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# Predicted Total-Tree Biomass of Understory Hardwoods



Conversion factors: English to metric

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| <i>Multiply</i>       | <i>by</i> | <i>To obtain</i>          |
|-----------------------|-----------|---------------------------|
| Inches                | 2.540     | centimeters               |
| Feet                  | .3048     | meters                    |
| Pounds                | .4536     | kilograms                 |
| Cubic feet            | .02832    | cubic meters              |
| Pounds per cubic foot | 16.02     | kilograms per cubic meter |

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All English units of measure in this report can be converted to metric units by multiplying by the appropriate conversion factor listed above.

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# PREDICTED TOTAL-TREE BIOMASS OF UNDERSTORY HARDWOODS

by  
Douglas R. Phillips, Mensurationist  
Forestry Sciences Laboratory  
Athens, Georgia

**ABSTRACT.**—Prediction equations and tables are presented for estimating total-tree green and dry weights and cubic-foot volumes of wood and bark of understory hardwoods 1 to 5 inches d.b.h. Eleven species common in the Mountains and Piedmont of the Southeast are described. Of these, yellow-poplar and sweetgum were lowest in green weights due to their low densities (specific gravity = 0.359 to 0.459), while the oaks, dogwood, and hickory were high in green weight due to high specific gravities (0.545 to 0.665). Total-tree green weights ranged from 4 to 9 pounds for 1-inch trees to approximately 150 to 280 pounds for 5-inch trees. Total-tree green weight of wood and bark per cubic foot of wood ranged from 65.2 pounds per cubic foot for yellow-poplar in the Mountains in North Carolina to 93.4 pounds per cubic foot for hickory in the Piedmont in Georgia. The proportion of bark expressed as a percentage of dry weight ranged from 14.4 percent for dogwood in the Mountains to 28.7 percent for hickory in the Piedmont.

**Keywords:** Weight, volume, specific gravity, moisture content, bark content, weight per cubic foot.

## INTRODUCTION

Understory hardwoods less than 5 inches d.b.h., long considered an unmerchantable forest component, are now being harvested for fuel and fiber. Improved equipment such as total-tree chippers and, more recently, mobile chippers make such harvesting practical. This new equipment was developed in part to meet the demand for energy wood, but small hardwoods can also be converted into fiber products.

Since understory hardwoods are essentially a new resource to the forest products industry, it is important to know as much about them as possible. Previous research on small hardwoods has been rather limited. Sollins and Anderson (1971) summarized dry-weight yields for some hardwood species. Barker (1974) and Jett and Zobel (1975) examined the papermaking properties of young hardwoods. The physical properties of understory hardwoods were examined by Phillips and McClure (1976), and green- and dry-weight prediction equations were developed by Phillips (1977) and Wartluft (1977).

This Paper presents regression equations and green and dry weight and cubic-foot volume tables for 11 of the most important understory hardwoods in the Piedmont and Mountain regions of the Southeastern United States. These equations improve and thus effectively replace those presented by Phillips (1977). This Paper also describes wood and bark properties and weight per cubic-foot factors for the 11 species. The information in this report makes it possible to inventory existing stands to determine the understory biomass that is available for harvest.

## PROCEDURES

### FIELD

Sample trees were selected from the understories of mature hardwood and mixed pine-hardwood stands in the Mountains and Piedmont Plateau. Six to eight of the most prevalent species in each physiographic region (as determined from Renewable Resources Evaluation data) were sampled at each of four locations—two in the Mountains in North Carolina, one in the Piedmont in Georgia, and one in the Piedmont in South Carolina (fig. 1).

At each location, approximately 12 trees of each species were sampled. Three trees were taken from each 1-inch d.b.h. class from 1 to 4 inches. Diameter classes were: 1-inch class (1.0 to 1.9 inches), 2-inch class (2.0 to 2.9 inches), 3-inch class (3.0 to 3.9 inches), and the 4-inch class (4.0 to 4.9 inches). Average d.b.h., total height, and age of understory hardwoods in the Mountain and Piedmont regions are given in table 1.

Trees were cut in winter when leaves were absent. Each tree was felled, separated into stem and branches, and weighed. Stems were measured from ground level to the terminal bud. Cross-sectional disks were cut from the stems of most trees at 1 foot, at 4.5 feet, and at 25, 50, 75, and near 100 percent of total-tree height. In some small trees, disks were taken only at 1 foot, 4.5 feet, and 75 percent of total height. Three to nine branch samples were taken from the lower, middle, and upper portions of the crown and processed as a unit to determine wood and bark specific gravity and moisture content of branches.

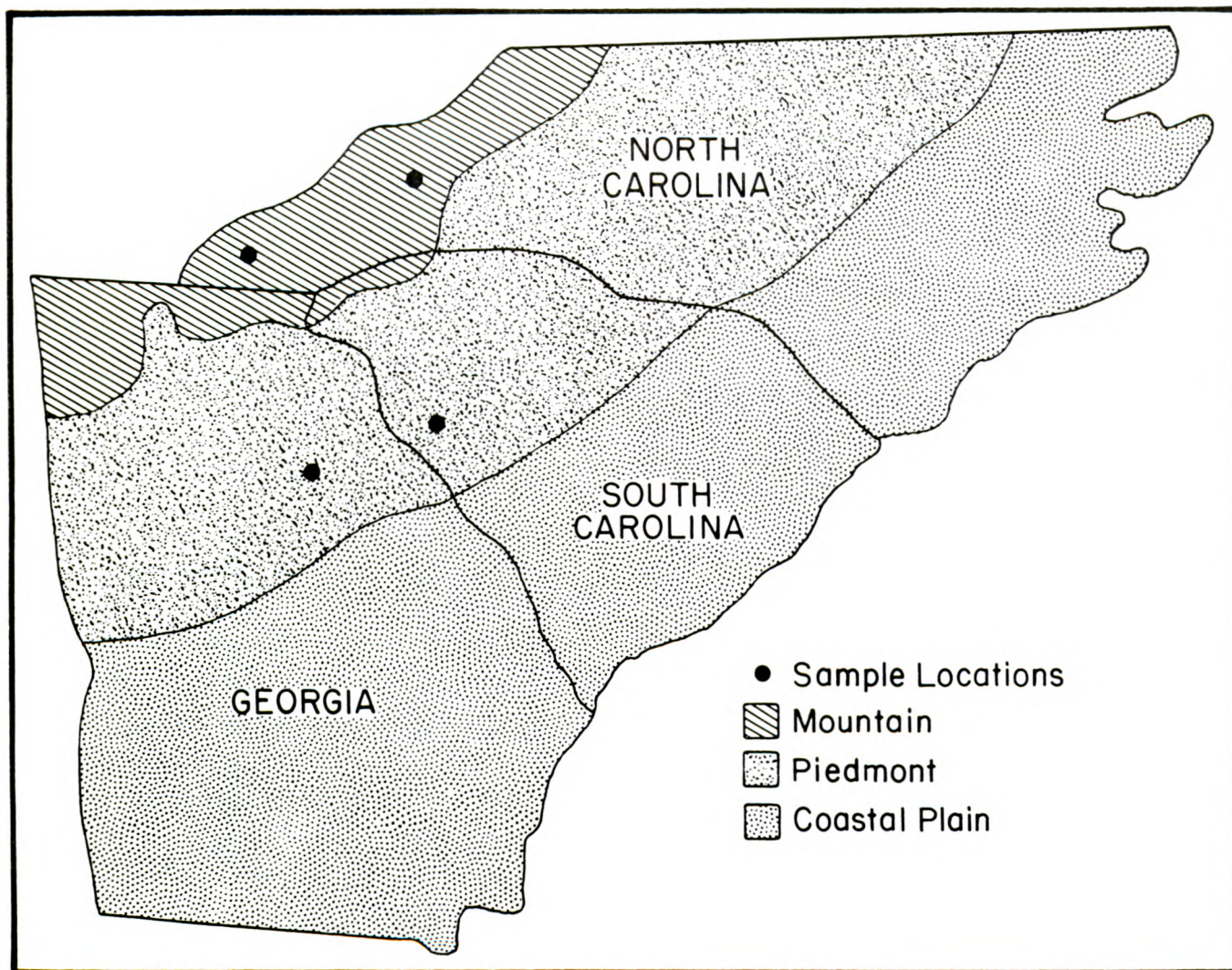


Figure 1.—Physiographic regions and locations where understory hardwoods were sampled.

## LABORATORY

In the laboratory, disk samples were weighed green, and diameter outside bark and inside bark were measured. Samples were then soaked for 2 to 3 days before determinations of green volume by displacement. Oven-dry weights were determined after samples were dried to a constant weight of 103°C. Specific gravity was computed on a green-volume and oven-dry-weight basis. Moisture content was computed on an oven-dry-weight basis. Percentage of bark was determined on a dry-weight basis from disk samples. Weighted values for specific gravity, moisture content, and bark percentage were calculated by weighting disk values in proportion to the component they represented.

Dry weights (oven-dry weight at 103°C) were calculated from measured green weights and weighted tree moisture contents using the following formula:

$$DWT = (GWT / (1 + (MC / 100)))$$

where: DWT = dry weight

GWT = green weight of tree or component

MC = weighted tree moisture content in percent.

Green weights per cubic-foot factors were computed from weighted tree specific gravity and moisture content values using the following formula:

$$GWT/FT^3 = (1 + (MC / 100)) \times SG \times 62.43$$

where: GWT/FT<sup>3</sup> = green weight per cubic foot

MC = weighted tree moisture content in percent

SG = weighted tree specific gravity.

Dry weights per cubic foot were computed using specific gravity.

$$DWT/FT^3 = SG \times 62.43$$

The cubic volume of wood and bark in the stem, crown, and the total tree were determined by dividing each component's weight by its weight per cubic foot.

