HOW TO MEASURE A BIG TREE

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To measure a Big Tree, you'll need a few basic tools. In cases where the tree is very large, it would also be nice to have an assistant help with the measurements. If you don't have the proper equipment or knowledge to get the job done, please contact the Forest's Big Tree Coordinator and he will be happy to assist you.

Before you get started, obtain a blank copy of the Champion Tree Nomination Form. Every tree should be submitted on its own nomination form. You can download a form from the Umatilla National Forest's big-tree website: www.fs.fed.us/r6/uma/nr/silv/bigtree.shtml

It is assumed you can identify the tree species and that is the first item that needs to be recorded on the nomination form. However, some of the minor tree species may be difficult to identify, in which case you should verify your identification using a comprehensive botanical flora such as "Flora of the Pacific Northwest" or a regional tree guide such as "Trees to know in Oregon."

If you are uncertain of your identification (is it an alder or a birch?), collect a sample for later verification. If you do collect a sample, be sure to include both foliage and fruits if possible. A list of tree identification books is included at the end of this document.

Each tree you nominate will be scored using a point system. The points are assigned based on three of the tree's dimensions – its circumference (in inches), its height (in feet), and one-quarter of its crown spread (in feet). A process has been established for measuring those dimensions and it is described in the remainder of this document.

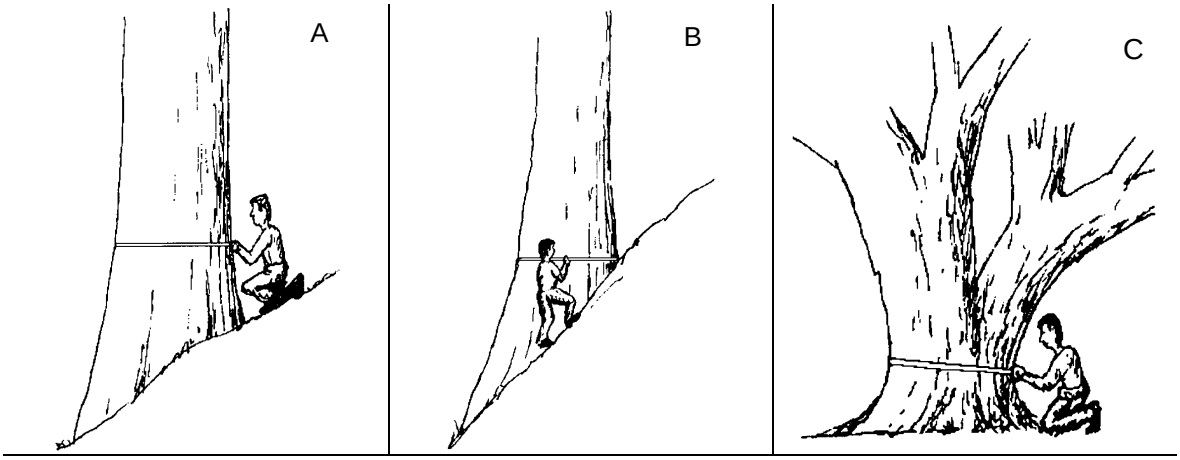
TREE DIAMETER OR CIRCUMFERENCE

Diameter should be measured with a diameter tape made of steel, not something that might stretch. Although you can wrap a piece of twine around the tree to measure its circumference, that is only an estimate and it would be necessary to remeasure the diameter with a steel tape.

Diameter is measured at breast height, which is defined as 4½ feet **above average ground level**. Note that this measurement standard differs from what everyone else uses because diameter is *NOT based on a measurement taken from the uphill side of the tree only*.

Diameter measurement problems are often related to the phrase "above average ground level." When trees are growing on a slope or uneven ground, the rule is to measure 4½ feet from both the uphill and downhill sides, find a point halfway between the two (this is the mid-point), and measure diameter there.

If a slope is so steep that the mid-point ends up below ground level on the uphill side of the tree, then it may be necessary to measure diameter at a point above 4½ feet. In this situation, measure the tree as near to ground level as possible and record the measurement height on the nomination form. See figure below for an example of this diameter measurement scenario.



