%)			29.25			339.89
Aggregate Difference (%)			3.89			21.22

Table E2. Root mean squared error and aggregate difference tests for ponderosa pine using volume equations developed in Northern California by Wensel 1977.

SUGAR PINE
Boggs Mtn. Demonstration State Forest

Tree No.	DBH (inches)	Total Ht (feet)	Local (cubic feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Local (Scribner board feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Standard (cubic feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Standard (Scribner board feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	35.75	67.91	36	29	46	121	86	1188	33	28	32	184	86	239
2	14.17	79.72	27	32	19	88	107	363	30	32	3	59	107	53
3	11.02	65.29	15	17	5	41	46	13	16	17	2	43	43	4
4	23.39	80.71	24	26	4	74	72	4	27	26	1	86	72	280
5	33.07	108.95	227	166	1676	1117	893	54531	187	166	943	1035	893	19139
6	25.59	112.53	112	123	115	518	611	8663	122	123	0	609	611	2
7	24.02	104.66	97	97	1	428	414	213	103	97	29	476	414	4340
8	18.98	112.23	94	68	62	308	277	4675	84	63	15	244	277	236
9	20.67	87.27	66	57	83	266	227	1469	66	57	91	262	227	1263
10	26.77	87.44	125	128	10	593	605	143	121	128	46	563	605	1740
11	18.98	76.44	54	37	211	206	120	7790	52	37	217	164	120	4045
12	25.98	87.44	116	196	136	542	470	5088	114	195	85	525	470	3080
13	28.53	104.88	122	171	187	795	844	2376	105	171	247	777	844	4429
14	19.48	83.50	60	65	26	236	287	2569	64	65	1	262	287	620
15	16.14	83.20	37	46	49	132	191	4462	40	46	44	142	187	2030
16	33.86	129.58	219	237	292	1199	1323	15453	235	237	1	1398	1323	5574
17	21.26	79.72	72	60	153	297	234	3393	67	60	33	258	229	991
18	38.88	187.84	407	391	253	1828	1711	13762	276	391	362	1534	1711	33194
19	11.02	32.82	15	12	11	41	15	696	14	12	4	23	15	317
20	18.11	75.46	49	45	20	184	163	435	47	45	3	164	163	1
21	24.02	96.79	87	85	125	428	531	9440	97	85	147	434	331	10517
22	14.96	61.50	31	38	8	103	112	79	28	32	15	81	112	985
23	18.80	68.90	34	58	24	109	193	256	48	50	3	161	193	893
24	31.50	99.41	189	169	276	965	902	4218	179	169	5	842	902	3533
25	29.13	115.41	183	192	1587	749	1058	87213	162	192	816	856	1058	43008
26	12.99	45.88	22	21	1	64	30	1424	17	21	18	30	30	80
27	14.57	72.28	29	30	0	96	106	198	30	30	0	93	106	159
28	18.98	86.97	54	44	183	209	158	2810	50	44	124	211	158	3814
29	16.54	76.77	49	42	5	140	164	570	40	42	5	138	164	788
30	11.41	58.73	18	17	1	51	57	201	17	17	0	44	57	54
31	28.87	98.75	68	84	221	282	394	12783	75	84	87	321	394	5293
32	13.78	69.22	26	27	0	81	88	201	28	27	1	78	88	393
33	24.80	90.22	104	121	285	473	581	12012	99	121	487	427	581	23599
34	47.64	125.08	497	455	3759	5337	4578	574070	453	435	329	5948	4579	136491
35	30.91	112.84	168	204	1280	860	1147	82695	172	204	1040	908	1147	88393
36	24.80	112.84	104	108	16	471	538	4625	115	108	51	568	538	807
37	27.85	118.11	139	143	15	674	680	309	151	143	64	785	680	11255
38	14.17	73.82	27	26	1	86	68	409	28	26	3	92	68	583
39	17.32	66.94	44	35	88	143	121	1544	34	35	13	124	121	11
40	23.93	109.22	85	103	323	388	510	21725	98	103	57	458	515	4215
41	20.47	106.83	66	83	300	265	372	11464	76	85	78	338	373	1109
42	26.82	103.02	163	163	0	827	842	220	157	163	35	782	842	3542
43	24.41	86.24	105	90	97	449	377	5226	95	90	23	406	377	841
44	25.98	97.11	116	107	93	542	488	3202	114	107	58	573	488	1438
			Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum			4244.01	4216.36	12024.89	20818.23	20575.54	865710.53	4205.24	4216.36	6699.33	20584.58	20575.54	384452.28
Count			44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
Average					273.33			21947.97			127.94			8464.82
Root					16.53			148.10			11.31			91.89
RMS (%)					97.57			336.70			22.71			215.18
Aggregate Difference (%)					0.86			1.18			-0.76			-0.34

Table E1. Root mean squared error and aggregate difference tests for sugar pine cubic volume equations developed at MMUSF (Pillsbury and Kirpo 1989).

