



## **The Art of Timber Cruising – Part I Point Sampling**

There are a number of methods that can be used to sample your woodlot as part of developing a forest inventory of your property. This two-part article will explore two different methods of collecting forest inventory information. Using either method – point sampling or fixed-area sample plots – you will be able to collect the necessary information to accurately describe the species composition of your woodlot.

Part One of “The Art of Timber Cruising” will examine the point sampling technique. Although this method is generally deemed more complex for novice “timber cruisers,” it does have several advantages in providing a relatively quick and accurate method of sampling larger tracts of forest.

Prior to undertaking this sampling method, you will require a forestry tool called a prism, or an angle gauge, and should have an understanding of the term “basal area.”

### **The Concept of Point Sampling**

Point sampling was developed in 1948 by a German forester Walter Bitterlich and is a widely accepted technique for sampling woodlots in the preparation of forest inventories. This sampling technique selects trees to be tallied based on their size, rather than their frequency of occurrence and does not require the measurement of either plot area or tree diameter.

Sample points are located within the forest compartment, and a prism or an angle gauge is used to “sight in” each tree at breast height. The likeliness for a given tree to be tallied within the plot depends on its diameter, its distance from the sample point, and the sighting angle used. The smaller the optical angle, the more stems that will be recorded in the sample plot. Prior to commencing the sampling, a predetermined basal area factor (BAF) is established, and the resulting tree tally can be easily converted to basal area or volume per hectare.

### **What is Basal Area?**

If you cut a tree off at breast height and measure the surface area of the stump, you would have the basal area (BA) of the tree. This measurement is used to describe the amount of space in a given area that is being occupied by tree stems.

The greater the stand’s basal area, the greater the portion of a hectare that is occupied by tree stems. Basal area does not indicate tree diameter. However, it is a measure that describes the

density of your woodlot. For example, a hard maple stand with a basal area of 21 m<sup>2</sup> may have 467 24-cm trees, while an adjacent stand with the same basal area may have 167 40-cm trees per hectare. Most woodlots will contain a mixture of all diameter size classes.

Basal area is measured at breast height (DBH) 1.3 m above the ground and is commonly expressed in square metres or square feet on a unit basis – generally on a per hectare or acre basis. The formulas to calculate the basal area of an individual tree or a stand of trees in square metres are as follows:

Basal area of a tree = the diameter of the tree (cm) squared, times 0.00007854 (expressed in square metres). For example, the basal area of a 30-cm tree is 0.070686 m<sup>2</sup>.

$$\text{Individual tree BA} = 30^2 \times 0.00007854 = 0.070686 \text{ m}^2$$

Basal area of a stand of trees = the sum of all the individual tree basal areas for a given land area (expressed in square metres). For example, if the woodlot contains 325 30-cm trees per hectare, the basal area would be 23 m<sup>2</sup>.

$$\text{Stand BA} = 325 \text{ trees per ha} \times 0.070686 = 23 \text{ m}^2$$

### Basal Area Factor (BAF)

All prisms or angle gauges have a basal area factor. This is the conversion factor used to convert your tree tally to basal area. The BAF depends on the sighting angle or “critical angle” of the wedge prism being used. The manufacturer will calculate this factor, and because there are a number of different prisms available on the market, be sure to ask what the BAF is before using the prism.

In Ontario, the most commonly used basal area instrument is a metric optical glass wedge prism that has a basal factor of two. When using this prism, you would multiply your tree tally by two to obtain the basal area. For example, a tree tally count of 13 trees would represent a basal area of 26 m<sup>2</sup>.

### Instruments to Measure Basal Area

The simplest instrument to measure basal area is an angle gauge, a notch plate through which you “sight on” trees to determine which tree to tally. Trees appearing larger than the notch (angle) are tallied, trees appearing borderline require a measurement and those smaller than the notch are not tallied. It is important to remember that when using an angle gauge, your eye must be over the sample point. Refer to Figure #1.

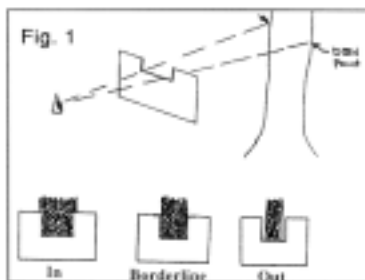


Figure #1: Viewing trees with an Angle Gauge – if a tree image is wider than the notch in the gauge, the tree is close enough to the point centre to be tallied. If they are precisely the same size, it is borderline, and a measurement is required. If the image is smaller than the notch, it is too far away and is not tallied. A problem with using an angle gauge is focusing on the gauge, 18-20 inches away, and the tree, several feet away, at the same time.

