

Stephen F. Austin State University

SFA ScholarWorks

Texas Forestry Papers, No. 1-29, 1970-1976

1-1972

Texas Forestry Paper No. 12

J. Robert Hasness

Stephen F. Austin State University

J. David Lenhart

Stephen F. Austin State University

Follow this and additional works at: https://scholarworks.sfasu.edu/texas_forestry_papers



Part of the [Other Forestry and Forest Sciences Commons](#)

[Tell us](#) how this article helped you.

Repository Citation

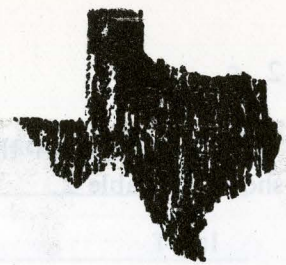
Hasness, J. Robert and Lenhart, J. David, "Texas Forestry Paper No. 12" (1972). *Texas Forestry Papers, No. 1-29, 1970-1976*. 24.

https://scholarworks.sfasu.edu/texas_forestry_papers/24

This Book is brought to you for free and open access by SFA ScholarWorks. It has been accepted for inclusion in Texas Forestry Papers, No. 1-29, 1970-1976 by an authorized administrator of SFA ScholarWorks. For more information, please contact cdsscholarworks@sfasu.edu.



TEXAS FORESTRY PAPER



NO. 12 - JANUARY 1972

SCHOOL OF FORESTRY

STEPHEN F. AUSTIN STATE UNIVERSITY

Nacogdoches, Texas

CUBIC - FOOT VOLUMES FOR LOBLOLLY PINE TREES IN OLD - FIELD PLANTATIONS IN THE INTERIOR WEST GULF COASTAL PLAIN

J. Robert Hasness

and

J. David Lenhart¹

Prediction equations and resulting tables are presented for estimating the cubic-foot volume of individual loblolly pine (*Pinus taeda* L.) trees based on diameter at breast height and total height. Eight different merchantability standards are used.

FIELD PROCEDURE

During the summer of 1971, four sample trees were randomly located in each of 158 unthinned old-field loblolly pine plantations throughout the Interior West Gulf Coastal Plain (Figure 1.) The distribution of the 158 plantations by age, site index, and trees per acre classes is tabulated in Table 1. In each plantation usually two or three of the four sample trees were dominant or codominant, while one or two were intermediate or suppressed. Each sample tree was felled, leaving a 6-inch tall stump, and sectioned into 4-foot bolts to a 2-inch or smaller diameter-outside bark (d.o.b.) top limit. Stem analysis data collected from each felled and sectioned tree consisted of:

1. Diameter at breast height, outside bark (D).
2. Total height including stump-height (H).
3. Diameter outside bark and inside bark at the stump and at the top of each 4-foot bolt.

¹ Graduate Research Assistant and Assistant Professor of Forest Biometrics, respectively, School of Forestry. Stephen F. Austin State University.

The distribution of the 632 sample trees by diameter at breast height and total height classes is shown in Table 2.

