

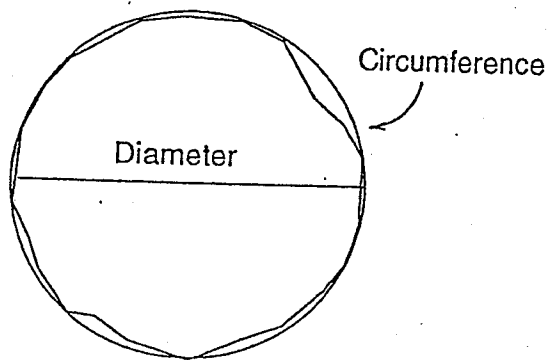
# Tree Measurement Types & Methods

## Diameter Measurement

Diameter is one of the most common tree measurements. The importance of diameter measurement is that it is one of the directly measurable dimensions from which cross-sectional area and volume can be computed. Diameter can be measured at any point on the stem, but there are some common points where diameter is taken. These include stump height, breast height, at the top of the first log, and at the base of the crown. Of these, breast height (DBH) is the most common. DBH is always measured at 4.5 feet (1.3m) from the ground.

## Diameter Tape

Diameter tapes are flexible steel tapes graduated so that the diameter can be read directly by wrapping the tape around the circumference of the trunk.



The conversion is accomplished by dividing the circumference by  $\pi$  (3.1415),

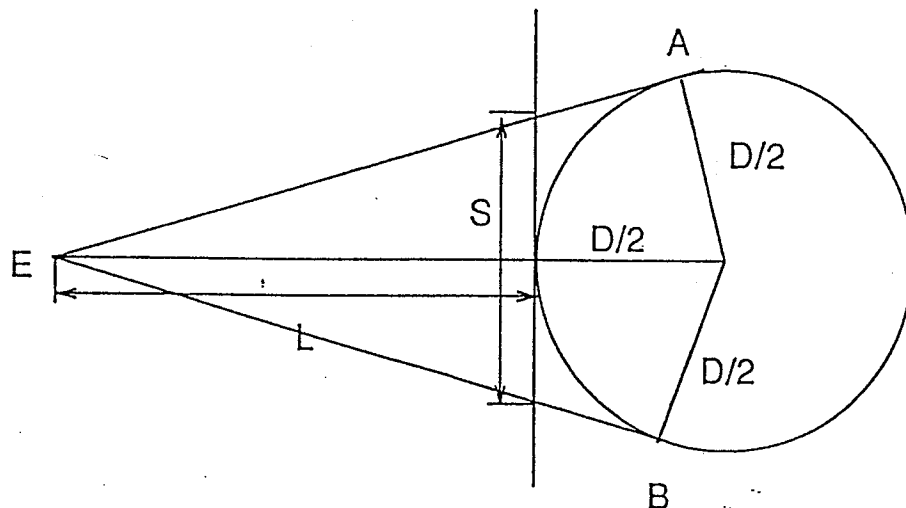
$$D = \frac{C}{\pi}$$

where D is the diameter, C is the circumference and  $\pi$  is pi (3.1415).

## Biltmore Stick

A Biltmore stick is a simple device used to measure tree diameter. It consists of a straight ruler which is held horizontally at arm's length against the tree. The zero end of the stick lies on the line of sight

tangent to one side of the tree. By shifting the same eye, the intersection of the line of sight to the other side of the tree with the scale of the stick will indicate the tree's diameter. The Biltmore stick's key advantage is that it is fast and simple to use. The Biltmore stick is calibrated to read angles as in the following figure:



where E is your eye, L is usually 25 inches, S is the tangent to the arc AB (tree diameter). The following formula can be used to construct a Biltmore stick for any L and diameter class:

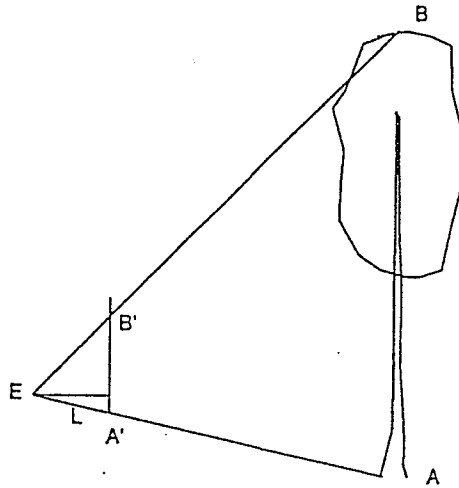
$$S = \sqrt{\frac{D^2 L}{L + D}}$$

## Height Measurement

Height is measured by applying geometry and trigonometry, usually using similar triangles and angle measuring devices. Foresters measure both the total height of a tree and the number and length of logs in the main stem. For the methods described here, both the top and base of the tree must be visible.