Another popular tool for point sampling is the wedge prism. It is available from most forestry equipment suppliers and can be purchased for about \$60.00. To ensure sighting accuracy, the prism must be positioned correctly. When sighting on the tree, hold the prism over the “point” (with the angle gauge your eye is over the point), in a vertical position and at right angles to the line of sight. Failure to hold the prism correctly will result in large errors in the tree tally.

Trees that are equal to or larger than the angle are tallied and counted in your plot – e.g. when the tree and its prism image overlap. Borderline trees are when the images barely touch – a measurement is required. If the images do not touch, the trees are too far away and are not tallied. Figure #2 illustrates the images seen when using a wedge prism for point sampling.

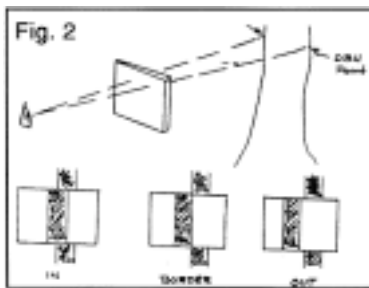


Figure #2: Measuring BA with a Wedge Prism – the prism must be held over the point so the top and bottom edges are horizontal. The prism displaces the tree’s image to the side. If the prism image and tree image overlap, the tree is within range and is tallied. If they barely touch, the tree is borderline and by using Table #1 – Limiting Distances, you can determine if the tree is “in” or “out.” If the images do not touch, the tree is too far away to be tallied.

### Making Your Own Angle Gauge

To make your own angle gauge (Figure #3) take a 3” x 2” piece of plastic cut from a coffee can top. Cut a notch in the centre of one edge ½” deep and 5/8” wide. Cut a length of string about 24” long and tie a knot in one end. Punch a small hole in the centre of the plastic and pass the string through until the knot is tight to the plastic. Now, tie another knot in the string exactly 20 5/8” from the plastic. You now have a BAF 10-angle gauge. View a tree with the knotted end between your teeth, sighting through the notch, and tally the “in” trees.

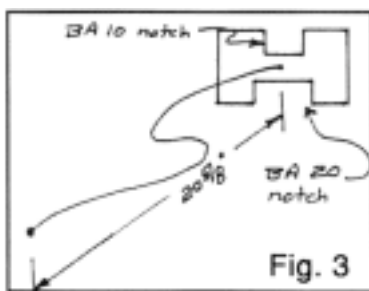


Figure #3: Make Your Own BAF 10-Angle Gauge

This angle gauge is simple to make and easy to use. Although this angle gauge is not a precision instrument, precision is only a factor with borderline trees. Measuring the tree’s diameter, its distance from the centre point of your plot, and applying the information provided for in the “limiting distance” table will provide the needed precision. Note – this homemade angle gauge has a BAF of 10 and provides measurements in square feet.

To convert from square feet to square metres, simply divide the basal area by 4.356. For example, a hard maple stand with a basal area of 80 ft<sup>2</sup> is equal to 18 m<sup>2</sup>.

### Tips on Using a Prism or Angle Gauge

The centre of your sample point should be marked with a stake so that you consistently measure from the same spot. As shown in Figure #4, beginning at north, use the angle gauge instrument to view each tree clockwise around the point. The tree boles that are close enough to the centre of the sample point that completely fills the fixed sighting angle are tallied. Those stems that are

too small or too far away are not tallied. The resulting tally can be used to calculate basal area of the forest compartment.

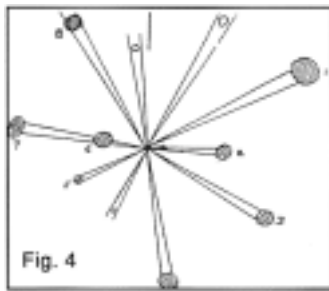


Figure #4: Tallying Trees Around a Sample Point – this tally began with tree #1 and proceeded, clockwise, to tree #8. Note tree #7 is masked by tree #6 and that tree #8 appears to be a borderline tree. Both trees required a measurement of the “limiting distance” to establish that they were within the sample point. Eight of the 11 trees were close enough to be tallied, and the basal area of the plot is eight times the BAF.

The amount of information tallied at each sample point will vary depending on your management objectives – e.g. managing for timber production or recreational values. As a minimum, in order to prepare a description of the forest compartment, you need to record your tree tally by species. If you are considering timber production as one of your objectives, you may want to consider collecting additional information that would assist in the preparation of a tree marking prescription and volume estimate. For example, you may want to separate your tree tally by species, size class, and quality class.

At every sample point, each tree should be checked carefully, especially all borderline trees. This is because an error in counting one tree is not just one tree – each tree represents many trees – keeping in mind the basal area factor. Speed is provided by the technique, so do not take shortcuts, as the errors can be sizable.

Borderline trees are a major cause of error, but can be checked by measuring their diameter (at breast height) and the distance from the sample point to the centre of the tree.