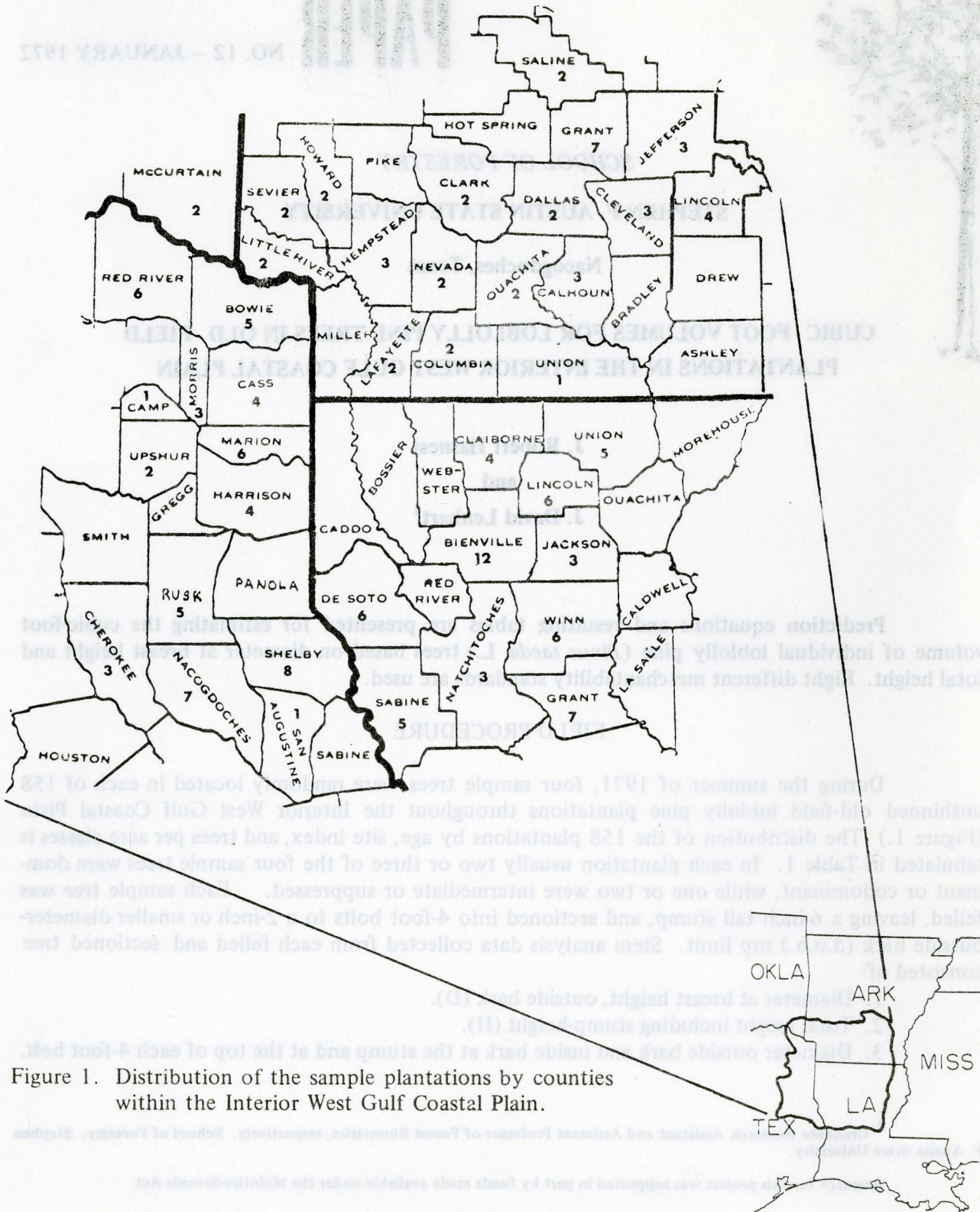


Figure 1. Distribution of the sample plantations by counties within the Interior West Gulf Coastal Plain.

Table 1. Number of sample plantations, by site index (base age 25), stand density levels, and age.

| Trees Per Acre | Age | Site Index | | | | | Total |
|-------------------|-------|------------|-----------|-----------|----------|----------|------------|
| | | 40 | 50 | 60 | 70 | 80 | |
| ≤ 450 | 10 | | 1 | | | | 1 |
| | 15 | 1 | 7 | 4 | 2 | | 14 |
| | 20 | | | 2 | 3 | | 5 |
| | 25 | | | | 2 | 1 | 3 |
| | 30 | | | | 1 | | 1 |
| | Total | | 1 | 8 | 6 | 8 | 1 |
| 500 | 10 | 1 | 6 | | | | 7 |
| | 15 | 2 | 18 | 3 | | | 23 |
| | 20 | | 2 | 2 | | 1 | 5 |
| | 25 | | | 1 | | | 1 |
| | 30 | | | | | | |
| | Total | | 3 | 26 | 6 | | 1 |
| 600 | 10 | 3 | 2 | 1 | | | 6 |
| | 15 | 2 | 6 | 4 | | | 12 |
| | 20 | | 1 | 1 | | | 2 |
| | 25 | | | | | | |
| | 30 | | | | | | |
| | Total | | 5 | 9 | 6 | | |
| 700 | 10 | 1 | 4 | 1 | | | 6 |
| | 15 | 1 | 13 | 4 | 1 | | 19 |
| | 20 | | 2 | | | | 2 |
| | 25 | | | | | | |
| | 30 | | | | | | |
| | Total | | 2 | 19 | 5 | 1 | |
| 800 | 10 | | 5 | | | | 5 |
| | 15 | 1 | 7 | 1 | | | 9 |
| | 20 | | | 1 | | | 1 |
| | 25 | | | | | | |
| | 30 | | | | | | |
| | Total | | 1 | 12 | 2 | | |
| 900 | 10 | 1 | 5 | 1 | | | 7 |
| | 15 | | 5 | | | | 5 |
| | 20 | 2 | | 1 | | | 3 |
| | 25 | | | | | | |
| | 30 | | | | | | |
| | Total | | 3 | 10 | 2 | | |
| ≥ 951 | 10 | 4 | 4 | | | | 8 |
| | 15 | 4 | 7 | 1 | | | 12 |
| | 20 | | | 1 | | | 1 |
| | 25 | | | | | | |
| | 30 | | | | | | |
| | Total | | 8 | 11 | 2 | | |
| TOTAL | | 23 | 95 | 29 | 9 | 2 | 158 |

