Measuring Forests: Field Techniques

Forests Through Time and Space Fall/ Winter, 2004/05

This workshop will give you a set of field techniques that you can use to quantify some attributes of forests. Most of these methods are standard field methods either from botany or from forestry. Over the quarter, you will be visiting a number of different forests and taking these same measurements. At the end of the quarter, you will be asked to summarize and reflect on what patterns are discernable in the data.

For most of these measurements, we will use feet and acres as units since they are standard in the forest industry and a number of the instruments we will use are calibrated in these units. Unfortunately, we don't have enough tapes that are in feet, so you will need to convert from metric to English and vice versa (1 ft = .3048 m, 1 inch= 2.54 cm)

Definitions

There are a number of terms and conventions that need to be defined.

Diameter at breast height (DBH). This the diameter of a cross section of a particular tree at about 4.5 ft above the ground. It is a measure of tree trunk size.

Basal area (BA). In simplest terms, basal area is the cross-sectional area of a tree at breast height. It can be calculated using the formula for the area of a circle = (π x r2). There are tables that give the BA for trees of varying DBH.

Basal area per acre. This is the sum of the basal areas for each tree in one acre of forest. It is a measure of stand density and expresses the relative amount of land occupied by trees. Another way to think about it is that it is the amount of tree vegetation on a unit of land area. BA/acre can also be used to compare the relative dominance of different tree species within a forest.

Variable plot sampling. This technique makes use of an angle gauge or a special prism to sample the forest. Through sampling theory and statistical calculations, these tools have been calibrated so that each tree counted in the sample represents a specific basal area per acre (expressed as ft^2 per acre). The chances of a tree being counted in the sample depend on its DBH and the distance between the viewer and the tree. Small trees will be counted if they are close to the viewer, while larger trees can be further away and still counted. The advantage of this sampling method is that it can be done rapidly and it gives a good estimate of the basal area per acre.

Fixed plot sampling. As the name implies, this involves establishing a plot of known dimensions and sampling the vegetation within that plot. We will be identifying the plants within the fixed plots and using this information to characterize the understory vegetation.

Variable Plot Sampling

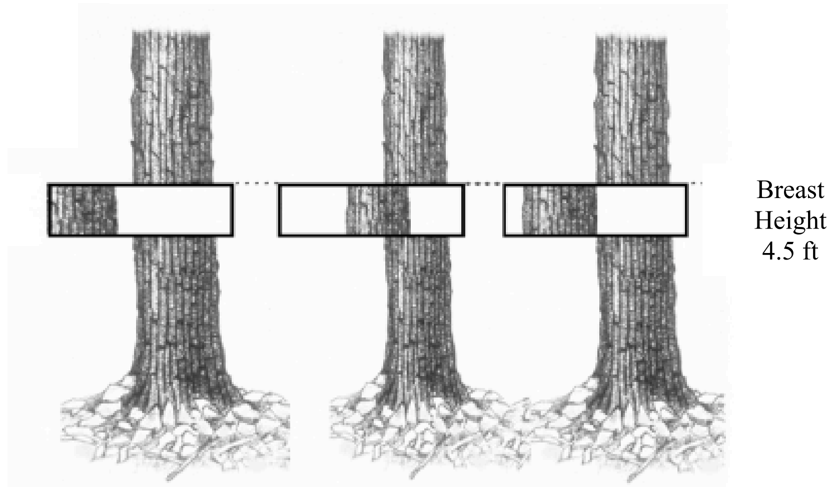
Each of the sampling devices used for variable plots are used slightly differently. We will be using a variety of wedge prisms or an angle gauge. Each device will have a basal area factor (BAF). You must note the BAF in your notebook. Multiplying the number of counted stems by the BAF will give you the basal area per acre. The main differences between prisms and angle gauges are as follows:

Prisms. It doesn't matter how far you hold the prism from your eye. However, as you rotate in a circle to sample the forest, the prism should remain over the same point. Mark the center of the plot with a stake. Prisms must be held with the thick edge perpendicular to the ground. The prism will offset an image of the tree trunk. If this offset image intersects with the actual trunk viewed outside the prism, the tree is counted. Trees where the offset image does not intersect the tree are ignored and borderline trees (offset image barely touches the tree) are counted as half a tree.

We have prisms with BAFs of 20 and 40, and angle gauges with BAFs of 5, 10, 20, and 40. The higher BAFs are used in stands with larger trees. We will use either 20 or 40 BAF for our surveys. Ideally, the chosen BAF will yield an average of 5 to12 counted trees per sample point.