## STATISTICAL

Standard regression analyses were applied to data on each species at each location and on soft hardwoods (yellow-poplar, sourwood, blackgum, red maple, and sweetgum), hard hardwoods (white oak, chestnut oak, post oak, southern red oak, dogwood, and hickory), and all species combined. Linear equations were developed



Table 1. D.b.h., total height, and age of understory hardwoods sampled at four locations

| Species          | Sample trees  | D.b.h.                    |           | Total height            |         | Age                      |         |
|------------------|---------------|---------------------------|-----------|-------------------------|---------|--------------------------|---------|
|                  |               | Mean                      | Range     | Mean                    | Range   | Mean                     | Range   |
|                  | <i>Number</i> | <i>----- Inches -----</i> |           | <i>----- Feet -----</i> |         | <i>----- Years -----</i> |         |
| MOUNTAINS        |               |                           |           |                         |         |                          |         |
| Yellow-poplar    | 24            | 3.0                       | 1.1 - 4.9 | 36.4                    | 21 - 60 | 18.9                     | 12 - 26 |
| Sourwood         | 11            | 3.1                       | 1.5 - 4.9 | 35.4                    | 23 - 56 | 31.3                     | 15 - 56 |
| Blackgum         | 18            | 3.3                       | 1.6 - 4.9 | 36.8                    | 21 - 60 | 37.5                     | 17 - 58 |
| Red maple        | 24            | 2.9                       | 1.2 - 4.6 | 38.0                    | 19 - 59 | 33.6                     | 12 - 70 |
| White oak        | 18            | 2.7                       | 1.1 - 4.9 | 26.9                    | 14 - 45 | 37.7                     | 12 - 60 |
| Chestnut oak     | 24            | 3.0                       | 1.5 - 4.7 | 34.0                    | 19 - 51 | 33.2                     | 12 - 56 |
| Dogwood          | 24            | 2.9                       | 1.0 - 4.9 | 26.0                    | 15 - 42 | 39.3                     | 17 - 75 |
| Hickory          | 24            | 3.0                       | 1.2 - 4.9 | 34.1                    | 17 - 60 | 38.7                     | 16 - 57 |
| PIEDMONT         |               |                           |           |                         |         |                          |         |
| Yellow-poplar    | 24            | 3.0                       | 1.0 - 4.9 | 35.1                    | 17 - 53 | 22.7                     | 6 - 36  |
| Sweetgum         | 24            | 3.3                       | 1.3 - 4.8 | 30.6                    | 15 - 48 | 26.7                     | 9 - 44  |
| Red maple        | 23            | 2.9                       | 1.3 - 4.5 | 34.4                    | 22 - 49 | 32.4                     | 14 - 45 |
| White oak        | 23            | 2.9                       | 1.2 - 4.9 | 29.8                    | 15 - 49 | 33.7                     | 18 - 55 |
| Post oak         | 12            | 3.0                       | 1.3 - 4.7 | 28.6                    | 15 - 43 | 29.8                     | 20 - 53 |
| Southern red oak | 25            | 3.1                       | 1.1 - 4.6 | 32.5                    | 13 - 49 | 30.9                     | 10 - 53 |
| Dogwood          | 24            | 3.0                       | 1.1 - 4.7 | 27.2                    | 16 - 35 | 35.0                     | 9 - 55  |
| Hickory          | 22            | 2.9                       | 1.0 - 4.7 | 31.4                    | 16 - 48 | 33.8                     | 13 - 56 |

using diameter at breast height squared ( $D^2$ ) and diameter at breast height squared times total height ( $D^2Th$ ) as independent variables. Plots of residuals across the  $D^2$  and  $D^2Th$  scales showed that the variance of  $Y$  increased as tree diameters and heights increased. Logarithmic transformations of the data were performed to make the variances more homogeneous and thus satisfy this assumption of regression. The resulting logarithmic equations proved to be better predictors than the linear equations, but Cunia (1964) cautioned that predicted values on the logarithmic scale are slightly biased downward when they are returned to the original scale. Baskerville (1972) proposed a correction factor for natural logarithms which we modified<sup>1</sup> to satisfy common logarithms. This correction factor was not used, however, since the bias in any given equation was less than 2 percent.

The final forms of the equations were:

$$\log_{10} Y = \log_{10} a + b \log_{10} (D^2) + \epsilon \quad (1)$$

$$\text{Thus, } Y = a(D^2)^b \epsilon$$

and

$$\log_{10} Y = \log_{10} a + b \log_{10} (D^2Th) + \epsilon$$

$$\text{Thus, } Y = a(D^2Th)^b \epsilon \quad (2)$$

where:  $Y$  = total-tree weight or volume

$a, b$  = regression coefficients

$D^2$  = diameter at breast height squared

$Th$  = total-tree height

$\epsilon$  = experimental error

## RESULTS

### AVERAGE TOTAL-TREE CHARACTERISTICS

The average green weight of 148 soft hardwood trees was 79.0 pounds, compared to 76.3 pounds for 196 hard hardwood trees (table 2). The soft hardwoods weighed more than the hard hardwoods because they were larger. Average diameter and total height were 3.02 inches and 35.2 feet for soft hardwoods and 2.94 inches and 30.3 feet for the hard hardwoods. Volume of the average soft hardwood was 1.372 cubic feet; that for the average hard hardwood was 1.220 cubic feet (table 2).

The higher density of the hard hardwoods shows up in tree dry weights. The average dry weight of hard hardwoods was 45.6 pounds compared to 39.4 pounds for soft hardwoods, even though the soft hardwoods were larger. Hard hardwoods contained more bark (23.7 percent) than soft hardwoods (20.7 percent), and were older (35 years old compared to 28 years old for soft hardwoods).

Total-tree green weight, dry weight, and cubic-foot volume increased steadily with increasing d.b.h. as would be expected (table 2). Bark percentage decreased as tree d.b.h. increased, while average age of the trees increased with increasing d.b.h.

**Specific gravity.**—Table 3 gives the specific gravity values of wood and bark and wood alone for stems,

Table 2.—Average total-tree green weight, dry weight, cubic volume, dry bark content, and age of understory hard hardwoods and soft hardwoods by d.b.h. class

| D.b.h. class <sup>a</sup>         | Sample trees  | Actual d.b.h. | Total height | Average total-tree    |            |                   |                  |              |
|-----------------------------------|---------------|---------------|--------------|-----------------------|------------|-------------------|------------------|--------------|
|                                   |               |               |              | Green weight          | Dry weight | Volume            | Dry bark content | Age          |
|                                   | <i>Number</i> | <i>Inches</i> | <i>Feet</i>  | <i>--- Pounds ---</i> |            | <i>Cubic feet</i> | <i>Percent</i>   | <i>Years</i> |
| <b>SOFT HARDWOODS<sup>b</sup></b> |               |               |              |                       |            |                   |                  |              |
| 1                                 | 35            | 1.55          | 23.0         | 13.8                  | 6.7        | 0.241             | 24.2             | 20           |
| 2                                 | 36            | 2.46          | 31.3         | 39.3                  | 19.2       | .679              | 21.3             | 25           |
| 3                                 | 39            | 3.47          | 38.9         | 90.9                  | 45.1       | 1.570             | 19.4             | 31           |
| 4                                 | 38            | 4.44          | 46.2         | 164.4                 | 83.0       | 2.866             | 18.3             | 36           |
| Weighted average                  | 148           | 3.02          | 35.2         | 79.0                  | 39.4       | 1.372             | 20.7             | 28           |
| <b>HARD HARDWOODS<sup>c</sup></b> |               |               |              |                       |            |                   |                  |              |
| 1                                 | 49            | 1.54          | 19.1         | 13.5                  | 8.0        | .219              | 27.7             | 24           |
| 2                                 | 54            | 2.48          | 27.6         | 41.2                  | 24.8       | .664              | 24.2             | 32           |
| 3                                 | 46            | 3.47          | 35.3         | 94.3                  | 56.5       | 1.503             | 21.7             | 40           |
| 4                                 | 47            | 4.41          | 40.1         | 164.6                 | 98.1       | 2.626             | 21.0             | 45           |
| Weighted average                  | 196           | 2.94          | 30.3         | 76.3                  | 45.6       | 1.220             | 23.7             | 35           |

<sup>a</sup>D.b.h. classes were broken down as follows:

1-inch class = 1.0 to 1.9 inches

2-inch class = 2.0 to 2.9 inches, etc.

<sup>b</sup>The soft hardwood group is made up of yellow-poplar, sweetgum, sourwood, blackgum, and red maple.

<sup>c</sup>The hard hardwood group is made up of white oak, chestnut oak, post oak, southern red oak, dogwood, and hickory.

Table 3.—Specific gravity, moisture content, and bark percentage of understory hardwoods

| Species             | Number of sample trees | Specific gravity |               |          |               |            |               | Moisture content, wood and bark |          |            | Bark content |          |            |
|---------------------|------------------------|------------------|---------------|----------|---------------|------------|---------------|---------------------------------|----------|------------|--------------|----------|------------|
|                     |                        | Stem             |               | Branches |               | Total tree |               |                                 |          |            |              |          |            |
|                     |                        | Wood             | Wood and bark | Wood     | Wood and bark | Wood       | Wood and bark | Stem                            | Branches | Total tree | Stem         | Branches | Total tree |
| ----- Percent ----- |                        |                  |               |          |               |            |               |                                 |          |            |              |          |            |
| MOUNTAINS           |                        |                  |               |          |               |            |               |                                 |          |            |              |          |            |
| Yellow-poplar       | 24                     | 0.361            | 0.359         | 0.393    | 0.393         | 0.365      | 0.363         | 127                             | 120      | 126        | 20.3         | 30.3     | 21.4       |
| Sourwood            | 11                     | .510             | .467          | .481     | .459          | .505       | .466          | 97                              | 108      | 99         | 17.3         | 26.2     | 18.8       |
| Blackgum            | 18                     | .555             | .516          | .511     | .503          | .548       | .516          | 84                              | 100      | 86         | 17.6         | 27.7     | 19.2       |
| Red maple           | 24                     | .501             | .510          | .487     | .501          | .499       | .508          | 90                              | 97       | 91         | 18.4         | 25.3     | 19.7       |
| White oak           | 18                     | .627             | .592          | .581     | .565          | .621       | .589          | 67                              | 73       | 68         | 22.4         | 33.2     | 23.9       |
| Chestnut oak        | 24                     | .632             | .600          | .582     | .569          | .626       | .597          | 64                              | 70       | 64         | 25.8         | 36.2     | 27.0       |
| Dogwood             | 24                     | .621             | .576          | .609     | .574          | .618       | .576          | 74                              | 79       | 76         | 13.4         | 16.8     | 14.4       |
| Hickory             | 24                     | .633             | .601          | .566     | .545          | .625       | .594          | 56                              | 61       | 57         | 27.9         | 32.9     | 28.4       |
| PIEDMONT            |                        |                  |               |          |               |            |               |                                 |          |            |              |          |            |
| Yellow-poplar       | 24                     | .395             | .396          | .401     | .397          | .396       | .396          | 137                             | 136      | 136        | 21.8         | 32.2     | 23.5       |
| Sweetgum            | 24                     | .448             | .411          | .459     | .447          | .450       | .417          | 117                             | 120      | 117        | 22.9         | 30.6     | 24.0       |
| Red maple           | 23                     | .514             | .529          | .497     | .503          | .510       | .522          | 83                              | 85       | 84         | 14.9         | 22.5     | 16.8       |
| White oak           | 23                     | .630             | .592          | .617     | .569          | .628       | .589          | 69                              | 69       | 69         | 23.4         | 35.0     | 24.7       |
| Post oak            | 12                     | .652             | .574          | .607     | .548          | .647       | .570          | 68                              | 61       | 67         | 20.2         | 38.2     | 22.2       |
| Southern red oak    | 25                     | .607             | .612          | .618     | .606          | .609       | .612          | 67                              | 63       | 67         | 27.9         | 30.6     | 28.3       |
| Dogwood             | 24                     | .624             | .582          | .625     | .578          | .625       | .581          | 78                              | 88       | 81         | 15.1         | 17.0     | 15.7       |
| Hickory             | 22                     | .671             | .651          | .632     | .590          | .665       | .641          | 58                              | 66       | 59         | 28.1         | 32.4     | 28.7       |

----- Percent -----



branches, and the total tree of 11 understory hardwood species. Yellow-poplar was lowest in specific gravity for all components (0.36 - 0.40), followed by sweetgum (0.41 - 0.46), and sourwood (0.46 - 0.51). Red maple (0.49 - 0.53) and blackgum (0.50 - 0.56) were intermediate in specific gravity, while the oaks (0.55 - 0.65), dogwood (0.57 - 0.62), and hickory (0.55 - 0.67) were highest. In terms of components, the highest specific gravity was for wood in the stem, while the lowest specific gravity was generally for wood and bark of branches. Red maple and southern red oak bark was generally higher in specific gravity than the wood from the same trees. Yellow-poplar wood had about the same density as yellow-poplar bark. The oaks, hickory, and especially dogwood had bark that was lower in specific gravity than the wood.

