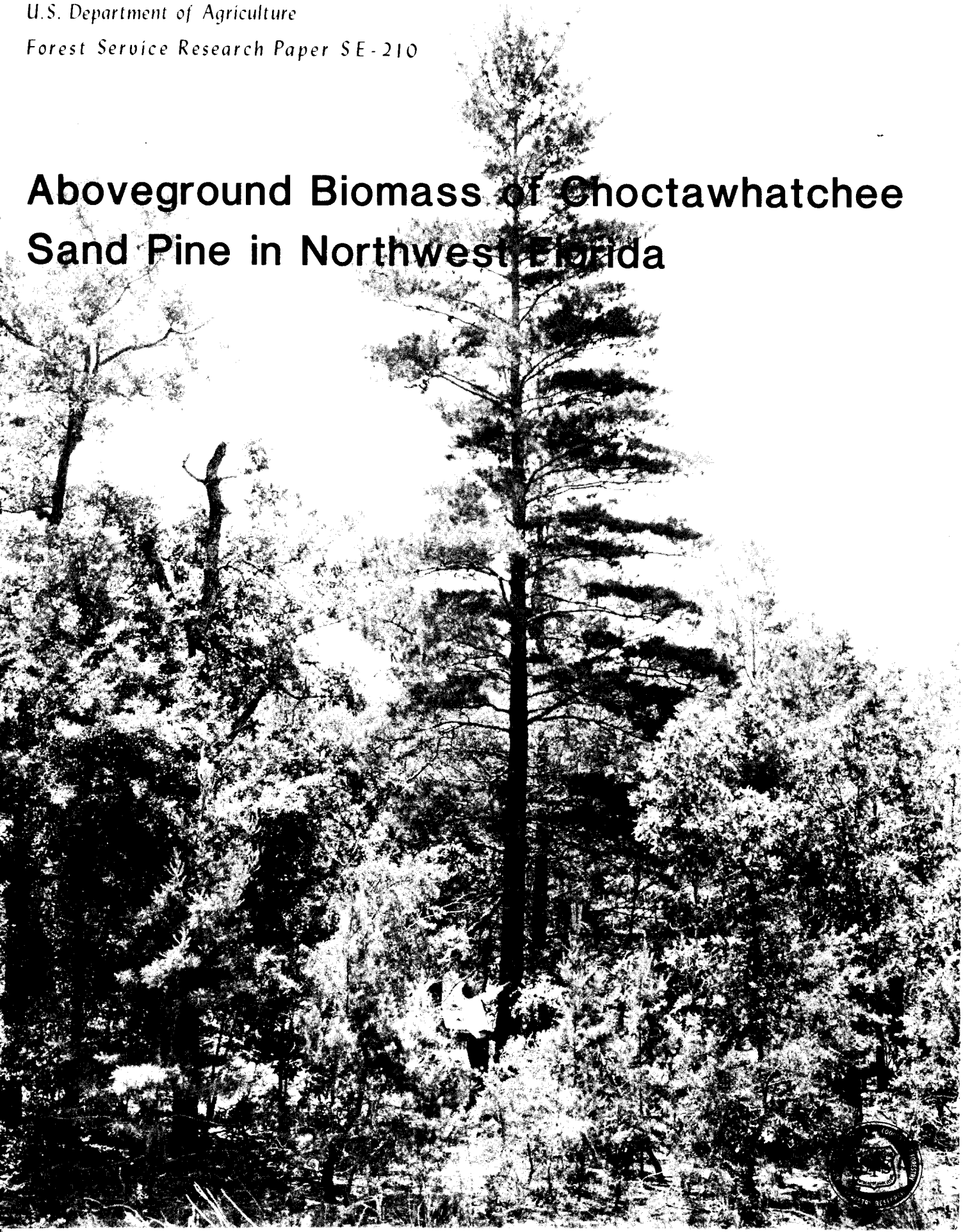
U.S. Department of Agriculture
Forest Service Research Paper SE-210

# Aboveground Biomass of Choctawhatchee Sand Pine in Northwest Florida



Conversion factors: English to metric

| *Multiply* | *By* | *To obtain* |
|---|---|---|
| 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 |

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

*July 1980*

*Southeastern Forest Experiment Station*
*Asheville, North Carolina*

# Aboveground Biomass of Choctawhatchee Sand Pine in Northwest Florida[1]

by
Michael A. Taras[2]

ABSTRACT.—Choctawhatchee sand pine trees 4 to 14 inches d.b.h. were selected from a natural, uneven-aged stand in northwest Florida to determine the weight and volume of aboveground biomass. On the average, 85 percent of the green weight of the total tree was wood, 11 percent bark, and 4 percent needles. The average tree sampled had 82 percent of its wood in the stem and 18 percent in the crown. Specific gravity, moisture content, and green weight per cubic foot are presented for the total tree and its components. Tables developed from regression equations predict weight and cubic-foot volume of the total tree and its components by d.b.h. and total height classes.

**Keywords:** *Pinus clausa* var. *immuginata* Ward, weight, volume, equations, component proportions.

This is the fifth in a series of reports on the aboveground biomass of southern pines. It contains information on Choctawhatchee sand pine (*Pinus clausa* var. *immuginata* Ward). The first four papers reported biomass for the four major southern pines (Taras and Clark 1975; Clark and Taras 1976; Taras and Clark 1977; and Taras and Phillips 1978).

This Paper reports weight and volume of various tree components (wood, bark, crown, branches, and foliage) as well as equations for predicting these values. The term "total tree" in this study refers only to the aboveground portion of the tree and does not include stump and roots.

## PROCEDURE

### *Field*

A stratified random sample of 36 trees was selected from a natural, uneven-aged Choctawhatchee sand pine stand on Eglin Air Force Base in northwest Florida. Site index (age 50) averaged about 50. Six trees in each even-inch d.b.h. class from 4 to 14 inches were randomly selected. Means and ranges in tree dimensions are shown in table 1.

Sample trees were felled and limbed and the main stem of each tree was bucked into 3- to 5-foot segments and weighed to the nearest one-quarter pound on a portable balance. Separate weights were recorded for the saw-log portion of the main stem to a 6-inch d.i.b. top and for the pulpwood portion of the stem to a 3-inch d.o.b. top. Sample branches were selected from the lower, middle, and upper portions of the crown. These were weighed and stripped of their needles, and the needles were weighed to establish the foliage: branch ratio. The remainder of the crown (needles and branches) was weighed together. Needle weight for the whole tree was computed by applying the needle:branch ratio developed from the branch samples. Dead branches were weighed separately but were not included in calculations for the total tree in this report.

Moisture content and specific gravity of wood and bark were determined from disks removed at the butt of each tree, at d.b.h., and at quarter points in the stem to a 3-inch d.o.b. top. Disks were also taken from the branches randomly selected from the lower, middle, and upper portions of the crown. Each disk sample was sealed in a plastic bag for subsequent laboratory analysis. Samples of needles and dead branches were selected for determination of moisture contents of these components.

### *Laboratory*

Each sample disk was weighed and diameters were measured with and without bark, and spe-

[1]This study was conducted in cooperation with the Forestry Division of Eglin Air Force Base, Fort Walton Beach, Fla.

[2]The author is now Professor of Forestry, College of Forest and Recreation Resources, Clemson University, Clemson, S.C. 29631.

Table 1.—Means and ranges in dimensions of sample Choctawhatchee sand pines, by d.b.h. class

| D.b.h. class (inches) | Sample trees | D.b.h. | | Total height | | Age | |
|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range |
| | *Number* | ..... *Inches* ..... | | ..... *Feet* ..... | | ..... *Years* ..... | |
| 4 | 6 | 4.2 | 3.9– 4.4 | 33 | 24–44 | 46 | 37–52 |
| 6 | 6 | 6.1 | 5.7– 6.4 | 47 | 41–56 | 54 | 46–59 |
| 8 | 6 | 8.1 | 7.8– 8.4 | 50 | 45–56 | 53 | 37–59 |
| 10 | 6 | 10.0 | 9.6–10.3 | 57 | 53–61 | 59 | 53–66 |
| 12 | 6 | 12.1 | 11.6–12.5 | 60 | 53–63 | 58 | 54–61 |
| 14 | 6 | 14.1 | 13.6–14.7 | 64 | 56–67 | 73 | 60–88 |
| All classes | 36 | 9.1 | 3.9–14.7 | 52 | 24–67 | 57 | 37–88 |

cific gravity was determined for each component on a green-volume and ovendry-weight basis. Moisture content samples were dried to a constant weight at 103° C, and moisture content was computed on an ovendry basis. Percentage of bark was determined from the disk samples on a green-weight basis. Values for moisture content (MC), specific gravity (SG), and percentage of bark in the stem, branches, and total tree were calculated by weighting disk values in proportion to the volume of the component each represented. Weighted moisture content values were used to convert component green weights to ovendry weights.

