

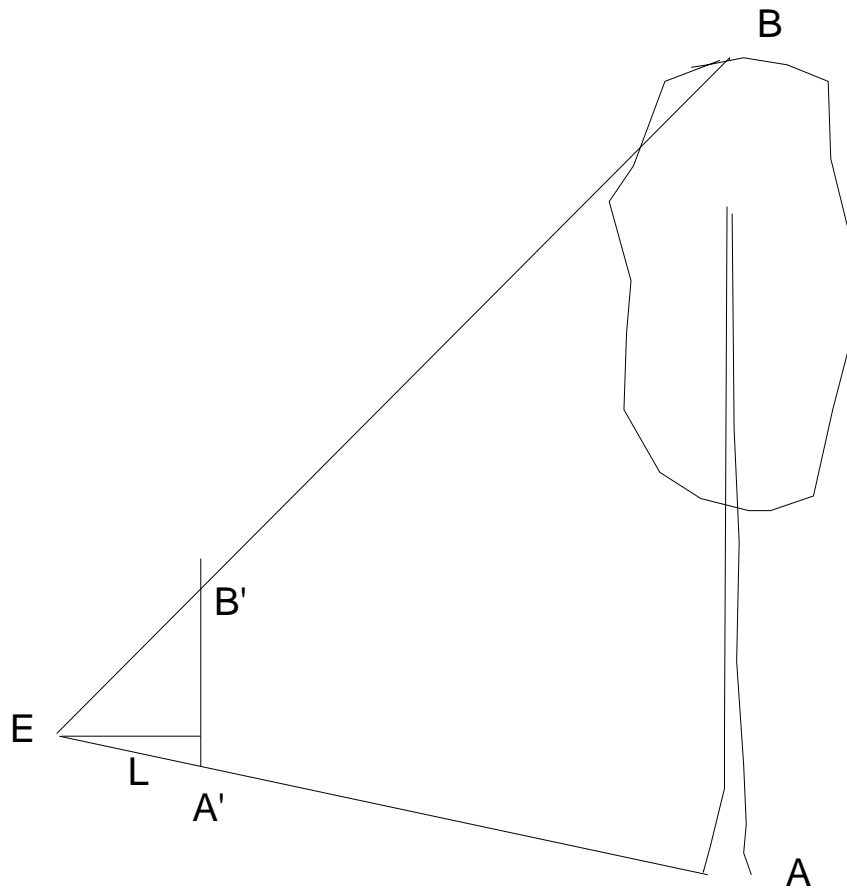
**FOR 2542 - Forest Inventory**  
**Height Measurements**  
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### Height Measurement

Height is measured by applying geometry and trigonometry usually using similar triangles and angle measuring devices.

### Merritt Hypsometer

A type of measurement similar to a Biltmore stick and often found on the same stick.



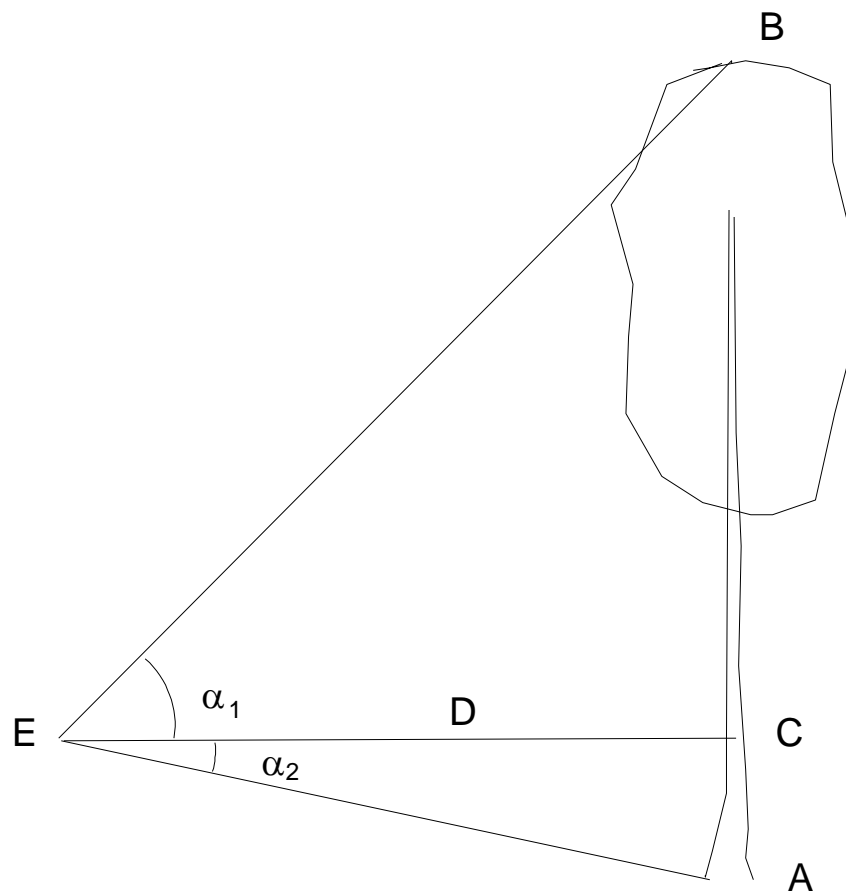
A Merritt hypsometer is a stick marked to measure similar triangles. It is unusually held 25 inches from your eye (L) and allow the tree height to be measured as a ratio of the distance from the tree. This method is usually used to measure large height classes such as number of 8' or 16' logs in a tree (Husch et al., 2003).