Specific gravity by species and component was always higher in the Piedmont than in the Mountains. The largest differences in stem specific gravity were for yellow-poplar (0.361 and 0.359 in the Mountains compared to 0.395 and 0.396 in the Piedmont) and hickory (0.633 and 0.601 in the Mountains compared to 0.671 and 0.651 in the Piedmont). The largest differences in branch specific gravity were for white oak (0.581 and 0.565 in the Mountains compared to 0.617 and 0.569 in the Piedmont) and hickory (0.566 and 0.545 in the Mountains compared to 0.632 and 0.590 in the Piedmont).

**Moisture content.**—Understory yellow-poplar was higher in moisture content by far than any other species sampled. Average total-tree moisture content (dry-weight basis) was 126 percent for yellow-poplar trees sampled in the Mountains and 136 percent for those sampled in the Piedmont (table 3). Only sweetgum was close to these highs with an average total-tree moisture content of 117 percent. All other species sampled had total-tree moisture contents below 100 percent. Hickory was lowest in moisture content with total-tree values of 57 percent in the Mountains and 59 percent in the Piedmont. Moisture contents for a given species were generally higher in the Piedmont than in the Mountains.

**Bark content.**—Understory hardwoods have more bark than do larger trees of the same species. Bark content (dry-weight basis) for the 11 species sampled ranged from 14.4 to 28.7 percent of the total tree (table 3). Chestnut oak, southern red oak, and hickory had the highest bark contents (27.0 to 28.7 percent of the total tree), while dogwood had the lowest (14.4 to 15.7 percent) (table 3).

As expected, branches contained a much higher proportion of bark than stems. Branch bark content was highest for post oak, chestnut oak, and white oak (33.2 to 38.2 percent) and lowest for dogwood (16.8 to 17.0 percent).

Bark content of most species was slightly higher in the Piedmont than in the Mountains. The one exception was red maple, which had more bark in the Mountains than in the Piedmont.

**Weights per cubic foot.**—Green and dry weight per cubic foot factors for understory hardwoods are given by species and geographic region in table 4. The green weight

of wood and bark per cubic foot of wood for stems ranged from 63.4 pounds per cubic foot for yellow-poplar in the Mountains to 92.5 pounds per cubic foot for hickory in the Piedmont. The values for branches ranged from 54.2 pounds per cubic foot for yellow-poplar in the Mountains to 103.5 pounds per cubic foot for post oak in the Piedmont. These weight per cubic foot values for small understory trees are higher than reported values for larger trees (Clark and others 1980a, 1980b). This difference is predictable, since small trees contain a higher proportion of bark than larger ones.

The green and dry weights of wood and bark per cubic foot of wood and bark showed trends similar to the weight-volume ratios just discussed. The lowest values were for yellow-poplar, especially in the Mountains, and the highest values were for southern red oak, dogwood, and hickory in the Piedmont. The weights of wood and bark per cubic foot of wood and bark for understory trees are similar to values reported for larger overstory trees (Jett and Zobel 1975).

#### REGRESSION EQUATIONS

Regression equations for predicting total-tree green weight, dry weight, and cubic-foot volume of understory hardwoods are presented in tables 5 through 12 in the Appendix. Tables 5 through 8 contain equations for predicting total-tree green weight, dry weight, cubic-foot volume of wood and bark, and cubic-foot volume of wood alone for species in the Mountains, in the Piedmont, and in both regions combined when both d.b.h. and total height are known. Tables 9 through 12 present equations for predicting the same dependent variables when only tree diameter is known.

Coefficients of determination ( $R^2$ ) for the equations ranged from 0.93 to 0.99, indicating strong relationships between tree weights and volumes and the independent variables ( $D^2Th$  and  $D^2$ ). Standard errors of the estimate ( $S_{y,x}$ ) show the relative variation between equations and are useful in computing confidence intervals about regression lines. Variation in  $S_{y,x}$  generally increased and  $R^2$  values decreased as data were combined, first across the two locations and then across species and locations. The sample mean of  $x$  ( $\bar{x}$ ) and the corrected sums of squares for  $x$  ( $\Sigma(x-\bar{x})^2$ ) are also given for each equation so confidence limits can be computed for the lognormal means using a procedure by Land (1972) and described on page 6. Prediction equations for soft hardwoods and hard hardwoods did not differ significantly by region, so only the overall combined equations are reported. These combined equations are provided for general use where species breakdowns are not practical or desired.

#### TOTAL-TREE GREEN-WEIGHT TABLES

Predicted total-tree green weights of 11 understory hardwood species, by d.b.h. classes from 1 to 6 inches and by total-tree height classes from 15 to 60 feet, are presented in Appendix tables 13 through 26. Predictions were extended to 6 inches (1-inch beyond the range of the data) for those who may want to use the data to this level.



Table 4.—Green and dry weight per cubic-foot factors for understory hardwoods

| Species                       | Green weight of wood and bark per cubic foot of wood |          |            | Green weight of wood and bark per foot of wood and bark <sup>a</sup> |          |            | Dry weight of wood and bark per cubic foot of wood and bark <sup>a</sup> |          |            |
|-------------------------------|------------------------------------------------------|----------|------------|----------------------------------------------------------------------|----------|------------|--------------------------------------------------------------------------|----------|------------|
|                               | Stem                                                 | Branches | Total tree | Stem                                                                 | Branches | Total tree | Stem                                                                     | Branches | Total tree |
| ----- Pounds/cubic foot ----- |                                                      |          |            |                                                                      |          |            |                                                                          |          |            |
| MOUNTAINS                     |                                                      |          |            |                                                                      |          |            |                                                                          |          |            |
| Yellow-poplar                 | 63.4                                                 | 84.2     | 65.2       | 50.9                                                                 | 53.3     | 51.2       | 22.4                                                                     | 24.5     | 22.7       |
| Sourwood                      | 76.6                                                 | 94.5     | 79.4       | 57.6                                                                 | 59.4     | 58.0       | 29.2                                                                     | 28.6     | 29.1       |
| Blackgum                      | 76.6                                                 | 99.5     | 80.0       | 59.7                                                                 | 62.1     | 60.1       | 32.2                                                                     | 31.4     | 32.2       |
| Red maple                     | 72.2                                                 | 75.9     | 72.7       | 60.1                                                                 | 61.4     | 60.4       | 31.8                                                                     | 31.3     | 31.7       |
| White oak                     | 81.5                                                 | 88.8     | 82.4       | 61.5                                                                 | 61.0     | 61.5       | 34.4                                                                     | 36.9     | 36.8       |
| Chestnut oak                  | 86.9                                                 | 100.8    | 88.2       | 61.3                                                                 | 60.4     | 61.2       | 37.5                                                                     | 35.5     | 37.2       |
| Dogwood                       | 77.6                                                 | 81.6     | 78.7       | 62.5                                                                 | 64.2     | 63.1       | 36.0                                                                     | 35.8     | 36.0       |
| Hickory                       | 85.8                                                 | 86.8     | 85.9       | 58.5                                                                 | 54.9     | 58.1       | 37.5                                                                     | 34.0     | 37.1       |
| PIEDMONT                      |                                                      |          |            |                                                                      |          |            |                                                                          |          |            |
| Yellow-poplar                 | 74.8                                                 | 86.0     | 76.4       | 58.4                                                                 | 58.2     | 58.3       | 24.7                                                                     | 24.8     | 24.7       |
| Sweetgum                      | 80.1                                                 | 91.0     | 81.5       | 55.5                                                                 | 61.0     | 56.4       | 25.6                                                                     | 27.9     | 26.0       |
| Red maple                     | 70.5                                                 | 77.4     | 72.3       | 60.2                                                                 | 58.1     | 59.7       | 33.0                                                                     | 31.4     | 32.6       |
| White oak                     | 86.1                                                 | 94.2     | 87.0       | 62.2                                                                 | 60.2     | 62.0       | 37.0                                                                     | 35.5     | 36.8       |
| Post oak                      | 91.8                                                 | 103.5    | 92.9       | 60.1                                                                 | 56.0     | 59.7       | 35.8                                                                     | 34.2     | 35.6       |
| Southern red oak              | 92.0                                                 | 87.9     | 91.3       | 64.0                                                                 | 61.9     | 63.8       | 38.2                                                                     | 37.8     | 38.2       |
| Dogwood                       | 86.9                                                 | 83.8     | 85.9       | 64.7                                                                 | 68.0     | 65.7       | 36.6                                                                     | 36.1     | 36.3       |
| Hickory                       | 92.5                                                 | 97.2     | 93.4       | 64.1                                                                 | 61.0     | 63.6       | 40.7                                                                     | 36.9     | 40.0       |

<sup>a</sup>Wood and bark cubic volume was determined by dividing wood and bark weight by wood and bark weight per cubic foot and thus does not include air space in the bark fissures.

In many cases (for example, for dogwood, sourwood, and possibly other species), predictions beyond 6 inches may be used, since equations for trees larger than 6 inches are not available. These tables were generated from equations in Appendix table 5. The most general equations were used, and thus the tables should have broad application across both geographic regions examined. Tables 13 through 23 give predicted weights of individual species. Tables 24 through 26 are general overall equations for soft hardwoods, hard hardwoods, and all hardwoods combined.

Predicted total-tree green weights of understory hardwoods based on d.b.h. alone ( $D^2$ ) are given in table 27. Weights are given by 1-inch diameter classes from 1 to 6 inches for each species in both the Mountain and Piedmont regions and for soft hardwoods and hard hardwoods. Differences between species are minimized when a single variable is used. The difference between soft and hard hardwoods is also small because soft hardwoods of a given diameter tend to be taller than hard hardwoods of the same diameter (see table 1).

The equations and yield tables in this report are directly applicable only to understory hardwoods in the Mountains and Piedmont of the Southeastern United States. Caution should be used when the equations are used in different regions of the country.

## COMPUTATION OF CONFIDENCE LIMITS

Tables 5 through 12 contain the standard errors of the estimate, the sample mean of  $x$  and the corrected sums of squares for  $x$  for each equation in  $\text{Log}_{10}$  form. These statistics can be used to calculate approximate confidence limits in pounds or cubic feet by using a modification of Cox's formula (Land 1972) for estimating confidence limits for lognormal means:

$$Y_{U,L} = 10^{\text{Log } Y \pm Z \sqrt{S_{y,x}^2 \left[ \frac{1}{n} + \frac{(x - \bar{x})^2}{\Sigma(x - \bar{x})^2} \right] + \frac{S_{y,x}^4}{2(n+1)}}}$$

- where:  $Y_{U,L}$  = upper and lower limits for  $Y$   
 $Y$  = predicted weight or volume  
 $Z$  = value from the standard normal table for appropriate confidence level  
 $S_{y,x}$  = standard error of estimate for prediction equation  
 $n$  = number of observations used to develop the equation  
 $\bar{x}$  = sample mean of  $\log x$ —(from table of equations)  
 $\Sigma(x - \bar{x})^2$  = corrected sums of squares for  $\log x$ —(from table of equations)



x = value of independent variable in  $\log_{10}$  form.

