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The tarif 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 tarif 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 tarif system for volume determinations of southern pines (Smith and Wiant, 1971; Wiant, 1972). The access tables give the tarif 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 tarif tables to those made using standard volume tables in southern pine.
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.”
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:

\[ \chi^2 = \frac{(196)^2}{p^2} \sum \left( \frac{x}{n} - 1 \right)^2 \]

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.

1 Wiant, 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 tarif 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.b.h.

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.

LITERATURE CITED


Bruce, D., and J. W. Girard. No date. Tables for estimating board foot volume of trees scaled in 16-foot logs based on diameter, form class, and total height. Published by Mason, Bruce, & Girard, American Bank Building, Portland, Oregon.


Table 1. Average stand dimensions and comparative sawtimber volumes.

<table>
<thead>
<tr>
<th>Species of pine</th>
<th>Location (county and state)</th>
<th>Avg. d.b.h.¹ (in.)</th>
<th>Avg. total h¹ (ft.)</th>
<th>Avg. form class¹</th>
<th>Avg. tarif no.¹</th>
<th>Percent difference</th>
<th>Percent difference value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortleaf</td>
<td>Garland County, Ark.</td>
<td>14.2±0.5</td>
<td>62±4</td>
<td>81±2</td>
<td>27.6±0.4</td>
<td>130</td>
<td>132</td>
</tr>
<tr>
<td>Shortleaf</td>
<td>Houston County, Tex.</td>
<td>16.1±1.0</td>
<td>82±9</td>
<td>83±1</td>
<td>33.7±0.8</td>
<td>257</td>
<td>264</td>
</tr>
<tr>
<td>Shortleaf</td>
<td>Nacogdoches County, Tex.</td>
<td>14.5±0.4</td>
<td>68±4</td>
<td>81±2</td>
<td>29.6±0.4</td>
<td>146</td>
<td>155</td>
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<tr>
<td>Longleaf</td>
<td>Jasper County, Tex.</td>
<td>13.4±0.3</td>
<td>60±3</td>
<td>78±2</td>
<td>23.8±0.4</td>
<td>95</td>
<td>87</td>
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<tr>
<td>Longleaf</td>
<td>Jasper County, Tex.</td>
<td>14.0±0.7</td>
<td>76±6</td>
<td>80±2</td>
<td>32.6±0.9</td>
<td>142</td>
<td>167</td>
</tr>
<tr>
<td>Longleaf</td>
<td>Natchitoches Parish, La.</td>
<td>14.1±0.4</td>
<td>69±7</td>
<td>80±1</td>
<td>26.2±0.6</td>
<td>130</td>
<td>116</td>
</tr>
<tr>
<td>Loblolly</td>
<td>Nacogdoches County, Tex.</td>
<td>15.8±1.0</td>
<td>72±6</td>
<td>80±2</td>
<td>30.4±0.6</td>
<td>190</td>
<td>212</td>
</tr>
<tr>
<td>Loblolly</td>
<td>Garland County, Ark.</td>
<td>14.2±1.0</td>
<td>63±19</td>
<td>77±3</td>
<td>24.6±1.3</td>
<td>128</td>
<td>113</td>
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<tr>
<td>Loblolly</td>
<td>Nacogdoches County, Tex.</td>
<td>14.4±0.8</td>
<td>72±7</td>
<td>80±2</td>
<td>31.1±0.8</td>
<td>151</td>
<td>170</td>
</tr>
</tbody>
</table>

¹ Averages are shown ± standard errors.
² Difference of tariff from standard volumes, in percent.
* Difference significant at 5% level of probability.
*¹ Based on 10 trees instead of 100 as the "Wiant-f-Wedge" was used improperly.

Table 2. Average stand dimensions and comparative pulpwood volumes.

<table>
<thead>
<tr>
<th>Species of pine</th>
<th>Location (county and state)</th>
<th>Avg. d.b.h.¹ (in.)</th>
<th>Avg. total h¹ (ft.)</th>
<th>Avg. form class¹</th>
<th>Avg. tarif no.¹</th>
<th>Percent difference</th>
<th>Percent difference value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slash</td>
<td>Nacogdoches County, Tex.</td>
<td>10.0±1.5</td>
<td>84±10</td>
<td>82±0</td>
<td>38.0±2.3</td>
<td>2770</td>
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<td>Slash</td>
<td>Garland County, Ark.</td>
<td>8.1±2.1</td>
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<td>36.1±2.5</td>
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<td>Natchitoches Parish, La.</td>
<td>7.3±1.5</td>
<td>42±9</td>
<td>79±3</td>
<td>24.2±1.7</td>
<td>1013</td>
<td>1021</td>
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<tr>
<td>Shortleaf</td>
<td>Polk County, Tex.</td>
<td>9.8±2.4</td>
<td>76±18</td>
<td>78±2</td>
<td>31.5±3.5</td>
<td>1349</td>
<td>1295</td>
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<td>Shortleaf</td>
<td>Garland County, Ark.</td>
<td>9.1±1.3</td>
<td>69±11</td>
<td>78±3</td>
<td>29.5±2.8</td>
<td>1423</td>
<td>1399</td>
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<td>Shortleaf</td>
<td>Sabine Parish, La.</td>
<td>9.0±1.9</td>
<td>51±6</td>
<td>79±3</td>
<td>24.3±1.6</td>
<td>1110</td>
<td>1332</td>
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<td>Longleaf</td>
<td>Newton County, Tex.</td>
<td>9.1±1.7</td>
<td>51±4</td>
<td>80±3</td>
<td>27.3±1.6</td>
<td>1339</td>
<td>1345</td>
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<tr>
<td>Longleaf</td>
<td>Natchitoches Parish, La.</td>
<td>9.9±1.6</td>
<td>56±10</td>
<td>78±4</td>
<td>24.5±4.1</td>
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<td>1174</td>
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<td>Loblolly</td>
<td>Polk County, Tex.</td>
<td>10.4±2.0</td>
<td>83±11</td>
<td>77±0</td>
<td>29.9±2.2</td>
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<td>Loblolly</td>
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<td>2195</td>
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<td>Natchitoches Parish, La.</td>
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<td>Loblolly</td>
<td>Perry County, Ark.</td>
<td>10.0±2.3</td>
<td>66±8</td>
<td>74±2</td>
<td>27.9±2.4</td>
<td>1322</td>
<td>1219</td>
</tr>
</tbody>
</table>

¹ Averages are shown ± standard errors.
² Differences of tariff from standard volumes, in percent.
* Difference not significant at 5% level of probability.
* Difference significant at 5% level of probability.