DBH	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	Sight Limiting Distances in Metres for a 2.0 Factor Telescope									
10.0	3.54	3.57	3.61	3.64	3.68	3.71	3.75	3.78	3.82	3.85
11.0	3.89	3.92	3.96	4.00	4.03	4.07	4.10	4.14	4.17	4.21
12.0	4.24	4.28	4.31	4.35	4.38	4.42	4.45	4.49	4.53	4.56
13.0	4.60	4.63	4.67	4.70	4.74	4.77	4.81	4.84	4.88	4.91
14.0	4.95	4.99	5.02	5.06	5.09	5.13	5.16	5.20	5.23	5.27
15.0	5.30	5.34	5.37	5.41	5.44	5.48	5.52	5.55	5.59	5.62
16.0	5.66	5.69	5.73	5.76	5.80	5.83	5.87	5.90	5.94	5.98
17.0	6.01	6.05	6.08	6.12	6.15	6.19	6.22	6.26	6.29	6.33
18.0	6.36	6.40	6.43	6.47	6.51	6.54	6.58	6.61	6.65	6.68
19.0	6.72	6.75	6.79	6.82	6.86	6.89	6.93	6.97	7.00	7.04
20.0	7.07	7.11	7.14	7.18	7.21	7.25	7.28	7.32	7.35	7.39
21.0	7.42	7.46	7.50	7.53	7.57	7.60	7.64	7.67	7.71	7.74
22.0	7.78	7.81	7.85	7.88	7.92	7.95	7.99	8.03	8.06	8.10
23.0	8.13	8.17	8.20	8.24	8.27	8.31	8.34	8.38	8.41	8.45
24.0	8.49	8.52	8.56	8.59	8.63	8.66	8.70	8.73	8.77	8.80
25.0	8.84	8.87	8.91	8.94	8.98	9.02	9.05	9.09	9.12	9.16
26.0	9.19	9.23	9.26	9.30	9.33	9.37	9.40	9.44	9.48	9.51
27.0	9.55	9.58	9.62	9.65	9.69	9.72	9.76	9.79	9.83	9.86
28.0	9.90	9.93	9.97	10.01	10.04	10.08	10.11	10.15	10.18	10.22
29.0	10.25	10.29	10.32	10.36	10.39	10.43	10.47	10.50	10.54	10.57
30.0	10.61	10.64	10.68	10.71	10.75	10.78	10.82	10.85	10.89	10.92
31.0	10.96	11.00	11.03	11.07	11.10	11.14	11.17	11.21	11.24	11.28
32.0	11.31	11.35	11.38	11.42	11.45	11.49	11.53	11.56	11.60	11.63
33.0	11.67	11.70	11.74	11.77	11.81	11.84	11.88	11.91	11.95	11.99
34.0	12.02	12.06	12.09	12.13	12.16	12.20	12.23	12.27	12.30	12.34
35.0	12.37	12.41	12.45	12.48	12.52	12.55	12.59	12.62	12.66	12.69
36.0	12.73	12.76	12.80	12.83	12.87	12.90	12.94	12.98	13.01	13.05
37.0	13.08	13.12	13.15	13.19	13.22	13.26	13.29	13.33	13.36	13.40
38.0	13.44	13.47	13.51	13.54	13.58	13.61	13.65	13.68	13.72	13.75
39.0	13.79	13.82	13.86	13.89	13.93	13.97	14.00	14.04	14.07	14.11
40.0	14.14	14.18	14.21	14.25	14.28	14.32	14.35	14.39	14.42	14.46
41.0	14.50	14.53	14.57	14.60	14.64	14.67	14.71	14.74	14.78	14.81
42.0	14.85	14.88	14.92	14.95	14.99	15.03	15.06	15.10	15.13	15.17
43.0	15.20	15.24	15.27	15.31	15.34	15.38	15.41	15.45	15.49	15.52
44.0	15.56	15.59	15.63	15.66	15.70	15.73	15.77	15.80	15.84	15.87
45.0	15.91	15.95	15.98	16.02	16.05	16.09	16.12	16.16	16.19	16.23
46.0	16.26	16.30	16.33	16.37	16.40	16.44	16.48	16.51	16.55	16.58
47.0	16.62	16.65	16.69	16.72	16.76	16.79	16.83	16.86	16.90	16.94
48.0	16.97	17.01	17.04	17.08	17.11	17.15	17.18	17.22	17.25	17.29
49.0	17.32	17.36	17.39	17.43	17.47	17.50	17.54	17.57	17.61	17.64
50.0	17.68	17.71	17.75	17.78	17.82	17.85	17.89	17.93	17.96	18.00
51.0	18.03	18.07	18.10	18.14	18.17	18.21	18.24	18.28	18.31	18.35
52.0	18.38	18.42	18.45	18.49	18.53	18.56	18.60	18.63	18.67	18.70
53.0	18.74	18.77	18.81	18.84	18.88	18.92	18.95	18.99	19.02	19.06
54.0	19.09	19.13	19.16	19.20	19.23	19.27	19.30	19.34	19.37	19.41
55.0	19.45	19.48	19.52	19.55	19.59	19.62	19.66	19.69	19.73	19.76