Angle Gauges. The angle gauges we have consist of a metal sight with three different size openings and a bead chain to measure the distance from your eye to the metal sight. Unlike a prism, which can be held any distance from your eye, the angle gauge sight must be held the same distance from your eye in order to function. Also, when using an angle gauge, the viewer's eye is the center of the plot, whereas with a prism, the prism is the center of the plot. Trees that are wider than the appropriate opening in the angle gauge are counted. Trees narrower are ignored and borderline trees (appear the same width as the opening) are counted as half a tree.

Variable plot sampling with wedge prism



This tree is OUT. Do not count. This tree is IN. Count. This tree is BORDERLINE. Count as a half, or count every other borderline as IN.

Sampling a forest with variable plot sampling

Determining the center of the plot is usually done arbitrarily prior to arriving in the field to minimize sampling bias. A common method is to layout a grid where a sample plot is located fixed distances along perpendicular lines. Once the plot center has been located, position either the observer (using an angle gauge) or the prism (using a wedge prism) over the center. Beginning with an obvious landmark tree, slowly rotate 360° and count all the trees that are "IN". It is permissible to move slightly to view hidden trees so long as the distance from the hidden tree is kept constant. For each plot, record the number of counted trees.

Once the process becomes familiar, sampling a variable plot is quite rapid. To accurately assess the forest, a number of variable plots should be sampled and the counts averaged (compute the average out to three decimal places). The average count is then multiplied by the BAF to determine the basal area per acre for the forest. This lumps all the tree species together. Data collected in the fixed plots can then be used to portion the total basal area of the forest into basal area per acre for each of the overstory tree species.

Fixed plot sampling

Fixed plots are used to sample additional attributes of the forest, such as overstory tree species composition, density and species of shrub and herbaceous layers, canopy coverage. Plot size varies depending on the number of trees per acre. Small plots are used in forests with many trees per acre. We will use primarily 0.1 and 0.05 acre plots.

Sample Plot Dimensions

Plot Size (acres)	Plot Size (ft2)	Plot Size (m2)	Circular Radius (ft)	Circular Radius (m)	Square side (ft)	Square side (m)
1	43,560.0	4,046.7	117.8	35.9	208.7	63.6
0.5	21,780.0	2,023.4	83.3	25.4	147.6	45.0
0.25	10,890.0	1,011.7	58.9	17.9	104.4	31.8
0.1	4,356.0	404.7	37.2	11.3	66.0	20.1
0.05	2,178.0	202.3	26.3	8.0	46.7	14.2

Plots can either be circular or square. It is often easier to layout a circular plot in the forest, but it can be more difficult to determine if a particular tree is in or out of the plot as compared to a square plot where you can sight between two corner stakes.

Within the fixed plot, you will measure each tree (DBH and height) and identify it to species. If all the overstory trees are about the same height, you can measure only one (we're not determining timber volume). Canopy cover and understory vegetation will also be estimated and recorded.

Sampling a forest with fixed plot sampling

There are five different layers in the forest community that you will assess, namely:

1. Tree. This is the tallest layer, consisting of the dominant trees. E.g. Douglas fir
2. Sapling/tall shrub. Any woody plants greater than 8 ft tall, but not reaching into the tree canopy. May include young overstory trees, as well as plants adapted to growing under the tree canopy. E.g. vine maple
3. Shrub. Woody plants less than 8 ft tall. E.g. salal, oregon grape, huckleberry
4. Herbaceous. Non-woody plants such as ferns.
5. Moss

Not every forest will have every layer. If one is missing, make a note of it. The techniques used to assess each layer are outlined below.

Assess the percent canopy cover using a sampling grid. At 10 random spots within the plot, hold the grid aloft and count the number of squares containing either visible sky or leaves. From these data, a percentage can be calculated which represents canopy cover.

Assessing the trees (and any saplings). Measure and record the DBH and species of every tree in the plot.

Assessing the understory layers. The relative abundance of plants in the tall shrub, shrub, herbaceous, and moss layers will be recorded as a subjective relative abundance according to the following scale:

- Dominant
- Abundant
- Common
- Occasional
- Rare

The first two terms can be modified by the use of "locally." For example, sword fern might totally cover one corner of your plot (locally dominant in NE corner), but be occasional in the rest of the plot.