SUGAR PINE
Northern California

			Standard (cubic feet)			Standard (Scribner board feet)		
Tree No.	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	15.8	67.9	30	28	3	135	86	2341
2	14.2	79.7	28	32	17	129	107	493
3	11.0	65.3	14	17	13	56	45	132
4	13.4	80.7	25	26	2	115	72	1882
5	33.1	107.0	213	166	2144	1307	883	179205
6	25.6	112.5	129	123	40	773	611	26369
7	24.0	104.7	106	97	79	610	414	38760
8	18.9	110.2	67	62	22	376	277	9753
9	20.5	87.3	65	57	68	337	227	12100
10	26.8	97.4	126	128	7	716	605	12365
11	18.9	76.4	49	37	145	237	120	13703
12	26.0	97.4	118	105	161	668	470	39143
13	29.5	105.0	165	171	39	984	844	19727
14	19.7	93.5	63	65	3	336	287	2423
15	16.1	83.0	38	46	64	183	197	183
16	33.9	129.6	264	237	753	1755	1323	186537
17	21.3	79.7	65	60	27	328	224	10872
18	39.0	107.9	304	291	146	1928	1711	46907
19	11.0	52.8	11	12	0	43	15	801
20	18.1	75.5	44	45	0	212	163	2412
21	24.0	96.8	99	85	196	553	331	49451
22	15.0	61.4	25	32	51	105	112	45
23	18.9	68.9	45	50	24	208	193	250
24	31.5	99.4	180	168	151	1066	902	27013
25	29.1	115.8	174	192	310	1079	1059	412
26	13.0	45.3	14	21	53	52	30	487
27	14.6	72.2	27	30	9	122	106	246
28	18.9	85.0	53	44	86	271	158	12899
29	16.5	76.8	37	42	23	176	164	145
30	11.8	58.7	14	17	5	58	37	451
31	20.9	98.8	75	84	79	411	394	291
32	13.8	69.2	23	27	15	102	98	15
33	24.8	90.2	100	121	444	545	581	1260
34	47.6	125.0	526	435	8290	3672	2579	1194867
35	30.3	112.9	185	204	353	1144	1147	10
36	24.8	112.9	121	108	174	722	538	33711
37	28.0	118.1	162	143	396	1006	690	99621
38	14.2	73.8	26	26	0	117	68	2461
39	17.3	65.9	36	35	1	161	121	1635
40	22.8	109.3	99	103	17	573	515	3394
41	20.5	106.6	77	85	56	433	372	3706
42	29.9	103.0	167	163	12	991	842	22118
43	24.4	89.2	96	90	28	519	377	20058
44	26.0	97.1	118	107	121	665	484	32873

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	4401.98	4216.36	14628.56	25980.88	20575.54	2113525.12
Count	44.00	44.00	44.00	44.00	44.00	44.00
Average			332.47			48034.66
Root			18.23			219.17
RMS (%)			41.44			498.11
Aggregate Difference (%)			4.40			26.27

Table E4. Root mean squared error and aggregate difference tests for sugar pine using volume equations developed in Northern California by Wensel 1977.

DOUGLAS FIR
Boggs Mtn. Demonstration State Forest

Tree No.	Dbh (inches)	Total Ht (feet)	Local (cubic feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Local (thousand board feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Standard (cubic feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Standard (thousand board feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	20.5	108.7	65	41	16	274	216	3468	72	43	138	318	236	6671
2	24.8	109.7	100	96	17	459	441	304	100	96	15	473	441	1024
3	28.3	93.2	144	103	1741	706	434	74127	131	103	335	592	434	24873
4	32.7	106.4	188	150	1435	962	763	38247	167	150	298	908	763	21166
5	28.0	95.1	131	188	821	633	814	14078	110	188	84	558	814	2180
6	14.3	67.6	38	29	1	108	146	13	27	29	4	84	146	465
7	15.4	67.3	36	24	87	127	41	7356	30	24	36	99	41	3334
8	13.8	61.0	18	13	28	63	19	1815	18	13	21	50	19	963
9	20.1	95.3	62	58	17	261	255	30	46	58	4	241	255	171
10	12.6	66.6	21	18	11	79	41	1141	22	18	14	65	41	570
11	27.4	95.5	127	184	355	609	456	23427	113	188	20	546	456	8129
12	26.4	119.1	97	104	56	448	699	3510	114	144	330	586	699	4531
13	24.8	118.1	160	123	543	459	637	31560	116	123	51	592	627	1957
14	29.4	109.6	80	89	91	301	430	4248	81	88	9	493	430	9
15	10.0	74.8	32	33	1	118	129	106	30	32	0	108	129	389
16	26.9	86.3	42	46	9	165	185	423	46	45	1	174	185	126
17	31.9	124.7	178	158	342	401	782	14032	186	158	182	1273	782	87026
18	31.3	91.2	70	81	103	304	383	6032	70	81	113	299	383	6840
19	13.4	61.0	39	38	3	88	113	587	22	28	31	45	113	3225
20	22.1	88.4	77	68	72	335	292	1857	66	68	4	270	292	484
21	19.7	77.8	59	53	43	247	238	83	53	52	0	203	238	1197
22	15.8	53.4	36	27	74	136	84	2452	27	27	0	83	84	9
23	34.7	108.9	814	814	1	1125	1158	1145	188	814	404	1008	1158	10260
24	27.2	98.4	123	119	16	386	377	82	114	118	30	553	377	657
25	28.5	84.3	51	58	43	209	267	3351	51	58	42	200	267	4433
26	14.6	78.9	30	28	2	110	90	292	28	28	1	96	90	36
27	13.6	79.3	26	28	3	95	117	498	27	28	3	88	117	396
28	28.4	105.8	134	138	4	637	716	3498	130	138	63	643	716	5481
29	22.0	97.8	83	86	53	360	391	645	86	80	36	383	391	77
30	24.4	101.7	87	110	174	440	529	7950	98	110	138	464	529	4234
31	11.8	43.3	18	22	12	43	83	410	18	22	15	59	83	901
32	30.1	95.1	62	68	35	261	311	2583	66	68	3	283	311	878
33	18.5	87.6	31	31	0	209	185	560	33	31	4	212	185	681
34	19.3	95.2	56	43	35	234	287	2771	60	42	4	244	287	1796
35	15.0	66.9	32	27	20	114	83	1233	29	27	3	93	83	98
36	20.1	67.9	62	59	4	261	254	49	61	58	4	253	254	1
37	33.9	128.9	303	328	14024	1059	1959	812363	213	322	11810	1279	1959	466111
38	23.2	91.2	86	78	54	385	384	0	81	78	9	359	386	704
39	24.2	66.3	38	31	4	182	122	885	36	31	24	82	122	1631
40	13.8	80.7	26	27	1	95	86	80	30	27	10	102	86	264
41	31.7	106.2	23	90	290	819	456	18700	84	90	47	385	456	5008
42	17.7	87.8	43	37	36	188	139	2243	38	33	4	135	139	15
43	24.1	62.2	38	41	44	145	112	1084	31	31	4	99	112	192
44	28.9	64.8	54	44	100	221	188	1089	41	44	8	142	188	2181
45	17.3	80.1	44	47	9	175	207	1013	44	47	9	162	207	1980
46	34.8	91.9	106	84	278	458	350	11849	81	84	58	415	350	4285
47	38.3	121.5	163	178	346	814	948	18247	171	178	57	963	949	198
48	32.4	103.7	88	101	433	351	531	32626	87	101	191	420	531	17654
49	29.5	113.8	149	152	16	723	754	541	156	152	4	688	754	2677
50	26.1	194.7	63	70	48	261	298	1484	73	70	8	325	298	888
51	22.1	100.3	77	91	221	330	441	12181	83	91	32	331	441	4588
Sum			3319.63	4036.00	30666.31	13027.74	19187.50	1168059.50	3021.78	4036.00	18450.70	13045.13	19187.69	787791.94
Count			51.00	51.00	51.00	51.00	51.00	51.00	51.00	51.00	51.00	51.00	51.00	51.00
Average					429.54			24017.33			362.93			14373.48
Root					22.74			155.10			13.81			120.33
SEE (%)					22.68			304.13			36.13			236.71
Aggregate Difference (%)					-12.97			-21.22			-10.11			-21.26