distance (m) = sqrt(0.25\*(dbh squared)/basal area factor of telescope

Table #1 (Sight Limiting Distances for a Metric Prism with a 2.0 Basal Area Factor) shows the “limiting distances,” in metres for trees measuring from 10 to 55 cm. In order for the tree to be tallied, it must be less than the maximum “limiting distance” as noted in the table. For example, a 41.4-cm diameter tree must be within 14.64 m of the point sample before it is tallied. You may want to have Table #1 photocopied onto coloured paper and laminated to use as a handy field sheet.

On slopes, horizontal distances to the tree are less than the slope distance (Figure #5), so “in” trees near the borderline may appear “out.” To be sure, measure the tree’s diameter and horizontal distance and check the “limiting distance” table to see if the tree should be tallied. A good rule of thumb – when in doubt – measure out.

Other important points:

- ✓ Brush, foliage and other trees can mask trees. Double-check all trees that might be in the plot. If in doubt, measure out and use the limiting distance table – it pays to be sure!
- ✓ When on slopes that exceed 10%, a measurement should be taken. Measure the horizontal distance, not slope distance and remember to measure to the tree’s centre.
- ✓ Always hold the prism over the centre point of the plot. However, when using an angle gauge, your eye must be over the centre point.
- ✓ When sighting on leaning trees, the vertical edge of the prism must be kept parallel to the lean of the tree.
- ✓ Remember – before using any prism or angle gauge, you must know the basal area factor!

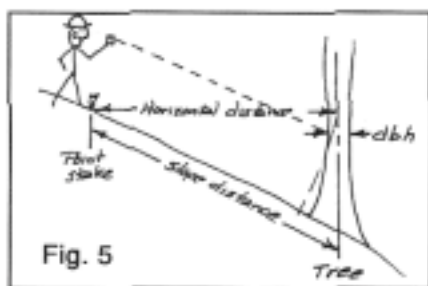


Figure #5: Measuring Distances on a Slope – note that the horizontal distance from the stake to the tree is less than the slope distance (parallel to the ground). Measuring along the ground reduces the “plot radius” of your sample point and may result in the loss of one or two trees at each point. To prevent this, measure horizontal distance using a clinometer, or swing the tape through a short vertical arc and read the shortest distance. On steep slopes, measure in several short, horizontal segments.

The price of the point sampling system’s increased efficiency is attention to detail and precision. Many cruisers fail by adding shortcuts to a system that already has time- saving techniques built in. Working too fast, missing measurements, using sloppy procedures and inattention to detail equals lower precision and multiplied errors.

## Calculating the Compartment Basal Area

To determine the basal area of the forest compartment, insert the information collected into the following formula.

$$BA = \frac{\text{total number of trees tallied}}{\text{number of points sampled}} \times (\text{BAF})$$

For example, if the basal area factor (BAF) of your prism is 2 and 180 trees are tallied at 20 sample points, the average basal area (BA) for the forest compartment would be  $180 \div 20 \times 2 = 18 \text{ m}^2$ .

## Preparing the Compartment Description

To calculate the species composition of your forest compartment, insert the information collected into the following formula.

$$\text{Species Composition \%} = \frac{\text{species tally}}{\text{total tree tally}} \times 100$$

These calculations need to be performed for each tree species tallied. For example, in your woodlot you tallied 180 trees; of this total 90 were hard maple, 72 were beech, and the remaining 18 trees were basswood. Using the formula, hard maple would represent 50% of the composition of this compartment (i.e.  $90 \div 181 \times 100 = 50$ ); beech would represent 40% (i.e.  $72 \div 181 \times 100 = 40$ ) and basswood would make up the final 10% (i.e.  $18 \div 181 \times 100 = 10$ ). Therefore, the tree species and percent composition for this forest compartment would be hard maple 50%, beech 40% and basswood 10%.

Note – the tree species and percent composition of the forest compartment should only list species that make up at least 10%; and the total of all species are not to exceed 100%.

## Recommended Reading

For additional information on preparing an inventory for your woodlot, you may want to consider reading one of the following documents:

*Making Cents Out of Forest Inventories – A Guide for Small Woodlot Owners*, Ministry of Natural Resources - \$10.00.

*A True Picture – Taking Inventory of Your Woodlot*, Eastern Ontario Model Forest - \$10.00.

Copies of the last two publications can be obtained from the LandOwner Resource Centre by calling (613) 692-2390.

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