Quick Cruising to Estimate Board-Foot Volume of Standing Hardwood Timber

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Introduction

Timber inventories are the main tool used to determine the volume and value of standing trees on a forested tract. A timber inventory, like any inventory, involves taking stock of how much material is available. While timber inventories are most often performed to place value on a stand before sale, they are also useful for providing information for the development of management strategies, estate planning, tax basis or litigation (Henning and Mercker 2014).

Nevertheless, timber inventories are time consuming and often expensive, and though the results are beneficial, full-scale inventories may produce more information than may be needed. More details about full-scale timber inventory can be found in “PB 1870 Conducting a Simple Timber Inventory” (Henning and Mercker 2014) at extension.tennessee.edu/publications/Documents/PB1780.pdf.

Many foresters, loggers and timber buyers (and in some cases landowners) have sought a quicker method of estimating the board-foot (bf) volume of standing timber. Sometimes full-scale inventories are not necessary and ballpark estimates are sufficient.

This publication addresses a method of timber inventory often called *quick cruising* that has been used for years in the forestry business. Quick cruising, when done properly, provides users with an estimate of standing timber volume that can assist in making decisions regarding selling, buying or evaluating timber.
**Procedure**

The quick cruise method converts the average number of 16-foot logs tallied per plot to an estimate of board feet per acre. Quick cruising uses the inventory method called variable-radius plot sampling. Also known as angle-gauge sampling, prism sampling or point sampling, this approach is a common and efficient sampling method.

When conducting a quick cruise, a 10-basal area factor (BAF) prism or angle gauge is used to determine the number of “in” trees for each plot. The number of 16-foot merchantable logs tallied (to a 10-inch top diameter) in the “in” trees is recorded. A conversion factor is then used to convert the number of logs tallied per plot to bf per acre, and it varies according to the average diameter at breast high (dbh) and average number of logs per tree. Therefore, it is also beneficial to note the number of “in” trees and the average dbh of the “in” trees.

The accuracy of any timber inventory improves when data variability decreases. Therefore, to decrease data variability with quick cruising, these steps should be followed:

- Delineate a timber tract into uniform smaller stands and inventory each stand separately. This makes each plot more representative of the stand. For instance, a fine-quality mature oak stand should be inventoried separately from a degraded and/or younger stand.
- Increase the number of plots. A rule of thumb is to incorporate one plot per acre for the first 40 acres, then one per 2 acres for the next 60 acres, then one per 5 acres thereafter. Although increasing plot intensity improves accuracy, it is more time consuming and may defeat the purpose of a quick cruise.
- Place plots systematically in a grid-like pattern to avoid biasing the plots toward the better-quality timber or on terrain more easily traversed.
- Collect data accurately to ensure that the correct “in” trees are tallied and with a precise tally of the number of 16-foot logs within the tallied trees.

An example with a basal area factor of 10 (ft²/ ac) and the Doyle log rule for 16-foot logs is used to demonstrate the procedure. Assume that we establish three sample points: A, B and C. For each sample point, trees are tallied by a 10-baf wedge prism or angle gauge. Average dbh and average number of logs per tree for the three sample points are listed in Table 1.

**Importance of Tree Factor:** In point sampling, tree factor is the number of trees on a per-acre basis represented by the diameter for each tallied tree and can be calculated as:

\[
\text{Tree factor} = \frac{\text{BAF}}{0.005454 \times \text{dbh}^2}
\]

Using a BAF of 10 (ft² /ac), tree factor can be simplified to:

\[
\text{Tree factor} = \frac{\text{BAF}}{0.005454 \times \text{dbh}^2}
\]

The tree factor by dbh is summarized in Table 2. Note a 14-inch dbh tree has a tree factor of 9.35, thus each 14-inch tree tallied represents 9.35 trees per acre, calculated as 1833.46/14². The corresponding tree factors for the dbh of 14, 20 and 26 inches are 9.35, 4.58 and 2.71 (trees/ac), respectively. For example, each 20-inch dbh tree tallied represents 4.58 trees per acre and so on. Notice that the tree factor is inversely related to dbh.

**Table 1.** Average diameter at breast height (dbh) and average number of 16-foot logs per tree for three sample points: A, B and C. Trees are tallied using a 10 baf prism.

<table>
<thead>
<tr>
<th>Sample point</th>
<th>Average dbh (in.)</th>
<th>Average # of logs/tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>14”</td>
<td>2.0</td>
</tr>
<tr>
<td>B</td>
<td>20”</td>
<td>2.5</td>
</tr>
<tr>
<td>C</td>
<td>26”</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Table 2.** Tree Factors by dbh (using a 10 baf).

