



The Art of Timber Cruising – Part II

Fixed-Area Plots

In this second article on timber cruising, we will be looking at a simple method of preparing a basic description of the forest compartments in your woodlot. It is an easy method of collecting data that can be completed by most woodlot owners – this system is called fixed-area plot sampling.

The Concept of Fixed-Area Cruising

The concept of fixed-area cruising involves collecting information from a number of small sample plots in an area, which is then used to project statements about the volume, species composition, density, and condition of the trees in the total area.

Table #1: Fixed-Area Sample Plots (Square)

Area of Plot	Dimensions	Plot per Hectare Factor
0.005 ha (50 m ²)	7.1 m x 7.1 m	200
0.01 ha (100 m ²)	10 m x 10 m	100
0.02ha. (200 m ²)	14.15 m x 14.15 m	50
0.05 ha (500 m ²)	22.4 m x 22.4 m	20
0.10 ha (1,000 m ²)	31.6 m x 31.6 m	10

Source: Adapted from Avery - Natural Resources Measurements. The plot per hectare factor is the number used to convert a plot total (trees tallied) to a per hectare basis.

Sampling a small portion of the woodlot and using this information to describe the entire forest compartment is a forestry standard practice. However, because many of your management decisions are based on the information collected from the cruise, it is important that the plots accurately represent the character of the forest area being sampled.

Fixed-area plot sampling offers the woodlot owner one method for sampling forests at all stages of development – from regeneration to mature timber.

Planning Your Cruise

A part of the decision-making process, prior to undertaking a fixed-area plot cruise, is determining the plot size, shape, sample size and cruise layout.

Plot shape – the shape of the plot is generally a matter of preference of the forest manager. Sample plots can be square, rectangular or circular.

Circular plots are easy to lay out and can be established on the ground by one person holding the tape at zero over the plot centre, while the second person walks out the distance equal to the

radius of the predetermined plot size. The plot radius should be measured a number of times along the circumference to determine the boundary of the plot. One disadvantage of circular plots is that they can be difficult to establish in dense undergrowth or in rough terrain.

Square or rectangular plots are best established by using a crew of two or more people. They usually take a little longer to establish; however, once established it is easier to determine the boundaries of the plot, which may provide for a more reliable tree tally.

Tables 1 and 2 provide a number of options for woodlot owners looking at using fixed-area plot sampling methods.

Plot size – Table #2

provides a number of recommendations in respect to plot size. The size of the plot is dependent on the type of vegetation being sampled. For example, it is recommended to use a smaller plot for young plantations (100 m²) or a larger plot size (400 m²) for natural stand conditions.

Sample size – the amount sampled will depend on the purpose of the inventory, the variability of the forest cover, the size of the forest compartment, and the how reliable the information needs to be.

As a rule...

- As the area to be sampled increases, the sample intensity decreases. Conversely, the smaller the area to be sampled, the sample intensity increases;

- The intensity of the sample should increase for operational decisions (e.g. harvesting). These types of management decisions require more precise information versus inventory requirements, which are used to make longer-term planning decisions.

Table #2: Fixed-Area Sample (Circular) Plot Sizes			
Area of Plot	Radius of Plot	Plot per Hectare Factor*	When to Use
.0001 (1m ²)	0.56	10,000	Ground plants, tree regeneration surveys.
.002 ha (20m ²)	2.52 m	500	Shrubs and tree saplings under 2.5 cm diameter at breast height.
.005 ha (50 m ²)	3.99 m	200	Shrubs and tree saplings under 2.5 cm diameter at breast height.
.01 ha (100 m ²)	5.64 m	100	Young plantations, uniform stand conditions.
.02 ha (200 m ²)	7.98 m	50	Young plantations, uniform stand conditions.
.03 ha (300 m ²)	9.77 m	33.3	Natural stand conditions. Variable tree species and age distribution.
.04 ha (400 m ²)	11.28 m	25	Natural stand conditions. Variable tree species and age distribution.
.05 ha (500 m ²)	12.62 m	20	Natural stand conditions. Variable tree species and age distribution.
The plot per hectare factor is the number used to convert a plot total (trees tallied) to a per hectare basis. Source: Making Cents Out of Forest Inventories – A Guide for Small Woodlot Owners.			

- The sampling intensity needs to be increased when the forest compartment consists of a variety of growing conditions and/or when variable terrain is encountered; and
- Increased reliability equates to an increased sampling intensity.

