



Extension FactSheet

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Measuring Standing Trees Determining Diameter, Merchantable Height, and Volume

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Woodland owners often need to measure the merchantable board-foot content (termed “volume”) of certain trees in their woodland. In order to sell timber, for example, an estimate is needed of the quantity to be sold. If trees are to be cut to provide lumber, an estimate of volume is needed to determine what size and how many trees to cut. Using the methods described in this article, a woodland owner can estimate the board-foot volume in one or several trees. If an estimate is needed for several acres, however, it is recommended that the woodland owner engage the services of an Ohio Department of Natural Resources Division of Forestry Service Forester, a consulting forester, or an industry forester. Methods needed to accurately and efficiently inventory timber volume on large areas are beyond the scope of this publication.

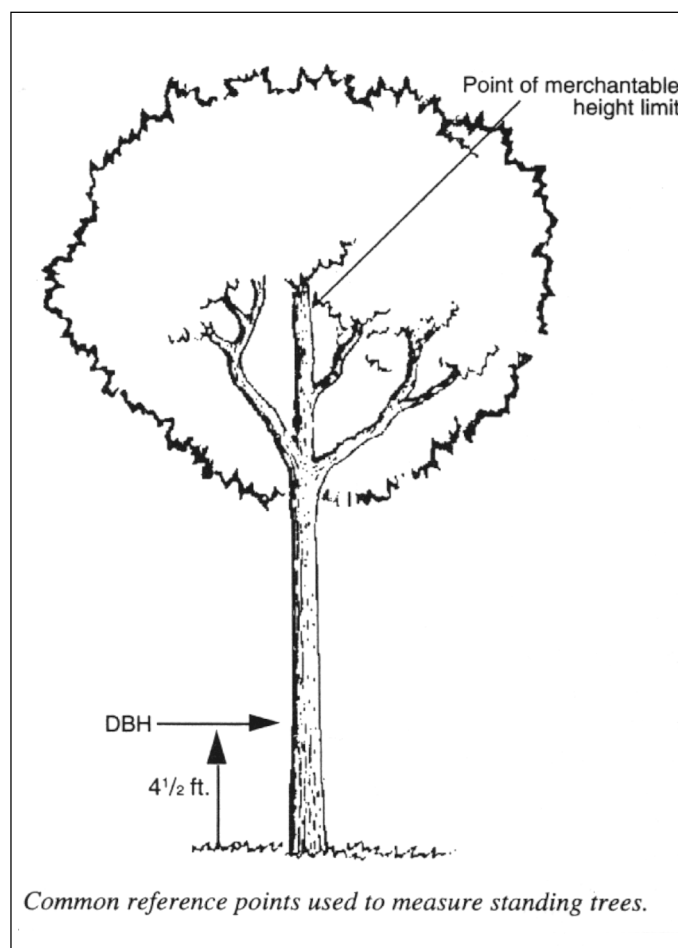
Tree Volume Estimation

In the United States, the most common measure of lumber volume is the board foot, defined as a piece of wood containing 144 cubic inches. It can most easily be visualized as a board 12 inches square and one inch thick ($12" \times 12" \times 1" = 144$ cubic inches). However, any piece of wood containing 144 cubic inches is a board foot (e.g., $3" \times 4" \times 12"$; $2" \times 6" \times 12"$; etc). The board-foot content of any board may be determined by multiplying the length by the width by the thickness, all expressed in inches, and dividing by 144 cubic inches.

The board foot is also the most common volume measure for trees and logs to be used for lumber and veneer. The board-foot volume of a tree or log is an expression of the number of board feet of lumber that can be cut from that tree or log. The lumber volume that can be cut from a tree or a log depends on a great many variables, including how the tree is cut into logs, the dimensions of the lumber, how much of the log is lost in sawdust and waste, and the efficiency of the sawmill and workers. Because of these variables, the board-foot volume of a tree or log cannot be measured exactly but is estimated.

Numerous methods (called “rules”) have been developed to

estimate board-foot tree volume. Two board-foot volume rules are commonly used in Ohio, the Doyle and the International 1/4-Inch rules (Tables 1 and 2). Both of these rules provide an estimate of the board-foot content of a tree based on tree-trunk diameter breast high and merchantable tree height (discussed later). The Doyle rule is the most common rule in Ohio. It is used



by the timber industry and many professional foresters. The International 1/4-Inch rule is used by state agencies and the U.S. Forest Service.

A comparison of these two volume tables will show that they are not identical. The International 1/4-Inch rule is generally considered to be the best estimate of the amount of lumber that can actually be sawn from a tree or a log under optimum conditions. The Doyle rule substantially underestimates the volume of trees in the smaller diameter classes. The International 1/4-Inch rule should, therefore, be used when the most accurate estimate of yield is important, as when determining how many trees to cut to obtain a specified amount of lumber. When marketing timber stumpage, however, the choice of volume rule is less critical. Confusion on quantity should not arise as long as both buyer and seller know which rule was used to estimate volumes. Timber stumpage prices are commonly adjusted based on which rule is used.

