



# Forest Mensuration

## PENNSYLVANIA FOREST RESOURCES

Number 59

Forest landowners need to know about the measurement of timber and logs before a buyer appears with an offer, a contract, and a check, one seemingly cannot refuse. Often the check seems very large and the offer very enticing, especially if the owner has a bill due. So the owner may accept the offer without knowing much about the quantity or quality of the timber.

Landowners who know how much timber they have to sell can make a better judgment about the fairness of an offer to buy. Comparing lists of timber volumes made several years apart will allow a landowner to calculate the growth of the forest in the amount of board feet per acre, per year. This growth, or "yield", is the amount that can be cut from the forest, indefinitely, for firewood or lumber. Forest owners, who know this figure, become forest managers, and their decisions should be of greater benefit to themselves, the forest, and other people.

This article deals with the basics needed by a landowner who wishes to measure the quantity of his own timber. Quality is another variable and will be discussed in a later article.

### MEASURING LOGS (SCALING)

The most accurate way to determine the amount of timber is to cut the trees down. Then, measure and tally the number of board feet in the logs. The only tool needed is a yardstick. Logs are commonly cut in even lengths from 8 to 16 feet long. An extra 4 inches is customarily added for trim so that a 16 foot log is actually 16 feet 4 inches in length.

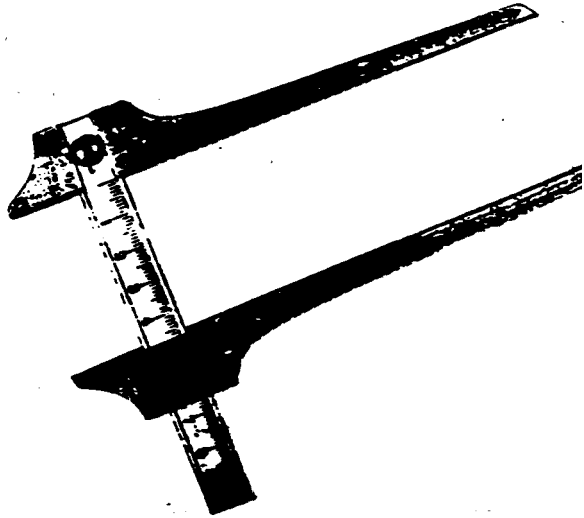
If the log is circular, the yardstick is laid across the heart of the small end of the log, and the diameter measurement is read inside the bark to the nearest inch. Readings are rounded up, if more than a half inch, and down, if less than a half inch. Readings of exactly one-half inch are alternately rounded up and down. Start by rounding down. Oval logs are measured across both widest and narrowest diameters and the two measurements averaged.

If the diameter and the length of the log are known, the owner must consult one of three log scales conventionally used in the locale where the timber is sold which show volumes. A tally of the log volumes by species is one way to determine the amount of each species being sold.

### MEASURING TREE DIAMETER

Measurement of standing trees requires special tools. All are used on the tree at breast height which is defined as 4-1/2 feet above the ground on the uphill side. Some of these tools are:

The tree caliper: This instrument is used for measuring tree diameter. Place the caliper so that the tree trunk, at a point 4.5 feet above the ground, fits snugly between the two perpendicular extensions of the caliper. The tree diameter is read at the intersection of the sliding extension with the scale. If the tree trunk, 4.5 feet from the ground, is not perfectly round, take several caliper readings around the trunk and average the readings for a more accurate estimate of diameter. You may wish to make your own tree caliper by attaching two extensions to a yardstick.



The diameter tape: This flexible tape is graduated by 3.14 inch marks. This constant factor represents the ratio of the diameter of a circle to its circumference. By measuring the circumference of a tree, an estimate of the diameter can be read directly. This is only an estimate, because it assumes all trees are perfect circles, which they are not. Consequently, estimates of tree diameters using a diameter tape run a bit large.

DOYLE'S LOG SCALE (BOARD FEET)

Log Diameter in Inches	Log Length in Feet				
	8	0	12	14	16
8	8	10	12	14	16
9	13	16	19	22	25
10	18	23	27	32	36
11	25	31	37	43	49
12	32	40	48	56	64
13	41	51	61	71	81
14	50	63	75	88	100
15	61	76	91	106	121
16	72	90	108	126	144

Diameter tapes can be made from flat spring steel, nylon, or plastic packing crate bands. Graduations are marked at even 3.14 inches with a felt tip pen or a stylus.