For each of the layers of the forest, identify as many of the plants as possible and record their relative abundance. Try to identify as many of the shrubs as possible. With the exception of the ferns, the herbaceous layer will be difficult to assess at this time of year. Mosses can be recorded simply as moss, although you can try to identify them or assess them letters, e.g. Moss A, moss B.

Measuring tree height

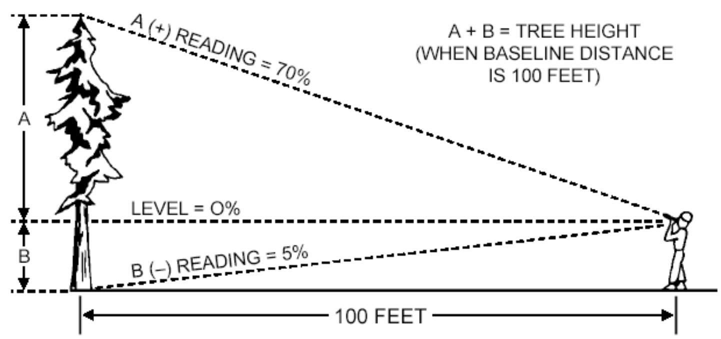
Tree height is measured using trigonometric principles. Two right triangles are formed with the horizontal distance forming one side and a portion of the tree height on the other side of the 90° angle. The interior angle between the horizontal side and the hypotenuse is measured and with this angle and the horizontal distance, the height can be calculated.

The instrument used to measure the angle is a clinometer, which is a small, light, robust and inexpensive instrument for measuring height. An internal scale normally indicates percentage slope (on the right and angle degrees on the left). Some people experience difficulties sighting through the clinometer. You must look into the clinometer while simultaneously sighting along side it to see the tree.

To measure tree height using a clinometer, the steps involved are:

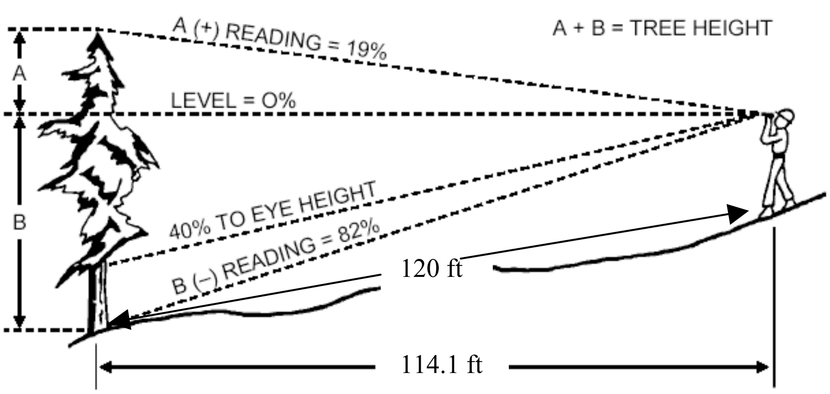
1. The horizontal distance to the tree is measured with a tape.
    a. On level ground, this is directly measured with the tape.
    b. On sloped ground, measure the tree from uphill if you can't measure it from the side as though it were level ground.
        i. The horizontal distance to the tree must be calculated by measuring the slope angle. Slope angle (expressed in degrees) must be measured by sighting at the tree at eye height. Percent slope can be converted to degrees by multiplying the percent slope (expressed as a decimal) by 45 to get degrees. E.g. a 50% slope angle is 22.5°.
        ii. Distance to the tree is taped along the slope. The cosine of the angle times the distance along the slope equals the horizontal distance. This is the horizontal distance.
2. The operator then measures the angles to the top of the tree and the bottom of the tree. If the angles are measured in percent slope, the angle to the top is added to the absolute value of the angle to the bottom (which is given as a negative slope).
3. This percent slope (as a decimal number) is then multiplied by horizontal distance to get the height.

For example, on level ground at 100 ft away from the base of the tree, the reading to the top of a tree is 70% and to the bottom is –5%. Adding the absolute value of the bottom reading to the top gives 75% (.75) times the distance (100 ft) gives a tree height of 75 ft.



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

Sloping ground. The slope angle is 40% (18°) and the distance to the tree along the slope is 120 ft. The horizontal distance is the cosine of 18° x 120 ft = 114.1 ft. The angles to the top and bottom of the tree (measured in percent slope) are 19% and -82%. Thus, the tree height is the sum of the angles (.19 + .82) =1.01 x 114.1 ft = 115.2 ft.



Measuring tree height on sloping ground using a percent clinometer