Cox's method of approximation sufficiently estimates actual confidence limits when applied to samples with small variances, as occur in the total-tree weight and volume equations in this Paper.

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## Appendix

Table 5.—Regression equations and associated statistics for predicting total-tree green weight of understory hardwoods based on diameter squared times total height ( $D^2Th$ )

| Species            | Number trees sampled (N) | Regression equation             | Standard error of estimate ( $S_{y.x}$ ) <sup>a</sup> | Sample mean of x ( $\bar{x}$ ) <sup>a</sup> | Corrected sums of squares for x ( $\Sigma(x-\bar{x})^2$ ) <sup>a</sup> | Coefficient of determination ( $R^2$ ) |
|--------------------|--------------------------|---------------------------------|-------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------|----------------------------------------|
| MOUNTAINS          |                          |                                 |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.30860 (D^2Th)^{0.89369}$ | 0.046                                                 | 2.409                                       | 5.867                                                                  | 0.99                                   |
| Sourwood           | 11                       | $Y = 0.31997 (D^2Th)^{0.93059}$ | .046                                                  | 2.449                                       | 2.025                                                                  | .99                                    |
| Blackgum           | 18                       | $Y = 0.52910 (D^2Th)^{0.83757}$ | .086                                                  | 2.554                                       | 2.971                                                                  | .95                                    |
| Red maple          | 24                       | $Y = 0.40005 (D^2Th)^{0.89596}$ | .054                                                  | 2.421                                       | 5.659                                                                  | .99                                    |
| White oak          | 18                       | $Y = 0.43637 (D^2Th)^{0.87624}$ | .042                                                  | 2.196                                       | 4.533                                                                  | .99                                    |
| Chestnut oak       | 24                       | $Y = 0.44567 (D^2Th)^{0.87324}$ | .040                                                  | 2.410                                       | 4.859                                                                  | .99                                    |
| Dogwood            | 24                       | $Y = 0.58180 (D^2Th)^{0.86365}$ | .062                                                  | 2.247                                       | 6.060                                                                  | .98                                    |
| Hickory            | 24                       | $Y = 0.38728 (D^2Th)^{0.89089}$ | .041                                                  | 2.401                                       | 5.782                                                                  | .99                                    |
| PIEDMONT           |                          |                                 |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.37031 (D^2Th)^{0.89090}$ | .050                                                  | 2.404                                       | 7.075                                                                  | .99                                    |
| Sweetgum           | 24                       | $Y = 0.34061 (D^2Th)^{0.88255}$ | .082                                                  | 2.353                                       | 5.567                                                                  | .97                                    |
| Red maple          | 23                       | $Y = 0.32119 (D^2Th)^{0.93057}$ | .054                                                  | 2.396                                       | 4.021                                                                  | .98                                    |
| White oak          | 23                       | $Y = 0.50057 (D^2Th)^{0.84452}$ | .084                                                  | 2.300                                       | 5.678                                                                  | .96                                    |
| Post oak           | 12                       | $Y = 0.45540 (D^2Th)^{0.86019}$ | .043                                                  | 2.341                                       | 2.393                                                                  | .99                                    |
| Southern red oak   | 25                       | $Y = 0.55167 (D^2Th)^{0.84140}$ | .079                                                  | 2.400                                       | 6.181                                                                  | .97                                    |
| Dogwood            | 24                       | $Y = 0.37500 (D^2Th)^{0.94932}$ | .050                                                  | 2.300                                       | 4.794                                                                  | .98                                    |
| Hickory            | 22                       | $Y = 0.47978 (D^2Th)^{0.86816}$ | .076                                                  | 2.324                                       | 5.603                                                                  | .97                                    |
| COMBINED EQUATIONS |                          |                                 |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 48                       | $Y = 0.33899 (D^2Th)^{0.89180}$ | .060                                                  | 2.406                                       | 12.942                                                                 | .98                                    |
| Red maple          | 47                       | $Y = 0.36353 (D^2Th)^{0.91070}$ | .053                                                  | 2.409                                       | 9.687                                                                  | .98                                    |
| White oak          | 41                       | $Y = 0.46590 (D^2Th)^{0.86130}$ | .062                                                  | 2.254                                       | 10.320                                                                 | .98                                    |
| Dogwood            | 48                       | $Y = 0.48010 (D^2Th)^{0.90174}$ | .062                                                  | 2.274                                       | 10.889                                                                 | .98                                    |
| Hickory            | 46                       | $Y = 0.43736 (D^2Th)^{0.87668}$ | .062                                                  | 2.364                                       | 11.453                                                                 | .98                                    |
| Soft hardwoods     | 148                      | $Y = 0.35379 (D^2Th)^{0.89767}$ | .074                                                  | 2.420                                       | 33.651                                                                 | .97                                    |
| Hard hardwoods     | 196                      | $Y = 0.47221 (D^2Th)^{0.87186}$ | .071                                                  | 2.328                                       | 46.815                                                                 | .97                                    |
| All hardwoods      | 344                      | $Y = 0.43247 (D^2Th)^{0.87655}$ | .079                                                  | 2.367                                       | 81.178                                                                 | .97                                    |

<sup>a</sup> In  $\log_{10}$  form.



Table 6.—Regression equations and associated statistics for predicting total-tree dry weight of understory hardwoods based on diameter squared times total height ( $D^2Th$ )

| Species            | Number trees sampled (N) | Regression equation             | Standard error of estimate ( $S_{y.x}$ ) <sup>a</sup> | Sample mean of x ( $\bar{x}$ ) <sup>a</sup> | Corrected sums of squares for x ( $\Sigma(x-\bar{x})^2$ ) <sup>a</sup> | Coefficient of determination ( $R^2$ ) |
|--------------------|--------------------------|---------------------------------|-------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------|----------------------------------------|
| MOUNTAINS          |                          |                                 |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.13341 (D^2Th)^{0.89858}$ | 0.058                                                 | 2.409                                       | 5.867                                                                  | 0.98                                   |
| Sourwood           | 11                       | $Y = 0.14272 (D^2Th)^{0.95161}$ | .040                                                  | 2.449                                       | 2.025                                                                  | .99                                    |
| Blackgum           | 18                       | $Y = 0.26845 (D^2Th)^{0.84961}$ | .098                                                  | 2.554                                       | 2.971                                                                  | .93                                    |
| Red maple          | 24                       | $Y = 0.18073 (D^2Th)^{0.92236}$ | .057                                                  | 2.421                                       | 5.659                                                                  | .98                                    |
| White oak          | 18                       | $Y = 0.26024 (D^2Th)^{0.87654}$ | .040                                                  | 2.196                                       | 4.533                                                                  | .99                                    |
| Chestnut oak       | 24                       | $Y = 0.27440 (D^2Th)^{0.87051}$ | .033                                                  | 2.410                                       | 4.859                                                                  | .99                                    |
| Dogwood            | 24                       | $Y = 0.32104 (D^2Th)^{0.87002}$ | .062                                                  | 2.247                                       | 6.060                                                                  | .98                                    |
| Hickory            | 24                       | $Y = 0.24818 (D^2Th)^{0.89025}$ | .042                                                  | 2.401                                       | 5.782                                                                  | .99                                    |
| PIEDMONT           |                          |                                 |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.13868 (D^2Th)^{0.91334}$ | .051                                                  | 2.404                                       | 7.075                                                                  | .99                                    |
| Sweetgum           | 24                       | $Y = 0.16560 (D^2Th)^{0.87099}$ | .081                                                  | 2.353                                       | 5.567                                                                  | .97                                    |
| Red maple          | 23                       | $Y = 0.16183 (D^2Th)^{0.94488}$ | .059                                                  | 2.396                                       | 4.021                                                                  | .98                                    |
| White oak          | 23                       | $Y = 0.28514 (D^2Th)^{0.85215}$ | .089                                                  | 2.300                                       | 5.678                                                                  | .96                                    |
| Post oak           | 12                       | $Y = 0.25516 (D^2Th)^{0.87219}$ | .047                                                  | 2.341                                       | 2.393                                                                  | .99                                    |
| Southern red oak   | 25                       | $Y = 0.34808 (D^2Th)^{0.83893}$ | .075                                                  | 2.400                                       | 6.181                                                                  | .97                                    |
| Dogwood            | 24                       | $Y = 0.20656 (D^2Th)^{0.95000}$ | .061                                                  | 2.300                                       | 4.794                                                                  | .98                                    |
| Hickory            | 22                       | $Y = 0.29434 (D^2Th)^{0.87271}$ | .071                                                  | 2.324                                       | 5.603                                                                  | .98                                    |
| COMBINED EQUATIONS |                          |                                 |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 48                       | $Y = 0.13570 (D^2Th)^{0.90638}$ | .060                                                  | 2.406                                       | 12.942                                                                 | .98                                    |
| Red maple          | 47                       | $Y = 0.17293 (D^2Th)^{0.93153}$ | .057                                                  | 2.409                                       | 9.687                                                                  | .98                                    |
| White oak          | 41                       | $Y = 0.27138 (D^2Th)^{0.86538}$ | .065                                                  | 2.254                                       | 10.320                                                                 | .98                                    |
| Dogwood            | 48                       | $Y = 0.26530 (D^2Th)^{0.90479}$ | .063                                                  | 2.274                                       | 10.889                                                                 | .98                                    |
| Hickory            | 46                       | $Y = 0.27356 (D^2Th)^{0.87912}$ | .059                                                  | 2.364                                       | 11.453                                                                 | .98                                    |
| Soft hardwoods     | 148                      | $Y = 0.15630 (D^2Th)^{0.91501}$ | .103                                                  | 2.420                                       | 33.651                                                                 | .95                                    |
| Hard hardwoods     | 196                      | $Y = 0.27591 (D^2Th)^{0.87600}$ | .064                                                  | 2.328                                       | 46.815                                                                 | .98                                    |
| All hardwoods      | 344                      | $Y = 0.23516 (D^2Th)^{0.87762}$ | .113                                                  | 2.367                                       | 81.178                                                                 | .94                                    |

<sup>a</sup> In  $\log_{10}$  form.