Green weights per cubic foot of wood and bark were computed from the weighted values for specific gravity and moisture content with the equation:

$$\text{Green wt/ft}^3 = \left[1 + \frac{\text{weighted MC in \%}}{100}\right](\text{weighted SG})(62.4) \quad (1)$$

The green cubic-foot volumes of wood and bark were computed by dividing a component's weight by its green weight per cubic foot. Green cubic-foot volume of wood and bark combined was computed by adding the green volume of wood to the green volume of bark.

*Analysis*

Regression equations for predicting green and dry weights of wood, bark, and needles in the total tree and its components were developed with d.b.h. and total height as independent variables. Equations were also developed to predict green cubic-foot volumes of wood and bark separately and combined. Total-tree and tree component weights and volumes were estimated with the equation:

$$Y = b_0 + b_1 D^2Th + e \quad (2)$$

where:

Y = predicted weight or volume of component
D = d.b.h. in inches
Th = total tree height in feet
e = experimental error

and

$b_0, b_1$ = coefficients.

Grouping of the data into $D^2Th$ classes indicated that the variance of Y increased with increasing $D^2Th$. Therefore, a logarithmic transformation was used to make the variance more nearly homogeneous and meet this basic assumption of regression analysis. The final form of the equation used to predict weight and volume of the total tree and each component sampled was:

$$\text{Log}_{10}Y = b_0 + b_1 \text{Log}_{10}(D^2Th) \quad (3)$$

## SAMPLE TREE CHARACTERISTICS

*Total-Tree Biomass*

Green weight of the total tree ranged from 126 pounds for 4-inch trees to 2,372 pounds for 14-inch trees. On the average, the trees sampled had 85 percent of their green weight in wood, 11 percent in bark, and 4 percent in needles. This distribution of wood, bark, and needles is similar

to those reported for the major southern pines. The proportion of tree weight in wood increased and the proportion in bark decreased sharply between the 4-inch and the 6-inch d.b.h. class, then remained relatively constant to the 14-inch class. The proportion of needles was highest (7 percent) in the 4-inch class and was consistently between 3 and 4 percent for all other diameter classes. Proportions of the various tree components computed on a dry basis varied slightly from those computed on a green basis because of differences in component moisture content (table 2).

When the trees are viewed as being composed of stem and crown, proportion of tree weight in the stem increases and that in branches decreases from the 4-inch d.b.h. class to the 6-inch class and then increases with tree size (table 3). The stem contained an average of 76 percent of the tree green weight, and the crown 24 percent. The proportion of biomass in the stems of Choctawhatchee sand pines is 5 to 8 percent lower than that reported for the four major species of southern pine. Since the needle proportion was the same as reported for other southern pines (about 4 percent), the primary cause for the difference in crown biomass is the greater weight of branch material in sand pine.

The green and dry weights of all wood in the tree and the distribution of wood throughout the tree are presented in table 4. On the average, 82 percent of green weight was in the main stem (to a 3-inch d.o.b. top), and 18 percent was in the branches. The proportion of wood increased in the main stem from the 4-inch d.b.h. class to the 6-inch class and then decreased as tree size increased. Branchwood proportions decreased be-

Table 2.—Average green and dry weights of the total tree and proportions of the tree in wood, bark, and needles for Choctawhatchee sand pines 4 to 14 inches d.b.h.

| D.b.h. class (inches) | Average total height | Sample trees | Total-tree green weight | Tree component proportions (green) | | | Total-tree dry weight | Tree component proportions (dry) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Wood | Bark | Needles | | Wood | Bark | Needles |
| | *Feet* | *Number* | *Pounds* | ..... *Percent* ..... | | | *Pounds* | ..... *Percent* ..... | | |
| 4 | 33 | 6 | 126 | 75 | 18 | 7 | 63 | 80 | 15 | 5 |
| 6 | 47 | 6 | 353 | 85 | 12 | 3 | 178 | 88 | 10 | 2 |
| 8 | 50 | 6 | 610 | 84 | 12 | 4 | 298 | 86 | 10 | 4 |
| 10 | 57 | 6 | 1,167 | 85 | 11 | 4 | 580 | 88 | 9 | 3 |
| 12 | 60 | 6 | 1,661 | 85 | 12 | 3 | 874 | 88 | 9 | 3 |
| 14 | 64 | 6 | 2,372 | 87 | 10 | 3 | 1,257 | 90 | 7 | 3 |
| Average | — | — | 1,048 | 85 | 11 | 4 | 542 | 88 | 9 | 3 |

Table 3.—Average green and dry weights of the total tree and proportions of the tree in the main stem[1] and crown (branches and needles) for Choctawhatchee sand pines 4 to 14 inches d.b.h.

| D.b.h. class (inches) | Average total height | Sample trees | Total-tree green weight | Tree component proportions (green) | | | Total-tree dry weight | Tree component proportions (dry) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Stem | Crown | | | Stem | Crown | |
| | | | | | Branches | Needles | | | Branches | Needles |
| | *Feet* | *Number* | *Pounds* | ..... *Percent* ..... | | | *Pounds* | ..... *Percent* ..... | | |
| 4 | 33 | 6 | 126 | 61 | 32 | 7 | 63 | 68 | 27 | 5 |
| 6 | 47 | 6 | 353 | 80 | 17 | 3 | 178 | 84 | 14 | 2 |
| 8 | 50 | 6 | 610 | 79 | 17 | 4 | 298 | 83 | 13 | 4 |
| 10 | 57 | 6 | 1,167 | 79 | 17 | 4 | 580 | 82 | 15 | 3 |
| 12 | 60 | 6 | 1,661 | 76 | 21 | 3 | 874 | 79 | 18 | 3 |
| 14 | 64 | 6 | 2,372 | 76 | 21 | 3 | 1,257 | 80 | 17 | 3 |
| Average | — | — | 1,048 | 76 | 20 | 4 | 542 | 80 | 17 | 3 |

[1]Stem material to 3-inch d.o.b. top.

Table 4.—Average green and dry weights of wood in the total tree and distribution of wood in the main stem[1] and branches for Choctawhatchee sand pines 4 to 14 inches d.b.h.

| D.b.h. class (inches) | Average total height | Sample trees | Total-tree wood weight | Proportion of wood in— | | | |
|---|---|---|---|---|---|---|---|
| | | | | Main stem | | | Branches |
| | | | | Saw log | Pulpwood | Total stem | |
| | *Feet* | *Number* | *Pounds* | ..... *Percent* ..... | | | |
| | | | GREEN | | | | |
| 4 | 33 | 6 | 95 | — | 70 | 70 | 30 |
| 6 | 47 | 6 | 299 | — | 85 | 85 | 15 |
| 8 | 50 | 6 | 509 | 42 | 43 | 85 | 15 |
| 10 | 57 | 6 | 995 | 68 | 16 | 84 | 16 |
| 12 | 60 | 6 | 1,408 | 74 | 7 | 81 | 19 |
| 14 | 64 | 6 | 2,069 | 75 | 6 | 81 | 19 |
| Average | — | — | 896 | 70 | 12 | 82 | 18 |
| | | | DRY | | | | |
| 4 | 33 | 6 | 52 | — | 73 | 73 | 27 |
| 6 | 47 | 6 | 156 | — | 88 | 88 | 12 |
| 8 | 50 | 6 | 257 | 45 | 42 | 87 | 13 |
| 10 | 57 | 6 | 510 | 71 | 15 | 86 | 14 |
| 12 | 60 | 6 | 768 | 76 | 7 | 83 | 17 |
| 14 | 64 | 6 | 1,138 | 79 | 5 | 84 | 16 |
| Average | — | — | 480 | 73 | 12 | 85 | 15 |

[1]Stem material to 3-inch d.o.b. top.

tween the 4- and 6-inch d.b.h. classes and then increased as tree size increased. The proportion of wood in the pulpwood section of a tree decreased, and proportion in the saw-log section increased as tree size increased. On the average, the trees contained 70 percent of their green wood in saw logs and 12 percent in pulpwood. The proportion of branches in Choctawhatchee sand pine is 5 to 7 percent greater than that found in the major species of southern pine because sand pines have a heavier branching habit.