Measuring Tree Diameter

Tree-trunk diameters are measured at breast height (termed diameter at breast height or DBH), defined as the diameter of the tree 4-1/2 feet above ground on the uphill side of the tree. If a tree forks below breast height, each trunk is treated as a separate tree. DBH can be measured with a tree caliper, a Biltmore stick, a tree diameter tape, or a flexible measuring tape (e.g., cloth or steel). Tree calipers, Biltmore sticks, and tree-diameter tapes can be purchased through forestry equipment supply companies. The flexible measuring tape can be used to measure tree trunk circumference and circumference divided by 3.14 to determine diameter.

Measuring Merchantable Height

Merchantable height is the height of the tree (or the length of its trunk) up to which a particular product may be obtained, usually minus a one-foot stump height. Merchantable tree heights for sawlogs and veneer are generally estimated to the height where the trunk diameter tapers to 10 inches, or until heavy

branching or defects are encountered. The merchantable height of very valuable trees, such as veneer black walnut, may be measured to the nearest foot or two feet. The merchantable height of most other trees is measured in units of 16-foot logs and 8-foot half-logs. Merchantable height measurements are rounded to the nearest half-log. Thus, a tree with a merchantable height of 42 feet would be measured as having 2-1/2 logs of merchantable height.

Merchantable heights may be measured with a number of special instruments designed specifically for tree-height measurements such as clinometers, altimeters, relascopes, or hypsometers. These instruments are available through forestry equipment supply companies. Merchantable heights can also be measured with a long pole if only a few trees are being measured and they have relatively short merchantable heights. With some practice, merchantable heights in log and half-log units can be estimated quite accurately, particularly for trees with short merchantable heights.

Using the Tables to Estimate Merchantable Tree Volume

Once the diameter at breast height and the merchantable height of a tree have been measured, Table 1 or 2 may be used to estimate its volume in board feet. For example, a 20-inch DBH oak tree with a merchantable height of 2-1/2 logs contains 260 board feet Doyle rule or 350 board feet International 1/4-Inch rule.

When using these tables, it is important to remember that only that portion of the trunk that will produce a useable product should be measured. Portions of the trunk or entire trunks that are hollow, excessively crooked, rotten, etc., should not be measured. You may hear foresters or buyers talking about gross and net volume. Gross volume is the estimated tree volume without deduction for defects (i.e., the DBH and merchantable heights of all of the trees were measured ignoring defects, volumes were determined, and the volumes were added up). Net volume is the estimated tree volume with proper deductions made for defects.

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Table 1. Standing Tree Board Foot Volumes — Doyle Rule

Dbh (inches)	Number of 16-Foot Logs							
	1/2	1	1-1/2	2	2-1/2	3	3-1/2	4
	Board Feet							
12	20	30	40	50	60			
14	30	50	70	80	90	100		
16	40	70	100	120	40	160	180	190
18	60	100	130	160	200	220	40	160
20	80	130	180	220	260	300	320	360
22	100	170	230	280	340	380	420	460
24	130	220	290	360	430	490	540	600
26	160	260	360	440	520	590	660	740
28	190	320	430	520	620	710	800	880
30	230	380	510	630	740	840	940	1,040
32	270	440	590	730	860	990	1,120	1,220
34	300	510	680	850	1,000	1,140	1,300	1,440
36	350	580	780	970	1,140	1,310	1,480	1,640
38	390	660	880	1,100	1,290	1,480	1,680	1,860
40	430	740	990	1,230	1,450	1,660	1,880	2,080
42	470	830	1,100	1,370	1,620	1,860	2,100	2,320

From: Ashley, Burl S. 1980. *Reference handbook for foresters*. USDA NA-FR-15. 35 pp.

Table 2. Standing Tree Board Foot Volumes — International 1/4-Inch Rule

Dbh (inches)	Number of 16-Foot Logs							
	1/2	1	1-1/2	2	2-1/2	3	3-1/2	4
	Board Feet							
12	30	60	80	100	120			
14	40	80	110	140	160	180		
16	60	100	150	180	210	250	280	310
18	70	140	190	240	280	320	360	400
20	90	170	240	300	350	400	450	500
22	110	210	290	360	430	490	560	610
24	130	250	350	430	510	590	660	740
26	160	300	410	510	600	700	790	880
28	190	350	480	600	700	810	920	1,020
30	220	410	550	690	810	930	1,060	1,180
32	260	470	640	790	940	1,080	1,220	1,360
34	290	530	730	900	1,060	1,220	1,380	1,540
36	330	600	820	1,010	1,200	1,380	1,560	1,740
38	370	670	910	1,130	1,340	1,540	1,740	1,940
40	420	740	1,010	1,250	1,480	1,700	1,920	2,160
42	460	820	1,100	1,360	1,610	1,870	2,120	2,360

From: Ashley, Burl S. 1980. *Reference handbook for foresters*. USDA NA-FR-15. 35 pp.