Table 7.—Regression equations and associated statistics for predicting total-tree cubic volume of understory hardwoods based on diameter squared times total height ( $D^2Th$ )

| Species            | Number trees sampled (N) | Regression equation             | Standard error of estimates ( $S_{y.x}$ ) <sup>a</sup> | Sample mean of x ( $\bar{x}$ ) <sup>a</sup> | Corrected sums of squares for x ( $\sum(x-\bar{x})^2$ ) <sup>a</sup> | Coefficient of determination ( $R^2$ ) |
|--------------------|--------------------------|---------------------------------|--------------------------------------------------------|---------------------------------------------|----------------------------------------------------------------------|----------------------------------------|
| MOUNTAINS          |                          |                                 |                                                        |                                             |                                                                      |                                        |
| Yellow-poplar      | 24                       | $Y = 0.00678 (D^2Th)^{0.87286}$ | 0.044                                                  | 2.409                                       | 5.867                                                                | 0.99                                   |
| Sourwood           | 11                       | $Y = 0.00527 (D^2Th)^{0.93907}$ | .036                                                   | 2.449                                       | 2.025                                                                | .99                                    |
| Blackgum           | 18                       | $Y = 0.00945 (D^2Th)^{0.82658}$ | .082                                                   | 2.554                                       | 2.971                                                                | .95                                    |
| Red maple          | 24                       | $Y = 0.00651 (D^2Th)^{0.89940}$ | .044                                                   | 2.421                                       | 5.659                                                                | .99                                    |
| White oak          | 18                       | $Y = 0.00777 (D^2Th)^{0.85866}$ | .043                                                   | 2.196                                       | 4.533                                                                | .99                                    |
| Chestnut oak       | 24                       | $Y = 0.00733 (D^2Th)^{0.87194}$ | .037                                                   | 2.410                                       | 4.859                                                                | .99                                    |
| Dogwood            | 24                       | $Y = 0.00895 (D^2Th)^{0.86951}$ | .059                                                   | 2.247                                       | 6.060                                                                | .98                                    |
| Hickory            | 24                       | $Y = 0.00735 (D^2Th)^{0.87356}$ | .049                                                   | 2.401                                       | 5.782                                                                | .99                                    |
| PIEDMONT           |                          |                                 |                                                        |                                             |                                                                      |                                        |
| Yellow-poplar      | 24                       | $Y = 0.00603 (D^2Th)^{0.90075}$ | .042                                                   | 2.404                                       | 7.075                                                                | .99                                    |
| Sweetgum           | 24                       | $Y = 0.00648 (D^2Th)^{0.86877}$ | .065                                                   | 2.353                                       | 5.567                                                                | .98                                    |
| Red maple          | 23                       | $Y = 0.00512 (D^2Th)^{0.93968}$ | .056                                                   | 2.396                                       | 4.021                                                                | .98                                    |
| White oak          | 23                       | $Y = 0.00839 (D^2Th)^{0.83759}$ | .079                                                   | 2.300                                       | 5.678                                                                | .97                                    |
| Post oak           | 12                       | $Y = 0.00889 (D^2Th)^{0.83218}$ | .035                                                   | 2.341                                       | 2.393                                                                | .99                                    |
| Southern red oak   | 25                       | $Y = 0.00954 (D^2Th)^{0.82383}$ | .076                                                   | 2.400                                       | 6.181                                                                | .97                                    |
| Dogwood            | 24                       | $Y = 0.00546 (D^2Th)^{0.95798}$ | .061                                                   | 2.300                                       | 4.794                                                                | .98                                    |
| Hickory            | 22                       | $Y = 0.00787 (D^2Th)^{0.86038}$ | .067                                                   | 2.324                                       | 5.603                                                                | .98                                    |
| COMBINED EQUATIONS |                          |                                 |                                                        |                                             |                                                                      |                                        |
| Yellow-poplar      | 48                       | $Y = 0.00635 (D^2Th)^{0.83802}$ | .048                                                   | 2.406                                       | 12.942                                                               | .99                                    |
| Red maple          | 47                       | $Y = 0.00587 (D^2Th)^{0.91636}$ | .050                                                   | 2.409                                       | 9.687                                                                | .99                                    |
| White oak          | 41                       | $Y = 0.00804 (D^2Th)^{0.84940}$ | .059                                                   | 2.254                                       | 10.320                                                               | .98                                    |
| Dogwood            | 48                       | $Y = 0.00722 (D^2Th)^{0.90780}$ | .063                                                   | 2.274                                       | 10.889                                                               | .98                                    |
| Hickory            | 46                       | $Y = 0.00760 (D^2Th)^{0.86717}$ | .054                                                   | 2.364                                       | 11.453                                                               | .99                                    |
| Soft hardwoods     | 148                      | $Y = 0.00632 (D^2Th)^{0.89344}$ | .061                                                   | 2.420                                       | 33.651                                                               | .98                                    |
| Hard hardwoods     | 196                      | $Y = 0.00787 (D^2Th)^{0.86537}$ | .064                                                   | 2.328                                       | 46.815                                                               | .98                                    |
| All hardwoods      | 344                      | $Y = 0.00729 (D^2Th)^{0.87440}$ | .064                                                   | 2.367                                       | 81.178                                                               | .98                                    |

<sup>a</sup> In  $\log_{10}$  form.



Table 8.—Regression equations and associated statistics for predicting the cubic volume of wood in the total tree for understory hardwoods based on diameter squared times total height ( $D^2Th$ )

| Species            | Number trees sampled (N) | Regression equation             | Standard error of estimate ( $S_{y,x}$ ) <sup>a</sup> | Sample mean of x ( $\bar{x}$ ) <sup>a</sup> | Corrected sums of squares for x ( $\Sigma(x-\bar{x})^2$ ) <sup>a</sup> | Coefficient of determination ( $R^2$ ) |
|--------------------|--------------------------|---------------------------------|-------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------|----------------------------------------|
| MOUNTAINS          |                          |                                 |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.00420 (D^2Th)^{0.91502}$ | 0.036                                                 | 2.409                                       | 5.867                                                                  | 0.99                                   |
| Sourwood           | 11                       | $Y = 0.00431 (D^2Th)^{0.91650}$ | .034                                                  | 2.449                                       | 2.025                                                                  | .99                                    |
| Blackgum           | 18                       | $Y = 0.00651 (D^2Th)^{0.84033}$ | .067                                                  | 2.554                                       | 2.971                                                                  | .97                                    |
| Red maple          | 24                       | $Y = 0.00506 (D^2Th)^{0.91027}$ | .049                                                  | 2.421                                       | 5.659                                                                  | .99                                    |
| White oak          | 18                       | $Y = 0.00472 (D^2Th)^{0.89935}$ | .056                                                  | 2.196                                       | 4.533                                                                  | .99                                    |
| Chestnut oak       | 24                       | $Y = 0.00441 (D^2Th)^{0.89612}$ | .042                                                  | 2.410                                       | 4.859                                                                  | .99                                    |
| Dogwood            | 24                       | $Y = 0.00710 (D^2Th)^{0.87000}$ | .072                                                  | 2.247                                       | 6.060                                                                  | .98                                    |
| Hickory            | 24                       | $Y = 0.00422 (D^2Th)^{0.90203}$ | .047                                                  | 2.401                                       | 5.782                                                                  | .99                                    |
| PIEDMONT           |                          |                                 |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.00405 (D^2Th)^{0.92507}$ | .052                                                  | 2.404                                       | 7.075                                                                  | .99                                    |
| Sweetgum           | 24                       | $Y = 0.00414 (D^2Th)^{0.88208}$ | .093                                                  | 2.353                                       | 5.567                                                                  | .96                                    |
| Red maple          | 23                       | $Y = 0.00351 (D^2Th)^{0.97130}$ | .063                                                  | 2.396                                       | 4.021                                                                  | .98                                    |
| White oak          | 23                       | $Y = 0.00458 (D^2Th)^{0.88804}$ | .061                                                  | 2.300                                       | 5.678                                                                  | .98                                    |
| Post oak           | 12                       | $Y = 0.00362 (D^2Th)^{0.92006}$ | .029                                                  | 2.341                                       | 2.393                                                                  | .99                                    |
| Southern red oak   | 25                       | $Y = 0.00466 (D^2Th)^{0.89415}$ | .046                                                  | 2.400                                       | 6.181                                                                  | .99                                    |
| Dogwood            | 24                       | $Y = 0.00474 (D^2Th)^{0.93312}$ | .055                                                  | 2.300                                       | 4.794                                                                  | .98                                    |
| Hickory            | 22                       | $Y = 0.00402 (D^2Th)^{0.91208}$ | .066                                                  | 2.324                                       | 5.603                                                                  | .98                                    |
| COMBINED EQUATIONS |                          |                                 |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 48                       | $Y = 0.00411 (D^2Th)^{0.92046}$ | .044                                                  | 2.406                                       | 12.942                                                                 | .99                                    |
| Red maple          | 47                       | $Y = 0.00433 (D^2Th)^{0.93599}$ | .057                                                  | 2.409                                       | 9.687                                                                  | .98                                    |
| White oak          | 41                       | $Y = 0.00473 (D^2Th)^{0.88911}$ | .060                                                  | 2.254                                       | 10.320                                                                 | .98                                    |
| Dogwood            | 48                       | $Y = 0.00599 (D^2Th)^{0.89600}$ | .066                                                  | 2.274                                       | 10.889                                                                 | .98                                    |
| Hickory            | 46                       | $Y = 0.00412 (D^2Th)^{0.90677}$ | .056                                                  | 2.364                                       | 11.453                                                                 | .98                                    |
| Soft hardwoods     | 148                      | $Y = 0.00430 (D^2Th)^{0.91427}$ | .078                                                  | 2.420                                       | 33.651                                                                 | .97                                    |
| Hard hardwoods     | 196                      | $Y = 0.00496 (D^2Th)^{0.88808}$ | .080                                                  | 2.328                                       | 46.815                                                                 | .97                                    |
| All hardwoods      | 344                      | $Y = 0.00468 (D^2Th)^{0.89912}$ | .079                                                  | 2.367                                       | 81.178                                                                 | .97                                    |

<sup>a</sup> In  $\log_{10}$  form.

Table 9.—Regression equations and associated statistics for predicting total-tree green weight of understory hardwoods based on diameter squared ( $D^2$ )