Diameter Measurement Examples. Example A shows diameter being measured at 4½ feet above average ground level. This can be done in two ways: on an even slope, find the point that is midway between the uphill and downhill sides, measure 4½ feet up from there, and then measure diameter. Or, measure 4½ feet from both the uphill and downhill sides of the tree, find the mid-point between the two, and measure diameter there (if the uphill and downhill points are 12" apart, then the proper place to measure diameter is either 6" below the uphill point or 6" above the downhill point). Example B shows diameter being measured at the soil surface because the tree is growing on a very steep slope. In this situation, it is not uncommon for average ground level to be at the soil surface for the tree's downhill side or perhaps even below the soil surface. If a soil surface measurement turns out to be higher than 4½ feet above average ground level, note the actual height on the nomination form. Example C shows how to measure diameter for a forked tree. For multiple-stemmed trees (those with more than two branches), the largest stem should be selected and measured at 4½ feet. For forked trees (those with two main branches), measure directly below the fork (as shown in the diagram) and record the measurement height on the nomination form.

Measuring diameter can be tricky because trees often grow in unusual situations or come in unusual shapes. Trees that are leaning, growing in hummocky terrain, or have an unusual shape (pistol butts, forks, butt swells or buttresses, and so forth) offer a measurement challenge.

If there is a growth or branch at breast height, measure diameter at the narrowest point below 4½ feet and note the actual measurement height on the nomination form.

For multi-stemmed trees, measure the single largest stem at a point 4½ feet above average ground level. Be careful to evaluate multi-stemmed clumps carefully because it can be difficult to tell if the clump is derived from one tree, or from many trees. In some situations, each stem in a clump is obviously part of the same tree; in others such as whitebark pine, several trees may have grown together (fused at the base) to form a clump.

If several individual trees grew together to form a clump, then each individual stem should be evaluated as a separate tree and measured as close to 4½ feet above average ground level as possible.

If each stem is obviously derived from a single tree, then judgment is needed: if many stems indicate that the tree is branched below 4½ feet, then measure the single largest branch (stem) at 4½ feet; if only two stems are present, then the tree is considered to be forked and you should measure the smallest trunk diameter below the fork and note the actual measurement height on the nomination form (example C above shows how to measure a forked tree).

Note: When calculating your tree's score for the Forest's "Register of Big Trees," a diameter measurement will be converted to circumference. The national scoring system for big trees has always utilized circumference rather than diameter.

TREE HEIGHT

Height is measured from ground level, on the uphill side of the tree, to the tip of the tree's tallest leader. A height measurement is best obtained by using forestry instruments such as a clinometer or relaskop. Although it's possible to estimate height using a stick or ruler and a process that won't be described here, that method yields an approximation only. It would then be necessary to revisit the tree and obtain an accurate measurement using a clinometer or relaskop.

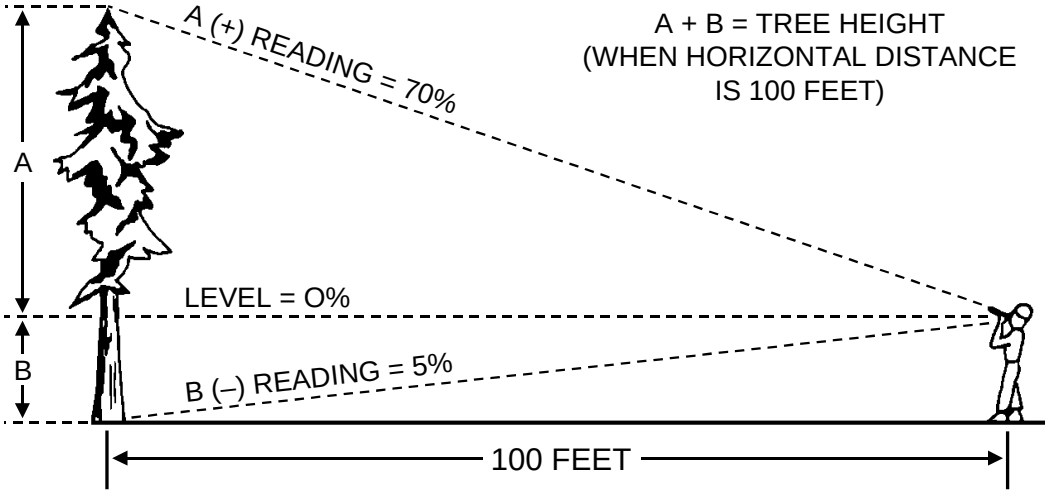
When measuring height for a very tall tree, it's important to get far enough way to stay within the accurate range of the scales in a clinometer or relaskop. Usually, this means a long tape is needed; a 100-foot logger's tape is a minimum, and a 200-foot tape is often required for trees over 150 feet tall.

