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ESTIMATING VOLUME OF SOUTHERN PINES USING TARIFF AND STANDARD VOLUME TABLES¹

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The tariff system, as developed by Turnbull *et al.* (1963), provides local cubic-foot and board-foot volume tables, relating volume to diameter measurements alone, which may be used for many forest species. These volume tables are indexed by tariff number, which is defined as the total cubic-foot volume from the stump to a 4-inch top (inside bark) for a tree of 1.0 square foot of basal area.

Access tables have recently been published which facilitate the use of the tariff system for volume determinations of southern pines (Smith and Wiant, 1971; Wiant, 1972). The access tables give the tariff numbers of sample trees based on d.b.h., total height, and Girard form class measurements. These tables were developed from volume equations for southern pine pulpwood derived by Merrifield and Foil (1967) from Minor's (1950) form class volume tables for southern pine pulpwood.

The studies reported here were designed to compare volume estimates derived through tariff tables to those made using standard volume tables in southern pine.

¹ Based on theses presented by the junior authors to the faculty of the Graduate School of SFA State University in partial fulfillment of the requirements for M.S.F. degrees. Studies supported in part by McIntire-Stennis funds.

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PROCEDURE

Nine sawtimber-size and 12 pulpwood-size stands were sampled in eastern Texas, central Arkansas, and western Louisiana. Species studied included loblolly (*Pinus taeda* L.), shortleaf (*P. echinata* Mill.), longleaf (*P. palustris* Mill.) and slash (*P. elliottii* Engelm.) pines. In each stand, the following determinations were made on sample trees:

- (1) Total height, using an abney or clinometer.
- (2) D.b.h., using a diameter tape.
- (3) Girard form class, using the "Wiant-f-c-Wedge."¹
- (4) Tarif number, using Smith's and Wiant's access tables.

In each sawtimber stand, the sample measured in this way consisted of 100 trees. In each pulpwood stand, 30 point samples (BAF 10) were randomly located and all "in-trees" on the plots were measured as described above, except the Girard form class and tarif number were determined for only the first "in-tree" to the right of north on each plot.

Volumes in board feet (Scribner) for sawtimber and in cubic feet for pulpwood, based on average Girard form classes and tarif numbers, were determined using tarif volume tables published by Turnbull *et al.* (1963). Once the volume table is selected according to the average tarif number of the stand, volumes are indexed by d.b.h. alone.

For comparisons, sawtimber volumes were determined also using Bruce's and Girard's (no date) form class standard volume tables and pulpwood volumes using Minor's (1950) form class standard volume tables. Once the proper form class table is selected for the stand, volumes are indexed by d.b.h. and total heights. Statistical comparisons for sawtimber were based on individual tree volumes; those for pulpwood were based on the per acre volumes at each sampling point.

ANALYSIS

Results were analyzed at the 5% level of probability using a chi-square analysis recommended by Freese (1960) for this type study, as follows:

$$\chi^2_{(n) df} = \frac{(196)^2}{p^2} \sum \left(\frac{x}{u} - 1 \right)^2$$

where: P = Percent of true standard value one specifies that the estimates be within unless a 1-in-20 chance has occurred, in this study set at 10%.

x = The board-foot volume of the tree or per-acre cubic-foot volume of the point sample as estimated by the tarif method.

u = The board-foot volume of the tree or per-acre cubic-foot volume of the point sample as measured by the standard volume tables.

(n)df = Degrees of freedom = 100 for each sawtimber stand, 30 for each pulpwood stand. Chi-square values of 124.34 or greater are significant for sawtimber, of 43.77 or greater are significant for pulpwood.

¹Wiant, H. V., Jr., Form class estimates - a simple guide. (in press in *J. Forest*).

RESULTS

All chi-square values for sawtimber comparisons and all but one for pulpwood comparisons were statistically significant, indicating that tariff volumes, as compared to standard volumes, did not provide the 10 percent accuracy (P) required (Tables 1 & 2). However, considering the advantages of local volume tables requiring diameter measurements only, average differences might be acceptable for some practical applications. A possible source of these differences may lie in Smith's and Wiant's (1971) access tables, which depend in part on extrapolation of data from pulpwood-size trees.

As Turnbull *et al.* (1963) have pointed out, a tariff table appropriate to a specific stand can be selected without an access table if an applicable volume table is available which estimates cubic-foot volume to 4-, 6-, or 8-inch tops or board-foot volume (International 1/4" or Scribner) to 6- or 8-inch tops, d.i.b.

