



Estimating Weight of Logs and Standing Timber

Guide for Foresters, the Forest Industry and Landowners

Introduction

Standing timber, logs and lumber are often bought and sold by the board foot. A board foot is a volume measurement (144 cubic inches) equal to a board that is 1-inch thick, 12 inches long and 12 inches wide.

The “board footage” of logs is an estimate of the amount of lumber that will be sawn from them. Many different techniques, or “scales,” have been developed to make these estimates, based on three measurements:

- Length — Measured in feet with a few extra inches of trim (4-8 inches).
- Diameter — The scaling diameter is measured as the wood diameter (i.e., inside the bark) at the small end of the log. Logs are usually not perfectly round, so the average of two measurements is often used. Diameter at breast height (dbh) is the outside-the-bark diameter of a standing tree measured at 4.5 feet above ground level (on the uphill side of the tree on sloping ground).
- Deductions for “scaling defects” — Reducing the amount of lumber that can be produced, including excessive sweep or rot.

Once the log has been scaled, the board footage is multiplied by the price per board foot to determine the value of the log. The price per board foot is a function of many variables, including the wood species, the grade of the log (i.e., the estimated lumber quality), the local market conditions, log size and more. The general approach to determine log value also can be applied to standing trees. Refer to PB 1772 A Hardwood Log Grading Handbook (Taylor 2009) for more detailed explanations of log valuation.

Some in the timber industry have switched from board foot measurement to weight measurement (**specifically tons**) for **delivered logs**. Within this system, trucks carrying logs arrive at the mill and then are weighed, unloaded and re-weighed. Loggers

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are paid based on the weight of the delivered logs. Many foresters and landowners are uncertain of how wood weight (tons) is measured, how to convert board feet estimates to tons, or how to arrive at the value of standing timber and logs when the board foot measurement is known but the weight is not. This publication has been developed to address these questions and does so for both hardwood and pine species. *Readers should note that there is great variability in the estimation of wood volume and weight of standing timber and logs.*

Estimating Footage and Weight

For traditional board foot measurements, simple tools have been developed for field estimations. Logs can be scaled quickly by measuring the small-end diameter with special sticks that are calibrated for particular log scales. Board footage estimates for standing trees can be performed using a Biltmore stick, diameter tape, clinometer and hypsometer. The diameter at breast height (dbh) and the number of logs and their lengths are used in volume tables to estimate the board foot volume of standing trees.

Regression equations have been developed for predicting log weights from species, diameter and length information (Table 1). Using these equations, data tables listing the weight of logs for given diameters and lengths can be derived. Here, we show results for average values for red and white oaks, hickory, and yellow poplar (Table 2) and for mixed Southern pines (Table 3). Log weight also can be estimated indirectly by converting a board foot measurement to tons. The weight of logs and the conversion of board foot to tons are subject to much uncertainty because many variables can affect the weight of logs and the accuracy of board foot scales (Table 4).

Table 1. Equations for predicting log weight based on length and diameter.

Species	Weight prediction equation	Standard error of the prediction (pounds)
Red oaks (<i>Quercus</i> spp.)	$W = 169.07 - 18.78D + 0.47D^2L$	10.1
White oaks (<i>Quercus</i> spp.)	$W = 224.77 - 24.92D + 0.47D^2L$	10.4
Hickory (<i>Carya</i> spp.)	$W = 190.12 - 18.73D + 0.45D^2L$	9.2
Yellow poplar (<i>Liriodendron tulipifera</i>)	$W = 144.09 - 11.16D + 0.36D^2L$	8.3
Southern yellow pine (<i>Pinus</i> spp.)	$W = 50.93 + 0.37D^2L$	n/a

Notes: W is log weight in pounds; D is small-end diameter, inside the bark, in inches; L is length in feet without trim. Equations for hardwoods are from Timson (1972); pine equation is from Siegel and Row (1960).

Conversion Factors — Logs

As introduced above, there is considerable variability in volume-to-ton conversion, especially among hardwood species. Log diameter has a particularly large influence, because log rules often underestimate lumber yields from small logs. For example, 1,000

board feet of Doyle scaled logs can weigh, on average, from 15 to 5 tons for log (scaling) diameters from 8 to 20 inches, respectively (Table 3). However, even for logs of the same diameter, weights for individual logs can range plus or minus 40 percent of the average value.

Table 2. Log weight table and MBF conversion factors for mixed hardwoods.

Scaling Diameter (inches)	Average Hardwood Log Weights (tons)					Tons per MBF Doyle
	--- Log length (feet) ---					
	8	10	12	14	16	
8	0.13	0.16	0.18	0.21	0.24	15.3
9	0.15	0.18	0.22	0.26	0.29	11.6
10	0.17	0.22	0.26	0.30	0.35	9.5
11	0.20	0.25	0.31	0.36	0.41	8.2
12	0.23	0.29	0.36	0.42	0.48	7.3
13	0.27	0.34	0.41	0.49	0.56	6.7
14	0.30	0.39	0.48	0.56	0.65	6.2
15	0.35	0.44	0.54	0.64	0.74	5.9
16	0.39	0.50	0.61	0.73	0.84	5.6
17	0.44	0.56	0.69	0.82	0.94	5.4
18	0.49	0.63	0.77	0.91	1.06	5.2
19	0.55	0.70	0.86	1.02	1.18	5.0
20	0.60	0.78	0.95	1.13	1.30	4.9
21	0.67	0.86	1.05	1.24	1.44	4.8
22	0.73	0.94	1.16	1.37	1.58	4.7
23	0.80	1.03	1.26	1.49	1.73	4.6
24	0.88	1.13	1.38	1.63	1.88	4.5

Data adapted from Timson (1972) for white and red oaks, yellow poplar and hickory sampled in West Virginia, Virginia and Maryland. Scaling diameter is the average diameter inside the bark at the small end of the log; MBF is 1,000 board feet. Tons per MBF value is an average over all log lengths.

