PICTURING YOUR WOODLOT

(FOREST INVENTORY)

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Many landowners have an idea in their mind of what their woodlot looks like. Some who have owned land for a long time can picture how the woodlot has changed over the years. If one were to describe the forest to a neighbour, typically such terms as "young growth", "second growth", or "mature" might be used. Do these terms really conjure up the correct image in the mind of the listener?

Foresters have a number of terms they use to describe forest stands. These descriptive terms are often built into an "inventory" or "operational cruise". Typically these descriptions include species present , tree size or diameter, quality and height, stand stocking and stand structure. From these figures, stand volume and growth can be measured or predicted. Once these factors are measured for a woodlot, the "picture" created produces a benchmark for comparing stands or determining how a woodlot develops over time, with or without treatments such as thinning or harvesting. For instance, the presence of some new species in the understorey (saplings), that are not present in the overstorey (main stand) often indicates a shift in species composition is in store for the future of the stand.

Stand stocking is expressed as basal area. This is simply the area of the ground occupied by the stems of the trees. The measure is important as it indicates how crowded or open the stand is, and is directly related to stand volume. For instance, if you picture a tree as a cylinder, the first thing to do to calculate volume of a cylinder is to calculate the area of one end, then multiply this figure, its basal area, times its length. Basal area can be expressed as square feet per acre. It is measured at the same point as tree diameter is measured, 4.5 feet above the highest point of the ground at the stump of the tree. This point on the stem is called DBH, or diameter, breast height.

Ideally, a sugar maple stand should have the following minimum basal areas for maximum growth:

Sapling trees with diameters up to 3.5 inches DBH -	8 square feet.
Polewood trees with diameters from 3.6 inches to 9.5 inches DBH -	16 square feet.
Sawlog trees with diameters from 9.6 inches and greater -	68 square feet.
Total basal area -	92 square feet.

The sawlog component can be allowed to approach 90 square feet before thinning or harvesting is required. Allowing the stand to exceed this figure may result in natural mortality in the stand.

By comparison, conifer plantations such as red pine or white pine should be maintained between 110 square feet as a minimum, up to 200 square feet as a maximum.

Sampling a Stand

Because it is time consuming and sometimes not practical to measure all trees in a stand, foresters use the science of mensuration to "sample" stands. A well designed sample or "operational cruise" of a stand will present a good picture of the stand with a reasonable amount of time spent doing the measurements.

One such "sampling" method is to use a fixed area plot. Plots are typically rectangular, square, or circular. A circular plot has less boundary than a rectangular or square plot of the same size. Therefore it offers less chance of error in determining whether edge trees are "in" or "out". Also, because they can be established from one point, the centre, instead of worrying about angles or corners, the circular plot can be relatively simple to establish and measure and even to come back later and re-measure.

Since the features of the stand are usually expressed in "per acre" figures, a simple method of determining stand characteristics is to measure five "tenth acre" plots. This produces data for a half acre "sample". The figures produced can then be doubled or multiplied by two in order to produce "per acre" figures. A "tenth acre" plot is also a convenient size as it has a radius of 37.2 feet, a workable distance for measuring trees, and a large enough plot that variations in the stand will not affect the accuracy of the sample. If a half acre sample is taken within a 10 acre woodlot, the sampling intensity is 5%. In a 20 acre woodlot, the sampling intensity is 2.5%. Both of these intensities are sufficient for a typical "operational cruise" of a stand. If, after establishing five plots, you are unsure of the results, or if the stand is much larger, a second "cluster" of five plots can be measured for comparison with the first.

Taking the measurements

To take the measurements of a stand, the following tools will be needed:

- a length of wire or rope with a loop at the "0" end and with a mark at 37.2 feet (37 feet, 2.4 inches).
- something to fasten the wire or rope at the centre of the plot. (an old strap and buckle such as an old dog collar works well.
- a tape measure.
- a tally sheet and clip board.

