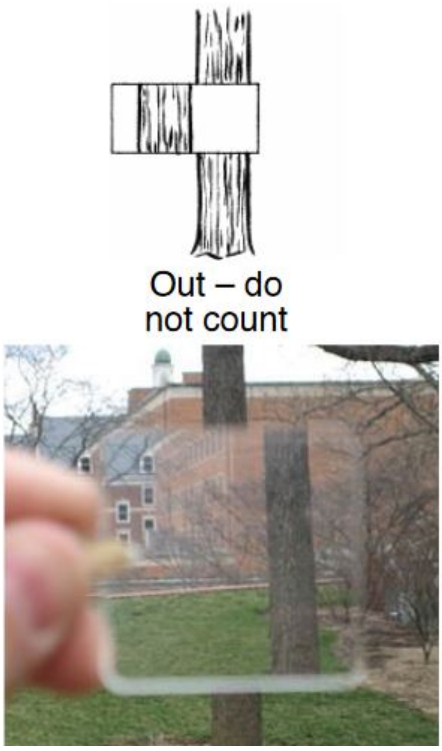
Using a Prism to Measure Basal Area

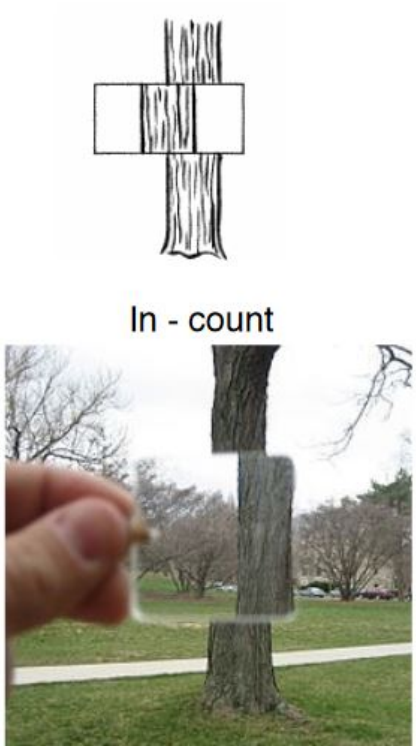
1. Hold prism (not your eye) over the selected point at a comfortable distance from the eye, with the long side horizontal. Hold prism with right hand by lower part of the thicker edge.

2. With one eye closed, point with the upper part of the prism so as to divide the tree in question at breast height. Refraction of light through the prism will cause the portion of the tree below breast height to appear separated. Count as 1 all of the trees whose figures are superimposed, as 1/2, or measure for accuracy those which touch only at the edge. If they do not touch each other they are not counted.

3. Turn in a circle, checking each visible tree, making sure not to count the same tree twice.

4. The number of trees counted, multiplied by basal area conversion factor of prism gives us the basal area per stand acre. BA/Acre = (Total number of trees counted X BAF of prism)/(Number of samples)





Borderline Trees

Always measure borderline trees more than a casual check on basal area. A short cut method counts borderline trees as 1/2.

1. Measure horizontal distance from sample point to center of tree at Breast Height.

2. Get Diameter at Breast Height (DBH).

3. Multiply DBH by Prism **P**lot **R**adius **F**actor. When this product is more than taped distance, the tree is "In".

> The Plot Radius Factor for a Prism is calculated using: √(75.625/BAF)
> The Plot Radius Factor for a 10 BA Prism = 2.75
>
> Example: (PRF is 2.75, DBH 10.0)
> 2.75 X 10.0 = 27.5 feet, taped distance is 27.2 feet; tree is "In".

Precautions

1. Prism must be in center of plot, not the eye. Walk around the prism; do not stand in one place and move the prism around you.

2. Always hold the face of the prism at right angel to eyesight, horizontally and vertically. (Except for leaning trees and when correcting for slopes).

3. For leaning trees move prism forward then backward on its vertical axis according to the inclination of the tree trunk.

4. Correct for slope by rotating prism to the same amount of slope between the prism and the tree, but at right angles to the eye.

5. If there is an object between you and the tree to be checked, move one step sideways, keeping a constant distance between you and the tree.

6. In dense strands be careful not to confuse or incorrectly associate the trunks. (If a tree is "In" above the brush, it is "In" at BH).

7. Remember that each diameter size has its own plot radius, the radius varies directly with the tree diameter. Therefore, the largest and most valuable trunks are usually sampled more intensely than the smaller trunks.

--The prism helps to train the eye to estimate the basal area of stands, use it.

For more detailed information on the differences on fixed area sampling versus variable point sampling (using a prism) please read below.

