Making Your Own Biltmore Cruiser Stick

By Steve Nix, About.com

Creating a "stick" that can estimate a tree's height and diameter is easy and very useful if you are trying to estimate tree volume or are a tree buff needing size information. This project can be completed in about an hour with only a slim 30" piece of wood, a yard stick and a water proof, pigment ink drawing pen. I have provided more than enough instruction to build this cruiser stick and include links to more instruction on how to use it.

Based on the relatively simple trigonometric principle of similar triangles, a Biltmore cruiser stick is a yardstick-styled "instrument" used to measure tree diameters and tree heights without climbing the tree or wrapping a tape around the trunk. Using this one stick, a tree's dimensions can be easily determined very quickly for approximate values and checking eyeball estimates.

Foresters often use the cruiser stick tool to keep their ocular estimates honed but most timber estimation data is measured and compiled using more sophisticated and accurate tools like diameter tapes and clinometers to measure diameter and heights. Some of these instruments - a perfect example is a relascope - can actually do all the calculating from one spot. They are also pricy.

Just a little history on our simple Biltmore stick. The Biltmore cruiser stick was developed for forestry students in the late 1800's at Professor Carl Schenck's forestry school on Biltmore Estate near Ashville, North Carolina. The instrument has passed the time test and is included in every forester's tool kit.

So, lets make and calibrate a Cruiser Stick. Materials you need to get started:

- 1 straight strip of wood approximately 30 inches long, one or two inches wide and one quarter inch thick
- 1 engineers scale (an inch rule broken into tenths)
- 1 small carpenter's square
- 1 yardstick with straight edge (preferably metal)
- 1 lead pencil and a permanent black pigment ink pen
- 1 hand calculator with a square root function key
- Optional: a 25" reach Biltmore stick to check your calculations

- Remember that there is no one correct way to begin and set up this project. You might want to modify your work space to fit your needs and equipment. I have a long work bench that offered all the working area I needed and allowed some clamping room for stability of stick/ruler/scribing.
- Scribing is the key to a stick's accuracy. All I mean by "scribing" is marking an accurately calculated distance point from the left (or "0") end of the blank stick to all calculated diameter or height points proceeding to the right. It is important to mark all points in sequence without removing the yardstick (as shown).
- You can see that I also include a metal yardstick plus my old, store-bought cruiser stick to aid in correctly marking and scribing a blank strip of white pine (30 inches long, one inch wide and .7 inch thick). That old (and tree paint splattered) Biltmore stick was used to recheck my calculations but is not necessary for completing the project. It was only used as another confirmation that my calculations were correct. All my scribing was based on calculated formula data and not by using that old and beat-up stick as a template.
- The beauty of a timber scaling stick is there are two dimensions of a tree you can scale using a four-sided stick. You will be using both of the stick's wide sides to scribe a tree diameter scale and a tree height scale. This very precise scribing is easier done if you can clamp and stabilize the stick and the ruler.
- One caution: I have verified all my point calculations using a Suunto clinometer and Lufkin Artisan diameter tape on a real tree. Bad news is, I have found several "building a Biltmore stick" sites who have inaccurate calculations. I also include two sources that I will use to enhance my report:
- It is fascinating to me that you can use a two dimensional stick scale to measure the diameter of a tree. Remember that the diameter of a tree is the measured length of a straight line running through the center or pith of a tree from bark edge to bark edge. That is compared to radius (measured from tree center to bark edge) and circumference (measuring the entire circular bark edge).
- This concept is captured in the mathematics and by using a fairly simple concept dealing with the principle of similar triangles. Use the math, define the points and you have a very useful tool that will accurately estimate diameters at breast height (DBH). The reason for breast height diameters is that most tree volume tables are developed at DBH or 4.5 feet from the tree stump.
- You now want to determine the diameter points and draw vertical lines across the stick that, while holding the stick horizontally at DBH and 25" away from your eye, you can determine the diameter of that tree. You now need to mark or scribe the marks and vertical lines at precise points representing the diameters using your carpenter's square.
- This project does not include my discussion about how to use a Biltmore stick, but it is necessary for you to understand the process before you go any further. Learning how to use a cruiser stick will make it easier to visualize how this project unfolds and it explains diameter classes.
- On your blank wood stick, pencil mark each diameter point from the 6 inch class mark through the 38 inch class mark in either single or double diameter increments (I prefer

double increments, 6,8,10). The starting point for the 6 inch diameter mark should be calculated from the left end of the stick according to the following consecutive point list.

- From the left and zero end of the stick, measure the length mark for each tree diameter: 5 and 7/16" is 6" tree diameter; 7" the 8" diameter; 8 and 7/16' is 10" diameter; 9 and 7/8" is 12" diameter; 11 and 3/16" is 14" diameter; 12 and 7/16" is 16" diameter; 13 and 11/16" is 18" diameter; 14 and 7/8" is 20" diameter; 16" is 22" diameter; 17 and 1/16" is 24" diameter; 18 and 1/8" is 26" diameter; 19 and 1/4" is 28" diameter; 20 and 3/16" is 30" diameter; 21 and 1/8" is 32" diameter; 22 and 1/8" is 34" diameter; 23" is 36" diameter; 23 and 7/8" is 38" diameter
- The formula for each diameter increment: Where R is reach or distance from the eye (25 inches), D is diameter - Diameter Increment=$\sqrt{[(R(DxD))/R+D]}$
- The tree height scale on the flip side of a cruiser stick is just as important as the diameter side. You have to record both the tree's diameter and the tree's height to calculate tree volume. These two measurements are used to estimate the usable wood content. There are hundreds of tables that use diameter and height to determine volume.
- Merchantable tree height refers to the length of the usable part of a tree. Height is measured from stump height, which is usually 1 foot above ground, to an end point where the tree's marketable wood potential stops. This cutoff height will vary with the wood product(s) being considered and where excessive limbs or top diameter becomes too small to be of value.
- The tree height side of the scale stick has been calibrated so that if you stand 66 feet from the tree being measured and hold the stick 25 inches from your eye in a vertical position, you can read the number of merchantable logs, usually in 16 foot increments, from the stick. Like with the diameter side, it is important not to move the stick or your head when taking a measurement. Position the bottom of the vertical stick at stump level and estimate the height where merchantable height stops.
- **Creating the Tree Height Scale**
- Again, on your blank wood stick, pencil mark each height point from the first 16 foot log height mark through the 4 log class mark. You might want to scribe a mid-point to indicate half logs. The starting point for the first log mark should be calculated from the left end of the stick according to the following consecutive point list.
- From the left and zero end of the stick, measure the length mark for each tree height: at 6.1 inches scribe the first 16' log; at 12.1" the second 16' log (32 feet); at 18.2" the third 16' log (48 feet); at 24.2" the fourth 16' log (64 feet)
- The formula for each hypsometer increment: Hypsometer (Height) Increment = (Biltmore Length x Log Length) / 66 ft.