Normally a forester or forestry technician would use a "diameter tape" or "calipers" to measure diameter. However a normal tape measure can be used and diameter calculated by dividing the circumference by pi, or 3.1415. To make matters easier, the diameters can be grouped into two inch diameter classes. These classes would have the following circumferences:

DIAMETER CLASS	CIRCUMFERENCE		(in eighths: .1 = 1.25 eighths)
2 inch (1.0 - 2.99)	3.1 - 9.4	or	3 1/8 - 9 3/8
4 inch (3.0 - 4.99)	9.5 - 15.7		9 1/2 - 15 3/4
6 inch (5.0 - 6.99)	15.8 - 21.9		15 3/4 - 21 7/8
8 inch (7.0 - 8.99)	22.0 - 28.2		22 - 28 1/4
10 inch (9.0 - 10.99)	28.3 - 34.5		28 1/4 - 34 1/2
12 inch (11.0 - 12.99)	34.6 - 40.8		34 1/2 - 40 3/4
14 inch (13.0 - 14.99)	40.9 - 47.1		40 7/8 - 47 1/8
16 inch (15.0 - 16.99)	47.2 - 53.4		47 1/4 - 53 3/8
18 inch (17.0 - 18.99)	53.5 - 59.7		53 1/2 - 59 7/8
20 inch (19.0 - 20.99)	59.8 - 65.9		59 3/4 - 65 7/8
22 inch (21.0 - 22.99)	66.0 - 72.2		66 - 72 1/4
24 inch (23.0 - 24.99)	72.3 - 78.5		72 1/4 - 78 1/2

To make things simple in the field, make up a chart like this and tape it to your clipboard. An alternative would be to take an old tape measure and place markings on the tape at the appropriate place, to make a "diameter tape" which reads directly in diameter rather than circumference.

You will need a tally sheet which has a grid to tally species and diameter, and quality if you wish. In each space of the grid, trees can be tallied by placing dots at 4 corners of a box (trees 1 to 4), drawing the sides of the box by connecting the corners (trees 5 to 8) and drawing an X through the box (trees 9 and 10). By using this system, and depending on your grid size, 40 to 60 trees can be tallied in a 1/4 inch square. Tree quality, particularly for sawlogs, could be tallied in a separate column by "good trees", "fair trees" and "culls" or "trees of wildlife value". (i.e. 14 inch class with three sub classes for quality).

Some things used to determine tree quality are:

- holes, large or small,
- dieback in the crown, (dead or dying branches or off-colour foliage),
- fruiting bodies or conks of fungus,
- crook or sweep, (sharp or gradual bends in the stem),
- seams (curved or straight cracks: may have sap seepage or fungus present),
- leaning trees,
- poor vigour (slow-growing trees have thick, corky bark compared to fast growing trees of the same diameter), or
- swollen butts or branch stubs indicating interior rot.

In the woodlot, space your plots so that you will sample across the stand. Try not to bunch them in one area. One way of removing bias (favouratism) in plot placement is to pace a pre-determined distance into the woodlot and place the plot centre at that point. Plot centres can be located with a stake, or by using the closest sturdy sapling. With the strap or other device, attach the loop of the wire or rope to this centre, so that when stretched out, the distance from the loop to the 37.2 mark is an accurate radius. If you have attached the wire or rope to a 4 inch tree, remember that the centre of the plot is actually the centre of this tree. The accurate radius for the plot is now your 37.2 foot mark, less 2 inches.

Start measuring your trees from a known direction such as north, or from a significant tree or tree-less part of the plot, so you don't forget where you started. Measure the trees around the plot in one direction or the other, using the wire or rope to check those trees close to the boundary. If more than half of the tree diameter is within the 37.2 feet radius, count the tree "in" and measure and tally it. When you have run the wire out to the radius, drop it and continue to measure trees around the plot. When you need it again to measure an "edge" tree, go back to the centre, pick up the section close to the centre, and feed it through your hands as you proceed in a line to the plot edge. The wire will trail after you through your hand until it is at full length. If you coil it up each time you move from the centre to the outside, or vice versa, your wire will tangle and be a nuisance. If you use the system described above, the wire can be stretched out when you enter the woodlot, and only coiled up at the end of your sample. Between plots, you simply drag it from the end. Depending on the material of your wire or rope, check the length after a lot of use to make sure it hasn't stretched and changed the radius. Depending on the stand, a plot can normally be established with only 6 to 8 radii. There is no need to permanently establish the boundary of the plot as you work around it, simply measure the edge trees as you go, then move on. When one plot is finished, make a mark of some sort on the tally sheet to keep track of the number of plots tallied. If you want to re-establish the same plot at some future time, mark the centre in some fashion, such as with paint, ribbon, or a stake.

With experience, some trees such as saplings can be "eye-balled" as you move around the plot, instead of measuring each tree.

Working up the Data

When you have your information, the number of trees in each diameter class, totalled, can be multiplied by the basal area per tree. This can be by individual species or for the stand as a whole. If you have measured half an acre, multiply your final figures X 2. If you are using this system in plantations which are of uniform size and species, you may decide to measure only two plots. In this case multiply your results X 5 to get per acre figures.

Number X Basal area (B.A.) per tree = Basal area per diameter class.