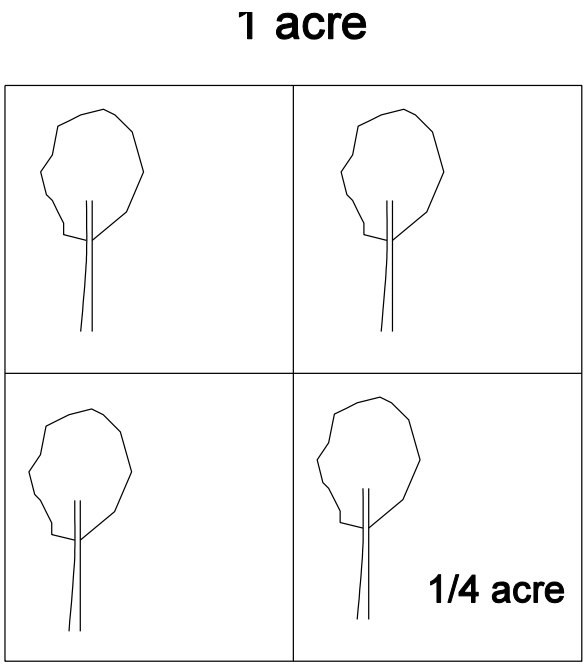
FOR 2542 – Forest Measurement and Inventory
Sample Design
David Larsen

There are two basic methods of sampling commonly used in forestry, fixed area plots and variable point samples. Fixed area plots are simply a fixed area that is selected within which all trees are measured. Variable point samples have with no specific area. Each sample tree represents a fixed ***basal area*** per acre.

Plot type	Reasons to select
Fixed Area Plots	Estimation of trees per acre Estimation of diameter distributions Repeat measurements
Variable point samples	Volume estimation Basal area estimation Temporary plots

Fixed Area Plot Sampling

In fixed area plot sampling, we assume that the plot area is representative in the remainder of the area of interest. Usually statistics about the stand are reported on the standard unit of measure (e.g., acres in English units and hectares in metric units). The consequence of the above assumption is that if, for example, we measure one tree in a 1/4 acre plot we assume that there are four trees just like the one we measured per acre.