Table 2. Number of sample trees, by total height and diameter classes.

| Diameter at breast height, o. b. inches | Total height - feet | | | | | | | | | | | | | | Total |
|---|---------------------|-----------|------------|------------|------------|-----------|-----------|-----------|----------|----------|----------|----------|----|--|------------|
| | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | | |
| 5 | 11 | 34 | 83 | 82 | 23 | 5 | 1 | | | | | | | | 239 |
| 6 | | 9 | 31 | 56 | 38 | 13 | 5 | | | | | | | | 152 |
| 7 | | | 9 | 34 | 44 | 14 | 12 | 2 | 1 | | | | | | 116 |
| 8 | | | 3 | 12 | 23 | 16 | 3 | 6 | | | | | | | 63 |
| 9 | | | 1 | 2 | 9 | 10 | 3 | 6 | 1 | | | | | | 32 |
| 10 | | | | | 1 | 4 | 3 | 2 | 1 | 2 | | | | | 13 |
| 11 | | | | | | 2 | | 1 | | 2 | 2 | | | | 7 |
| 12 | | | | | | | | | 2 | | 1 | | | | 3 |
| 13 | | | | | 1 | | | | | | 2 | | | | 3 |
| 14 | | | | | | | | 1 | | | | | | | 1 |
| 15 | | | | | | | | | | | | | 1 | | 1 |
| 16 | | | | | | | | | | 1 | | | | | 1 |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | 1 | | 1 |
| TOTAL | 11 | 43 | 127 | 186 | 138 | 65 | 27 | 18 | 5 | 5 | 5 | 2 | | | 632 |

PREDICTION EQUATIONS

For each sample tree the cubic-foot volumes of each bolt measured outside bark (o.b.) and inside bark (i.b.), were determined, using Smalian's formula. The topwood volume (main stem above uppermost bolt) was calculated as a cone. The bolt and cone volumes were summed to give total volume o.b. and i.b. for the entire tree. Volumes o.b. and i.b. to a 2-inch d.o.b., 3-inch d.o.b., and 4-inch d.o.b. merchantability limit were calculated for each tree by summing the bolts below the bolt in which the top diameter limit occurred, plus the partial volume of the latter found by linear interpolation on cross-sectional area. Each of the resulting eight different volumes for each tree was entered, together with its diameter at breast height and total height, as input in a regression analysis.

The equations for predicting the cubic-foot volumes per tree, inside and outside bark, for whole trees, and merchantable portions to 3 diameter limits, are:

- (1) Total volume (o.b.) = $0.0023035D^2H + 0.13698$
- (2) Total volume (i.b.) = $0.0019571D^2H - 0.08461$
- (3) Volume (o.b.) to a 2-inch top (d.o.b.) = $0.0023050D^2H + 0.06159$
- (4) Volume (i.b.) to a 2-inch top (d.o.b.) = $0.0019584D^2H - 0.14520$
- (5) Volume (o.b.) to a 3-inch top (d.o.b.) = $0.0023164D^2H - 0.15438$
- (6) Volume (i.b.) to a 3-inch top (d.o.b.) = $0.0019680D^2H - 0.32395$
- (7) Volume (o.b.) to a 4-inch top (d.o.b.) = $0.0023521D^2H - 0.70594$
- (8) Volume (i.b.) to a 4-inch top (d.o.b.) = $0.0019973D^2H - 0.78752$

Each equation accounted for 98% or more of the total variation in volume, and the standard deviation about regression varied from 0.516 to 0.669.

The values shown in Tables 3 through 10 were calculated from equations (1) through (8), respectively.

Within the range of diameters and heights given in Tables 3 through 10, the equations to predict volumes to different top utilization limits do not intersect one another. They may in some instances intersect beyond the scope of the tables. As with most volume tables, extrapolation beyond published sizes may introduce sizable error.