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

### Using Angles

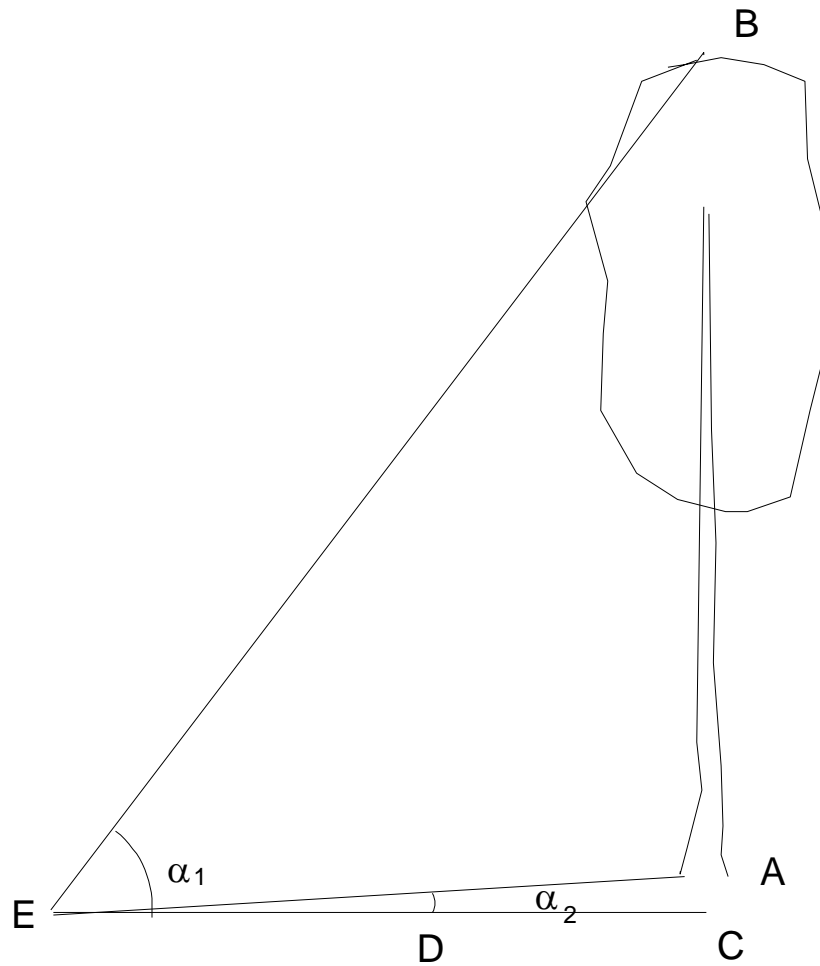
Most heights are measured using a known distance from a subject tree and an angle measuring device. Typical angle measuring devices include an abney level, haga altimeter, suunto clinometer, and relaskop. New devices also include laser measuring devices.

The following is the formula used for trees in the normal position and with a device 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 angle are subtracted as opposed to added as in the previous example.