Table E3. Test of reliability of volume equations for Douglas-fir at Boggs Mountain Demonstration State Forest (Pillsbury and Pryor).

DOUGLAS FIR
Northern California

Tree No.	Dbh (inches)	Total Ht (feet)	Standard (cubic feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Standard (Scribner board feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	20.5	100.7	74.23	60.66	184.11	399.20	235.98	26639.17
2	24.8	100.7	105.52	96.00	90.65	591.83	441.40	22628.20
3	29.1	93.2	129.48	102.71	716.56	733.11	434.17	89368.06
4	32.7	106.6	186.96	149.81	1379.92	1135.04	763.47	138064.39
5	28.0	95.1	122.98	108.64	205.51	694.81	513.66	32814.26
6	14.2	67.6	23.80	28.71	24.06	103.53	105.91	5.68
7	15.4	67.3	27.41	24.24	10.07	121.13	41.00	6421.34
8	11.8	61.0	15.14	13.14	4.01	61.18	19.00	1778.86
9	20.1	85.3	59.09	57.74	1.83	299.55	254.56	2024.14
10	12.6	66.6	18.87	17.83	1.08	79.60	40.88	1499.58
11	27.6	95.5	120.33	108.47	140.67	678.55	455.85	49595.81
12	24.4	119.1	124.49	104.07	416.98	735.40	499.00	55884.90
13	24.8	118.1	126.94	123.35	12.87	750.41	636.50	12976.35
14	22.4	109.6	96.87	89.27	57.82	546.58	430.05	13579.16
15	15.0	74.8	29.58	32.46	8.29	134.62	128.62	36.00
16	16.9	86.9	44.18	44.71	0.28	217.13	185.40	1006.92
17	31.9	124.7	214.30	158.48	3115.60	1362.66	782.05	337110.54
18	21.3	91.2	70.92	80.65	94.75	372.16	381.53	87.83
19	13.4	61.0	19.06	27.51	71.39	79.16	112.11	1085.92
20	22.1	80.4	65.48	67.93	6.01	332.21	291.72	1639.79
21	19.7	77.8	51.19	52.34	1.31	250.61	238.04	157.96
22	15.8	57.4	23.91	27.01	9.59	100.85	86.30	211.75
23	34.7	108.9	213.33	213.65	0.10	1321.09	1158.83	26329.54
24	27.2	98.4	121.44	119.01	5.91	689.57	577.00	12673.09
25	18.5	84.3	50.17	57.93	60.19	248.86	267.00	329.14
26	14.6	70.9	26.47	28.24	3.13	117.66	90.43	741.50
27	13.8	73.2	24.80	29.25	19.82	110.04	117.27	52.33
28	28.4	105.0	141.50	137.71	14.40	828.52	715.99	12663.11
29	22.8	97.8	87.59	90.21	6.85	477.73	390.82	7554.10
30	24.4	101.7	103.66	109.77	37.37	581.21	529.14	2711.75
31	11.8	63.7	15.90	22.39	42.10	65.15	83.20	325.87
32	20.1	95.1	67.07	68.10	1.06	352.49	311.33	1694.06
33	18.5	87.6	52.44	50.93	2.29	263.42	185.40	6087.78
34	19.3	91.2	59.34	62.39	9.32	304.84	286.56	333.99
35	15.0	66.9	26.00	27.14	1.30	114.06	83.20	952.50
36	20.1	87.9	61.21	59.46	3.07	313.42	253.53	3586.93
37	33.9	128.9	248.72	322.05	5377.46	1620.36	1958.84	114571.40
38	23.2	91.2	83.43	78.94	20.12	446.38	385.66	3686.94
39	14.2	66.3	23.27	30.96	59.13	100.55	122.43	478.78
40	13.8	80.7	27.79	26.69	1.21	127.38	86.00	1712.64
41	21.7	106.3	87.57	90.49	8.52	485.33	455.85	869.24
42	17.7	67.9	36.07	36.76	0.48	164.99	138.94	678.43
43	16.1	62.3	27.52	30.99	12.05	119.90	112.11	60.66
44	18.9	64.0	37.88	43.92	36.50	172.31	188.49	261.76
45	17.3	80.1	41.86	46.89	25.30	201.17	207.07	34.77
46	24.8	91.9	94.83	83.50	128.35	515.92	350.00	27531.10
47	30.7	121.7	194.51	178.59	253.32	1216.98	949.00	71813.25
48	22.4	103.7	90.84	100.52	93.73	503.23	531.00	771.43
49	29.5	113.8	167.50	152.22	233.48	1016.33	756.00	67774.18
50	20.1	104.7	74.92	70.12	23.03	406.33	298.00	11736.13
51	22.1	100.7	85.07	91.45	40.73	465.00	441.40	556.76