Table 3. Total volume, outside bark, cubic feet, for loblolly pine trees.

| D. b. h. inches | Total height, feet | | | | | | | | | | | |
|--------------------|--------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 |
| 5 | 1.29 | 1.58 | 1.86 | 2.15 | 2.44 | 2.73 | 3.02 | 3.30 | 3.59 | | | |
| 6 | | 2.21 | 2.62 | 3.04 | 3.45 | 3.87 | 4.28 | 4.70 | 5.11 | 5.53 | 5.94 | |
| 7 | | | 3.52 | 4.09 | 4.65 | 5.22 | 5.78 | 6.34 | 6.91 | 7.47 | 8.04 | |
| 8 | | | 4.56 | 5.30 | 6.03 | 6.77 | 7.51 | 8.25 | 8.98 | 9.72 | 10.46 | |
| 9 | | | 5.73 | 6.67 | 7.60 | 8.53 | 9.47 | 10.40 | 11.33 | 12.26 | 13.20 | |
| 10 | | | | 8.20 | 9.35 | 10.50 | 11.65 | 12.81 | 13.96 | 15.11 | 16.26 | 17.41 |
| 11 | | | | | | 12.68 | 14.07 | 15.47 | 16.86 | 18.25 | 19.65 | 21.04 |
| 12 | | | | | | 15.06 | 16.72 | 18.38 | 20.04 | 21.70 | 23.36 | 25.01 |
| 13 | | | | | | 17.66 | 19.60 | 21.55 | 23.49 | 25.44 | 27.39 | 29.33 |
| 14 | | | | | | | 22.71 | 24.97 | 27.23 | 29.48 | 31.74 | 34.00 |

Table 4. Total volume, inside bark, cubic feet, for loblolly pine trees.

| D. b. h. inches | Total height, feet | | | | | | | | | | | |
|--------------------|--------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 |
| 5 | 0.89 | 1.14 | 1.38 | 1.63 | 1.87 | 2.12 | 2.36 | 2.61 | 2.85 | | | |
| 6 | | 1.68 | 2.03 | 2.38 | 2.73 | 3.09 | 3.44 | 3.79 | 4.14 | 4.50 | 4.85 | |
| 7 | | | 2.79 | 3.27 | 3.75 | 4.23 | 4.71 | 5.19 | 5.67 | 6.15 | 6.63 | |
| 8 | | | 3.67 | 4.30 | 4.93 | 5.55 | 6.18 | 6.80 | 7.43 | 8.06 | 8.68 | |
| 9 | | | 4.67 | 5.46 | 6.26 | 7.05 | 7.84 | 8.63 | 9.43 | 10.22 | 11.01 | |
| 10 | | | | 6.77 | 7.74 | 8.72 | 9.70 | 10.68 | 11.66 | 12.64 | 13.62 | |
| 11 | | | | | | 10.57 | 11.76 | 12.94 | 14.12 | 15.31 | 16.49 | 17.68 |
| 12 | | | | | | 12.60 | 14.01 | 15.42 | 16.82 | 18.23 | 19.64 | 21.05 |
| 13 | | | | | | 14.80 | 16.45 | 18.11 | 19.76 | 21.41 | 23.07 | 24.72 |
| 14 | | | | | | | 19.09 | 21.01 | 22.93 | 24.85 | 26.77 | 28.68 |

Table 5. Merchantable volume, outside bark, cubic feet, to 2.0-inch top d.o.b., for loblolly pine trees.

| D. b. h. inches | Total height, feet | | | | | | | | | | | |
|--------------------|--------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 |
| 5 | 1.21 | 1.50 | 1.79 | 2.08 | 2.37 | 2.65 | 2.94 | 3.23 | 3.52 | | | |
| 6 | | 2.14 | 2.55 | 2.97 | 3.38 | 3.80 | 4.21 | 4.63 | 5.04 | 5.46 | 5.87 | |
| 7 | | | 3.45 | 4.01 | 4.58 | 5.14 | 5.71 | 6.27 | 6.84 | 7.40 | 7.97 | |
| 8 | | | 4.49 | 5.22 | 5.96 | 6.70 | 7.44 | 8.18 | 8.91 | 9.65 | 10.39 | |
| 9 | | | 5.66 | 6.60 | 7.53 | 8.46 | 9.40 | 10.33 | 11.26 | 12.20 | 13.13 | |
| 10 | | | | 8.13 | 9.28 | 10.43 | 11.59 | 12.74 | 13.89 | 15.04 | 16.20 | |
| 11 | | | | | | 12.61 | 14.01 | 15.40 | 16.80 | 18.19 | 19.58 | 20.98 |
| 12 | | | | | | 15.00 | 16.66 | 18.32 | 19.98 | 21.64 | 23.30 | 24.96 |
| 13 | | | | | | 17.59 | 19.54 | 21.49 | 23.43 | 25.38 | 27.33 | 29.28 |
| 14 | | | | | | | 22.65 | 24.91 | 27.17 | 29.43 | 31.69 | 33.95 |