For most small woodlot owners, a sampling intensity from 2% to 10% is common. However, if you are considering harvesting activities, you may want to consider a sampling intensity of 10% or higher. (Source - *Making Cents Out of Forest Inventories*)

Cruise layout – a series of transect lines (or cruise lines) are laid out parallel to each other to ensure that conditions throughout the forest compartment are sampled in an unbiased manner. The cruise lines should run against the topography (i.e. up and down the hills), and the sample plots are located at regular intervals along the line. The accuracy with which the sample plots represent the forest compartment depends on this unbiased selection of plots. See Figure 1.

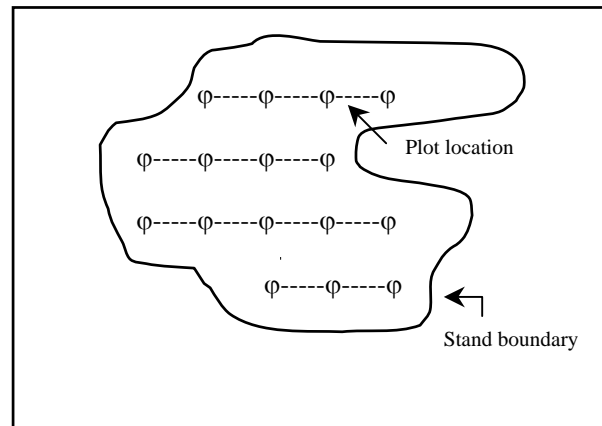


Figure 1. Cruise lines should be laid out in a grid fashion so the lines are run at right angles to the topography.

Instruments Required

In contrast to point sampling, where a special forestry tool called a wedge prism is required, collecting information from fixed-area plots requires no special tools. Most woodlot owners will have all the necessary tools in their workshop. These include: two tape measures (3-m tape to measure tree diameters and a 25-m tape to lay out the plot boundaries); wooden stakes; steel pins or flagging tape (to mark the centre or corners of the plot); a clipboard and tally sheets (to record your information).

Important note – if you are going to use a regular tape measure to measure the diameter of the tree you must convert this circumference measurement into diameter. The conversion factor is 3.1416. For example, a measurement of 38-cm using a regular tape would be recorded on your tally sheet as a 12-cm diameter tree.

However, if you plan on undertaking a large cruising project, you should consider purchasing or borrowing forestry equipment specifically designed for measuring tree diameters, e.g. diameter tape, calipers, or a Biltmore stick. This equipment is available from most forest equipment retailers such as Canadian Forestry Equipment, Mississauga, ON, 1-800-387-4940.

Information Collected

The amount of information collected at each plot will depend on your objectives – timber production, wildlife management, or recreation. At a minimum, the tree species and the diameter of each tree in the plot should be collected, and an average age and height need to be determined

for each forest compartment. Collecting this minimum amount of information will provide you with a general description of the forest compartment and will meet the minimum requirements for the Managed Forest Tax Incentive Program.

In most forest inventories tree diameters are measured at 1.3 m above the ground (referred to as dbh), and only those trees with a diameter of 10 cm or larger are tallied.

Optional information that you may want to collect would include – tree quality (AGS or UGS); individual tree heights and ages; soil information; advanced regeneration; and flora information.

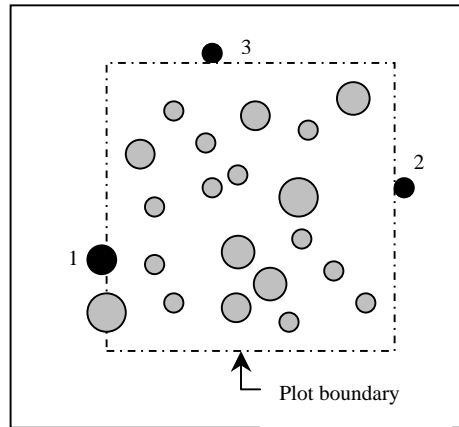


Figure 2. A square sample plot measuring 20 metres by 20 metres equals an area of .04 hectares. Only those trees measuring greater than 10 cm in diameter at dbh within the plot are tallied. Note borderline trees are tallied only if more than ½ of the bole of tree are in the plot. In this example 20 trees are tallied representing 500 trees per hectare. Note – trees 1, 2 and 3 are outside the plot and are not tallied.