The Biltmore Stick: The forester's yardstick is named for the first forestry school at the Biltmore Estate near Asheville, North Carolina. The stick measures a tangent to a circle, from a point, exactly 25 inches from the tree. (The stick is graduated to show the diameter as if it were projected from the user's eye into the tree.)

This specially graduated stick is placed against the tree trunk with the diameter scale facing the user. Keep your head 25 inches from the stick, and without moving your head, slide the stick so that the left edge of the stick appears to line up exactly with the left edge of the tree trunk. Keep your head stationary, and move your eyes to read the number on the scale that lines up exactly with the right edge of the tree trunk. That number is a reasonable estimate of the diameter of the tree at breast height (DBH). If the measurement of the right edge of the tree falls between two numbers on the scale, the lower number is used as the diameter.

The Biltmore stick tends to be inaccurate on large timber. Trees over 20 inches should be checked with a diameter tape. The following table will help in using a Biltmore stick.

### MEASURING TREE HEIGHT

Diameter at breast height is but one measurement required to estimate board feet. Height is also needed. A hypsometer is the instrument used for determining height.

Table of Biltmore Stick Graduating Distances

Tree Diameter in inches	Graduating Dist. in Inches from End of Stick	Tree Diameter in Inches	Graduating Dist. in Inches from End of Stick	Tree Diameter in Inches	Graduating Dist. in inches from End of Stick
5	4.53	17	13.12	29	19.73
6	5.39	18	13.72	30	20.25
7	6.19	19	14.32	31	20.71
8	6.96	20	14.90	32	21.19
9	7.72	21	15.48	33	21.67
10	8.45	22	16.05	34	22.13
11	9.17	23	16.60	35	22.59
12	9.86	24	17.14	36	23.05
13	10.54	25	17.68	37	23.50
14	11.21	26	18.20	38	23.94
15	11.86	27	18.72	39	24.38
16	12.49	28	19.23	40	24.80

The Merritt hypsometer: This scale is usually located along one edge of the Biltmore stick. After measuring the diameter of a tree, the estimator walks a known distance away from the tree. This distance has been standardized at one chain. A chain is equal to 66 feet. For a man, this is about 12 paces; for a

woman, 13 paces. A pace is two steps. The stick is held vertically until the bottom edge is at stump height, which is about 18 inches from the ground. The distance to the top of the last log, or the top of the tree, can be read directly at the point where the line-of-sight intersects on the stick. This is the same principle used to measure diameter. Hold the Biltmore stick 25 inches from your eye and make your sightings without moving your head. Move just your eyes. A hypsometer can be drawn on a Biltmore stick using this data.

Another useful method for measuring tree height is quite simple. It is done on level ground by people wearing trousers. Walk away from the tree until, by bending forward and looking between your own legs, you can see both the base of the tree and its top. Pace back to the tree. That distance equals the height.

Graduating a Merrit Hypsometer

Height in Feet	Graduation in Inches from the End of Stick	Height in Feet	Graduation in Inches from the End of Stick
10	3.79	16	6.06
20	7.58	32	12.12
30	11.37	48	18.18
40	15.16	64	24.24
50	18.95	80	30.30
60	22.74	96	36.36

#### ESTIMATING BOARD FEET

Knowing the diameter at breast height and the height to the top of the last log (to the nearest 8 feet) enables landowners to use a volume table and find the volume in board feet for each tree. Separating the data by species is more valuable. The final step is a simple tally of the board feet volume by species. The landowner then knows what species he has, and what he can sell. The following table will help the landowner determine board feet volume.

Estimates of board feet vary depending upon which log scale or log rule is used. The Scribner log rule is one of the oldest. It was developed when machinery and technology were less sophisticated than they are today. Estimates of board feet using the Scribner rule are based upon the area of the small end of the log and fail to account for log taper. Consequently volume estimates based on the Scribner rule tend to be low.

The Doyle rule is another old rule which is still widely used. It tends to underestimate the volume of small logs and overestimate the volume of large logs.

The International log rule is based upon a rather precise mathematical formula. Of the three, it is the most accurate scale. The international rule does allow for log taper.

Volume Table International Scale

Diameter in Inches at Breast Height (DBH)	Volume for 16 Foot Logs in Board Feet			
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
12	60	105	145	180
13	70	125	165	200

14	80	150	190	220
15	95	175	220	250
16	110	205	255	285
17	125	235	290	330
18	140	265	325	375
19	160	295	365	425
20	180	325	410	475

Measuring individual trees is a first step in forest management or selling timber. Additional procedures for estimating timber volume in an entire stand will be outlined in a subsequent issue of Pennsylvania Forest Resources.

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