The weight and distribution of bark in the tree are presented in table 5. On the average, 44 percent of all green bark in the tree was in the saw logs, 16 percent in the pulpwood, and 40 percent in the branches. In comparing the bark proportions with similar computations made from the major southern pine species, we find bark proportion of the crown to be 7 to 11 percent greater in sand pine. This difference is due to the greater proportion of branches in the crown of this species.

*Crown Biomass*

When the crown was analyzed as a separate entity composed of branchwood, branchbark, and needles, the proportion of crown weight in wood increased, the proportion of crown bark decreased, and the proportion of needles decreased as tree size increased (table 6). On the average, 66 percent of the green weight of the crown was wood, 19 percent was bark, and 15 percent was needles. Compared to the crowns of the major southern pine species, Choctawhatchee sand pine has a higher percentage of wood in the crown, about the same amount of bark, and fewer needles.

The dead branch components of these trees were not included in the total-tree weight or the weight of the crown even though the weight data on this component were collected. The reason it was not included was that it was felt that a high proportion of this material would be lost in felling and skidding and not recoverable. Equations

were developed, however, for predicting this component (*see* tables 9 and 10).

*Main Stem Biomass*

When the main stem was analyzed separately, the proportion of stem weight in wood increased and the proportion of bark decreased as tree size increased (table 7). On the average, 91 percent of the green weight of the main stem was wood, and 9 percent was bark. Similar proportions of wood and bark in the main stem have been reported for the four major species of southern pine.

Table 5.—Average green and dry weights of bark in the total tree and distribution of bark in the main stem[1] and branches for Choctawhatchee sand pines 4 to 14 inches d.b.h.

| D.b.h. class (inches) | Average total height | Sample trees | Total-tree bark weight | Proportion of bark in— | | | |
|---|---|---|---|---|---|---|---|
| | | | | Main stem | | | Branches |
| | | | | Saw log | Pulpwood | Total stem | |
| | *Feet* | *Number* | *Pounds* | ..... *Percent* ..... | | | |
| | | | GREEN | | | | |
| 4 | 33 | 6 | 22 | — | 48 | 48 | 52 |
| 6 | 47 | 6 | 43 | — | 67 | 67 | 33 |
| 8 | 50 | 6 | 74 | 34 | 36 | 70 | 30 |
| 10 | 57 | 6 | 126 | 50 | 14 | 64 | 36 |
| 12 | 60 | 6 | 197 | 53 | 6 | 59 | 41 |
| 14 | 64 | 6 | 225 | 50 | 5 | 55 | 45 |
| Average | — | — | 115 | 44 | 16 | 60 | 40 |
| | | | DRY | | | | |
| 4 | 33 | 6 | 9 | — | 59 | 59 | 41 |
| 6 | 47 | 6 | 18 | — | 74 | 74 | 26 |
| 8 | 50 | 6 | 30 | 41 | 34 | 75 | 25 |
| 10 | 57 | 6 | 52 | 57 | 12 | 69 | 31 |
| 12 | 60 | 6 | 83 | 61 | 5 | 66 | 34 |
| 14 | 64 | 6 | 87 | 54 | 5 | 59 | 41 |
| Average | — | — | 44 | 50 | 16 | 66 | 34 |

[1]Stem material to 3-inch d.o.b. top.

Table 6.—Average green and dry weights of the crown and proportion of the crown in wood, bark, and needles for Choctawhatchee sand pines 4 to 14 inches d.b.h.

| D.b.h. class (inches) | Average total height | Sample trees | Crown weight (green) | Crown proportion (green)— | | | Crown weight (dry) | Crown proportion (dry)— | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Branch-wood | Branch-bark | Needles | | Branch-wood | Branch-bark | Needles |
| | *Feet* | *Number* | *Pounds* | ..... *Percent* ..... | | | *Pounds* | ..... *Percent* ..... | | |
| 4 | 33 | 6 | 49 | 59 | 24 | 17 | 21 | 65 | 19 | 16 |
| 6 | 47 | 6 | 71 | 64 | 20 | 16 | 28 | 68 | 16 | 16 |
| 8 | 50 | 6 | 126 | 61 | 18 | 21 | 51 | 64 | 15 | 21 |
| 10 | 57 | 6 | 248 | 63 | 18 | 19 | 103 | 67 | 15 | 18 |
| 12 | 60 | 6 | 407 | 66 | 20 | 14 | 182 | 72 | 15 | 13 |
| 14 | 64 | 6 | 571 | 68 | 18 | 14 | 248 | 73 | 14 | 13 |
| Average | — | — | 245 | 66 | 19 | 15 | 106 | 70 | 15 | 15 |

Table 7.—Average green and dry weights of the stem[1] and proportion of the stem in wood and bark for Choctawhatchee sand pines 4 to 14 inches d.b.h.

| D.b.h. class (inches) | Average total height | Sample trees | Main stem weight (green) | Stem proportion in green— | | Main stem weight (dry) | Stem proportion in dry— | |
|---|---|---|---|---|---|---|---|---|
| | | | | Wood | Bark | | Wood | Bark |
| | *Feet* | *Number* | *Pounds* | ..... *Percent* ..... | | *Pounds* | ..... *Percent* ..... | |
| 4 | 33 | 6 | 77 | 86 | 14 | 42 | 87 | 13 |
| 6 | 47 | 6 | 283 | 90 | 10 | 150 | 91 | 9 |
| 8 | 50 | 6 | 484 | 89 | 11 | 248 | 91 | 9 |
| 10 | 57 | 6 | 919 | 91 | 9 | 477 | 93 | 7 |
| 12 | 60 | 6 | 1,254 | 91 | 9 | 691 | 92 | 8 |
| 14 | 64 | 6 | 1,802 | 93 | 7 | 1,009 | 95 | 5 |
| Average | — | — | 803 | 91 | 9 | 436 | 93 | 7 |

[1]Stem material to 3-inch d.o.b. top.

*Physical Properties*

Wood and bark specific gravity, moisture content, and green weight per cubic foot in the total tree and its components are presented in table 8. Wood specific gravity for the total tree averaged 0.475. Wood specific gravity of the saw-log portion of the tree and the main stem as a whole averaged 0.485, which is the average reported in a wood density survey of the species (Clark and Taras 1969). Specific gravity of the pulpwood portion of the tree averaged 0.455, which is slightly lower than the saw-log portion of the tree but slightly higher than that for the

Table 8.—Average wood and bark specific gravity, moisture content, and green weight per cubic foot for Choctawhatchee sand pine trees and tree components

| Tree component | Average and standard deviation | | |
|---|---|---|---|
| | Specific gravity | Moisture content | Green weight per cubic foot |
| | | *Percent* | *Pounds* |
| | WOOD | | |
| Total tree | 0.475 ± 0.025 | 91 ± 14 | 56.4 ± 3.4 |
| Saw log | .485 ± .030 | 81 ± 11 | 54.7 ± 3.9 |
| Pulpwood | .455 ± .041 | 101 ± 21 | 56.8 ± 3.7 |
| Main stem | .485 ± .029 | 84 ± 13 | 55.7 ± 3.5 |
| Branches | .433 ± .028 | 123 ± 21 | 59.9 ± 3.9 |
| | BARK | | |
| Total tree | 0.349 ± 0.022 | 151 ± 15 | 53.3 ± 2.3 |
| Saw log | .398 ± .037 | 117 ± 26 | 53.4 ± 3.2 |
| Pulpwood | .316 ± .066 | 183 ± 57 | 53.5 ± 2.7 |
| Main stem | .390 ± .035 | 121 ± 26 | 53.4 ± 3.3 |
| Branches | .288 ± .016 | 195 ± 18 | 52.9 ± 1.8 |
| | WOOD AND BARK | | |
| Total tree | 0.457 ± 0.020 | 96 ± 16 | 55.8 ± 2.9 |
| Saw log | .478 ± .027 | 84 ± 10 | 54.5 ± 3.5 |
| Pulpwood | .440 ± .041 | 110 ± 23 | 56.4 ± 3.3 |
| Main stem | .475 ± .026 | 88 ± 12 | 55.3 ± 3.2 |
| Branches | .398 ± .023 | 140 ± 17 | 58.3 ± 3.1 |

branches (0.433). Bark specific gravity was consistently lower than wood specific gravity, averaging 0.349 for the total tree, 0.390 for the main stem, and 0.288 for the branches. The specific gravity of the main stem bark approached that reported for longleaf pine (0.409) and was higher than that reported for loblolly, shortleaf, and slash pine. The branchbark specific gravity (0.288) was lower than that found for the four major species of southern pine.

Wood moisture content averaged 91 percent for the total tree, 84 percent for the main stem, and 123 percent for the branches (table 8). Wood moisture content was considerably higher for pulpwood (101 percent) than for saw logs (81 percent).