| Species            | Number trees sampled (N) | Regression equation           | Standard error of estimate ( $S_{y,x}$ ) <sup>a</sup> | Sample mean of x ( $\bar{x}$ ) <sup>a</sup> | Corrected sums of squares for x ( $\Sigma(x-\bar{x})^2$ ) <sup>a</sup> | Coefficient of determination ( $R^2$ ) |
|--------------------|--------------------------|-------------------------------|-------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------|----------------------------------------|
| MOUNTAINS          |                          |                               |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 3.97092 (D^2)^{1.20080}$ | 0.061                                                 | 0.869                                       | 3.226                                                                  | 0.98                                   |
| Sourwood           | 11                       | $Y = 4.97417 (D^2)^{1.18675}$ | .076                                                  | .961                                        | 1.222                                                                  | .97                                    |
| Blackgum           | 18                       | $Y = 5.01543 (D^2)^{1.16009}$ | .083                                                  | 1.002                                       | 1.553                                                                  | .95                                    |
| Red maple          | 24                       | $Y = 5.47926 (D^2)^{1.20022}$ | .057                                                  | .860                                        | 3.148                                                                  | .98                                    |
| White oak          | 18                       | $Y = 4.17904 (D^2)^{1.19546}$ | .062                                                  | .787                                        | 2.384                                                                  | .98                                    |
| Chestnut oak       | 24                       | $Y = 4.81741 (D^2)^{1.20024}$ | .052                                                  | .892                                        | 2.555                                                                  | .98                                    |
| Dogwood            | 24                       | $Y = 5.99504 (D^2)^{1.09340}$ | .063                                                  | .848                                        | 3.780                                                                  | .98                                    |
| Hickory            | 24                       | $Y = 4.44954 (D^2)^{1.20990}$ | .079                                                  | .892                                        | 3.066                                                                  | .97                                    |
| PIEDMONT           |                          |                               |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 4.50088 (D^2)^{1.20035}$ | .046                                                  | .880                                        | 3.904                                                                  | .99                                    |
| Sweetgum           | 24                       | $Y = 3.51823 (D^2)^{1.19147}$ | .102                                                  | .888                                        | 2.988                                                                  | .95                                    |
| Red maple          | 23                       | $Y = 5.00668 (D^2)^{1.19140}$ | .058                                                  | .870                                        | 2.446                                                                  | .98                                    |
| White oak          | 23                       | $Y = 4.36406 (D^2)^{1.17708}$ | .106                                                  | .851                                        | 2.870                                                                  | .94                                    |
| Post oak           | 12                       | $Y = 3.86920 (D^2)^{1.19942}$ | .062                                                  | .904                                        | 1.217                                                                  | .98                                    |
| Southern red oak   | 25                       | $Y = 4.81192 (D^2)^{1.18368}$ | .077                                                  | .911                                        | 3.130                                                                  | .97                                    |
| Dogwood            | 24                       | $Y = 4.94325 (D^2)^{1.21168}$ | .057                                                  | .878                                        | 2.944                                                                  | .98                                    |
| Hickory            | 22                       | $Y = 4.91584 (D^2)^{1.18639}$ | .062                                                  | .849                                        | 3.027                                                                  | .98                                    |
| COMBINED EQUATIONS |                          |                               |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 48                       | $Y = 4.21906 (D^2)^{1.20158}$ | .059                                                  | .875                                        | 5.295                                                                  | .98                                    |
| Red maple          | 47                       | $Y = 5.24817 (D^2)^{1.19535}$ | .061                                                  | .865                                        | 5.595                                                                  | .98                                    |
| White oak          | 41                       | $Y = 4.23067 (D^2)^{1.19489}$ | .079                                                  | .823                                        | 5.295                                                                  | .97                                    |
| Dogwood            | 48                       | $Y = 5.52430 (D^2)^{1.14618}$ | .063                                                  | .863                                        | 6.734                                                                  | .98                                    |
| Hickory            | 46                       | $Y = 4.69064 (D^2)^{1.19640}$ | .071                                                  | .871                                        | 6.114                                                                  | .98                                    |
| Soft hardwoods     | 148                      | $Y = 4.52670 (D^2)^{1.19344}$ | .090                                                  | .892                                        | 18.763                                                                 | .96                                    |
| Hard hardwoods     | 196                      | $Y = 4.69848 (D^2)^{1.18743}$ | .073                                                  | .896                                        | 25.206                                                                 | .97                                    |
| All hardwoods      | 344                      | $Y = 4.62896 (D^2)^{1.18950}$ | .081                                                  | .879                                        | 44.016                                                                 | .97                                    |

<sup>a</sup> In  $\log_{10}$  form.



Table 10.—Regression equations and associated statistics for predicting total-tree dry weight of understory hardwoods based on diameter squared ( $D^2$ )

| Species            | Number trees sampled (N) | Regression equation           | Standard error of estimate ( $S_{v,x}$ ) <sup>a</sup> | Sample mean of x ( $\bar{x}$ ) <sup>a</sup> | Corrected sums of squares for x ( $\sum(x-\bar{x})^2$ ) <sup>a</sup> | Coefficient of determination ( $R^2$ ) |
|--------------------|--------------------------|-------------------------------|-------------------------------------------------------|---------------------------------------------|----------------------------------------------------------------------|----------------------------------------|
| MOUNTAINS          |                          |                               |                                                       |                                             |                                                                      |                                        |
| Yellow-poplar      | 24                       | $Y = 1.74524 (D^2)^{1.20610}$ | 0.073                                                 | 0.869                                       | 3.226                                                                | .98                                    |
| Sourwood           | 11                       | $Y = 2.37722 (D^2)^{1.21022}$ | .081                                                  | .961                                        | 1.222                                                                | .97                                    |
| Blackgum           | 18                       | $Y = 2.56795 (D^2)^{1.18685}$ | .083                                                  | 1.002                                       | 1.553                                                                | .95                                    |
| Red maple          | 24                       | $Y = 2.67148 (D^2)^{1.23601}$ | .060                                                  | .860                                        | 3.148                                                                | .98                                    |
| White oak          | 18                       | $Y = 2.50124 (D^2)^{1.19431}$ | .065                                                  | .787                                        | 2.384                                                                | .98                                    |
| Chestnut oak       | 24                       | $Y = 2.93819 (D^2)^{1.19746}$ | .044                                                  | .892                                        | 2.555                                                                | .99                                    |
| Dogwood            | 24                       | $Y = 3.37156 (D^2)^{1.10056}$ | .065                                                  | .848                                        | 3.780                                                                | .98                                    |
| Hickory            | 24                       | $Y = 2.86238 (D^2)^{1.20634}$ | .085                                                  | .892                                        | 3.066                                                                | .96                                    |
| PIEDMONT           |                          |                               |                                                       |                                             |                                                                      |                                        |
| Yellow-poplar      | 24                       | $Y = 1.79951 (D^2)^{1.22938}$ | .052                                                  | .880                                        | 3.904                                                                | .99                                    |
| Sweetgum           | 24                       | $Y = 1.67422 (D^2)^{1.17677}$ | .102                                                  | .888                                        | 2.988                                                                | .95                                    |
| Red maple          | 23                       | $Y = 2.62288 (D^2)^{1.21132}$ | .059                                                  | .870                                        | 2.446                                                                | .98                                    |
| White oak          | 23                       | $Y = 2.54413 (D^2)^{1.18590}$ | .113                                                  | .851                                        | 2.870                                                                | .94                                    |
| Post oak           | 12                       | $Y = 2.23774 (D^2)^{1.21527}$ | .067                                                  | .904                                        | 1.217                                                                | .98                                    |
| Southern red oak   | 25                       | $Y = 2.96156 (D^2)^{1.17059}$ | .072                                                  | .911                                        | 3.130                                                                | .97                                    |
| Dogwood            | 24                       | $Y = 2.73676 (D^2)^{1.21095}$ | .064                                                  | .878                                        | 2.944                                                                | .98                                    |
| Hickory            | 22                       | $Y = 3.06011 (D^2)^{1.19138}$ | .060                                                  | .849                                        | 3.027                                                                | .98                                    |
| COMBINED EQUATIONS |                          |                               |                                                       |                                             |                                                                      |                                        |
| Yellow-poplar      | 48                       | $Y = 1.76621 (D^2)^{1.21948}$ | .064                                                  | .875                                        | 5.295                                                                | .98                                    |
| Red maple          | 47                       | $Y = 2.64377 (D^2)^{1.22458}$ | .060                                                  | .865                                        | 5.595                                                                | .98                                    |
| White oak          | 41                       | $Y = 2.49773 (D^2)^{1.19895}$ | .085                                                  | .823                                        | 5.295                                                                | .96                                    |
| Dogwood            | 48                       | $Y = 3.08355 (D^2)^{1.14915}$ | .067                                                  | .863                                        | 6.734                                                                | .98                                    |
| Hickory            | 46                       | $Y = 2.96561 (D^2)^{1.19764}$ | .073                                                  | .871                                        | 6.114                                                                | .97                                    |
| Soft hardwoods     | 148                      | $Y = 2.10553 (D^2)^{1.21538}$ | .117                                                  | .892                                        | 18.763                                                               | .93                                    |
| Hard hardwoods     | 196                      | $Y = 2.79822 (D^2)^{1.18897}$ | .075                                                  | .869                                        | 25.206                                                               | .97                                    |
| All hardwoods      | 344                      | $Y = 2.50008 (D^2)^{1.19572}$ | .108                                                  | .879                                        | 44.016                                                               | .94                                    |

<sup>a</sup> In  $\log_{10}$  form.

Table 11.—Regression equations and associated statistics for predicting the cubic volume of wood and bark in the total tree for understory hardwoods based on diameter squared ( $D^2$ )

| Species            | Number trees sampled (N) | Regression equation           | Standard error of estimate ( $S_{y.x}$ ) <sup>a</sup> | Sample mean of x ( $\bar{x}$ ) <sup>a</sup> | Corrected sums of squares for x ( $\Sigma(x-\bar{x})^2$ ) <sup>a</sup> | Coefficient of determination ( $R^2$ ) |
|--------------------|--------------------------|-------------------------------|-------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------|----------------------------------------|
| MOUNTAINS          |                          |                               |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.08237 (D^2)^{1.17182}$ | 0.061                                                 | 0.869                                       | 3.226                                                                  | 0.98                                   |
| Sourwood           | 11                       | $Y = 0.08389 (D^2)^{1.19826}$ | .070                                                  | .961                                        | 1.222                                                                  | .98                                    |
| Blackgum           | 18                       | $Y = 0.08752 (D^2)^{1.14221}$ | .083                                                  | 1.002                                       | 1.553                                                                  | .95                                    |
| Red maple          | 24                       | $Y = 0.09032 (D^2)^{1.20343}$ | .053                                                  | .860                                        | 3.148                                                                  | .99                                    |
| White oak          | 18                       | $Y = 0.07110 (D^2)^{1.17132}$ | .062                                                  | .787                                        | 2.384                                                                  | .98                                    |
| Chestnut oak       | 24                       | $Y = 0.07852 (D^2)^{1.20087}$ | .049                                                  | .892                                        | 2.555                                                                  | .99                                    |
| Dogwood            | 24                       | $Y = 0.09394 (D^2)^{1.09946}$ | .064                                                  | .848                                        | 3.780                                                                  | .98                                    |
| Hickory            | 24                       | $Y = 0.07998 (D^2)^{1.18954}$ | .071                                                  | .892                                        | 3.066                                                                  | .98                                    |
| PIEDMONT           |                          |                               |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.07538 (D^2)^{1.21347}$ | .037                                                  | .880                                        | 3.904                                                                  | .99                                    |
| Sweetgum           | 24                       | $Y = 0.06448 (D^2)^{1.17839}$ | .082                                                  | .888                                        | 2.988                                                                  | .96                                    |
| Red maple          | 23                       | $Y = 0.08232 (D^2)^{1.20093}$ | .065                                                  | .870                                        | 2.446                                                                  | .98                                    |
| White oak          | 23                       | $Y = 0.07168 (D^2)^{1.16882}$ | .100                                                  | .851                                        | 2.870                                                                  | .95                                    |
| Post oak           | 12                       | $Y = 0.07045 (D^2)^{1.16035}$ | .056                                                  | .904                                        | 1.217                                                                  | .98                                    |
| Southern red oak   | 25                       | $Y = 0.07947 (D^2)^{1.15921}$ | .072                                                  | .911                                        | 3.130                                                                  | .97                                    |
| Dogwood            | 24                       | $Y = 0.07366 (D^2)^{1.22280}$ | .060                                                  | .878                                        | 2.944                                                                  | .98                                    |
| Hickory            | 22                       | $Y = 0.07897 (D^2)^{1.17591}$ | .051                                                  | .849                                        | 3.027                                                                  | .99                                    |
| COMBINED EQUATIONS |                          |                               |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 48                       | $Y = 0.07851 (D^2)^{1.19459}$ | .050                                                  | .875                                        | 5.295                                                                  | .99                                    |
| Red maple          | 47                       | $Y = 0.08644 (D^2)^{1.20142}$ | .062                                                  | .865                                        | 5.595                                                                  | .98                                    |
| White oak          | 41                       | $Y = 0.07072 (D^2)^{1.17881}$ | .076                                                  | .823                                        | 5.295                                                                  | .97                                    |
| Dogwood            | 48                       | $Y = 0.08463 (D^2)^{1.15352}$ | .065                                                  | .863                                        | 6.734                                                                  | .98                                    |
| Hickory            | 46                       | $Y = 0.07934 (D^2)^{1.18416}$ | .062                                                  | .871                                        | 6.114                                                                  | .98                                    |
| Soft hardwoods     | 148                      | $Y = 0.07983 (D^2)^{1.18817}$ | .079                                                  | .892                                        | 18.763                                                                 | .97                                    |
| Hard hardwoods     | 196                      | $Y = 0.07703 (D^2)^{1.17815}$ | .067                                                  | .869                                        | 25.206                                                                 | .98                                    |
| All hardwoods      | 344                      | $Y = 0.07807 (D^2)^{1.18353}$ | .073                                                  | .879                                        | 44.016                                                                 | .97                                    |

<sup>a</sup> In  $\log_{10}$  form.