## Merritt Hypometer

The Merritt Hypometer is similar to a Biltmore stick and is often found on the same stick. It is a ruler marked to measure similar triangles.



$$\frac{A'B'}{AB} = \frac{EA'}{EA}$$

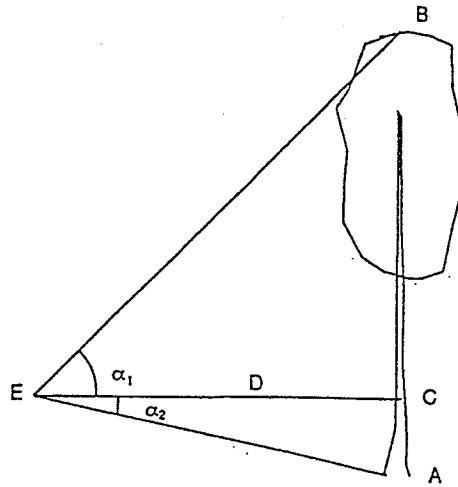
or

$$A'B' = \frac{(AB)(EA')}{EA}$$

The graduations are commonly marked to measure 8- or 16-foot logs, although any unit may be used. The ruler is held vertically at a fixed distance from the observer's eye, usually 25 inches. The observer stands at a fixed distance (50 or 66 feet) from the tree and holds the ruler vertically so that the lower line of sight to the base of the tree is tangent to the zero end of the stick. The intersection of the line of sight to the top of the tree with the hypsometer is the height.

## Using Angles

Height can be measured by using an angle measuring device at a known distance from the tree. Typical angle measuring instruments include the Abney level, Haga altimeter and clinometer. New devices include laser measuring instruments. The following is the formula used for trees in a normal position and with an instrument measuring angles in degrees.



$$AB = D (\tan \alpha_1 + \tan \alpha_2)$$

The following shows the changes to the formula when the observer is below the base of the tree. This is a common problem in very steep terrain. In this case, the angles are subtracted as opposed to added as in the previous example.

$$AB = D (\tan \alpha_1 - \tan \alpha_2)$$

### Using a Ruler and a Kid

A fun and simple way to measure the height of a tree is to use a one-foot ruler and a child (or a pole) of known height. Have the child stand at the base of the tree. Hold a ruler vertically at arm's length so the zero end of the ruler is at the tree's base. Move forward or backward until the child exactly fills the one-inch mark. Shift your line of sight to the top of the tree and note the ruler measurement where your line of sight crosses the ruler. Tree height is calculated as a proportion. For example, if the child is 5 feet tall and the total tree height fills 10 inches on the ruler, then the tree is 50 feet tall.

$$\frac{1''}{5'} = \frac{10''}{X}$$

$$X = 50'$$

## Making Your Own Scale Stick

The Biltmore stick and Merritt Hypsometer are commonly put on the same ruler, giving the forester an easy-to-use tool for measuring tree diameter and height. This tool is called a scale stick. Scale sticks may be purchased but are easily made from a yardstick-sized strip of lumber or a yardstick covered with plain contact paper. The following formulas are used to calculate the graduations on the scales.

### Biltmore Stick

$$S = \sqrt{\frac{D^2 L}{L + D}}$$

where,

S = distance from the zero end of ruler (in inches)

D = diameter of tree

L = distance from eye (usu. 25 inches)

D	S
2	1.9
4	3.7
6	5.4
8	7.0
10	8.5
12	9.9
14	11.2
16	12.5
18	13.7

## Merritt Hypsometer

$$F = \frac{L \times I}{B}$$

where,

F = distance from zero end of ruler (in inches)

L = distance from eye (usu. 25 inches)

I = scale interval

B = base distance (usu. 50' or 66')

Example:

To measure tree heights in 2' increments (I), standing 50' away from the tree:

$$F = \frac{25'' \times 2'}{50'} = 1''$$

So, to measure in 2' increments, the graduations on the ruler should be 1" apart.

DIAMETERS - INCHES - 25 INCHES FROM EYE TO TREE	6	8	10	12
PREVENT WOODS FIRES				
DON'T GRAZE YOUR WOODLANDS				
HARVEST YOUR TREE CROP WISELY				
NUMBER OF 16-FOOT LOGS - 50 FEET FROM TREE - HOLD STICK PLUMB 25 INCHES FROM EYE				