<table>
<thead>
<tr>
<th>DBH (in.)</th>
<th>Tree Factor (Trees/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>114.59</td>
</tr>
<tr>
<td>6</td>
<td>50.93</td>
</tr>
<tr>
<td>8</td>
<td>28.65</td>
</tr>
<tr>
<td>10</td>
<td>18.33</td>
</tr>
<tr>
<td>12</td>
<td>12.73</td>
</tr>
<tr>
<td>14</td>
<td>(9.35)</td>
</tr>
<tr>
<td>16</td>
<td>7.16</td>
</tr>
<tr>
<td>18</td>
<td>5.66</td>
</tr>
<tr>
<td>20</td>
<td>(4.58)</td>
</tr>
<tr>
<td>22</td>
<td>3.79</td>
</tr>
<tr>
<td>24</td>
<td>3.18</td>
</tr>
<tr>
<td>26</td>
<td>(2.71)</td>
</tr>
<tr>
<td>28</td>
<td>2.34</td>
</tr>
<tr>
<td>30</td>
<td>2.04</td>
</tr>
</tbody>
</table>
When the tree factor is multiplied by the bf volume/tree, the product is bf volume/acre. Dividing this number by the average number of logs/tree produces a conversion factor (Table 3, column 7).

Table 4 shows an overall summary of the conversion factor based on dbh and the average number of logs per tree. Column 3 is the conversion factor and is the component sought. For example, a sample plot has an average of 2.5 logs per tree and an average dbh of 20 inches. If nine logs are tallied on this plot, then the bf volume per acre would be 9 x 480 bf = 4,320 bf per acre. Table 4 could be expanded by using odd-numbered dbh’s and by increasing the average number of logs per tree.

### Table 3: Procedure for Estimating Conversion Factor per 16-foot Log Tallied.

<table>
<thead>
<tr>
<th>Sample point</th>
<th>Avg. dbh (in.)</th>
<th># of logs/ tree</th>
<th>Avg. Tree Factor (Trees/ac)</th>
<th>Avg. bf/tree</th>
<th>Avg. bf/ac</th>
<th>Avg. bf/ac/log tallied</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>14</td>
<td>2.0</td>
<td>9.35</td>
<td>75</td>
<td>701</td>
<td>350</td>
</tr>
<tr>
<td>B</td>
<td>20</td>
<td>2.5</td>
<td>4.58</td>
<td>261</td>
<td>1195</td>
<td>480</td>
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<tr>
<td>C</td>
<td>26</td>
<td>3.0</td>
<td>2.71</td>
<td>619</td>
<td>1677</td>
<td>560</td>
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</tbody>
</table>

Method of Calculation

\[
\frac{1833.46}{(2)^2} = \text{Doyle Table} \times \frac{(4) \times (5)}{(6) / (3)}
\]

1 Often this number is estimated, but users may wish to calculate the average number of logs per tree.

2 Also known as the conversion factor.

### Discussion

It is important to note that as dbh increases and the average number of logs per tree increases, the conversion factor also increases. This is one reason why the quick cruise method may not be as accurate as a full-scale inventory because users often apply a fixed conversion factor (for all stands) rather than a variable factor (depending on the average tree dbh and average number of logs per tree). Average dbh and average number of logs are not consistent plot to plot or stand to stand. Forest practitioners often settle on the conversion factor that seems to work for them; 450-500 bf per acre per 16-foot log tallied fits many hardwood stands that have reached the point of financial maturity (trees measuring roughly 18-22-inch dbh), but readers should verify the number themselves.

Applying a price to volumes derived from a quick cruise is challenging, too, since often the logs are not separated by species and grade. These steps are necessary to apply market price and doing so may defeat the purpose of a “quick” cruise.

### Conclusion

To reiterate, quick cruising may not be as accurate as a full-scale timber inventory. The consequences of being inaccurate may lead one away from quick cruising. Still, for some there is application with this method. Quick Cruising is especially useful for a point-in-place estimate of bf volume. Previous experience with the process of timber inventory is recommended prior to engaging in quick cruising. It may be beneficial to first conduct a full-scale timber inventory, then follow up with a quick cruise to determine the log conversion factor that is best suited to your region and timber type.
Example
Estimating Board Foot Volume Per Acre Using Quick Cruise

This red oak is 20 inches dbh and has 2.5 logs that measure 16 feet each. Using Table 4 and a conversion factor of 480 bf per log suggests this single-tallied tree would represent a total of 1,200 bf per acre (2.5 x 480).

Users may confirm this figure using Table 2 and the Doyle board-foot volume table located in the appendix. In Table 2, each 20-inch dbh tree represents 4.58 trees per acre. The Doyle table indicates that a 20-inch dbh tree with 2.5 logs has 261 bf. Therefore, 4.58 trees per acre x 261 bf per tree = 1,195 bf per acre.

Disclaimer
Quick cruising is a method used by some in the forestry profession to provide a rough estimate of the board-foot volume of standing timber. Users of this method should understand that quick cruising may not produce the accuracy of a more thorough, full-scale timber inventory. It has very good application for a point-in-place estimate of board-foot volume.

Reference
Henning, J. and D. Mercker. 2014. PB 1780 Conducting a Simple Timber Inventory. University of Tennessee Extension.
## Appendix

Doyle Board-Foot Volume Form Class 78

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<tr>
<th>DBH (in)</th>
<th>1/2</th>
<th>1</th>
<th>1 1/2</th>
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<th>2 1/2</th>
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