Table 6. Merchantable volume, inside bark, cubic feet, to 2.0-inch top d.o.b. for loblolly pine trees.

| D. b. h. inches | Total height, feet | | | | | | | | | | | |
|--------------------|--------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 |
| 5 | 0.83 | 1.08 | 1.32 | 1.57 | 1.81 | 2.06 | 2.30 | 2.55 | 2.79 | | | |
| 6 | | 1.62 | 1.97 | 2.32 | 2.67 | 3.03 | 3.38 | 3.73 | 4.08 | 4.44 | 4.79 | |
| 7 | | | 2.73 | 3.21 | 3.69 | 4.17 | 4.65 | 5.13 | 5.61 | 6.09 | 6.57 | |
| 8 | | | 3.61 | 4.24 | 4.87 | 5.49 | 6.12 | 6.75 | 7.38 | 8.00 | 8.63 | |
| 9 | | | 4.61 | 5.41 | 6.20 | 6.99 | 7.79 | 8.58 | 9.37 | 10.17 | 10.96 | |
| 10 | | | | 6.71 | 7.69 | 8.67 | 9.65 | 10.63 | 11.61 | 12.58 | 13.56 | |
| 11 | | | | | | 10.52 | 11.70 | 12.89 | 14.07 | 15.26 | 16.44 | 17.63 |
| 12 | | | | | | 12.55 | 13.96 | 15.37 | 16.78 | 18.19 | 19.60 | 21.01 |
| 13 | | | | | | 14.75 | 16.40 | 18.06 | 19.71 | 21.37 | 23.02 | 24.68 |
| 14 | | | | | | | 19.05 | 20.97 | 22.89 | 24.80 | 26.72 | 28.64 |

Table 7. Merchantable volume, outside bark, cubic feet, to 3.0-inch d.o.b. loblolly pine trees.

| D. b. h. inches | Total height, feet | | | | | | | | | | | |
|--------------------|--------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 |
| 5 | 1.00 | 1.29 | 1.58 | 1.87 | 2.16 | 2.45 | 2.74 | 3.03 | 3.32 | | | |
| 6 | | 1.93 | 2.35 | 2.76 | 3.18 | 3.60 | 4.02 | 4.43 | 4.85 | 5.27 | 5.68 | |
| 7 | | | 3.25 | 3.82 | 4.39 | 4.95 | 5.52 | 6.09 | 6.66 | 7.22 | 7.79 | |
| 8 | | | 4.29 | 5.03 | 5.78 | 6.52 | 7.26 | 8.00 | 8.74 | 9.48 | 10.22 | |
| 9 | | | 5.47 | 6.41 | 7.35 | 8.29 | 9.23 | 10.17 | 11.10 | 12.04 | 12.98 | |
| 10 | | | | 7.95 | 9.11 | 10.27 | 11.43 | 12.59 | 13.74 | 14.90 | 16.06 | |
| 11 | | | | | | 12.46 | 13.86 | 15.26 | 16.66 | 18.06 | 19.47 | 20.87 |
| 12 | | | | | | 14.86 | 16.52 | 18.19 | 19.86 | 21.53 | 23.19 | 24.86 |
| 13 | | | | | | 17.46 | 19.42 | 21.38 | 23.33 | 25.29 | 27.25 | 29.21 |
| 14 | | | | | | | 22.55 | 24.82 | 27.09 | 29.36 | 31.63 | 33.90 |

Table 8. Merchantable volume, inside bark, cubic feet, to 3.0 inch d.o.b., for loblolly pine trees.