On a total-tree basis, bark moisture content averaged 151 percent, which was 60 percent higher than the corresponding value for wood (table 8). Bark moisture content was lower for saw logs (117 percent) than for pulpwood (183 percent) or branches (195 percent). The bark moisture contents reported here are all considerably higher (up to 100 percent higher) than those reported for other species of southern pine. These large differences are probably due to sand pine's considerably thinner bark and higher ratio of inner bark (which has an extremely high moisture content) to outer bark.

Green wood weight per cubic foot ranged from 54.7 pounds in saw logs to 59.9 pounds in branches and averaged 56.4 pounds in the total tree. Bark green weight per cubic foot was consistently lower than that of the wood (table 8), averaging about 53.4 pounds per cubic foot. Green weight of wood and bark per cubic foot of wood and bark averaged 55.8 pounds for the total tree, 55.3 pounds for the main stem, and 58.3 pounds for the branches.

## PREDICTION EQUATIONS

Equations were developed to predict weights and volumes of the total tree and its components. Those used for predicting dry weight (Y) and green:dry weight ratio ($Y_r$) to 6- and 4-inch d.i.b. tops are presented in table 9. Similar equations for predicting cubic-foot volume (Y) and cubic-foot volume ratio ($Y_r$) are given in table 10. A ratio technique developed by Burkhart (1977) was used to avoid crossovers in which predicted values to a 6-inch top exceed values to a 4-inch top in the same tree. In this procedure, two equations are used to predict the weight or volume at any given top diameter: (1) a total stem volume of weight equation, and (2) an equation for estimating the ratio of merchantable stem volume or weight to total stem volume or weight for the specified top diameter. With these two equations, volume or weight can be obtained to any top diameter limit or between any two specific points on the stem simply by subtraction. In this study, we developed equations to predict the weight and volume ratios to a 6-inch d.i.b. top and a 4-inch d.i.b. top.

The equations presented in tables 9 and 10 for predicting wood, bark, and wood and bark to a 6- or 4-inch d.i.b. top predict only the volume or weight ratios of the merchantable stem and not the actual weight or volume. To find the weight or volume to these merchantable limits, the predicted ratio ($Y_r$) must be subtracted from the value 1 and then multiplied by the predicted total stem weight or volume. An example of application of this ratio technique is presented in the Appendix.

## YIELD TABLES

For convenience to the users, the equations for total tree, stem to a 3-inch d.o.b. top, and crown in tables 9 and 10 were used to develop weight and volume tables; they are presented in the Appendix (tables 11–21). Other equations in tables 9 and 10 can be used to construct tables as needed, or they can be requested from the author.

Trees with the same d.b.h. and total height can vary considerably in weight and volume because of differences in crown size, moisture content, specific gravity, and taper. The yield tables presented in the Appendix should not be used indiscriminately over the range of sand pine without testing. Rather, they should be applied only to trees in natural stands which are similar in age, taper rate, and wood properties.

Table 9.—Regression equations for estimating green and dry weights and weight ratios of the aboveground biomass of Choctawhatchee sand pine trees and tree components with d.b.h. and total height as independent variables

| Weight (Y) | Regression equation[1] | Coefficient of determination ($R^2$) | Standard error ($S_{y \cdot x}$)[2] |
|---|---|---|---|
| Total tree (including needles): | | | |
| Green | $Log_{10}Y = -0.55650 + 0.95706\ Log_{10}D^2Th$ | 0.99 | 0.045 |
| Dry | $Log_{10}Y = -0.91826 + 0.97593\ Log_{10}D^2Th$ | .99 | .043 |
| Total tree (excluding needles): | | | |
| Green | $Log_{10}Y = -0.62122 + 0.96994\ Log_{10}D^2Th$ | .99 | .039 |
| Dry | $Log_{10}Y = -0.97356 + 0.98720\ Log_{10}D^2Th$ | .99 | .047 |
| Total tree—wood: | | | |
| Green | $Log_{10}Y = -0.79639 + 1.00201\ Log_{10}D^2Th$ | .99 | .041 |
| Dry | $Log_{10}Y = -1.12844 + 1.01698\ Log_{10}\ ^2Th$ | .99 | .044 |
| Total tree—bark: | | | |
| Green | $Log_{10}Y = -0.84088 + 0.77934\ Log_{10}D^2Th$ | .96 | .073 |
| Dry | $Log_{10}Y = -1.16148 + 0.76005\ Log_{10}D^2Th$ | .94 | .088 |
| Wood in total stem from stump to a 6-inch d.i.b. top:[3,4] | | | |
| Green | $Log_{10}Y_r = 2.93777 - 3.62385\ Log_{10}D$ | .85 | .143 |
| Dry | $Log_{10}Y_r = 3.01711 - 3.73405\ Log_{10}D$ | .84 | .156 |
| Bark in total stem from stump to a 6-inch d.i.b. top:[3,4] | | | |
| Green | $Log_{10}Y_r = 2.51837 - 3.15915\ Log_{10}D$ | .87 | .113 |
| Dry | $Log_{10}Y_r = 2.51422 - 3.23465\ Log_{10}D$ | .81 | .148 |
| Wood and bark in total stem from stump to a 6-inch d.i.b. top:[3,4] | | | |
| Green | $Log_{10}Y_r = 2.90335 - 3.58539\ Log_{10}D$ | .86 | .139 |
| Dry | $Log_{10}Y_r = 2.98467 - 3.70246\ Log_{10}D$ | .84 | .154 |
| Wood in total stem from stump to a 4-inch d.i.b. top:[4] | | | |
| Green | $Log_{10}Y_r = 1.87940 - 3.58590\ Log_{10}D$ | .94 | .162 |
| Dry | $Log_{10}Y_r = 1.97120 - 3.78576\ Log_{10}D$ | .92 | .211 |
| Bark in total stem from stump to a 4-inch d.i.b. top:[4] | | | |
| Green | $Log_{10}Y_r = 1.52148 - 3.14421\ Log_{10}D$ | .92 | .169 |
| Dry | $Log_{10}Y_r = 1.05411 - 2.86826\ Log_{10}D$ | .73 | .320 |
| Wood and bark in total stem from stump to a 4-inch d.i.b. top:[4] | | | |
| Green | $Log_{10}Y_r = 1.84122 - 3.53864\ Log_{10}D$ | .94 | .158 |
| Dry | $Log_{10}Y_r = 1.91231 - 3.72593\ Log_{10}D$ | .96 | .208 |
| Wood in total stem from stump to a 3-inch d.o.b. top: | | | |
| Green | $Log_{10}Y = -1.08343 + 1.05588\ Log_{10}D^2Th$ | .98 | .052 |
| Dry | $Log_{10}Y = -1.37915 + 1.06463\ Log_{10}D^2Th$ | .98 | .053 |
| Bark in total stem from stump to a 3-inch d.o.b. top: | | | |
| Green | $Log_{10}Y = -1.20771 + 0.81960\ Log_{10}D^2Th$ | .96 | .069 |
| Dry | $Log_{10}Y = -1.33809 + 0.76003\ Log_{10}D^2Th$ | .94 | .090 |
| Wood and bark in total stem from stump to a 3-inch d.o.b. top: | | | |
| Green | $Log_{10}Y = -0.94689 + 1.03056\ Log_{10}D^2Th$ | .99 | .046 |
| Dry | $Log_{10}Y = -1.23518 + 1.03557\ Log_{10}D^2Th$ | .99 | .046 |
| Crown weight (including branchwood, branchbark, and needles): | | | |
| Green | $Log_{10}Y = -0.69292 + 0.81995\ Log_{10}D^2Th$ | .86 | .157 |
| Dry | $Log_{10}Y = -1.13105 + 0.83740\ Log_{10}D^2Th$ | .84 | .165 |
| Needles: | | | |
| Green | $Log_{10}Y = -1.41056 + 0.79520\ Log_{10}D^2Th$ | .72 | .233 |
| Dry | $Log_{10}Y = -1.86151 + 0.80988\ Log_{10}D^2Th$ | .72 | .235 |
| Wood in live branch material: | | | |
| Green | $Log_{10}Y = -1.03397 + 0.86048\ Log_{10}D^2Th$ | .87 | .153 |
| Dry | $Log_{10}Y = -1.41556 + 0.87041\ Log_{10}D^2Th$ | .86 | .165 |
| Bark in live branch material: | | | |
| Green | $Log_{10}Y = -1.12593 + 0.74215\ Log_{10}D^2Th$ | .81 | .166 |
| Dry | $Log_{10}Y = -1.68595 + 0.76767\ Log_{10}D^2Th$ | .82 | .171 |
| Wood and bark in live branch material: | | | |
| Green | $Log_{10}Y = -0.81148 + 0.83105\ Log_{10}D^2Th$ | .86 | .154 |
| Dry | $Log_{10}Y = -1.25295 + 0.85039\ Log_{10}D^2Th$ | .85 | .164 |
| Wood and bark in dead branch material: | | | |
| Green | — | — | — |
| Dry | $Log_{10}Y = -3.26819 + 1.17798\ Log_{10}D^2Th$ | .79 | .282 |

[1] $Log_{10}Y = b_0 + b_1\ Log_{10}D^2Th$

where:

Y = weight of tree or component in pounds,
D = d.b.h. in inches,
Th = total height in feet.