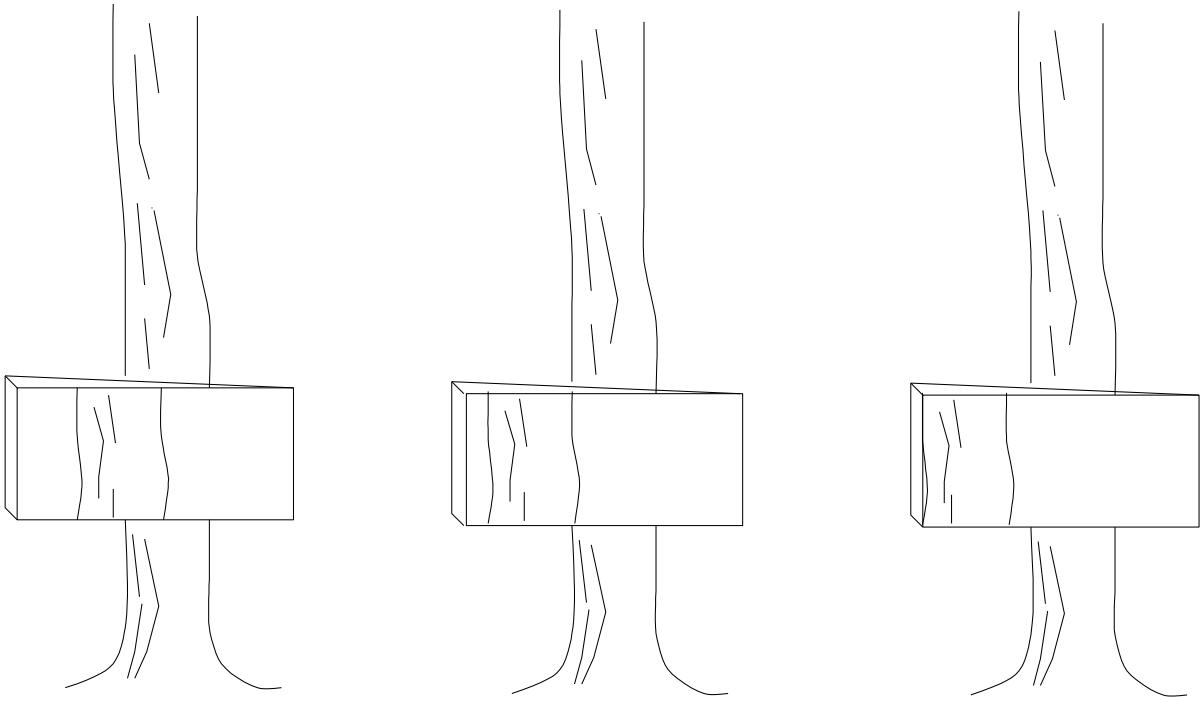


This kind of sampling is the easiest to calculate as the expansion factor or TPA multiplier is the reciprocal of acre fraction. In this method, we spend most of the time measuring the tree sizes that are most frequent in the stand. Commonly, small trees are most frequent in forest so this method will give you a better picture of the numbers and size of small trees.

Variable Point Sampling

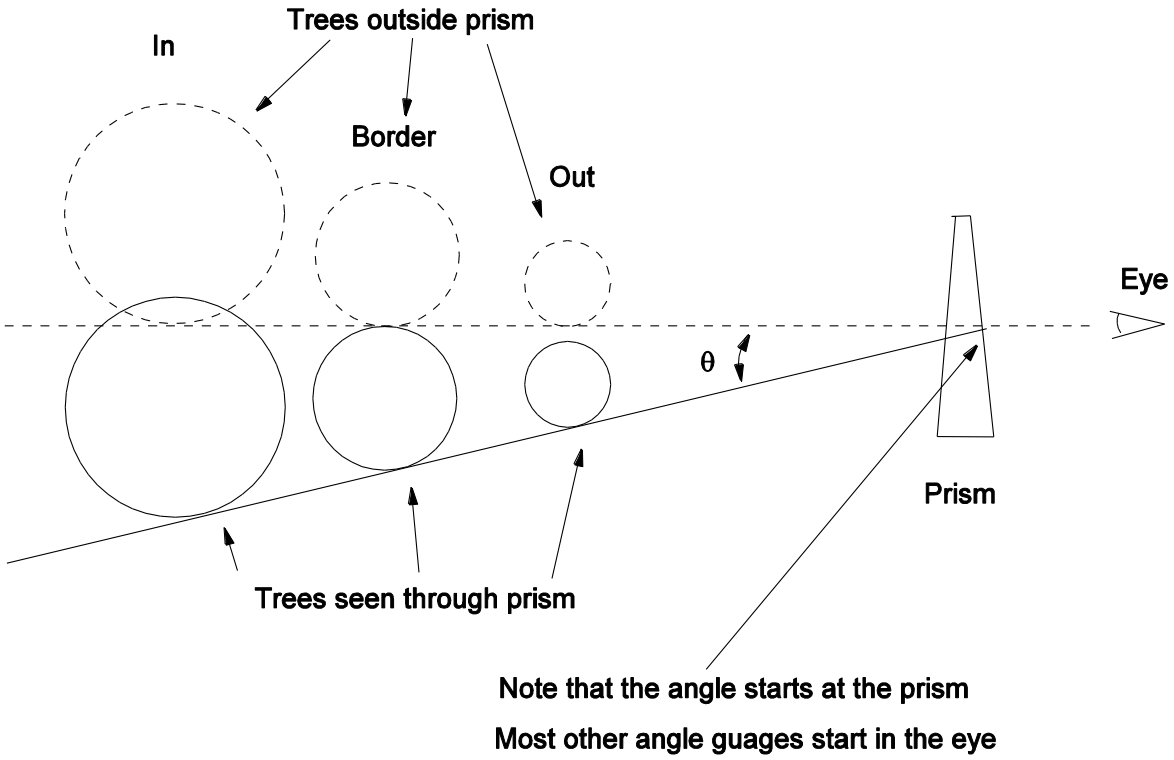
Point sampling or variable plot sampling is based on the idea that every tree size has a different size plot all centered on a point. The plot extent is usually measured with a angle gauge. The angle gauge can be mechanical (e.g., angle spanning gauges), optical (e.g., prisms), or a combination (e.g., relaskop).

The following figure illustrates how a prism is used on level ground to determine if a tree is in or out of the plot. Border trees can greatly influence the statistics collected from the sample so it is recommended to measure all border trees and compare against a limiting distance table. This table can be calculated using the formula for plot radius below and a spreadsheet. Limiting distances are measured from plot center to the center of the tree.