Table 3. Log weight table and MBF conversion factors for Southern pine.

Scaling Diameter (inches)	Average Pine Log Weights (tons)					Tons per MBF Doyle
	--- Log length (feet) ---					
	8	10	12	14	16	
8	0.12	0.14	0.17	0.19	0.22	14.1
9	0.15	0.18	0.21	0.24	0.27	11.1
10	0.17	0.21	0.25	0.29	0.32	9.2
11	0.21	0.25	0.29	0.34	0.38	8.1
12	0.24	0.29	0.35	0.40	0.45	7.2
13	0.28	0.34	0.40	0.46	0.53	6.6
14	0.32	0.39	0.46	0.53	0.61	6.2
15	0.36	0.44	0.53	0.61	0.69	5.8
16	0.41	0.50	0.60	0.69	0.79	5.5
17	0.45	0.56	0.67	0.78	0.88	5.3
18	0.51	0.63	0.75	0.87	0.99	5.1
19	0.56	0.70	0.83	0.96	1.10	4.9
20	0.62	0.77	0.92	1.06	1.21	4.8
21	0.68	0.84	1.01	1.17	1.33	4.7
22	0.74	0.92	1.10	1.28	1.46	4.5
23	0.81	1.01	1.20	1.40	1.60	4.5
24	0.88	1.09	1.31	1.52	1.74	4.4

Data adapted from Siegel and Row (1960) for mixed loblolly and shortleaf pines sampled in Louisiana and Arkansas. Scaling diameter is the average diameter inside the bark at the small end of the log; MBF is 1,000 board feet. Tons per MBF value is an average over all log lengths.

Table 4. Variables affecting log weight and scale measurements.

Variable	Effect
Diameter	Board foot “scaling rules” tend to underestimate the lumber yield from small logs. This is especially true of the Doyle rule, in which this “over-run” (the difference between the actual and estimated yield) can be over 100 percent for small logs.
Position of the log in the tree	Wood density can increase further up the tree, meaning upper logs weigh more per board foot; conversely, there can be more taper in butt logs, and tapered logs will weigh more for a given footage, because footage is estimated using the small end diameter.
Time after felling	Logs lose moisture — and thus weight — once harvested, especially during hot and dry periods.
Species	Different tree species produce wood with different density and moisture content. These both affect log weight. However, denser wood species often contain less water, so log weights don’t vary as much by species as do dry lumber weights.
Location	Log weight can differ depending on site characteristics and genetics.
Season of the year	Logs may weigh slightly more in the spring and slightly less in the summer than in the rest of the year. This is likely due to changes in the water content of the wood.
Growth rate	Depending on the species, increased growth rates may be associated with lower, higher or unchanged log weights.

Conversion Factors — Standing Timber

As described above, the conversion of log volumes to weight varies with log diameter. For convenience, mills commonly settle on a fixed conversion factor when procuring logs (for example, from 8-9 tons/mbf for hardwood and from 7-8 tons/mbf for pine). However, as Tables 2, 3 and 5 illustrate, using a fixed conversion factor requires making an accurate assumption about average log or tree diameter.

Table 5. Relationship of diameter at breast height (DBH) measurements to tons/mbf (Doyle) conversion factors.

DBH (inches)	Log Weights tons/mbf (Doyle)	
	Mixed hardwoods ¹	Southern pine sawlogs
10	17.7	14.0
12	14.2	9.8
14	12.1	8.5
16	10.7	7.7
18	9.8	7.2
20	9.1	6.7
22	8.6	6.3
24	8.1	5.9
26	7.8	5.5
28	7.5	5.2
30	7.3	5.0
32	7.1	4.8
34	6.9	4.6
36	6.8	4.4

Adapted from Dicke and Parker (2010) and Doruska et al. (2006)
¹ oaks, hickory, sweetgum

Converting Tonnage Price to Board Foot Price

In some cases, log prices are reported as the price/ton delivered to the mill. In other cases, prices are given on a board foot basis. Thus, field practitioners and landowners may be interested in converting the delivered price/ton to a price/bf.

The conversion process is simple but requires assuming a ton-to-mbf conversion factor.

If a hardwood conversion of 9 tons/mbf (Doyle) is assumed, then each ton has 111 board feet (1,000 board feet ÷ 9 tons/mbf = 111 bf):

Therefore, a delivered sawlog price of **\$40/ton** is equal to **\$40/111 bf**, or **36 cents/board foot (\$360/mbf)**.

Similarly,
\$50/ton = 45 cents/board foot = \$450/mbf
\$60/ton = 54 cents /board foot = \$540/mbf

Notes

- As explained above, the conversion of board foot measurements to weight is subject to much uncertainty. Thus, the conversion factors listed here and the calculations derived from them should be used only for *general* guidance.
- To arrive at stumpage value (the value of the standing timber), the costs of logging and hauling are subtracted from the delivered price.

References

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