Measuring tree height on level ground is relatively easy. When working on steep slopes, it can be trickier and the instrument readings may need to be adjusted to convert from slope distance to horizontal distance.

The examples described next show how to measure tree height in three different situations; all assume use of a common instrument called a clinometer (short for an incline meter).

1. Measuring height on flat ground and assuming a 100-foot baseline distance.

This is the simplest height measurement scenario. With a percent clinometer, which is based on a 100-foot baseline distance instead of a 66-foot baseline (as would be used with a topog clinometer), you can read the top and bottom measurements directly, add them together, and end up with total tree height.



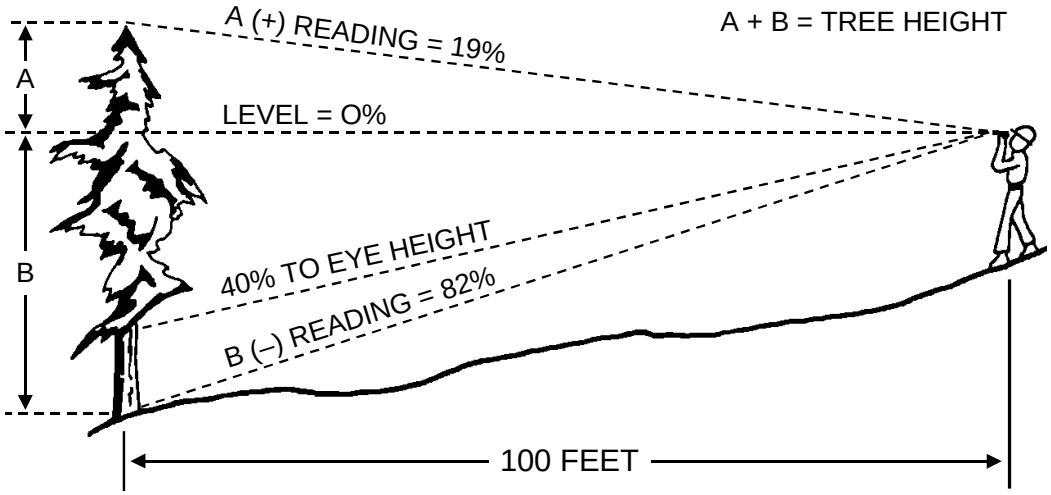
Measuring tree height on flat ground using a percent clinometer and a 100-foot baseline distance.

The A (+) readings on a clinometer mean that you are looking up; the B (–) readings mean you are looking down. A level (not up or down) reading would be 0 on a clinometer. In our example below, the A (70) reading was looking up at the top of the tree; the B (5) reading

was looking down at its base (where the trunk meets the ground). To get the tree's total height, you add the top reading (70) and the bottom reading (5) together: 75 feet tall for our example tree.

2. Measuring height on sloping ground and assuming a 100-foot baseline distance.

Measuring tree height is a little more complicated for this scenario. When using a clinometer on sloping ground, you must apply a slope correction factor to convert slope distance to horizontal (flat) distance. Here's a height measurement example for sloping ground:



Measuring tree height on sloping ground using a percent clinometer and a 100-foot baseline distance.