| D. b. h. inches | Total height, feet | | | | | | | | | | | |
|--------------------|--------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 |
| 5 | 0.66 | 0.91 | 1.15 | 1.40 | 1.64 | 1.89 | 2.14 | 2.38 | 2.63 | | | |
| 6 | | 1.45 | 1.80 | 2.16 | 2.51 | 2.86 | 3.22 | 3.57 | 3.93 | 4.28 | 4.64 | |
| 7 | | | 2.57 | 3.05 | 3.53 | 4.02 | 4.50 | 4.98 | 5.46 | 5.94 | 6.43 | |
| 8 | | | 3.45 | 4.08 | 4.71 | 5.34 | 5.97 | 6.60 | 7.23 | 7.86 | 8.49 | |
| 9 | | | 4.46 | 5.26 | 6.05 | 6.85 | 7.65 | 8.44 | 9.24 | 10.04 | 10.83 | |
| 10 | | | | 6.56 | 7.55 | 8.53 | 9.52 | 10.50 | 11.48 | 12.47 | 13.45 | |
| 11 | | | | | | 10.39 | 11.58 | 12.77 | 13.96 | 15.15 | 16.35 | 17.54 |
| 12 | | | | | | 12.43 | 13.85 | 15.26 | 16.68 | 18.10 | 19.51 | 20.93 |
| 13 | | | | | | 14.64 | 16.31 | 17.97 | 19.63 | 21.29 | 22.96 | 24.62 |
| 14 | | | | | | | 18.96 | 20.89 | 22.82 | 24.75 | 26.68 | 28.61 |

Table 9. Merchantable volume, outside bark, cubic feet, to 4.0-inch top d.o.b., for loblolly pine trees.

| D. b. h. inches | Total height, feet | | | | | | | | | | | |
|--------------------|--------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 |
| 5 | 0.47 | 0.76 | 1.06 | 1.35 | 1.65 | 1.94 | 2.23 | 2.53 | 2.82 | | | |
| 6 | | 1.41 | 1.83 | 2.26 | 2.68 | 3.10 | 3.53 | 3.95 | 4.37 | 4.80 | 5.22 | |
| 7 | | | 2.75 | 3.33 | 3.90 | 4.48 | 5.06 | 5.63 | 6.21 | 6.79 | 7.36 | |
| 8 | | | 3.81 | 4.56 | 5.32 | 6.07 | 6.82 | 7.57 | 8.33 | 9.08 | 9.83 | |
| 9 | | | 5.01 | 5.96 | 6.91 | 7.87 | 8.82 | 9.77 | 10.73 | 11.68 | 12.63 | |
| 10 | | | | 7.53 | 8.70 | 9.88 | 11.05 | 12.23 | 13.41 | 14.58 | 15.76 | |
| 11 | | | | | | 12.10 | 13.52 | 14.95 | 16.37 | 17.79 | 19.22 | 20.64 |
| 12 | | | | | | 14.54 | 16.23 | 17.92 | 19.62 | 21.31 | 23.00 | 24.70 |
| 13 | | | | | | 17.18 | 19.17 | 21.16 | 23.14 | 25.13 | 27.12 | 29.11 |
| 14 | | | | | | | 22.34 | 24.65 | 26.95 | 29.26 | 31.56 | 33.87 |

Table 10. Merchantable volume, inside bark, cubic feet, to 4.0 d.o.b. for loblolly pine trees.

| D. b. h. inches | Total height, feet | | | | | | | | | | | |
|--------------------|--------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 |
| 5 | 0.21 | 0.46 | 0.71 | 0.96 | 1.21 | 1.46 | 1.71 | 1.96 | 2.21 | | | |
| 6 | | 1.01 | 1.37 | 1.73 | 2.09 | 2.45 | 2.81 | 3.17 | 3.53 | 3.89 | 4.25 | |
| 7 | | | 2.15 | 2.64 | 3.13 | 3.62 | 4.11 | 4.60 | 5.08 | 5.57 | 6.06 | |
| 8 | | | 3.05 | 3.69 | 4.33 | 4.96 | 5.60 | 6.24 | 6.88 | 7.52 | 8.16 | |
| 9 | | | 4.07 | 4.87 | 5.68 | 6.49 | 7.30 | 8.11 | 8.92 | 9.73 | 10.54 | |
| 10 | | | | 6.20 | 7.20 | 8.20 | 9.20 | 10.20 | 11.20 | 12.19 | 13.19 | |
| 11 | | | | | | 10.09 | 11.30 | 12.50 | 13.71 | 14.92 | 16.13 | 17.34 |
| 12 | | | | | | 12.15 | 13.59 | 15.03 | 16.47 | 17.91 | 19.35 | 20.78 |
| 13 | | | | | | 14.40 | 16.09 | 17.78 | 19.47 | 21.15 | 22.84 | 24.53 |
| 14 | | | | | | | 18.79 | 20.74 | 22.70 | 24.66 | 26.62 | 28.57 |