$Log_{10}Y_r = b_0 + b_1\ Log_{10}D$

where:

$$Y_r = \frac{\text{Total stem weight} - \text{weight to specified d.i.b. top}}{\text{Total stem weight}}$$

D = d.b.h. in inches.

[2] Standard error of estimate in $Log_{10}$ form.

[3] Regression equations based on 24 trees 8 to 14 inches d.b.h.

[4] Weight to a specified d.i.b. top can be computed using ratio values ($Y_r$) developed by these equations as follows:

Weight to specified d.i.b. top = 1 − ($Y_r$) (total stem weight to 3-inch d.o.b. top).

Table 10.—Regression equations for estimating green cubic-foot and volume ratios of aboveground biomass of Choctawhatchee sand pine trees and tree components with d.b.h. and total height as independent variables

| Cubic-foot volume (Y) | Regression equation[1] | Coefficient of determination ($R^2$) | Standard error $(S_{y \cdot x})^2$ |
|---|---|---|---|
| Total tree: | | | |
| Wood | $Log_{10}Y = -2.63695 + 1.02742\ Log_{10}D^2Th$ | 0.99 | 0.036 |
| Bark | $Log_{10}Y = -2.52437 + 0.76732\ Log_{10}D^2Th$ | .96 | .076 |
| Wood & bark | $Log_{10}Y = -2.43029 + 0.98764\ Log_{10}D^2Th$ | .99 | .032 |
| Total stem to a 6-inch top:[3,4] | | | |
| Wood | $Log_{10}Y_r = 3.00835 - 3.70252\ Log_{10}D$ | .86 | .143 |
| Bark | $Log_{10}Y_r = 2.52777 - 3.19292\ Log_{10}D$ | .86 | .123 |
| Wood & bark | $Log_{10}Y_r = 2.97064 - 3.66251\ Log_{10}D$ | .86 | .140 |
| Total stem to a 4-inch top:[3,4] | | | |
| Wood | $Log_{10}Y_r = 1.97174 - 3.72042\ Log_{10}D$ | .93 | .191 |
| Bark | $Log_{10}Y_r = 1.45182 - 3.11971\ Log_{10}D$ | .90 | .185 |
| Wood & bark | $Log_{10}Y_r = 1.91809 - 3.65827\ Log_{10}D$ | .93 | .183 |
| Total stem to a 3-inch top: | | | |
| Wood | $Log_{10}Y = -2.92462 + 1.08298\ Log_{10}D^2Th$ | .99 | .052 |
| Bark | $Log_{10}Y = -2.83818 + 0.79252\ Log_{10}D^2Th$ | .97 | .066 |
| Wood & bark | $Log_{10}Y = -2.75688 + 1.04968\ Log_{10}D^2Th$ | .99 | .044 |
| Live branch material: | | | |
| Wood | $Log_{10}Y = -2.83057 + 0.86608\ Log_{10}D^2Th$ | .88 | .151 |
| Bark | $Log_{10}Y = -2.86248 + 0.74598\ Log_{10}D^2Th$ | .81 | .167 |
| Wood & bark | $Log_{10}Y = -2.58501 + 0.83384\ Log_{10}D^2Th$ | .87 | .154 |
| Dead branch material: | | | |
| Wood & bark | $Log_{10}Y = -4.72271 + 1.18320\ Log_{10}D^2Th$ | .81 | .271 |

[1] $Log_{10}Y = b_0 + b_1\ Log_{10}D^2Th$

where:

Y = cubic feet of tree or component,
D = d.b.h. in inches,
Th = total height in feet.

$Log_{10}Y_r = b_0 + b_1\ Log_{10}D$

where:

$$Y_r = \frac{\text{Total stem volume} - \text{volume to specified d.i.b. top}}{\text{Total stem volume}}$$

D = d.b.h. in inches.

[2] Standard error of estimate in $Log_{10}$ form.

[3] Regression equations based on 24 trees 8 to 14 inches d.b.h.

[4] Cubic-foot volume to a specified d.i.b. top can be computed using ratio values ($Y_r$) as follows:

Volume to specified d.i.b. top = 1 − ($Y_r$) (total stem volume to 3-inch d.o.b. top).

# LITERATURE CITED


Burkhart, Harold E.

1977. Cubic-foot volume of loblolly pine to any merchantable top limit. South. J. Appl. For. 1(2): 7–9.

Clark, Alexander, III, and Michael A. Taras.

1969. Wood density surveys of the minor species of yellow pine in the Eastern United States. Part II—sand pine (*Pinus clausa* (Chapm.) Vasey). USDA For. Serv., Res. Pap. SE-51, 14 p. Southeast. For. Exp. Stn., Asheville, N.C.

Clark, Alexander, III, and Michael A. Taras.

1976. Biomass of shortleaf pine in a natural sawtimber stand in northern Mississippi. USDA For. Serv., Res. Pap. SE-146, 32 p. Southeast. For. Exp. Stn., Asheville, N.C.

Taras, Michael A., and Alexander Clark III.

1977. Aboveground biomass of longleaf pine in a natural sawtimber stand in southern Alabama. USDA For. Serv., Res. Pap. SE-162, 32 p. Southeast. For. Exp. Stn., Asheville, N.C.

Taras, Michael A., and Alexander Clark III.

1975. Aboveground biomass of loblolly pine in a natural, uneven-aged sawtimber stand in central Alabama. TAPPI 58(2):103–105.

Taras, Michael A., and Douglas R. Phillips.

1978. Aboveground biomass of slash pine in a natural sawtimber stand in southern Alabama. USDA For. Serv., Res. Pap. SE-188, 31 p. Southeast. For. Exp. Stn., Asheville, N.C.

# APPENDIX

# ILLUSTRATION OF THE RATIO TECHNIQUE

Suppose you have a tree with a d.b.h. of 9.8 inches and a total height of 58 feet and you wish to compute the cubic-foot volume to a 4-inch top. First select the appropriate cubic-foot volume equation from table 10 for predicting total stem volume to a 3-inch top and substitute the tree dimensions:

$$\begin{aligned}\text{Log}_{10}(Y) &= -2.75688 + 1.04968\,\text{Log}_{10}(D^2(Th)) \\ &= -2.75688 + 1.04968\,\text{Log}_{10}(9.8^2(58)) \\ &= 14.97\ \text{ft}^3 \text{ in total stem.}\end{aligned}$$

Cubic-foot volume to a 4-inch top (d.i.b.) is computed by substituting into the appropriate volume ratio ($Y_r$) equation in table 10. In this case, since we wish to predict volume of wood and bark to a 4-inch top, we would use the following equation:

$$\begin{aligned}\text{Log}_{10}(Y_r) &= 1.91809 - 3.65827\,\text{Log}_{10}(D) \\ &= 1.91809 - 3.65827\,\text{Log}_{10}(9.8) \\ &= 0.01958.\end{aligned}$$

The ratio computed above is the proportion of wood in the main stem between the 4-inch (d.i.b.) and the 3-inch (d.o.b.) top. To compute the actual weight or volume to a 4-inch top, the above ratio must be subtracted from 1 and the resultant value multiplied by the previously computed total stem value as follows:

Volume to a 4-inch top

$$\begin{aligned}&= (1 - Y_r)\,(\text{Total stem volume to 3-inch top}) \\ &= (1 - 0.01958)\,(14.97\ \text{ft}^3) \\ &= 14.68\ \text{ft}^3\end{aligned}$$