Table 12.—Regression equations and associated statistics for predicting the cubic volume of wood in the total tree for understory hardwoods based on diameter squared ( $D^2$ )

| Species            | Number trees sampled (N) | Regression equation                    | Standard error of estimate ( $S_{y.x}$ ) <sup>a</sup> | Sample mean of x ( $\bar{x}$ ) <sup>a</sup> | Corrected sums of squares for x ( $\Sigma(x-\bar{x})^2$ ) <sup>a</sup> | Coefficient of determination ( $R^2$ ) |
|--------------------|--------------------------|----------------------------------------|-------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------|----------------------------------------|
| MOUNTAINS          |                          |                                        |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.05748 (D^2)$ <sup>1.22852</sup> | .058                                                  | 0.869                                       | 3.226                                                                  | .98                                    |
| Sourwood           | 11                       | $Y = 0.06472 (D^2)$ <sup>1.16537</sup> | .076                                                  | .961                                        | 1.222                                                                  | .97                                    |
| Blackgum           | 18                       | $Y = 0.06276 (D^2)$ <sup>1.15983</sup> | .071                                                  | 1.002                                       | 1.553                                                                  | .96                                    |
| Red maple          | 24                       | $Y = 0.07256 (D^2)$ <sup>1.21748</sup> | .058                                                  | .860                                        | 3.148                                                                  | .98                                    |
| White oak          | 18                       | $Y = 0.04709 (D^2)$ <sup>1.23947</sup> | .057                                                  | .787                                        | 2.384                                                                  | .98                                    |
| Chestnut oak       | 24                       | $Y = 0.05116 (D^2)$ <sup>1.22801</sup> | .064                                                  | .892                                        | 2.555                                                                  | .98                                    |
| Dogwood            | 24                       | $Y = 0.07462 (D^2)$ <sup>1.10037</sup> | .075                                                  | .848                                        | 3.780                                                                  | .97                                    |
| Hickory            | 24                       | $Y = 0.05031 (D^2)$ <sup>1.22208</sup> | .089                                                  | .892                                        | 3.066                                                                  | .96                                    |
| PIEDMONT           |                          |                                        |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 24                       | $Y = 0.05411 (D^2)$ <sup>1.24745</sup> | .042                                                  | .880                                        | 3.904                                                                  | .00                                    |
| Sweetgum           | 24                       | $Y = 0.04310 (D^2)$ <sup>1.19172</sup> | .112                                                  | .888                                        | 2.988                                                                  | .94                                    |
| Red maple          | 23                       | $Y = 0.06201 (D^2)$ <sup>1.24092</sup> | .072                                                  | .870                                        | 2.446                                                                  | .97                                    |
| White oak          | 23                       | $Y = 0.04451 (D^2)$ <sup>1.23922</sup> | .084                                                  | .851                                        | 2.870                                                                  | .97                                    |
| Post oak           | 12                       | $Y = 0.03549 (D^2)$ <sup>1.28517</sup> | .049                                                  | .904                                        | 1.217                                                                  | .99                                    |
| Southern red oak   | 25                       | $Y = 0.04596 (D^2)$ <sup>1.23763</sup> | .061                                                  | .911                                        | 3.130                                                                  | .98                                    |
| Dogwood            | 24                       | $Y = 0.05968 (D^2)$ <sup>1.19218</sup> | .051                                                  | .878                                        | 2.944                                                                  | .99                                    |
| Hickory            | 22                       | $Y = 0.04670 (D^2)$ <sup>1.24274</sup> | .061                                                  | .849                                        | 3.027                                                                  | .98                                    |
| COMBINED EQUATIONS |                          |                                        |                                                       |                                             |                                                                        |                                        |
| Yellow-poplar      | 48                       | $Y = 0.05569 (D^2)$ <sup>1.23870</sup> | .050                                                  | .875                                        | 5.295                                                                  | .99                                    |
| Red maple          | 47                       | $Y = 0.06750 (D^2)$ <sup>1.22670</sup> | .069                                                  | .865                                        | 5.595                                                                  | .98                                    |
| White oak          | 41                       | $Y = 0.04589 (D^2)$ <sup>1.23633</sup> | .073                                                  | .823                                        | 5.295                                                                  | .97                                    |
| Dogwood            | 48                       | $Y = 0.06773 (D^2)$ <sup>1.13963</sup> | .066                                                  | .863                                        | 6.734                                                                  | .98                                    |
| Hickory            | 46                       | $Y = 0.04838 (D^2)$ <sup>1.23349</sup> | .076                                                  | .871                                        | 6.114                                                                  | .97                                    |
| Soft hardwoods     | 148                      | $Y = 0.05847 (D^2)$ <sup>1.20940</sup> | .104                                                  | .892                                        | 18.763                                                                 | .95                                    |
| Hard hardwoods     | 196                      | $Y = 0.05140 (D^2)$ <sup>1.21046</sup> | .080                                                  | .869                                        | 25.206                                                                 | .97                                    |
| All hardwoods      | 344                      | $Y = 0.05405 (D^2)$ <sup>1.21249</sup> | .094                                                  | .879                                        | 44.016                                                                 | .95                                    |

<sup>a</sup> In  $\log_{10}$  form.

Table 13. Predicted total-tree green weight of yellow-poplar trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |    |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20 | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|                    | ----- Pounds -----       |    |     |     |     |     |     |     |     |     |
| 1                  | 4                        | 5  | 6   | 7   | 8   | 9   |     |     |     |     |
| 2                  | 13                       | 17 | 21  | 24  | 28  | 31  | 35  | 38  |     |     |
| 3                  | 27                       | 35 | 42  | 50  | 57  | 65  | 72  | 79  | 86  | 93  |
| 4                  | 45                       | 58 | 71  | 83  | 96  | 108 | 120 | 132 | 143 | 155 |
| 5                  |                          | 87 | 106 | 124 | 143 | 161 | 178 | 196 | 213 | 230 |
| 6                  |                          |    | 146 | 172 | 197 | 222 | 247 | 271 | 295 | 319 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.33899 (D^2Th)^{0.89180}$ .Table 14.—Predicted total-tree green weight of sourwood trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |     |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|                    | ----- Pounds -----       |     |     |     |     |     |     |     |     |     |
| 1                  | 4                        | 5   | 6   | 8   | 9   | 10  |     |     |     |     |
| 2                  | 14                       | 19  | 23  | 28  | 32  | 36  | 40  |     |     |     |
| 3                  | 31                       | 40  | 49  | 59  | 68  | 77  | 85  | 94  | 103 |     |
| 4                  | 52                       | 69  | 84  | 100 | 115 | 131 | 146 | 161 | 176 | 191 |
| 5                  |                          | 104 | 128 | 152 | 175 | 198 | 221 | 244 | 266 | 289 |
| 6                  |                          |     | 180 | 213 | 246 | 278 | 310 | 342 | 374 | 406 |

Blocked-in area indicates range of data.

Based on the equation  $Y = 0.31997 (D^2Th)^{0.90599}$ .Table 15.—Predicted total-tree green weight of blackgum trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |    |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20 | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|                    | ----- Pounds -----       |    |     |     |     |     |     |     |     |     |
| 1                  | 5                        | 7  | 8   | 9   | 10  | 12  |     |     |     |     |
| 2                  | 16                       | 21 | 25  | 29  | 33  | 37  | 41  | 45  |     |     |
| 3                  | 32                       | 41 | 49  | 58  | 65  | 73  | 81  | 88  | 96  | 103 |
| 4                  | 52                       | 66 | 80  | 93  | 106 | 119 | 131 | 143 | 155 | 167 |
| 5                  |                          | 96 | 116 | 135 | 154 | 172 | 190 | 208 | 225 | 242 |
| 6                  |                          |    | 158 | 184 | 209 | 234 | 258 | 282 | 305 | 328 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.52910(D^2Th)^{0.84555}$ .



Table 16.—Predicted total-tree green weight of sweetgum trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |    |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20 | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|                    | ----- Pounds -----       |    |     |     |     |     |     |     |     |     |
| 1                  | 4                        | 5  | 6   | 7   | 8   | 9   |     |     |     |     |
| 2                  | 13                       | 16 | 20  | 23  | 27  | 30  | 33  | 37  |     |     |
| 3                  | 26                       | 33 | 41  | 48  | 55  | 61  | 68  | 75  | 81  | 88  |
| 4                  | 43                       | 55 | 67  | 79  | 91  | 102 | 113 | 124 | 135 | 146 |
| 5                  |                          | 82 | 100 | 117 | 135 | 151 | 168 | 184 | 200 | 216 |
| 6                  |                          |    | 138 | 162 | 186 | 209 | 232 | 254 | 277 | 299 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.34061(D^2Th)^{0.86130}$ .Table 17.—Predicted total-tree green weight of red maple trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |     |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|                    | ----- Pounds -----       |     |     |     |     |     |     |     |     |     |
| 1                  | 4                        | 6   | 7   | 8   | 9   | 10  | 12  |     |     |     |
| 2                  | 15                       | 20  | 24  | 28  | 33  | 37  | 41  | 45  |     |     |
| 3                  | 32                       | 41  | 50  | 60  | 69  | 77  | 86  | 95  | 103 | 112 |
| 4                  | 53                       | 69  | 85  | 101 | 116 | 131 | 145 | 160 | 175 | 189 |
| 5                  |                          | 104 | 128 | 151 | 174 | 196 | 218 | 240 | 262 | 284 |
| 6                  |                          |     | 178 | 210 | 242 | 273 | 304 | 335 | 365 | 396 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.36353(D^2Th)^{0.91030}$ .Table 18.—Predicted total-tree green weight of white oak trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |    |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20 | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|                    | ----- Pounds -----       |    |     |     |     |     |     |     |     |     |
| 1                  | 5                        | 6  | 7   | 9   | 10  | 11  |     |     |     |     |
| 2                  | 16                       | 20 | 25  | 29  | 33  | 37  | 41  |     |     |     |
| 3                  | 32                       | 41 | 49  | 58  | 66  | 74  | 82  | 90  | 98  | 105 |
| 4                  | 52                       | 67 | 81  | 95  | 108 | 122 | 135 | 147 | 160 | 173 |
| 5                  |                          | 98 | 119 | 140 | 159 | 179 | 198 | 217 | 235 | 253 |
| 6                  |                          |    | 163 | 191 | 218 | 245 | 271 | 297 | 322 | 347 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.46590(D^2Th)^{0.86130}$ .