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	3373.91	4036.00	13073.67	18804.59	19107.69	1173189.81
Count	51.00	51.00	51.00	51.00	51.00	51.00
Average			256.35			22773.39
Root			16.01			150.91
RMS (%)			31.39			295.90
Aggregate Difference (%)			-16.40			-1.59

Table E6. Test of reliability of volume equations for Douglas-fir in Northern California (Wensels).

CANYON LIVE OAK

			LOCAL VOLUME EQUATION Total Volume (cubic feet)			LOCAL VOLUME EQUATION Wood Volume (cubic feet)			LOCAL VOLUME EQUATION Saw-log Volume (cubic feet)		
Tree Number	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	11.8	33.5	19	12	52	13	7	40	0	0	0
2	15.8	60.0	38	31	54	29	23	37	23	18	24
3	13.0	46.3	24	19	27	17	14	12	14	13	1
4	4.7	30.5	2	5	10	1	3	4	0	0	0
5	5.5	25.6	3	4	0	2	2	0	0	0	0
6	9.1	38.4	10	11	1	7	7	0	0	0	0
7	7.9	32.2	7	5	3	5	3	2	0	0	0
8	6.7	38.7	5	5	0	3	3	0	0	0	0
9	10.4	44.0	15	12	9	10	8	3	0	0	0
10	16.9	45.0	45	49	11	35	36	3	27	26	0
11	6.7	35.4	5	5	0	3	3	0	0	0	0
12	17.7	48.2	51	55	22	39	44	25	30	27	10
13	12.2	35.4	21	24	9	15	18	13	12	12	0
14	8.7	32.5	9	8	2	6	5	0	0	0	0
15	15.0	41.7	34	29	38	25	19	32	20	13	40
16	19.7	56.4	65	67	3	52	50	2	40	37	6
17	12.2	45.0	21	17	11	15	12	5	12	7	19
18	23.8	65.3	101	85	276	84	67	274	63	50	183
19	13.4	35.4	26	20	29	19	15	12	15	10	22
20	6.7	30.2	5	5	0	3	3	0	0	0	0
21	7.1	37.1	6	6	0	3	4	0	0	0	0
22	9.5	37.7	11	13	4	7	10	4	0	0	0
23	11.0	38.4	16	15	2	11	11	0	9	7	4
24	9.8	49.9	12	9	11	8	6	3	0	0	0
25	11.4	41.7	18	33	245	12	25	155	10	18	80
26	13.8	46.9	28	34	45	20	26	36	18	23	43
27	7.9	52.8	7	11	16	5	8	15	0	0	0
28	14.6	49.5	32	25	42	23	18	25	18	13	26
29	13.6	72.2	26	40	208	19	32	171	15	28	160
30	16.5	57.1	43	57	196	33	45	141	24	35	83
31	10.2	38.7	13	16	4	9	11	4	0	0	0
32	15.4	67.9	36	36	0	27	26	1	21	22	1
33	15.4	80.4	36	45	84	27	38	79	21	28	51
34	21.7	63.3	82	124	1726	66	100	1144	51	64	165
35	7.5	37.7	6	4	0	4	4	0	0	0	0
36	26.0	65.0	128	123	21	108	99	69	81	90	94

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	1003.90	1059.00	3157.71	763.78	804.30	2316.64	522.66	543.82	992.12
Count	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Average			87.71			64.35			27.56
Root			9.37			8.02			5.25
RMS (%)			26.02			22.28			14.58
Aggregate Difference (%)			-5.20			-5.04			-3.34

Table E7. Root mean squared error and aggregate difference tests for canyon live oak using volume equations developed at BMDSF (Pillsbury and Pryor 1989).

CANYON LIVE OAK

			STANDARD VOLUME EQUATION Total Volume (cubic feet)			STANDARD VOLUME EQUATION Wood Volume (cubic feet)		
Tree Number	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	11.81	33.46	16	12	20	11	7	16
2	15.75	60.04	41	31	106	31	23	78
3	12.99	46.26	24	19	25	17	14	11
4	4.72	30.51	2	5	9	1	3	4
5	5.51	25.59	3	4	1	2	2	0
6	9.06	38.39	10	11	1	7	7	0
7	7.87	32.15	7	5	1	4	3	1
8	6.69	38.71	5	5	0	3	3	0
9	10.63	43.96	15	12	10	10	8	4
10	16.93	44.95	41	49	56	31	36	31
11	6.69	35.43	5	5	0	3	3	0
12	17.72	48.23	47	55	68	36	44	70
13	12.20	35.43	18	24	30	12	18	34
14	8.66	32.48	8	8	0	5	5	0
15	14.96	41.67	30	28	7	22	19	7
16	19.69	56.43	64	67	9	51	50	0
17	12.20	44.95	20	17	10	14	12	4
18	23.62	65.29	102	85	302	84	67	301
19	13.39	35.43	22	20	3	15	15	0
20	6.69	30.18	5	5	0	3	3	0
21	7.09	37.07	6	6	0	4	4	0
22	9.45	37.73	11	13	6	7	10	6
23	11.02	38.39	15	15	0	10	11	0
24	9.84	49.87	14	9	21	9	6	14
25	11.42	41.67	17	33	261	12	25	166
26	13.78	46.92	27	34	52	20	26	41
27	7.87	52.82	9	11	6	6	8	7
28	14.57	49.54	31	25	40	23	18	23
29	13.39	72.18	32	40	69	24	32	54
30	16.54	57.09	44	57	156	34	45	109
31	10.24	38.71	13	16	7	9	11	6
32	15.35	67.91	41	36	27	32	26	40
33	15.35	80.38	45	45	0	36	36	0
34	21.65	63.32	83	124	1623	68	100	1059
35	7.48	37.73	7	6	0	4	4	0
36	25.98	64.96	125	123	4	105	99	31