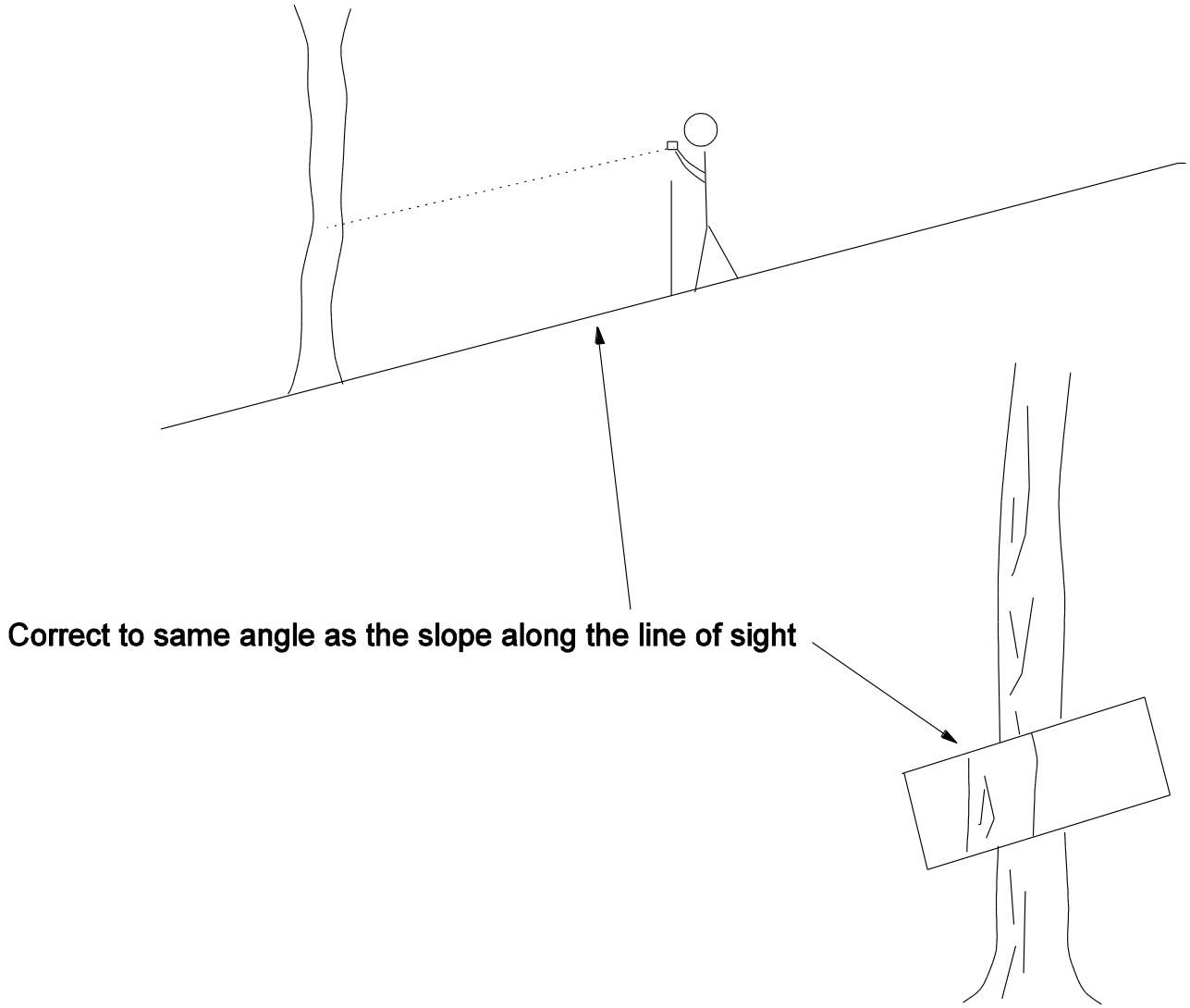


The following diagram illustrates what the prism is doing and how the image is displaced by the prism. Please note that the apexes of different angle gauges are different. The apex should be

held over plot center. With optical gauges the apex is the device it self. With mechanical gauges, it is your eye.



If using an angle gauge on a slope you must correct for the slope in the direction you are looking. That means up and down slope you correct, looking side slope you do not correct. The way to slope correct with a prism is by turning the prism at an angle parallel to the slope along which you are looking. Again, when in doubt, measure the distance to the tree and compare to a table of limiting distances.



Formulas in English units

The following formulas are most of the formulas needed when doing normal horizontal point sampling. A more complete set is available in Husch (2003).