Table 19.—Predicted total-tree green weight of chestnut oak trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |     |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
| ----- Pounds ----- |                          |     |     |     |     |     |     |     |     |     |
| 1                  | 5                        | 6   | 7   | 9   | 10  | 11  |     |     |     |     |
| 2                  | 16                       | 20  | 25  | 29  | 33  | 37  | 42  | 46  |     |     |
| 3                  | 32                       | 42  | 50  | 59  | 68  | 76  | 84  | 92  | 100 | 108 |
| 4                  | 53                       | 69  | 83  | 98  | 112 | 126 | 139 | 153 | 166 | 179 |
| 5                  |                          | 101 | 123 | 144 | 165 | 186 | 206 | 226 | 245 | 264 |
| 6                  |                          |     | 169 | 199 | 227 | 255 | 283 | 310 | 337 | 364 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.44567(D^2Th)^{0.87324}$ Table 20.—Predicted total-tree green weight of post oak trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |    |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20 | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
| ----- Pounds ----- |                          |    |     |     |     |     |     |     |     |     |
| 1                  | 5                        | 6  | 7   | 8   | 10  | 11  |     |     |     |     |
| 2                  | 15                       | 20 | 24  | 28  | 32  | 36  | 40  |     |     |     |
| 3                  | 31                       | 40 | 48  | 56  | 64  | 72  | 80  | 87  | 95  |     |
| 4                  | 51                       | 65 | 79  | 92  | 105 | 118 | 131 | 143 | 155 | 167 |
| 5                  |                          | 96 | 116 | 135 | 155 | 173 | 192 | 210 | 228 | 246 |
| 6                  |                          |    | 158 | 185 | 211 | 237 | 263 | 287 | 312 | 336 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.45540(D^2Th)^{0.86019}$ Table 21.—Predicted total-tree green weight of southern red oak trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |     |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
| ----- Pounds ----- |                          |     |     |     |     |     |     |     |     |     |
| 1                  | 5                        | 7   | 8   | 10  | 11  | 12  |     |     |     |     |
| 2                  | 17                       | 22  | 27  | 31  | 35  | 39  | 44  | 48  |     |     |
| 3                  | 34                       | 44  | 53  | 61  | 70  | 78  | 86  | 94  | 102 |     |
| 4                  | 56                       | 71  | 85  | 99  | 113 | 127 | 140 | 153 | 166 | 178 |
| 5                  |                          | 103 | 124 | 145 | 165 | 184 | 204 | 223 | 241 | 259 |
| 6                  |                          |     | 169 | 197 | 224 | 251 | 277 | 302 | 328 | 353 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.55167(D^2Th)^{0.84140}$

Table 22.—Predicted total-tree green weight of dogwood trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |     |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
| ----- Pounds ----- |                          |     |     |     |     |     |     |     |     |     |
| 1                  | 6                        | 7   | 9   | 10  | 12  | 13  |     |     |     |     |
| 2                  | 19                       | 25  | 31  | 36  | 41  | 47  | 52  |     |     |     |
| 3                  | 40                       | 52  | 63  | 75  | 86  | 97  | 108 | 119 | 129 |     |
| 4                  | 67                       | 87  | 107 | 126 | 144 | 163 | 181 | 199 | 217 | 235 |
| 5                  |                          | 130 | 159 | 188 | 216 | 244 | 271 | 298 | 325 | 351 |
| 6                  |                          |     | 221 | 261 | 300 | 338 | 376 | 414 | 451 | 488 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.48010(D^2Th)^{0.90174}$ Table 23.—Predicted total-tree green weight of hickory trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |     |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
| ----- Pounds ----- |                          |     |     |     |     |     |     |     |     |     |
| 1                  | 5                        | 6   | 7   | 9   | 10  | 11  |     |     |     |     |
| 2                  | 16                       | 20  | 25  | 29  | 33  | 37  | 41  | 46  |     |     |
| 3                  | 32                       | 41  | 50  | 59  | 68  | 76  | 84  | 93  | 101 | 109 |
| 4                  | 53                       | 69  | 84  | 98  | 112 | 126 | 140 | 153 | 167 | 180 |
| 5                  |                          | 102 | 124 | 145 | 166 | 187 | 207 | 227 | 247 | 266 |
| 6                  |                          |     | 170 | 200 | 228 | 257 | 285 | 312 | 340 | 367 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.43736(D^2Th)^{0.87668}$ Table 24.—Predicted total-tree green weight of soft hardwood trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |    |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20 | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
| ----- Pounds ----- |                          |    |     |     |     |     |     |     |     |     |
| 1                  | 4                        | 5  | 6   | 7   | 9   | 10  | 11  |     |     |     |
| 2                  | 14                       | 18 | 22  | 26  | 30  | 34  | 37  | 41  |     |     |
| 3                  | 29                       | 37 | 46  | 54  | 62  | 70  | 78  | 85  | 93  | 100 |
| 4                  | 48                       | 63 | 77  | 90  | 104 | 117 | 130 | 143 | 156 | 168 |
| 5                  |                          | 94 | 114 | 135 | 155 | 174 | 194 | 213 | 232 | 251 |
| 6                  |                          |    | 159 | 187 | 215 | 242 | 269 | 296 | 322 | 348 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.35379(D^2Th)^{0.89767}$



Table 25. Predicted total-tree green weight of hard hardwood trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |     |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|                    | ----- Pounds -----       |     |     |     |     |     |     |     |     |     |
| 1                  | 5                        | 6   | 8   | 9   | 10  | 12  |     |     |     |     |
| 2                  | 17                       | 22  | 26  | 31  | 35  | 39  | 44  | 48  |     |     |
| 3                  | 34                       | 44  | 53  | 62  | 71  | 80  | 89  | 97  | 106 | 114 |
| 4                  | 56                       | 72  | 88  | 103 | 118 | 132 | 146 | 160 | 174 | 188 |
| 5                  |                          | 106 | 129 | 152 | 173 | 195 | 216 | 237 | 257 | 277 |
| 6                  |                          |     | 178 | 208 | 238 | 268 | 297 | 325 | 353 | 381 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.47221(D^{2.7}Th)^{0.81186}$ .Table 26.---Predicted total-tree green weight of all hardwood trees<sup>a b</sup>

| D.b.h.<br>(inches) | Total-tree height (feet) |     |     |     |     |     |     |     |     |     |
|--------------------|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                    | 15                       | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 55  | 60  |
|                    | ----- Pounds -----       |     |     |     |     |     |     |     |     |     |
| 1                  | 5                        | 6   | 7   | 9   | 10  | 11  | 12  |     |     |     |
| 2                  | 16                       | 20  | 24  | 29  | 33  | 37  | 41  | 45  |     |     |
| 3                  | 32                       | 41  | 50  | 59  | 67  | 75  | 83  | 92  | 100 | 107 |
| 4                  | 53                       | 68  | 83  | 97  | 111 | 125 | 138 | 152 | 165 | 178 |
| 5                  |                          | 100 | 122 | 143 | 164 | 184 | 204 | 224 | 244 | 263 |
| 6                  |                          |     | 168 | 197 | 226 | 254 | 281 | 309 | 336 | 362 |

<sup>a</sup>Blocked-in area indicates range of data.<sup>b</sup>Based on the equation  $Y = 0.43247(D^{2.7}Th)^{0.87622}$ .

Table 27.— Predicted total-tree green weight of understory hardwoods based on d.b.h. alone<sup>a</sup>

| Species              | Total-tree green weight by d.b.h. class |        |        |        |        |        |
|----------------------|-----------------------------------------|--------|--------|--------|--------|--------|
|                      | 1 inch                                  | 2 inch | 3 inch | 4 inch | 5 inch | 6 inch |
| ----- Pounds -----   |                                         |        |        |        |        |        |
| MOUNTAINS            |                                         |        |        |        |        |        |
| Yellow-poplar        | 4                                       | 21     | 56     | 111    | 189    | 294    |
| Sourwood             | 5                                       | 26     | 67     | 134    | 227    | 350    |
| Blackgum             | 5                                       | 25     | 64     | 125    | 210    | 320    |
| Red maple            | 5                                       | 29     | 77     | 153    | 261    | 404    |
| White oak            | 4                                       | 22     | 58     | 115    | 196    | 303    |
| Chestnut oak         | 5                                       | 25     | 67     | 134    | 229    | 355    |
| Dogwood              | 6                                       | 27     | 66     | 124    | 202    | 302    |
| Hickory              | 4                                       | 24     | 64     | 127    | 219    | 340    |
| PIEDMONT             |                                         |        |        |        |        |        |
| Yellow-poplar        | 5                                       | 24     | 63     | 126    | 214    | 332    |
| Sweetgum             | 4                                       | 18     | 49     | 97     | 166    | 257    |
| Red maple            | 5                                       | 26     | 69     | 137    | 233    | 359    |
| White oak            | 4                                       | 22     | 58     | 114    | 193    | 296    |
| Post oak             | 4                                       | 20     | 54     | 108    | 184    | 285    |
| Southern red oak     | 5                                       | 25     | 65     | 128    | 217    | 335    |
| Dogwood              | 5                                       | 27     | 71     | 142    | 244    | 380    |
| Hickory              | 5                                       | 25     | 67     | 132    | 224    | 345    |
| COMBINED PREDICTIONS |                                         |        |        |        |        |        |
| Soft hardwoods       | 4                                       | 24     | 62     | 123    | 210    | 324    |
| Hard hardwoods       | 5                                       | 25     | 64     | 127    | 214    | 328    |

<sup>a</sup>Predicted values in this table are based on equations in table 8.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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| <p>Phillips, Douglas R.<br/>1981. Predicted total-tree biomass of understory hardwoods. USDA For. Serv., Res. Pap. SE-223, 22 p. Southeast. For. Exp. Stn., Asheville, N.C.<br/>Prediction equations and tables are presented for estimating total-tree green and dry weights and cubic-foot volumes of wood and bark of understory hardwoods 1 to 5 inches d.b.h. Eleven species common in the Mountains and Piedmont of the Southeast are described.<br/>KEYWORDS: Weight, volume, specific gravity, moisture content, bark content, weight per cubic foot.</p> | <p>Phillips, Douglas R.<br/>1981. Predicted total-tree biomass of understory hardwoods. USDA For. Serv., Res. Pap. SE-223, 22 p. Southeast. For. Exp. Stn., Asheville, N.C.<br/>Prediction equations and tables are presented for estimating total-tree green and dry weights and cubic-foot volumes of wood and bark of understory hardwoods 1 to 5 inches d.b.h. Eleven species common in the Mountains and Piedmont of the Southeast are described.<br/>KEYWORDS: Weight, volume, specific gravity, moisture content, bark content, weight per cubic foot.</p> |
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