Here is the process you'd use to measure this tree's height:

a. Use the clinometer to measure the slope percent from you to your 'eye height' on the tree trunk (this sighting is a line that's parallel to the ground surface). In our example, the slope percent is 40.

b. Find a slope correction factor in table 1 for the slope percent you just measured (1.08 is the slope correction factor for 40 percent).

c. [Note: many clinometers show slope correction factors on the same scale as the slope percent values, which is handy because then you don't have to look them up in a table.]

d. Multiply the slope correction factor by the baseline distance. In our example with a 100-foot baseline, the result is: 100 feet × 1.08 = 108 feet. This means that on a 40 percent slope, you must be 108 feet away from a tree to get the same answer as if you were 100 feet away on flat ground.

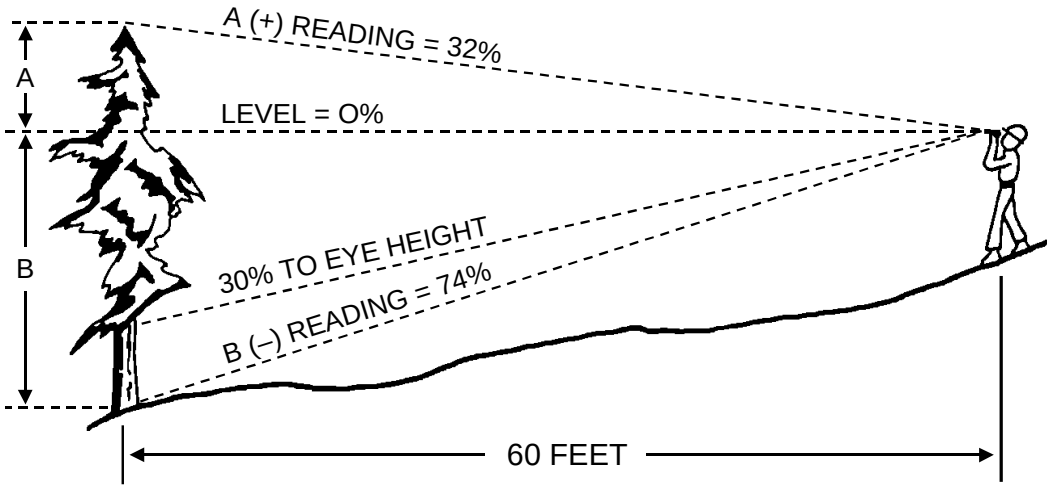
e. Back up to 108 feet from the tree before taking clinometer readings of its top and base.

f. Take clinometer readings of the tree's top and base, and add them together to come up with a total height. In our example, the result would be: 19 + 82 = 101 feet.

3. Measuring height on sloping ground using a baseline distance other than 100 feet.

It is often hard to measure heights from exactly 100 feet away, particularly if thick brush or downed logs hide your view of the tree's base. And as explained earlier, you will generally want to measure height from more than 100 feet away for very tall trees in order to stay within the accurate range of the instrument's scales.

For these trickier situations, you'll need to measure height from someplace other than 100 feet away and adjust the clinometer results accordingly. Here's a height measurement example that uses a baseline distance other than 100 feet:



Measuring tree height on sloping ground using a percent clinometer and a baseline distance other than 100 feet.

Here is what you'd do to measure this tree's height:

a. Use the clinometer to measure a slope percent to eye height on the tree (30 percent in this example).

b. Get a slope correction factor from table 1 (1.04 for 30 percent).

c. Multiply the slope correction factor by your baseline distance: 60 feet $\times$ 1.04 = 62.4 feet.

d. Back up to 62.4 feet before taking clinometer readings of the tree's top and base.

e. Take clinometer readings of the top and base, and add them together. In our example, the result is: 32 + 74 = 106.

f. Does this mean that the tree is 106 feet tall? No, it does not! Do you remember that a clinometer is designed to be used with a 100-foot baseline? Any time you are not 100 feet away from the tree (slope-corrected distance), the clinometer readings must be adjusted to account for a different baseline distance. In our example, the slope-corrected baseline distance was only 60 feet, not 100.

g. Calculate a baseline adjustment factor by dividing your baseline distance by 100: 60 feet $\div$ 100 = 0.6.

h. Multiply the sum of the clinometer readings (see step 5 above) by the adjustment factor to finally get a total height for your tree: 106 $\times$ 0.6 = 63.6 feet.