Variable	English Formula
Gauge angle	$k = \frac{D}{12R} = 2 \cdot \sin\frac{\theta}{2}$
Plot radius	$R = \frac{D}{12k} = \frac{33\sqrt{10} \cdot D}{12\sqrt{F}}$
Plot area	$A = \pi R^2 = \pi\left(\frac{D}{12k}\right)^2$

Trees per acre	$TPA = \frac{43560}{A} = \frac{10{,}890k^2}{0.005454D^2} = \frac{F}{BA} = \frac{E}{D^2}$
Basal Area Factor	$F = BA(TPA) = 10{,}890k^2$
Expansion constant	$E = \frac{F}{0.005454}$

Source: Husch et al. 1993.

Formulas in metric units

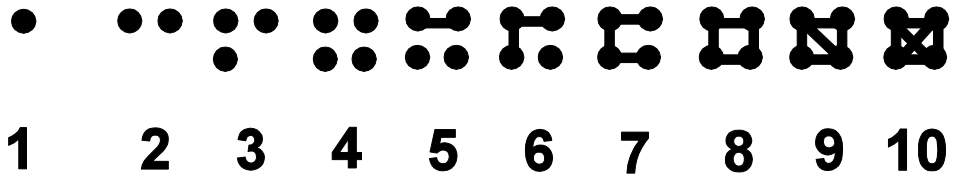
These are the same formulas only the constants have been change for use with metric units.

Variable	Metric Formula
Gauge angle	$k = \frac{D}{100k} = 2 \cdot \sin\frac{\theta}{2}$
Plot radius	$R = \frac{D}{100k} = \frac{D}{2\sqrt{F}}$
Plot area	$A = \pi R^2 = \pi\left(\frac{D}{100k}\right)^2$
Trees per acre	$TPA = \frac{10000}{A} = \frac{2{,}500k^2}{0.00007854D^2} = \frac{F}{BA} = \frac{E}{D^2}$
Basal Area Factor	$F = BA(TPA) = 2500k^2$
Expansion constant	$E = \frac{F}{0.00007854}$

Source: Husch et al. 1993.

Tally marking method

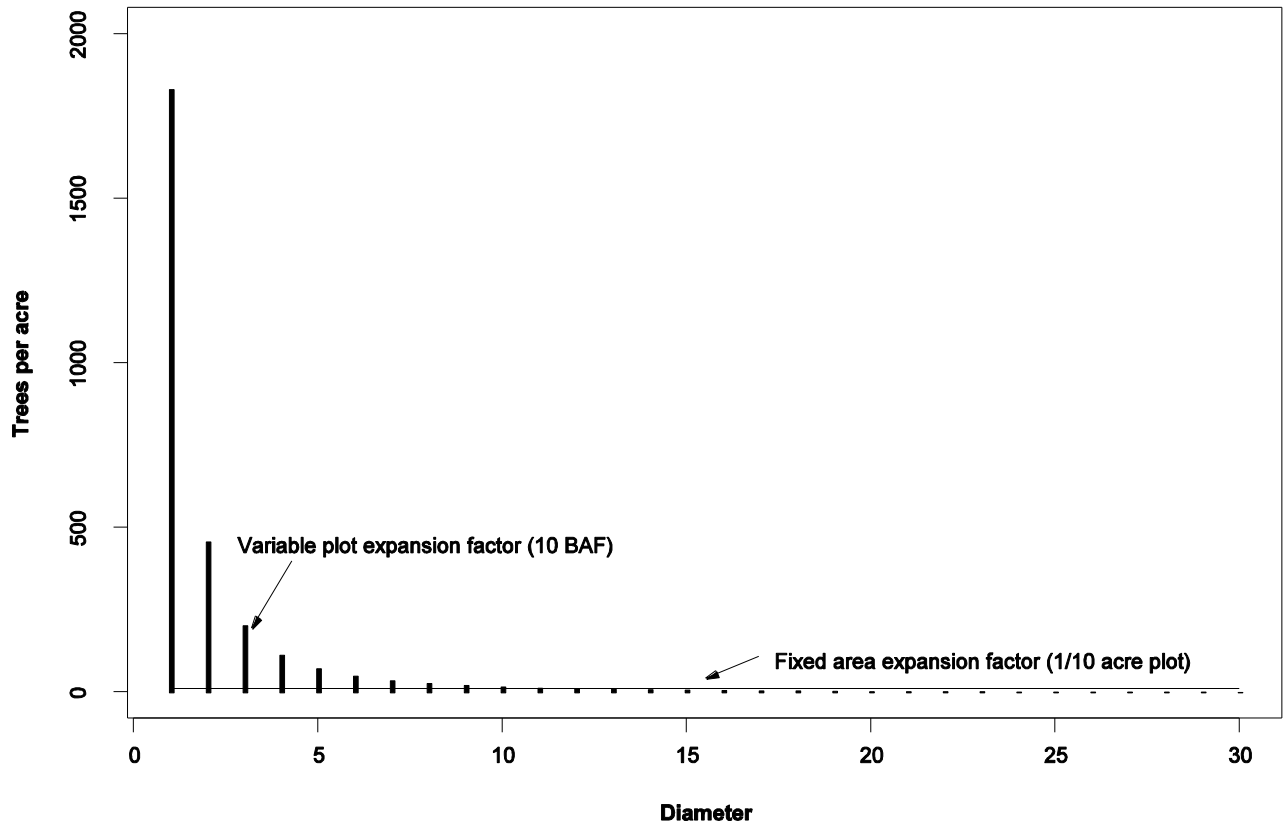
The following is a commonly used method of marking counts by class for quick cruises. These marks are cumulative and can be made in a rather small area allowing the tally of a entire inventory on a single page.