Table 11.—Predicted weight of total tree (wood, bark, and needles) above ground for Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Pounds* | | | | | |
| | GREEN[3] | | | | | |
| 4 | 69 | 102 | 135 | 167 | 198 | |
| 5 | 106 | 157 | 206 | 256 | 304 | |
| 6 | 151 | 222 | 293 | 362 | 431 | 500 |
| 7 | 202 | 298 | 393 | 487 | 579 | 671 |
| 8 | 261 | 385 | 508 | 628 | 748 | 867 |
| 9 | 328 | 483 | 636 | 787 | 937 | 1,086 |
| 10 | | 591 | 778 | 963 | 1,147 | 1,329 |
| 11 | | 709 | 934 | 1,156 | 1,376 | 1,595 |
| 12 | | 837 | 1,103 | 1,365 | 1,626 | 1,884 |
| 13 | | | 1,285 | 1,591 | 1,895 | 2,196 |
| 14 | | | 1,481 | 1,834 | 2,183 | 2,530 |
| 15 | | | | | 2,492 | 2,888 |
| | DRY[4] | | | | | |
| 4 | 34 | 50 | 66 | 82 | 98 | |
| 5 | 52 | 77 | 102 | 127 | 152 | |
| 6 | 74 | 110 | 146 | 181 | 217 | 252 |
| 7 | 100 | 149 | 197 | 245 | 293 | 340 |
| 8 | 130 | 193 | 256 | 318 | 380 | 442 |
| 9 | 164 | 243 | 322 | 400 | 478 | 556 |
| 10 | | 299 | 395 | 492 | 587 | 683 |
| 11 | | 360 | 476 | 592 | 708 | 822 |
| 12 | | 426 | 564 | 702 | 838 | 975 |
| 13 | | | 660 | 820 | 980 | 1,139 |
| 14 | | | 763 | 948 | 1,133 | 1,317 |
| 15 | | | | | 1,296 | 1,507 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -0.55650 + 0.95706\ \text{Log}_{10}D^2Th.$
[4]$\text{Log}_{10}Y = -0.91826 + 0.97593\ \text{Log}_{10}D^2Th.$

Table 12.—Predicted weight of total tree (wood and bark) excluding needles for Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Pounds* | | | | | |
| | GREEN[3] | | | | | |
| 4 | 64 | 95 | 126 | 156 | 186 | |
| 5 | 99 | 147 | 194 | 241 | 288 | |
| 6 | 141 | 209 | 276 | 344 | 410 | 476 |
| 7 | 191 | 282 | 373 | 464 | 553 | 642 |
| 8 | 246 | 366 | 484 | 601 | 717 | 832 |
| 9 | 310 | 460 | 608 | 754 | 901 | 1,046 |
| 10 | | 564 | 746 | 926 | 1,105 | 1,283 |
| 11 | | 678 | 897 | 1,114 | 1,329 | 1,544 |
| 12 | | 803 | 1,062 | 1,318 | 1,574 | 1,828 |
| 13 | | | 1,241 | 1,540 | 1,838 | 2,134 |
| 14 | | | 1,432 | 1,778 | 2,122 | 2,464 |
| 15 | | | | | 2,426 | 2,818 |
| | DRY[4] | | | | | |
| 4 | 32 | 47 | 63 | 78 | 93 | |
| 5 | 49 | 73 | 97 | 121 | 145 | |
| 6 | 70 | 105 | 139 | 174 | 208 | 242 |
| 7 | 95 | 142 | 189 | 236 | 282 | 328 |
| 8 | 124 | 185 | 246 | 307 | 367 | 428 |
| 9 | 157 | 234 | 310 | 387 | 463 | 540 |
| 10 | | 288 | 382 | 477 | 570 | 664 |
| 11 | | 347 | 461 | 575 | 689 | 802 |
| 12 | | 412 | 548 | 683 | 818 | 952 |
| 13 | | | 642 | 800 | 958 | 1,115 |
| 14 | | | 743 | 926 | 1,109 | 1,291 |
| 15 | | | | | 1,270 | 1,479 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -0.62122 + 0.96994\ \text{Log}_{10}D^2Th$.
[4]$\text{Log}_{10}Y = -0.97356 + 0.98720\ \text{Log}_{10}D^2Th$.

Table 13.—Predicted weight of all aboveground wood excluding bark for Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Pounds* | | | | | |
| | GREEN[3] | | | | | |
| 4 | 52 | 78 | 104 | 130 | 156 | |
| 5 | 81 | 122 | 162 | 203 | 243 | |
| 6 | 117 | 175 | 234 | 292 | 351 | 409 |
| 7 | 159 | 238 | 318 | 398 | 477 | 557 |
| 8 | 208 | 312 | 416 | 520 | 624 | 728 |
| 9 | 263 | 394 | 526 | 658 | 790 | 922 |
| 10 | | 487 | 650 | 813 | 976 | 1,139 |
| 11 | | 590 | 787 | 984 | 1,181 | 1,378 |
| 12 | | 702 | 937 | 1,171 | 1,406 | 1,641 |
| 13 | | | 1,100 | 1,375 | 1,651 | 1,927 |
| 14 | | | 1,276 | 1,595 | 1,915 | 2,235 |
| 15 | | | | | 2,199 | 2,566 |
| | DRY[4] | | | | | |
| 4 | 26 | 40 | 53 | 67 | 80 | |
| 5 | 41 | 62 | 84 | 105 | 126 | |
| 6 | 60 | 90 | 121 | 152 | 183 | 214 |
| 7 | 82 | 124 | 166 | 208 | 250 | 293 |
| 8 | 108 | 162 | 218 | 273 | 329 | 384 |
| 9 | 137 | 206 | 277 | 347 | 418 | 489 |
| 10 | | 256 | 343 | 430 | 517 | 605 |
| 11 | | 310 | 416 | 522 | 628 | 735 |
| 12 | | 370 | 496 | 623 | 750 | 877 |
| 13 | | | 584 | 733 | 882 | 1,032 |
| 14 | | | 679 | 852 | 1,026 | 1,200 |
| 15 | | | | | 1,180 | 1,381 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -0.79639 + 1.00201\ \text{Log}_{10}D^2Th.$
[4]$\text{Log}_{10}Y = -1.12844 + 1.01698\ \text{Log}_{10}D^2Th.$

Table 14.—Predicted weight of wood and bark in main stem to a 3-inch d.o.b. top for Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Pounds* | | | | | |
| | GREEN[3] | | | | | |
| 4 | 43 | 66 | 88 | 111 | 134 | |
| 5 | 68 | 104 | 140 | 176 | 212 | |
| 6 | 100 | 151 | 203 | 256 | 309 | 362 |
| 7 | 137 | 208 | 279 | 351 | 424 | 497 |
| 8 | 180 | 273 | 368 | 463 | 558 | 655 |
| 9 | 229 | 348 | 469 | 590 | 712 | 834 |
| 10 | | 433 | 582 | 733 | 885 | 1,037 |
| 11 | | 527 | 709 | 892 | 1,077 | 1,262 |
| 12 | | 631 | 848 | 1,067 | 1,288 | 1,510 |
| 13 | | | 1,000 | 1,259 | 1,519 | 1,781 |
| 14 | | | 1,165 | 1,467 | 1,770 | 2,074 |
| 15 | | | | | 2,040 | 2,391 |
| | DRY[4] | | | | | |
| 4 | 23 | 35 | 47 | 59 | 71 | 84 |
| 5 | 36 | 55 | 74 | 94 | 113 | 133 |
| 6 | 53 | 80 | 109 | 137 | 165 | 194 |
| 7 | 73 | 111 | 149 | 188 | 227 | 267 |
| 8 | 96 | 146 | 197 | 248 | 300 | 352 |
| 9 | 123 | 187 | 251 | 317 | 383 | 449 |
| 10 | | 232 | 313 | 394 | 476 | 558 |
| 11 | | 283 | 381 | 480 | 580 | 680 |
| 12 | | 339 | 456 | 575 | 694 | 814 |
| 13 | | | 538 | 678 | 819 | 961 |
| 14 | | | 628 | 791 | 955 | 1,120 |
| 15 | | | | | 1,102 | 1,292 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -0.94689 + 1.03056\ \text{Log}_{10}D^2Th$.
[4]$\text{Log}_{10}Y = -1.23518 + 1.03557\ \text{Log}_{10}D^2Th$.