Table 1: Slope correction factors

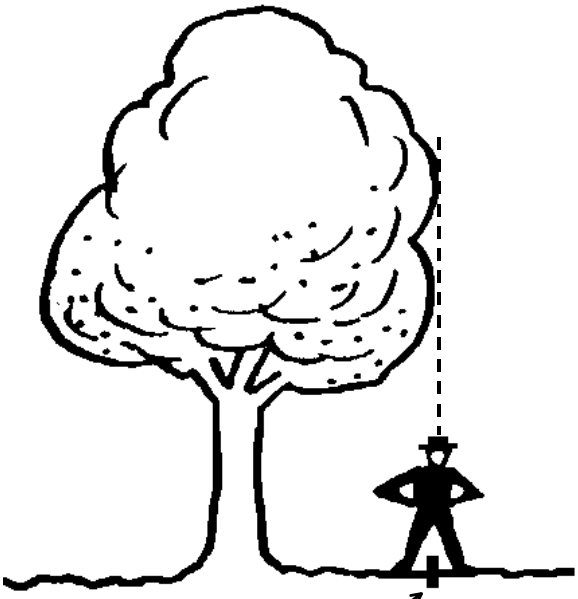
SLOPE PERCENT	CORRECTION FACTOR
0 – 9	1.00
10 – 17	1.01
18 – 22	1.02
23 – 26	1.03
27 – 30	1.04
31 – 33	1.05
34 – 36	1.06
37 – 39	1.07
40 – 42	1.08
43 – 44	1.09
45 – 47	1.10
48 – 49	1.11
50 – 51	1.12
52 – 53	1.13
54 – 55	1.14
56 – 57	1.15
58 – 59	1.16
60 – 61	1.17

CROWN SPREAD

Average crown spread is a measurement that we seldom collect as part of our normal job. This differs from diameter or height, both of which are commonly measured when completing stand examinations or timber cruises.

To determine a tree's average crown spread, you first find the widest and narrowest points of the tree's crown. Those points are then marked on the ground. If you bring some wooden stakes along, such as those used for road surveys or plantation survival checks, it will make this part of your measurement job much easier.

Here's how it is done. Walk around beneath the tree and visually determine where the tree's branches extend the farthest from the bole. Drive a stake in the ground at that point.



Next, follow an imaginary line that goes from the stake to the opposite side of the crown; the line must pass through the center of the tree's bole. Line yourself up with the outside of the crown (having an assistant help you here is a good idea) and drive a stake at that point.

Then complete the same process for the narrowest part of the crown. Walk around beneath the tree and find the point at which the branches are closest to the bole. Drive a stake at that point; move to the exact opposite side of the crown as you did before, and drive a stake there too.

You have now marked the widest and narrowest dimensions of the tree's crown. Measure the distance between the stakes marking the widest part of the crown, in feet. Measure the distance between the stakes marking the narrow dimension. Calculate an average crown spread by adding the numbers together, and then dividing by two. Record the average crown spread value on the big-tree nomination form.

SCORING FORMULA

Each tree is evaluated according to a point system – one point for each inch of circumference, one point for each foot of height, and one point for each quarter of crown spread.

After its measurements have been collected, your tree's final score will be calculated using this formula developed by American Forests (administrator of the national Big Tree program):

Circumference (inches) + Height (feet) + ¼ of crown spread (feet) = Score (points)

If you are starting with a diameter (DBH) in inches, multiply it by pi (3.14) to convert from diameter to circumference. For example, let's say you submit a western white pine with a 63.1" diameter (measured at 4½ feet above average ground level), a 198' height, and a 24' average crown spread (wide and narrow dimensions averaged together).

The DBH would first need to be converted to circumference by multiplying 63.1 by 3.14, which yields 198.1 (round it to the nearest whole number when using it in the formula).

The final score for this example tree would then be calculated this way:

198" circumference + 198' height + ¼ of 24' crown spread = 402 points

TREE REFERENCES

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graphs and illustrations; also a good guide for identifying wildflowers. ISBN: 1551052199.]

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