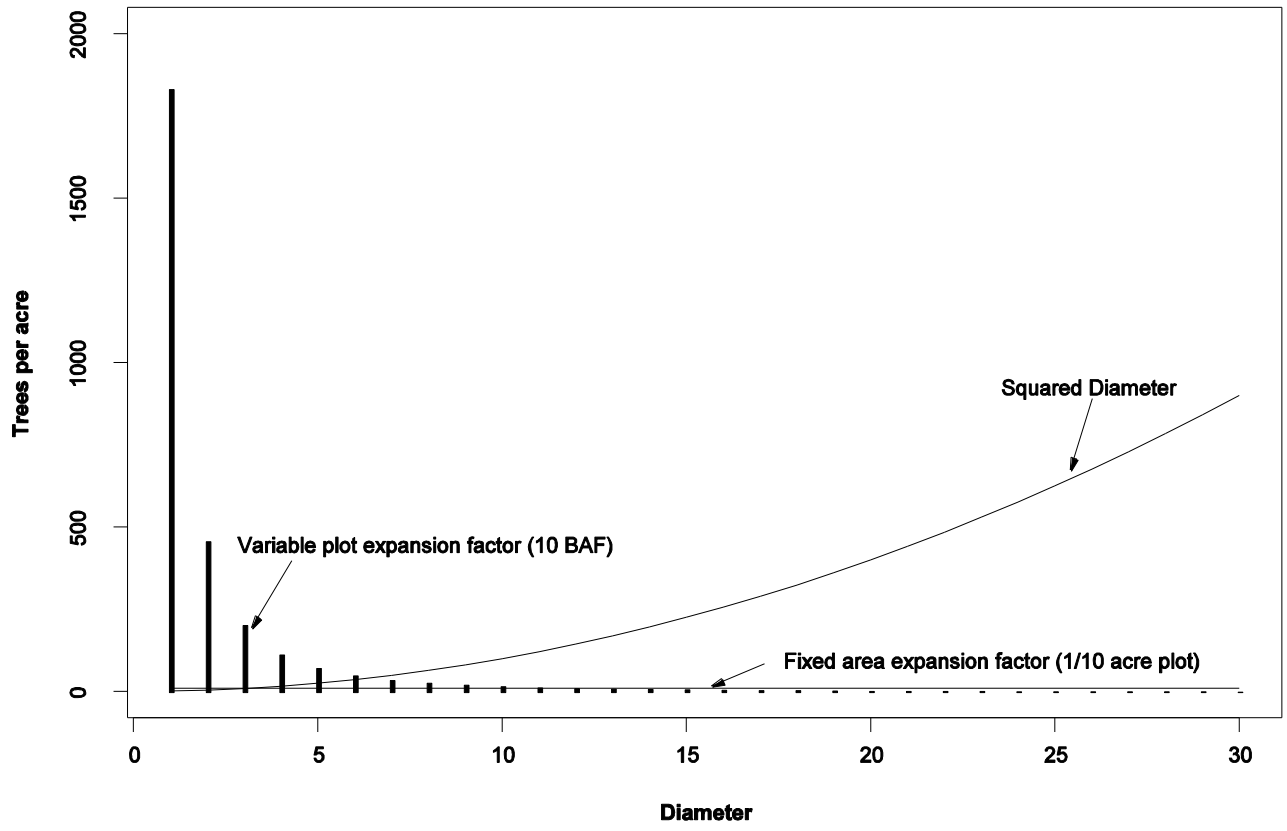
The following is an example of how to use the tally system.