Table 15.—Predicted weight of wood excluding bark in main stem to a 3-inch d.o.b. top for Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Pounds* | | | | | |
| | GREEN[3] | | | | | |
| 4 | 36 | 56 | 76 | 96 | 116 | |
| 5 | 58 | 90 | 121 | 154 | 186 | |
| 6 | 86 | 132 | 178 | 226 | 274 | 322 |
| 7 | 119 | 182 | 247 | 313 | 379 | 446 |
| 8 | 158 | 242 | 328 | 415 | 503 | 591 |
| 9 | 202 | 310 | 420 | 532 | 645 | 758 |
| 10 | | 387 | 525 | 664 | 805 | 947 |
| 11 | | 474 | 642 | 812 | 985 | 1,159 |
| 12 | | 569 | 771 | 976 | 1,183 | 1,392 |
| 13 | | | 913 | 1,156 | 1,401 | 1,649 |
| 14 | | | 1,068 | 1,352 | 1,638 | 1,928 |
| 15 | | | | | 1,895 | 2,230 |
| | DRY[4] | | | | | |
| 4 | 19 | 30 | 41 | 52 | 62 | |
| 5 | 31 | 48 | 65 | 83 | 100 | |
| 6 | 46 | 71 | 96 | 122 | 148 | 175 |
| 7 | 64 | 98 | 134 | 170 | 206 | 242 |
| 8 | 85 | 131 | 178 | 225 | 273 | 322 |
| 9 | 109 | 168 | 228 | 289 | 351 | 414 |
| 10 | | 210 | 286 | 362 | 440 | 518 |
| 11 | | 258 | 350 | 444 | 539 | 635 |
| 12 | | 310 | 421 | 534 | 648 | 764 |
| 13 | | | 499 | 633 | 769 | 906 |
| 14 | | | 585 | 741 | 900 | 1,061 |
| 15 | | | | | 1,043 | 1,229 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -1.08343 + 1.05588\ \text{Log}_{10}D^2Th$.
[4]$\text{Log}_{10}Y = -1.37915 + 1.06463\ \text{Log}_{10}D^2Th$.

Table 16.—Predicted weight of crown material (branchwood, branchbark, and needles) in Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Pounds* | | | | | |
| | GREEN[3] | | | | | |
| 4 | 23 | 32 | 41 | 49 | 57 | |
| 5 | 33 | 46 | 58 | 70 | 82 | |
| 6 | 45 | 62 | 79 | 95 | 110 | 125 |
| 7 | 58 | 80 | 102 | 122 | 142 | 161 |
| 8 | 72 | 100 | 126 | 152 | 176 | 200 |
| 9 | 87 | 121 | 153 | 184 | 214 | 243 |
| 10 | | 144 | 182 | 219 | 254 | 288 |
| 11 | | 168 | 213 | 256 | 297 | 337 |
| 12 | | 194 | 246 | 295 | 343 | 389 |
| 13 | | | 280 | 336 | 391 | 443 |
| 14 | | | 316 | 380 | 441 | 501 |
| 15 | | | | | 494 | 561 |
| | DRY[4] | | | | | |
| 4 | 9 | 13 | 17 | 20 | 23 | |
| 5 | 14 | 19 | 24 | 29 | 34 | |
| 6 | 18 | 26 | 33 | 39 | 46 | 52 |
| 7 | 24 | 33 | 42 | 51 | 59 | 68 |
| 8 | 30 | 42 | 53 | 64 | 74 | 84 |
| 9 | 36 | 51 | 64 | 78 | 90 | 103 |
| 10 | | 60 | 77 | 93 | 108 | 123 |
| 11 | | 71 | 90 | 109 | 126 | 144 |
| 12 | | 82 | 104 | 126 | 146 | 167 |
| 13 | | | 119 | 144 | 167 | 190 |
| 14 | | | 135 | 163 | 189 | 216 |
| 15 | | | | | 213 | 242 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -0.69292 + 0.81995\ \text{Log}_{10}D^2Th$.
[4]$\text{Log}_{10}Y = -1.13105 + 0.83740\ \text{Log}_{10}D^2Th$.

Table 17.—Predicted weight of wood and bark in branches of Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Pounds* | | | | | |
| | GREEN[3] | | | | | |
| 4 | 19 | 26 | 33 | 40 | 46 | |
| 5 | 27 | 38 | 48 | 58 | 67 | |
| 6 | 37 | 51 | 65 | 78 | 91 | 104 |
| 7 | 47 | 66 | 84 | 101 | 118 | 134 |
| 8 | 59 | 83 | 105 | 126 | 147 | 167 |
| 9 | 72 | 100 | 128 | 154 | 179 | 203 |
| 10 | | 120 | 152 | 183 | 213 | 242 |
| 11 | | 140 | 178 | 214 | 250 | 284 |
| 12 | | 162 | 206 | 248 | 288 | 228 |
| 13 | | | 235 | 283 | 329 | 374 |
| 14 | | | 266 | 320 | 373 | 424 |
| 15 | | | | | 418 | 475 |
| | DRY[4] | | | | | |
| 4 | 6 | 11 | 14 | 16 | 19 | |
| 5 | 11 | 16 | 20 | 24 | 28 | |
| 6 | 15 | 21 | 27 | 33 | 38 | 44 |
| 7 | 20 | 28 | 35 | 43 | 50 | 57 |
| 8 | 24 | 35 | 44 | 53 | 62 | 71 |
| 9 | 30 | 42 | 54 | 65 | 76 | 87 |
| 10 | | 51 | 65 | 78 | 91 | 104 |
| 11 | | 60 | 76 | 92 | 107 | 122 |
| 12 | | 69 | 88 | 106 | 124 | 142 |
| 13 | | | 101 | 122 | 142 | 162 |
| 14 | | | 114 | 138 | 161 | 184 |
| 15 | | | | | 182 | 207 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -0.81148 + 0.83105\ \text{Log}_{10}D^2Th$.
[4]$\text{Log}_{10}Y = -1.25295 + 0.85039\ \text{Log}_{10}D^2Th$.

Table 18.—Predicted weight of branchwood in Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Pounds* | | | | | |
| | GREEN[3] | | | | | |
| 4 | 13 | 19 | 24 | 29 | 34 | |
| 5 | 19 | 26 | 35 | 43 | 50 | |
| 6 | 27 | 38 | 48 | 58 | 68 | 78 |
| 7 | 35 | 49 | 63 | 76 | 89 | 102 |
| 8 | 44 | 62 | 79 | 96 | 112 | 128 |
| 9 | 53 | 76 | 97 | 117 | 138 | 157 |
| 10 | | 91 | 116 | 141 | 165 | 188 |
| 11 | | 107 | 137 | 166 | 194 | 222 |
| 12 | | 124 | 159 | 193 | 226 | 258 |
| 13 | | | 183 | 221 | 259 | 296 |
| 14 | | | 206 | 251 | 294 | 336 |
| 15 | | | | | 331 | 378 |
| | DRY[4] | | | | | |
| 4 | 6 | 8 | 11 | 13 | 15 | |
| 5 | 9 | 12 | 16 | 19 | 22 | |
| 6 | 12 | 17 | 22 | 26 | 31 | 35 |
| 7 | 15 | 22 | 28 | 34 | 40 | 46 |
| 8 | 19 | 28 | 36 | 43 | 51 | 58 |
| 9 | 24 | 34 | 44 | 53 | 62 | 71 |
| 10 | | 41 | 52 | 64 | 75 | 85 |
| 11 | | 48 | 62 | 75 | 88 | 101 |
| 12 | | 56 | 72 | 88 | 103 | 117 |
| 13 | | | 83 | 101 | 118 | 135 |
| 14 | | | 94 | 114 | 134 | 153 |
| 15 | | | | | 151 | 173 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -1.03397 + 0.86048\ \text{Log}_{10}D^2Th.$
[4]$\text{Log}_{10}Y = -1.41556 + 0.87041\ \text{Log}_{10}D^2Th.$

Table 19.—Predicted green volume of wood and bark of the total tree for Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | ..... *Cubic feet* ..... | | | | | |
| | WOOD AND BARK[3] | | | | | |
| 4 | 1.1 | 1.6 | 2.2 | 2.7 | 3.3 | |
| 5 | 1.7 | 2.6 | 3.4 | 4.2 | 5.1 | |
| 6 | 2.5 | 3.7 | 4.9 | 6.1 | 7.3 | 8.5 |
| 7 | 3.3 | 5.0 | 6.6 | 8.3 | 9.9 | 11.5 |
| 8 | 4.4 | 6.5 | 8.6 | 10.8 | 12.9 | 15.0 |
| 9 | 5.5 | 8.2 | 10.9 | 13.6 | 16.2 | 18.9 |
| 10 | | 10.1 | 13.4 | 16.7 | 20.0 | 23.3 |
| 11 | | 12.2 | 16.2 | 20.2 | 24.2 | 28.1 |
| 12 | | 14.5 | 19.2 | 24.0 | 28.7 | 33.4 |
| 13 | | | 22.5 | 28.1 | 33.6 | 39.1 |
| 14 | | | 26.1 | 32.5 | 38.9 | 45.3 |
| 15 | | | | 37.2 | 44.6 | 51.9 |
| | WOOD[4] | | | | | |
| 4 | 0.9 | 1.3 | 1.8 | 2.2 | 2.7 | |
| 5 | 1.4 | 2.1 | 2.8 | 3.5 | 4.2 | |
| 6 | 2.0 | 3.0 | 4.1 | 5.1 | 6.2 | 7.2 |
| 7 | 2.7 | 4.1 | 5.6 | 7.0 | 8.4 | 9.9 |
| 8 | 3.6 | 5.4 | 7.3 | 9.2 | 11.1 | 13.0 |
| 9 | 4.6 | 6.9 | 9.3 | 11.7 | 14.2 | 16.6 |
| 10 | | 8.6 | 11.6 | 14.6 | 17.6 | 20.6 |
| 11 | | 10.5 | 14.1 | 17.7 | 21.4 | 25.0 |
| 12 | | 12.5 | 16.9 | 21.2 | 25.6 | 29.9 |
| 13 | | | 19.9 | 25.0 | 30.1 | 35.3 |
| 14 | | | 23.1 | 29.1 | 35.1 | 41.1 |
| 15 | | | | 33.5 | 40.4 | 47.4 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -2.43029 + 0.98764\ \text{Log}_{10}D^2Th$.
[4]$\text{Log}_{10}Y = -2.63695 + 1.02742\ \text{Log}_{10}D^2Th$.