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

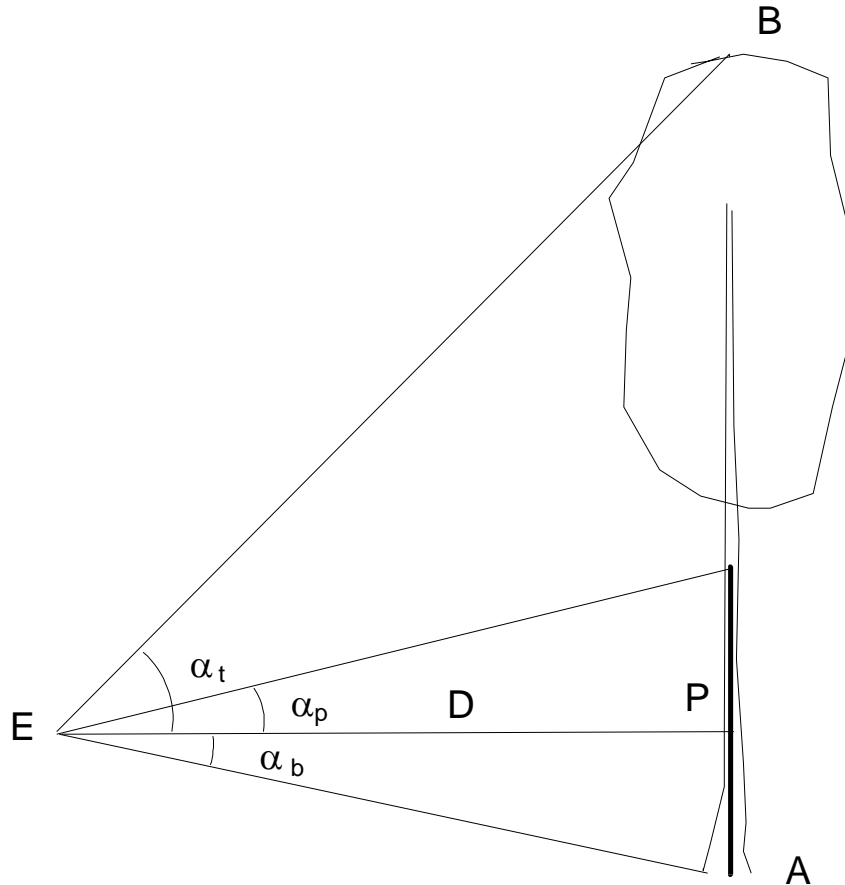
If one uses a percent scale ( $45^\circ = 100\%$ ) the formula is as follows.

$$AB = \frac{D}{100}(\text{percent} : \alpha_1 + \text{percent} : \alpha_2)$$

If one uses a topographic scale ( $45^\circ = 66$ ) the formula is as follows.

$$AB = \frac{D}{66}(\text{topo} : \alpha_1 + \text{topo} : \alpha_2)$$

An alternative that has merit in steep, brushy or difficult terrain is to measure height with the pole method (Larsen, 1987). In the pole method a telescoping pole on know length is placed next to the subject tree. The observer may walk any were to get a good view of all measurement points. Then the angles to the top of the tree, top of the pole and base of the tree are used in the following formula to calculate tree height. In effect you are using the triangle formed by the pole to calculate your distance from the tree and then using that distance to calculate tree height.



$$AB = P \frac{\tan : \alpha_t + \tan : \alpha_b}{\tan : \alpha_p + \tan : \alpha_b}$$

or

$$AB = P \frac{\text{percent} : \alpha_t + \text{percent} : \alpha_b}{\text{percent} : \alpha_p + \text{percent} : \alpha_b}$$

**Fixed-angle height measurement**

If the ground is fairly level the use of a 45° angle can be used to measure tree height. This can be done either with a angle gauge or a stick the same length as your arm. Once you have found the spot where the tree fills your angle you simply measure the distance to the center of the tree as the tree height. Remember to account to the height of your eye.

**References**

**Husch, B., T. W. Beers and J. A. Kershaw.** 2003. Forest Mensuration. Fourth Edition. *John Wiley and Son, Hoboken, New Jersey* 443 p.

**Larsen, D. R., D. W. Hann and S. C. Stearns-Smith.** 1987. Accuracy and Precision of the Tangent Method of Measuring Tree Height. *Western Journal of Applied Forestry.* 2:26-28.