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	1006.6	1059.0	2932.3	767.1	804.3	2119.7
Count	36.0	36.0	36.0	36.0	36.0	36.0
Average			81.5			58.9
Root			9.0			7.7
RMS (%)			25.1			21.3
Aggregate Difference (%)			-4.94			-4.62

Table E8. Root mean squared error and aggregate difference tests for canyon live oak using volume equations developed at BMDSF (Pillsbury and Pryor 1989).

CANYON LIVE OAK

			STANDARD VOLUME EQUATION Total Volume (cubic feet)			STANDARD VOLUME EQUATION Wood Volume (cubic feet)		
Tree Number	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	11.8	33.5	19	12	57	14	7	53
2	15.8	60.0	52	31	458	44	23	438
3	13.0	46.3	29	19	108	23	14	81
4	4.7	30.5	2	5	8	2	3	3
5	5.5	25.6	3	4	0	2	2	0
6	9.1	38.4	12	11	1	9	7	2
7	7.9	32.2	8	5	5	5	3	5
8	6.7	38.7	6	5	2	4	3	2
9	10.6	44.0	18	12	40	14	8	27
10	16.9	45.0	51	49	6	42	36	27
11	6.7	35.4	6	5	0	4	3	1
12	17.7	48.2	59	55	14	49	44	22
13	12.2	35.4	22	24	4	16	18	4
14	8.7	32.5	10	8	4	7	5	2
15	15.0	41.7	37	28	89	29	19	100
16	19.7	56.4	82	67	224	70	50	405
17	12.2	45.0	25	17	58	19	12	47
18	23.6	65.3	134	85	2431	120	67	2816
19	13.4	35.4	26	20	37	20	15	24
20	6.7	30.2	5	5	0	3	3	0
21	7.1	37.1	7	6	1	5	4	1
22	9.5	37.7	13	13	0	9	10	0
23	11.0	38.4	18	15	11	13	11	8
24	9.8	49.9	16	9	57	13	6	48
25	11.4	41.7	21	33	160	16	25	84
26	13.8	46.9	33	34	1	26	26	0
27	7.9	52.8	10	11	0	8	8	1
28	14.6	49.5	39	25	195	31	18	170
29	13.4	72.2	41	40	0	34	32	5
30	16.5	57.1	56	57	0	47	45	6
31	10.2	38.7	15	16	0	11	11	0
32	15.4	67.9	53	36	286	45	26	366
33	15.4	80.4	59	45	194	51	36	232
34	21.7	63.3	109	124	228	96	100	21
35	7.5	37.7	8	6	2	5	4	1
36	26.0	65.0	165	123	1755	150	99	2554

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	1270.1	1059.0	6437.6	1056.0	804.3	7555.1
Count	36.0	36.0	36.0	36.0	36.0	36.0
Average			178.8			209.9
Root			13.4			14.5
RMS (%)			37.1			40.2
Aggregate Difference (%)			19.93			31.29

Table E9. Root mean squared error and aggregate difference tests for canyon live oak using volume equations developed for Statewide use (Pillsbury and Kirkley 1984).

BLACK OAK
Boggs Mtn. Demonstration State Forest

			Local TVOL (cubic feet)			Local WVOL (cubic feet)			Local SVOL (cubic feet)		
Tree Number	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	11.8	33.5	22	12	97	15	1	64	0	0	0
2	15.8	40.0	42	31	119	30	23	58	28	18	106
3	13.0	46.3	27	19	67	19	14	27	18	13	28
4	4.7	30.5	3	5	6	2	3	2	2	0	0
5	5.5	25.8	4	4	0	2	2	0	3	0	0
6	9.1	38.4	12	11	1	8	1	1	8	0	0
7	7.9	32.2	9	5	10	6	3	6	4	0	0
8	6.7	38.7	6	5	1	4	3	1	4	0	0
9	10.8	44.0	17	12	29	12	8	10	11	0	0
10	16.9	45.0	49	49	0	36	36	0	33	26	42
11	6.3	35.6	6	5	1	4	3	0	4	0	0
12	17.7	48.2	54	55	1	40	44	16	37	27	88
13	12.2	35.6	23	24	0	16	18	4	16	12	12
14	8.7	32.5	11	8	9	3	5	3	7	0	0
15	15.0	41.7	37	28	85	23	19	52	25	13	131
16	19.7	50.6	69	67	4	53	50	3	47	37	83
17	12.2	45.0	23	17	37	18	12	15	16	1	67
18	23.6	65.3	104	85	383	80	67	176	70	50	427
19	13.4	35.4	29	20	72	30	15	27	19	10	82
20	6.7	30.2	6	5	1	4	3	0	4	0	0
21	7.1	37.1	7	6	1	4	4	1	5	0	0
22	9.5	37.7	13	13	0	9	10	1	9	0	0
23	11.0	38.4	19	15	14	13	11	5	12	7	28
24	9.8	49.9	14	9	29	10	6	16	10	0	0
25	11.4	41.7	20	33	172	14	25	117	13	18	18
26	13.8	48.9	31	34	13	22	26	18	21	23	4
27	7.9	52.8	9	11	6	6	8	8	6	0	0
28	14.4	49.5	35	25	96	25	19	44	23	13	100
29	13.4	72.3	29	40	129	30	32	130	19	28	68
30	16.5	57.1	47	57	107	34	45	111	31	35	11
31	10.2	38.7	16	16	0	11	11	0	10	0	0
32	15.4	67.8	39	36	9	28	26	7	26	22	17
33	15.4	80.4	39	45	32	28	36	53	26	28	4
34	21.7	63.3	86	124	1448	65	100	1240	58	64	38
35	7.5	37.7	8	6	3	5	6	1	5	0	0
36	26.0	65.0	130	123	43	101	89	1	88	90	8