DBH	Logs			
	1/2	1	1 1/2	2
10	⁘	⊠	⊠	
11	⊠ ⁘	⊠ ⁞	⊠ ⌑	
12	⌑	⊠ ⁘	⁘	
13	⊠ ⁞	⊠ ⊠ ⌑		
14	⁘	⊠ ⊠ ⁞		
15	⌑	⁘		

Why select a plot type?

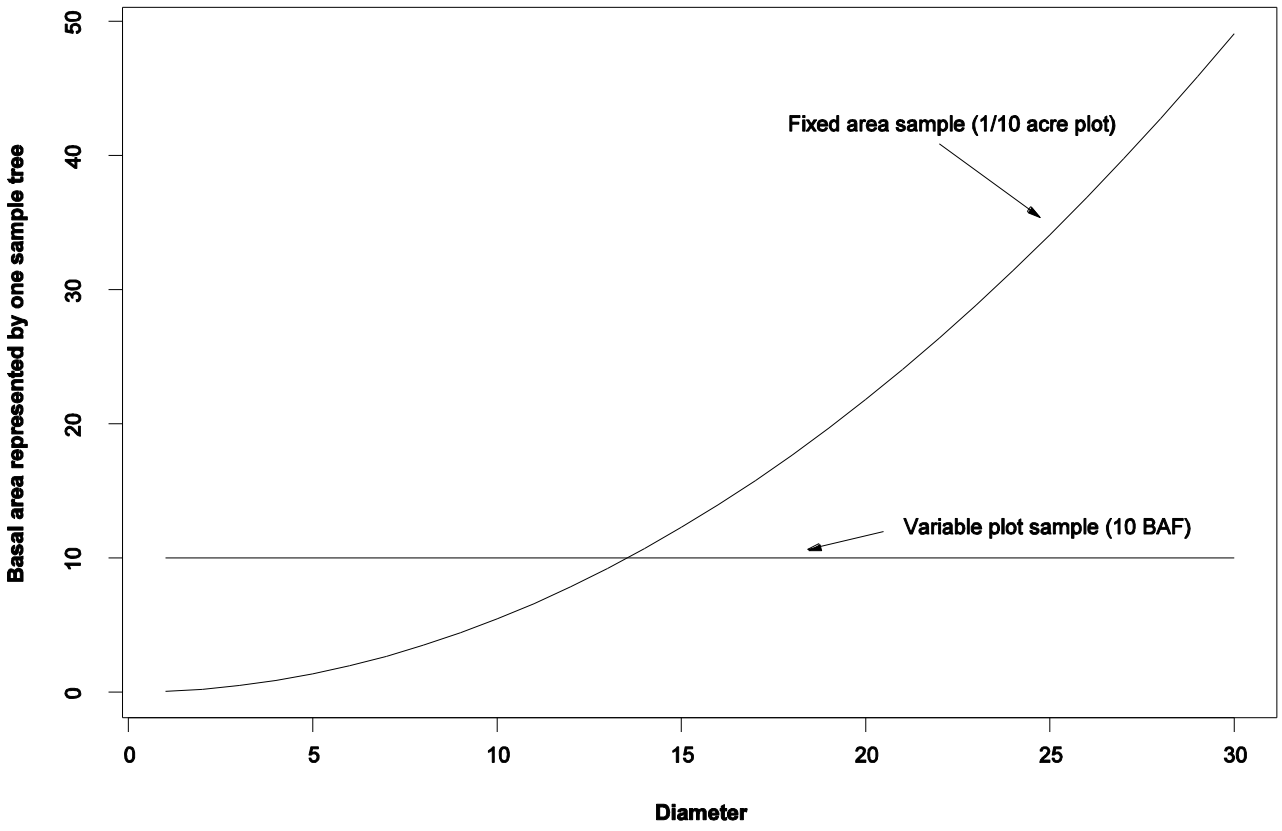


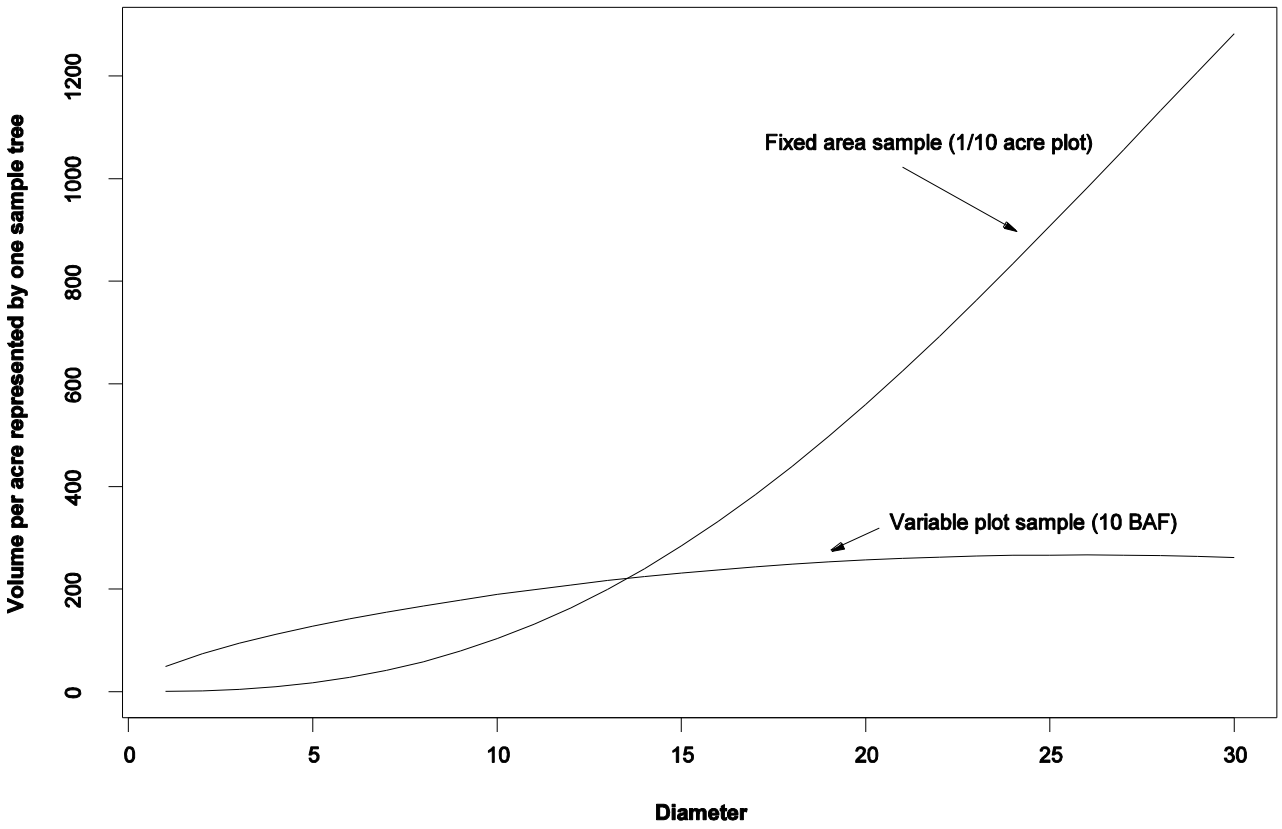
The first consideration is to compare the Fixed Area Plot and Variable Point Sample expansion factors (the trees per acres represented by one sample tree.) The following figure plots the trees per acre represented by one tree of the specified diameter. Consider this as the effect of missing a tree that should be included or including a tree that should not be sampled. Note in variable point sampling one 1-inch tree represents 1833 trees per acre. Also note that on variable point sample large trees represent many fewer trees per acre than a 1/10 acre fixed are plot. Now consider that you are more interested in size that the number of trees. Basal area is related to squared diameter by a constant. So I have plotted the squared diameter on the same figure. You will note that the trees per acre represented by one tree on a variable point sample are smallest where the squared diameter is the largest.



Let us consider the effect of combining size and number of trees. In the following graph I have plotted the basal area represented by one tree of a given diameter in the two sampling methods. If your objective is to sample basal area there seems to be less chance of error using the variable point sample method. Also note that one 30-inch tree in a 1/10 acre fixed area plot can represent as 49 ft^2/acre.

Most sampling designs in forestry are optimized to estimate volume. This graph illustrates the effect on volume when considering the effect of including or excluding trees with these two sample methods. from this graph you can see that variable point sampling will usually make a 260 board foot error for including or excluding a sample tree. Where a 30-inch tree in a fixed area plot can represent 1282 board feet per acre in the Missouri Ozarks.


Basal area represented by one sample tree
0
10
20
30
40
50
0
5
10
15
20
25
30
Diameter
Fixed area sample (1/10 acre plot)
Variable plot sample (10 BAF)



From this you can see that variable point sample have advantages in estimating basal area or volume but is quite poor at estimating tree per acre or diameter distributions. Fixed area plots have basically the reverse advantages and disadvantages. Fixed area plot also have many advantages when developing plots that will be measured repeatedly such as a Continuous Forest Inventory (CFI).

References

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