

# Scaling Timber

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How much lumber can be sawn from of this tree? Note that the question is not “how much wood is in the tree?”, rather “how much lumber?” We are interested how much lumber a given tree will provide once it comes out on the other side of the saw mill as opposed to calculating the total volume of wood.

First, let’s look at how lumber is measured. The standard unit of measurement for lumber is a board foot. This is defined as a board 12 inches wide x 12 inches long x 1 inch thick.

The next thing to understand is that tree scales are always *estimates*. The sawmill operator will saw each log differently so it would be rare that two similar logs produce the same amount of lumber.

There are a few widely used tree scales and many more “local” scales developed based on individual experience. The three widely used scales are Scribner, Doyle, and International. While the International scale tends to be a more accurate estimate, the Doyle scale is far more frequently used – most likely because we are resistant to change. When looking at a scale, it is important to ensure you are using a tree scale and not a log scale. Both estimate board foot volume, but the measurements are different.

A scale chart lists diameter on the left side and log height on the top. The 2 specific measurements we are looking for are *diameter at breast height* (dbh) and *log height* (number of 16 foot logs).

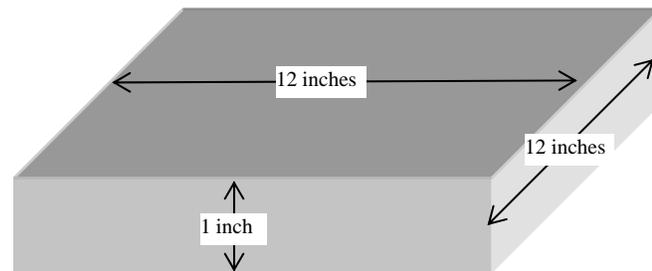


Figure 1: Visual representation of one board foot.  
Note: image is not to scale.

## TREE SCALE

(Doyle)

DBH (in.)	Number of 16-Foot Logs							
	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4
	Contents in Board Feet							
12	20	30	40	50	60			
14	30	50	70	80	90	100		
16	40	70	100	120	140	160	180	190
18	60	100	130	160	200	220	240	260
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	1040
32	270	440	590	730	860	990	1120	1220
34	300	510	680	850	1000	1140	1300	1440
36	350	580	780	970	1140	1310	1480	1640
38	390	660	880	1100	1290	1480	1680	1860
40	430	740	990	1230	1450	1660	1880	2080
42	470	830	1100	1370	1620	1860	2100	2320

Figure 2: Doyle Tree Scale chart. Source: [Reference Handbook for Foresters](#); USDA-Forest Service Publication NA-FR-15, September 1999.

DBH is defined as 4.5 feet above the ground on the uphill side of the tree. The diameter is measured at this height rather than the base for two reasons: first, different trees flare more than others at the base introducing greater inconsistency; and, secondly because somebody, somewhere was smart enough 100+ years ago to realize that their back feels better at the end of the day after measuring trees chest height as opposed to at the base. Most tree scales use a two inch increment for diameter. Therefore, if you measure the tree at 16.8 inches, it is tallied as a 16 inch diameter tree. If the tree measures 17.0 inches, it is tallied as 18 inches.

Log height is the second measurement to take. For purposes of estimating lumber volume, we are not interested in the total height of the tree, just the length of the log that will be harvested. Generally, we are looking for where the log tapers to a diameter smaller than eight inches or where there are too many defects to make the log merchantable. A standard log is 16 feet long, and is reported by 1/2 log lengths – so lengths are really recorded in 8 foot increments.

With a basic understanding of what we are looking for, let's take a trip to the woods and find some trees to scale. Don't forget your equipment! There are a few commonly used and readily available tools for measuring trees. For diameter we most often use either a diameter tape or Biltmore stick. To measure tree height you will most often find either a Biltmore stick or clinometer. There are also laser-based units that will measure height and/or diameter, but these are costly.

The diameter tape (D-tape) looks like a regular measuring tape that you wrap around the tree. However, as you pull the tape, you will notice that there is a lot of space between each inch marking. The distance between each marking is 3.14 inches (remember pi from 8<sup>th</sup> grade math?). That is because when you measure around the outside of a circle (the circumference), you must divide by pi to figure out the diameter. The D-tape is designed with this calculation built in.

For height, the clinometer simply measures an angle. With a known angle and distance from the tree, you will know the height. Most clinometers are designed to be used either 66 feet or 100 feet away from the tree. Once you measure your designated distance from a tree, use the clinometer to measure the log height by looking at the numbers on the dial with one eye while sighting the tree with the other open eye. The same measurement can be made with many other tools designed to measure angles, but there is not room in this article to offer a worthwhile description of these methods.

A Biltmore stick, or tree scale stick, is designed to be an all-in-one measuring tool. The biggest mistake people make with Biltmore sticks is using the wrong side for diameter measurement. One side of the stick is intended for measuring logs while the other is for measuring trees. When measuring log diameter, you place the stick across the end of the log. However, this is not possible with a standing tree. You will see on the tree scale side that the inch markings get closer together as the diameter increases. That is because of the geometry associated with the angles you are using. Here are the steps for measuring the tree diameter with a scale stick:

- 1) Once you have confirmed you are looking at the correct side of the stick, place the stick horizontally against the tree at 4.5 feet off the ground and hold it 25 inches from your eye (about an arm's length).
- 2) Stand roughly at the center of the tree.
- 3) Visually line up the left end of the stick with the widest part of the tree in your line of sight.
- 4) Look to the right without moving your head – just shift your line of sight – to the widest part of the tree that you can see on the right and read the number.
- 5) This is your diameter. It is important that you do NOT move your head as you shift your line of sight from left to right.
- 6) Walk to the side of the tree and take another measurement.
- 7) Average these two measurements. Taking two measurements helps compensate for trees that are not perfectly circular.

To measure log height with a Biltmore stick, you will see the log heights either on the edge or along the length on the tree scale side of the stick. The technical name for this is a Merritt hypsometer. To use the hypsometer:

- 1) Measure a distance of 66 feet away from the trunk of the tree (either with a measuring tape or by pacing if you know your pace distance well – something you should practice if you are going to measuring many trees).

- 2) Hold the stick vertically 25 inches from your eye with the long height numbers facing you.
- 3) Move the stick such that the bottom of the stick lines up with the bottom of the tree.
- 4) Without moving your head, shift your line of sight to look at the top of the log.
- 5) Observe the number of logs – note that you cannot stretch to the next biggest size. In other words, if the log is 30 feet, it will be really close to being 2 logs, but you have to tally it as 1.5 logs because that is how it will be scaled when it is harvested. Some sticks are marked by the half log, but most only have whole log markings on them. The chart on the stick will also usually only show whole log lengths, but you can use another chart to get to greater precision if you want to record lengths down to half-log accuracy.

Once you have determined both the diameter and the log height, you can use the charts to estimate volume. The Biltmore stick will have a chart on it. If the only Biltmore stick you have shows volume in one scale, but you want another, you can still use that stick to obtain the measurements with that stick and use another scale to estimate your volumes.

The next question most people will ask after they know the volume is “how much is this worth?”. Volume is only half of the equation. Log quality is another topic that combines with volume to help determine value.

*Editor’s note: tree measuring sticks can be obtained through your local Soil and Water Conservation District or a forest supply catalog. Contact a forester for more tips on tree measuring, volume determination, log quality, and calculating the monetary value of your woodland.*