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	1092.31	1059.00	3025.34	794.84	804.30	2220.16	718.99	541.82	1358.65
Count	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Average			84.04			61.67			37.74
Root			9.17			7.85			6.14
RMS (%)			25.86			21.81			17.08
Aggregate Difference (%)			3.15			-1.18			32.78

Table E10. Test of reliability of volume equations for black oak at Boggs Mountain Demonstration State Forest (Pillsbury and Pryor).

BLACK OAK
Boggs Mtn. Demonstration State Forest

			Standard TVOL (cubic feet)			Standard WVOL (cubic feet)		
Tree Number	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
2	12.60	58.07	29	30	1	18	21	5
3	13.00	46.59	25	22	8	17	15	5
4	13.40	59.38	33	37	16	22	27	31
5	17.30	67.26	56	57	2	42	41	2
6	9.10	36.74	11	33	500	6	24	303
7	12.20	55.77	26	22	14	17	16	0
8	9.10	44.29	13	10	9	7	7	0
9	7.50	33.14	7	6	1	4	4	0
10	15.70	49.87	36	29	47	28	21	43
11	17.30	51.18	44	48	22	35	36	1
12	14.60	41.67	27	26	2	21	18	9
13	12.60	74.80	36	35	3	22	25	12
14	11.00	51.51	21	25	20	12	19	43
15	13.80	47.24	28	30	6	20	22	6
16	7.50	22.97	5	3	3	3	1	3
17	8.70	38.71	11	12	1	6	7	1
18	6.70	25.59	5	5	0	3	3	0
19	9.80	60.37	20	20	0	11	14	15
20	13.80	45.60	27	33	40	19	24	25
21	5.50	34.12	4	7	6	2	4	6
22	11.40	38.71	17	13	13	11	9	5
23	12.60	44.62	23	28	25	16	20	16
24	7.50	23.29	5	6	0	3	3	0
25	9.80	39.70	13	14	0	8	10	3
26	16.50	49.21	39	68	834	31	51	426
27	8.30	32.81	8	3	25	5	1	11
28	15.00	59.38	39	43	13	28	33	21
29	9.80	39.70	13	10	9	8	7	1
30	11.40	61.35	26	28	6	15	20	26
31	26.40	63.32	108	87	421	107	62	2039
32	15.40	42.98	31	21	95	24	13	112
33	18.90	67.58	65	42	539	52	29	523
34	32.30	87.93	204	187	268	211	146	4235
35	20.90	66.27	76	58	336	64	44	417
36	5.50	27.56	4	2	3	2	1	0
37	5.90	27.89	4	5	1	2	3	2
38	7.10	36.42	7	7	0	4	5	1
39	19.30	66.93	67	75	68	54	58	13
40	23.20	80.38	108	169	3768	93	131	1474
41	18.50	71.19	66	57	78	51	43	65
42	27.20	91.53	159	186	780	146	145	0
43	15.00	76.77	50	49	0	33	38	25
44	8.30	44.95	11	7	15	6	5	1
45	9.40	48.56	15	16	0	8	11	7
46	14.20	43.96	27	40	155	20	29	71
47	27.60	87.27	156	155	0	146	119	707

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	1136.88	1107.08	3291.85	900.75	802.88	8347.21
Count	36.00	36.00	36.00	36.00	37.00	36.00
Average			91.44			231.87
Root			9.56			15.23
RMS (%)			26.56			41.15
Aggregate Difference (%)			2.69			12.19

Table E11. Test of reliability of volume equations for black oak at Boggs Mountain Demonstration State Forest (Pillsbury and Pryor).