Preparing a Compartment Description

It is easy to calculate the species composition of your forest compartment by inserting the cruise information you have collected into the formula noted below.

Species Composition % = (species tally divided by total tree tally) x 100

For example, you have collected the following information in compartment “A” of your woodlot:

Circular fixed-area sample plot = 9.77 m radius (0.03 ha)

Number of plots sampled = 3

Conversion factor = 33.3

Tree tally of all 3 plots = 42 (maple = 24, beech = 13, red oak = 5)

Trees per ha = (42 x 33.3) divided by 3 = 466

This calculation needs to be completed for each species tallied in your cruise.

Compartment “A” has an average of 466 trees per hectare; of this total 266 were hard maple, 144 were beech, and the remaining 56 trees were red

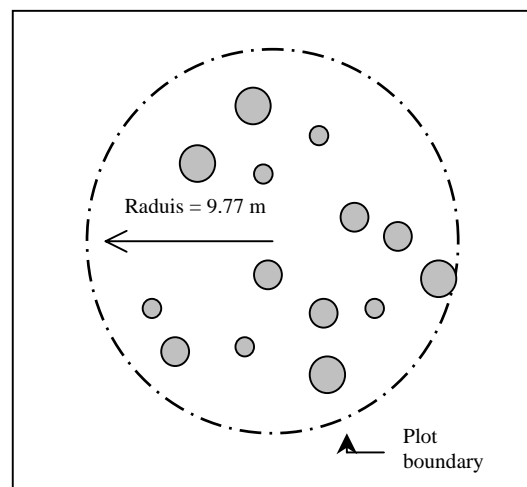


Figure 3. A circular plot with a radius of 9.77 metres is equal to an area of 300 square metres or .03 hectares. The 14 trees tallied in the sample plot represents 466 trees per hectare (14 x 33.3 conversion factor = 466).

oak. Using the formula, hard maple would represent 57% of the composition of this compartment (i.e. $266 \div 466 \times 100 = 57$); beech would represent 31% (i.e. $144 \div 466 \times 100 = 31$) and red oak would make up the final 12% (i.e. $56 \div 466 \times 100 = 12$). Therefore, the tree species and percent composition for this forest compartment would be hard maple 60%, beech 30% and red oak 10%.

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

Table 3: Basal Area Table	
Diameter (cm)	Basal Area of stem (m ²)
10	0.008
12	0.011
14	0.015
16	0.020
18	0.025
20	0.031
22	0.038
24	0.045
26	0.053
28	0.062
30	0.071
32	0.080
34	0.091

Expressing Density as Stems per Hectare Using a Fixed-Area Plot

Expressing the density of the woodlot based on the number of trees per hectare is a relatively straightforward measure that most woodlot owners can easily identify with.

Expressing the density in this manner with the information collected in your fixed-area plots is simple.

To calculate the stems per hectare you would total the trees tallied in the plot (or plots sampled) and multiply this number by the “plot per hectare factor” as shown in Figure #3. Tables #1 and #2 provide you with the “plot per hectare factor” for a variety of different sized sample plots.

Calculating the Compartment Basal Area

Although you are not measuring the compartment’s basal area as you gather data from your fixed-area plots, the stem diameter information collected and the information contained in Table #3 can be used to calculate the basal area.

Table 3 - provides the basal area in square metres of individual trees measured at breast height (1.3 m from the ground).

For example, in compartment “A” you have an average of 466 trees per hectare, with the diameter distribution as shown in Table #4. Using the information and the individual stem basal

Table 4: Calculating Basal Area.			
Diameter	Stems	Basal Area of stem (m ²)	Total BA
16 cm	333	0.020	6.7
32 cm	100	0.080	8.0
44 cm	21	0.152	3.2
50 cm	12	0.196	2.4
Total trees/ha	466	BA/ha (m ²)	20.3

area information from Table #3, the basal area of this compartment is 20 m² per hectare.

Recommended Reading

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

Making Cents Out of Forest Inventories – A Guide for Small Woodlot Owners, Ontario Ministry of Natural Resources - \$10.00. Or, A True Picture – Taking Inventory of Your Woodlot, Eastern Ontario Model Forest - \$10.00. Copies of these two publications can be obtained from the LandOwner Resource Centre by calling (613) 692-2390.

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