Table 20.—Predicted green volume of wood and bark in the main stem to a 3-inch d.o.b. top for Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Cubic feet* | | | | | |
| | WOOD AND BARK[3] | | | | | |
| 4 | 0.8 | 1.1 | 1.5 | 2.0 | 2.4 | |
| 5 | 1.2 | 1.8 | 2.5 | 3.1 | 3.8 | |
| 6 | 1.8 | 2.7 | 3.6 | 4.6 | 5.5 | 6.5 |
| 7 | 2.4 | 3.7 | 5.0 | 6.3 | 7.6 | 9.0 |
| 8 | 3.2 | 4.9 | 6.6 | 8.4 | 10.1 | 11.9 |
| 9 | 4.1 | 6.3 | 8.5 | 10.7 | 13.0 | 15.2 |
| 10 | | 7.8 | 10.6 | 13.4 | 16.2 | 19.0 |
| 11 | | 9.6 | 12.9 | 16.3 | 19.8 | 23.2 |
| 12 | | 11.5 | 15.5 | 19.6 | 23.7 | 27.9 |
| 13 | | | 18.3 | 23.2 | 28.1 | 33.0 |
| 14 | | | 21.4 | 27.1 | 32.8 | 38.6 |
| 15 | | | | 31.3 | 37.9 | 44.6 |
| | WOOD[4] | | | | | |
| 4 | 0.6 | 1.0 | 1.3 | 1.7 | 2.0 | |
| 5 | 1.0 | 1.6 | 2.1 | 2.7 | 3.3 | |
| 6 | 1.5 | 2.3 | 3.1 | 4.0 | 4.9 | 5.7 |
| 7 | 2.1 | 3.2 | 4.4 | 5.6 | 6.8 | 8.0 |
| 8 | 2.8 | 4.3 | 5.9 | 7.4 | 9.1 | 10.7 |
| 9 | 3.6 | 5.5 | 7.5 | 9.6 | 11.7 | 13.8 |
| 10 | | 6.9 | 9.5 | 12.1 | 14.7 | 17.4 |
| 11 | | 8.5 | 11.6 | 14.8 | 18.1 | 21.3 |
| 12 | | 10.3 | 14.1 | 17.9 | 21.8 | 25.8 |
| 13 | | | 16.7 | 21.3 | 25.9 | 30.6 |
| 14 | | | 19.6 | 25.0 | 30.4 | 36.0 |
| 15 | | | | 29.0 | 35.4 | 41.8 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -2.75688 + 1.04968\ \text{Log}_{10}D^2Th.$
[4]$\text{Log}_{10}Y = -2.92462 + 1.08298\ \text{Log}_{10}D^2Th.$

Table 21.—Predicted green volume of wood and bark in branches for Choctawhatchee sand pine trees 4 to 14 inches d.b.h.[1]

| D.b.h. (inches) | Total-tree height[2] (feet) | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 |
| | *Cubic feet* | | | | | |
| | WOOD AND BARK[3] | | | | | |
| 4 | 0.3 | 0.4 | 0.6 | 0.7 | 0.8 | |
| 5 | 0.5 | 0.6 | 0.8 | 1.0 | 1.2 | |
| 6 | 0.6 | 0.9 | 1.1 | 1.4 | 1.6 | 1.8 |
| 7 | 0.8 | 1.1 | 1.4 | 1.7 | 2.0 | 2.3 |
| 8 | 1.1 | 1.4 | 1.8 | 2.2 | 2.5 | 2.9 |
| 9 | 1.2 | 1.7 | 2.2 | 2.6 | 3.1 | 3.5 |
| 10 | | 2.1 | 2.6 | 3.2 | 3.7 | 4.2 |
| 11 | | 2.4 | 3.1 | 3.7 | 4.3 | 4.9 |
| 12 | | 2.8 | 3.6 | 4.3 | 5.0 | 5.7 |
| 13 | | | 4.1 | 4.9 | 5.7 | 6.5 |
| 14 | | | 4.6 | 5.5 | 6.4 | 7.3 |
| 15 | | | | 6.2 | 7.2 | 8.2 |
| | WOOD[4] | | | | | |
| 4 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | |
| 5 | 0.3 | 0.5 | 0.6 | 0.7 | 0.8 | |
| 6 | 0.4 | 0.6 | 0.8 | 1.0 | 1.1 | 1.3 |
| 7 | 0.6 | 0.8 | 1.0 | 1.3 | 1.5 | 1.7 |
| 8 | 0.7 | 1.0 | 1.3 | 1.6 | 1.9 | 2.2 |
| 9 | 0.9 | 1.3 | 1.6 | 2.0 | 2.3 | 2.6 |
| 10 | | 1.5 | 2.0 | 2.4 | 2.8 | 3.2 |
| 11 | | 1.8 | 2.3 | 2.8 | 3.3 | 3.7 |
| 12 | | 2.1 | 2.7 | 3.2 | 3.8 | 4.3 |
| 13 | | | 3.1 | 3.8 | 4.4 | 5.0 |
| 14 | | | 3.5 | 4.2 | 5.0 | 5.7 |
| 15 | | | | 4.8 | 5.6 | 6.4 |

[1]Blocked-in area indicates range of data.
[2]Includes 1-foot stump allowance.
[3]$\text{Log}_{10}Y = -2.58501 + 0.83384\ \text{Log}_{10}D^2Th$.
[4]$\text{Log}_{10}Y = -2.83057 + 0.86608\ \text{Log}_{10}D^2Th$.

U.S. Government Printing Office: 1979 - 635 100/4005 Region No. 8 II

Taras, Michael A.
1980. Aboveground biomass of Choctawhatchee sand pine in northwest Florida. USDA For. Serv., Res. Pap. SE-210, 00 p. Southeast. For. Exp. Stn., Asheville, N.C.

Choctawhatchee sand pine trees 4 to 14 inches d.b.h. were selected from a natural, uneven-aged stand in northwest Florida to determine the weight and volume of aboveground biomass. On the average, 85 percent of the green weight of the total tree was wood, 11 percent bark, and 4 percent needles. The average tree sampled had 82 percent of its wood in the stem and 18 percent in the crown. Specific gravity, moisture content, and green weight per cubic foot are presented for the total tree and its components. Tables developed from regression equations predict weight and cubic-foot volume of the total tree and its components by d.b.h. and total height classes.

KEYWORDS: *Pinus clausa* var. *immuginata* Ward, weight, volume, equations, component proportions.

Taras, Michael A.
1980. Aboveground biomass of Choctawhatchee sand pine in northwest Florida. USDA For. Serv., Res. Pap. SE-210, 00 p. Southeast. For. Exp. Stn., Asheville, N.C.

Choctawhatchee sand pine trees 4 to 14 inches d.b.h. were selected from a natural, uneven-aged stand in northwest Florida to determine the weight and volume of aboveground biomass. On the average, 85 percent of the green weight of the total tree was wood, 11 percent bark, and 4 percent needles. The average tree sampled had 82 percent of its wood in the stem and 18 percent in the crown. Specific gravity, moisture content, and green weight per cubic foot are presented for the total tree and its components. Tables developed from regression equations predict weight and cubic-foot volume of the total tree and its components by d.b.h. and total height classes.

KEYWORDS: *Pinus clausa* var. *immuginata* Ward, weight, volume, equations, component proportions.


The Forest Service, U.S. Department of Agriculture, is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.