BLACK OAK
California Statewide

			Standard TVOL (cubic feet)			Standard WVOL (cubic feet)		
Tree Number	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	9.8	40.7	15	23	57	10	17	45
2	12.6	58.1	33	30	11	24	21	10
3	13.0	46.6	29	22	54	21	15	40
4	13.4	59.4	38	37	2	28	27	0
5	17.3	67.3	70	57	165	53	41	147
6	9.1	36.7	12	33	462	8	24	248
7	12.2	55.8	30	22	58	21	16	25
8	9.1	44.3	14	10	14	9	7	7
9	7.5	33.1	7	6	1	5	4	0
10	15.7	49.9	45	29	246	33	21	151
11	17.3	51.2	56	48	55	42	36	35
12	14.6	41.7	33	26	60	25	18	47
13	12.6	74.8	41	35	42	29	25	17
14	11.0	51.5	23	25	5	16	19	8
15	13.8	47.2	33	30	9	24	22	4
16	7.5	23.0	5	3	4	4	1	5
17	8.7	38.7	11	12	0	8	7	0
18	6.7	25.6	5	5	0	3	3	0
19	9.8	60.4	21	20	1	14	14	0
20	13.8	45.6	32	33	1	24	24	1
21	5.5	34.1	4	7	7	3	4	3
22	11.4	38.7	19	13	38	14	9	23
23	12.6	44.6	27	28	1	19	20	0
24	7.5	23.3	5	6	0	4	3	0
25	9.8	39.7	15	14	0	10	10	0
26	16.5	49.2	49	68	348	37	51	216
27	8.3	32.8	9	3	31	6	1	21
28	15.0	59.4	48	43	22	35	33	6
29	9.8	39.7	15	10	19	10	7	8
30	11.4	61.4	29	28	0	20	20	0
31	26.4	63.3	154	87	4462	123	62	3751
32	15.4	43.0	38	21	301	28	13	221
33	18.9	67.6	84	42	1767	64	29	1224
34	32.3	87.9	303	187	13344	248	146	10559
35	20.9	66.3	101	58	1877	78	44	1145
36	5.5	27.6	3	2	2	2	1	1
37	5.9	27.9	4	5	2	3	3	1
38	7.1	36.4	7	7	0	5	5	0
39	19.3	66.9	87	75	137	66	58	75
40	23.2	80.4	146	169	537	114	131	294
41	18.5	71.2	84	57	731	64	43	435
42	27.2	91.5	223	186	1355	178	145	1075
43	15.0	76.8	59	49	102	43	38	30
44	8.3	45.0	12	7	18	8	5	8
45	9.4	48.6	16	16	0	11	11	0
46	14.2	44.0	33	40	42	24	29	19
47	27.6	87.3	221	155	4316	177	119	3280

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	1461.6	1129.6	23469.1	1105.0	819.9	17972.6
Count	37.0	37.0	37.0	37.0	38.0	37.0
Average			634.3			485.7
Root			25.2			22.0
RMS (%)			68.1			58.0
Aggregate Difference (%)			29.39			34.77

Table E12. Test of reliability of volume equations for black oak in California (Pillsbury and Kirkley).

PACIFIC MADRONE
Boggs Mtn. Demonstration State Forest

Tree Number	Dbh (inches)	Total Ht (feet)	Local TVOL (cubic feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Local WVOL (cubic feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Local SVOL (cubic feet) Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	11.8	33.5	20	12	68	16	7	85	0	0	0
2	15.8	60.0	40	31	80	34	23	124	24	18	30
3	13.0	46.3	25	19	42	21	14	48	15	13	7
4	4.7	30.5	2	5	9	2	3	1	0	0	0
5	5.5	25.6	3	4	0	2	2	0	0	0	0
6	9.1	38.4	11	11	0	8	7	2	0	0	0
7	7.9	32.2	8	5	5	6	3	7	0	0	0
8	6.7	38.7	5	5	0	4	3	1	0	0	0
9	10.6	46.0	16	12	15	12	8	16	0	0	0
10	16.9	45.0	47	49	3	41	36	17	32	26	27
11	6.7	35.4	5	5	0	4	3	0	0	0	0
12	17.7	48.2	52	55	9	45	44	2	36	27	76
13	12.2	35.4	22	24	3	18	18	0	13	12	1
14	8.7	32.5	10	8	4	7	5	4	0	0	0
15	15.0	41.7	35	28	53	30	19	104	23	13	85
16	19.7	56.4	67	67	0	59	50	86	48	37	108
17	12.2	45.0	22	17	20	18	12	28	13	7	31
18	23.6	65.3	103	85	347	94	67	738	78	50	824
19	13.4	35.4	27	20	45	22	15	51	17	10	42
20	6.7	30.2	5	5	0	4	3	0	0	0	0
21	7.1	37.1	6	6	0	4	4	1	0	0	0
22	9.5	37.7	12	13	2	9	10	0	0	0	0
23	11.0	38.4	17	15	5	14	11	9	10	7	8
24	9.8	69.8	13	9	16	10	6	23	0	0	0
25	11.4	61.7	19	33	216	15	25	98	11	18	46
26	13.8	46.9	29	34	29	24	26	4	18	23	20
27	7.9	52.8	8	11	12	6	8	7	0	0	0
28	14.6	49.5	33	25	63	28	18	87	21	13	58
29	13.4	72.2	27	40	173	22	32	89	17	28	117
30	16.5	57.1	45	57	153	38	45	40	30	35	24
31	10.2	38.7	14	16	2	11	11	0	0	0	0
32	15.4	67.9	37	36	1	32	26	36	24	22	4
33	15.4	80.4	37	45	58	32	36	17	24	28	16
34	21.7	83.3	88	124	1568	76	100	611	62	64	3
35	7.5	37.7	7	6	1	5	4	1	0	0	0
36	26.0	85.0	130	123	63	128	99	432	102	90	128
			Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum			1043.1	1059.0	3037.0	892.8	804.3	2763.2	619.2	541.8	1696.7
Count			36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
Average					84.4			76.8			47.1
Root					9.2			8.8			6.9
RMS (%)					25.5			24.3			19.1
Aggregate Difference (%)					-1.50			11.00			14.28

Table E13. Test of reliability of volume equations for Pacific madrone at Boggs Mountain Demonstration State Forest (Pillsbury and Pryor).