1. On a representative subsample of 20 to 30 trees, measurements are made as needed for the applicable volume table: i. e., height, diameter, form class. Sample trees should be selected with a probability of their appearance in the sample proportional to basal area (Berry and Wiant, 1967). For example, the sample tree may be the first tree clockwise from north that is within a variable plot defined by any convenient prism or similar point sampling tool.

2. On all other trees measure diameter only.

3. For each sample tree of known d.b.h. and estimated volume, search through Turnbull's *et al.* tariff tables under the appropriate volume column to find the tariff table (indexed by the tariff number) showing the correct volume for the sample tree d.b.h.

4. Ascertain the average tariff number from the sample trees. The tariff volume table indexed by that number is used for volume determinations.

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Table 1. Average stand dimensions and comparative sawtimber volumes.

Species of pine	Location (county and state)	Avg. d.b.h. ¹ (in.)	Avg. total ht. ¹ (ft.)	Avg. form class ¹	Avg. tarif no. ¹	Avg. volume per acre		Percent difference	Chi-square value
						Standard (bd. ft.)	Tarif (bd. ft.)		
Shortleaf	Garland County, Ark.	14.2±0.5	62±4	81±2	27.6±0.4	130	132	1.5	221*
Shortleaf	Houston County, Tex.	16.1±1.0	82±9	83±1	33.7±0.8	257	264	2.7	425*
Shortleaf	Nacogdoches County, Tex.	14.5±0.4	68±4	81 ^a	29.6±0.4	146	155	6.2	478*
Longleaf	Jasper County, Tex.	13.4±0.3	60±3	78±2	23.8±0.4	95	87	-8.4	400*
Longleaf	Jasper County, Tex.	14.0±0.7	76±6	80±2	32.6±0.9	142	167	17.6	1579*
Longleaf	Natchitoches Parish, La.	14.1±0.4	69±7	80±1	26.2±0.6	130	116	-10.8	612*
Loblolly	Nacogdoches County, Tex.	15.8±1.0	72±6	80±2	30.4±0.6	190	212	11.6	1101*
Loblolly	Garland County, Ark.	14.2±1.0	63±19	77±3	24.6±1.3	128	113	-11.7	738*
Loblolly	Nacogdoches County, Tex.	14.4±0.8	72±7	80±2	31.1±0.8	151	170	12.6	1301*

¹Averages are shown ± standard errors.²Difference of tarif from standard volumes, in percent.

* Difference significant at 5% level of probability.

^aBased on 10 trees instead of 100 as the "Wiant-f-c-Wedge" was used improperly.

Table 2. Average stand dimensions and comparative pulpwood volumes.

Species of pine	Location (county and state)	Avg. d.b.h. ¹ (in.)	Avg. total ht. ¹ (ft.)	Avg. form class ¹	Avg. tarif no. ¹	Avg. volume per acre		Percent difference	Chi-square value
						Standard (cu. ft.)	Tarif (cu. ft.)		
Slash	Nacogdoches County, Tex.	10.2±1.5	84±10	82±0	38.0±2.3	2770	2744	-0.9	42 n. s.
Slash	Garland County, Ark.	8.1±2.1	69±8	79±2	36.1±2.5	1550	1458	-5.9	93*
Slash	Natchitoches Parish, La.	7.3±1.5	42±9	79±3	24.2±1.7	1013	1021	0.8	67*
Shortleaf	Polk County, Tex.	9.8±2.4	76±18	78±2	31.5±3.5	1349	1295	-4.0	243*
Shortleaf	Garland County, Ark.	9.1±1.3	69±11	78±3	29.5±2.8	1423	1399	-1.7	133*
Shortleaf	Sabine Parish, La.	9.0±1.9	51±6	79±3	24.3±1.6	1110	1332	20.0	618*
Longleaf	Newton County, Tex.	9.1±1.7	51±4	80±3	27.3±1.6	1339	1345	0.4	72*
Longleaf	Natchitoches Parish, La.	9.9±1.6	56±10	78±4	24.5±4.1	1264	1174	-7.1	164*
Loblolly	Polk County, Tex.	10.4±2.0	83±11	77±0	29.9±2.2	1479	1318	-10.9	184*
Loblolly	Shelby County, Tex.	10.4±2.5	66±20	82±2	32.5±6.7	2241	2195	-2.1	383*
Loblolly	Natchitoches Parish, La.	9.9±1.9	52±11	78±2	24.0±4.6	1149	1051	-8.5	190*
Loblolly	Perry County, Ark.	10.0±2.3	66±8	74±2	27.9±2.4	1322	1219	-7.8	142*

¹Averages are shown ± standard errors.²Differences of tarif from standard volumes, in percent.

ns Difference not significant at 5% level of probability.

* Difference significant at 5% level of probability.