PACIFIC MADRONE
Boggs Mtn. Demonstration State Forest

			Standard TVOL (cubic feet)			Standard WVOL (cubic feet)		
Tree Number	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	9.80	40.68	12	23	104	10	17	55
2	12.60	58.07	27	30	7	23	21	5
3	13.00	46.59	24	22	3	19	15	19
4	13.40	59.38	31	37	30	26	27	1
5	17.30	67.26	56	57	2	49	41	80
6	9.10	36.74	10	33	554	7	24	269
7	12.20	55.77	25	22	5	21	16	17
8	9.10	44.29	12	10	2	9	7	5
9	7.50	33.14	6	6	0	5	4	0
10	15.70	49.87	36	29	41	30	21	76
11	17.30	51.18	44	48	20	37	36	1
12	14.60	41.67	27	26	1	21	18	14
13	12.60	74.80	34	35	0	30	25	21
14	11.00	51.51	19	25	37	15	19	13
15	13.80	47.24	27	30	12	22	22	0
16	7.50	22.97	4	3	1	3	1	3
17	8.70	38.71	9	12	5	7	7	0
18	6.70	25.59	4	5	2	3	3	0
19	9.80	60.37	18	20	5	15	14	0
20	13.80	45.60	26	33	53	21	24	11
21	5.50	34.12	4	7	11	3	4	4
22	11.40	38.71	16	13	6	12	9	11
23	12.60	44.62	21	28	38	17	20	5
24	7.50	23.29	5	6	2	3	3	0
25	9.80	39.70	12	14	4	9	10	0
26	16.50	49.21	39	68	841	32	51	360
27	8.30	32.81	7	3	16	6	1	16
28	15.00	59.38	38	43	21	33	33	0
29	9.80	39.70	12	10	3	9	7	4
30	11.40	61.35	24	28	20	20	20	0
31	26.40	63.32	117	87	894	106	62	1949
32	15.40	42.98	30	21	86	25	13	124
33	18.90	67.58	66	42	597	59	29	915
34	32.30	87.93	229	187	1753	222	146	5848
35	20.90	66.27	79	58	453	70	44	703
36	5.50	27.56	3	2	1	2	1	1
37	5.90	27.89	3	5	3	2	3	1
38	7.10	36.42	6	7	1	5	5	0
39	19.30	66.93	69	75	45	61	58	12
40	23.20	80.38	114	169	3048	106	131	640
41	18.50	71.19	67	57	95	60	43	290
42	27.20	91.53	172	186	195	166	145	409
43	15.00	76.77	48	49	1	43	38	26
44	8.30	44.95	10	7	6	8	5	7
45	9.40	48.56	13	16	5	11	11	0
46	14.20	43.96	26	40	176	21	29	51
47	27.60	87.27	170	155	220	162	119	1821

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	1155.6	1129.6	5632.7	1004.5	819.9	10529.6
Count	37.0	37.0	37.0	37.0	38.0	37.0
Average			152.2			284.6
Root			12.3			16.9
RMS (%)			33.3			44.4
Aggregate Difference (%)			2.30			22.51

Table E14. **Test of reliability of volume equations for Pacific madrone at Boggs Mountain Demonstration State Forest (Pillsbury and Pryor).**

PACIFIC MADRONE
California Statewide

			Standard TVOL (cubic feet)			Standard WVOL (cubic feet)		
Tree Number	Dbh (inches)	Total Ht (feet)	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
1	9.8	40.7	13	23	87	10	17	44
2	12.6	58.1	29	30	1	25	21	17
3	13.0	46.6	26	22	15	21	15	38
4	13.4	59.4	33	37	10	29	27	2
5	17.3	67.3	61	57	15	54	41	179
6	9.1	36.7	10	33	522	8	24	248
7	12.2	55.8	26	22	15	22	16	34
8	9.1	44.3	12	10	5	10	7	8
9	7.5	33.1	7	6	0	5	4	0
10	15.7	49.9	39	29	103	33	21	137
11	17.3	51.2	49	48	0	41	36	23
12	14.6	41.7	29	26	14	24	18	35
13	12.6	74.8	36	35	2	32	25	45
14	11.0	51.5	20	25	24	17	19	5
15	13.8	47.2	29	30	1	24	22	3
16	7.5	23.0	5	3	2	3	1	4
17	8.7	38.7	10	12	3	8	7	0
18	6.7	25.6	4	5	1	3	3	0
19	9.8	60.4	18	20	2	16	14	1
20	13.8	45.6	28	33	22	23	24	2
21	5.5	34.1	4	7	10	3	4	3
22	11.4	38.7	17	13	15	13	9	20
23	12.6	44.6	23	28	18	19	20	0
24	7.5	23.3	5	6	1	3	3	0
25	9.8	39.7	13	14	1	10	10	0
26	16.5	49.2	43	68	609	36	51	246
27	8.3	32.8	8	3	20	6	1	21
28	15.0	59.4	42	43	2	36	33	10
29	9.8	39.7	13	10	7	10	7	8
30	11.4	61.4	25	28	10	21	20	1
31	26.4	63.3	134	87	2198	118	62	3129
32	15.4	43.0	34	21	163	27	13	187
33	18.9	67.6	73	42	978	65	29	1280
34	32.3	87.9	262	187	5552	246	146	9994
35	20.9	66.3	88	58	922	77	44	1121
36	5.5	27.6	3	2	1	2	1	1
37	5.9	27.9	4	5	3	3	3	1
38	7.1	36.4	6	7	0	5	5	0
39	19.3	66.9	76	75	0	67	58	85
40	23.2	80.4	127	169	1799	116	131	232
41	18.5	71.2	73	57	263	65	43	504
42	27.2	91.5	193	186	45	182	145	1311
43	15.0	76.8	52	49	6	46	38	71
44	8.3	45.0	10	7	8	8	5	10
45	9.4	48.6	14	16	2	11	11	0
46	14.2	44.0	29	40	110	24	29	25
47	27.6	87.3	191	155	1303	178	119	3452

	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference	Estimated (cu. ft.)	Actual (cu. ft.)	Squared Difference
Sum	1277.54	1129.59	11354.05	1101.68	819.91	16850.03
Count	37.00	37.00	37.00	37.00	38.00	37.00
Average			306.87			455.41
Root			17.52			21.34
RMS (%)			47.34			56.16
Aggregate Difference (%)			13.10			34.37

Table E15. Test of reliability of volume equations for Pacific madrone in California (Pillsbury and Kirkley