Diam. Cl.	X	B.A. = TOT. B.A.	Ideal #	Ideal B.A.
Saplings				
2	#	.02	202	8
4	#	.1		
Polewood				
6	#	.2	65	16
8	#	.3		
Sawlogs: small				
10	#	.5		
12	#	.8	28	22*
14	#	1.1		
Sawlogs: medium				
16	#	1.4		
18	#	1.8	17	26*
Sawlogs: large				
20	#	2.2		
22	#	2.6	8	20*
24	#	3.1		
				*Total = 68
26	#	3.7		
28	#	4.3		
30	#	4.9		
Total		Grand total =	320	92

The "ideal stand" is based on a "selection management" model to optimize growth of trees greater than 9.5 inches. This model can be changed based on different management objectives and desired changes to thinning interval i.e. light thinnings can be made at shorter intervals than heavier thinnings, but light thinnings favour shade tolerant species such as maple and beech. This "all-aged" model is not suitable for shade intolerant species such as oak and hickory.

What to do Next

When you have a finished picture of the woodlot, you can see such things as:

- size classes that might be missing, such as regeneration
- surplus of poor quality trees
- evidence that the overstorey and understorey trees are different. For instance a maple overstorey with an ironwood understorey does not indicate good sugarbush health. A red maple, sugar maple or ash understorey in an oak or pine bush indicates that the oak or pine may in time be replaced by other species.
- a surplus of large trees or generally stand overstocking may indicate a need for thinning or harvesting, and may also indicate the sizes where the harvest should be taken.
- presence or absence of den trees, or mast species such as oak or beech.

If you decide to do some thinning in a hardwood stand and use the residual stocking levels (ideal stand structure after thinning, as shown above), growth in southern Ontario on good sites should average between 2 and 2.5 square feet of basal area per acre per year. This figure is for trees 4.5 inches and larger and would translate to a volume growth per acre of 60 to 90 cubic feet of wood. A full cord of wood, 4 feet X 4 feet X 8 feet = 128 cubic feet, and contains 85 cubic feet of solid wood as well as some air space and bark. Of this cubic foot volume growth, assuming sufficient sawlog trees are present in the stand, half of the volume would be in board foot growth of 200 to 300 board feet per acre per year and the remainder would be in firewood. Therefore, to remove one square foot of basal area of good quality sawlogs, would generally result in the production of $\pm$ 100 board feet of lumber. For every 1000 board feet of lumber harvested, 1.5 cords of firewood is generated from tops.

In a conifer stand such as red pine, if you divide the basal area of a 50 foot high stand of trees by a factor of 4, the resulting number is cords per acre. You can therefore get an idea of cordage yield by figuring the basal area to be removed. Conifer stands, as opposed to hardwoods, do not use the stand model above, but are managed as "even-aged" stands of one general size class. They are managed and thinned until the time of maturity or replacement which is determined by economics or site capabilities. Through management, growth rates of five square feet of basal area per acre per year should be maintained. Because they are normally light-demanding species, some form of uniform stand replacement by a complete new stand, is normally necessary. Selection cutting in conifer stands normally results in stand replacement by shade tolerant species such as sugar maple or semi shade-tolerant species such as ash or cherry. The replacement species often depends on available seed source.

Summary

Stand sampling, far from being purely a statistical exercise, offers the opportunity to see how a stand is functioning. Besides its uses for commercial assessment, it provides some of the first steps in an ecological assessment of what is in the stand, and what is happening to it over time. Not only can you look at the overstorey and understorey, but you can get the woodlot to tell you it's own story: it's health and function, it's history, and its future.

John Irwin
May, 1996

Appendix

Attached are three sample tally forms, one made out for a 5 1/10th acre samples of a hardwood stand, one made out for 2 1/10th acre samples of a plantation, one blank for your use.

sp species: pr, red pine; pw, white pine; ps, Scots pine; Sw, white spruce; Sn, Norway Spruce; le, European larch.

Mh, sugar maple; Mr, red maple; Aw, white ash; Bd, basswood; Cb, cherry; Be, Beech; Id, Ironwood;

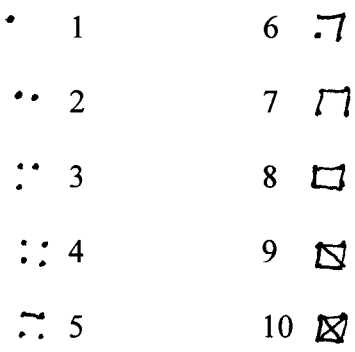
M Marked trees
R Residual trees (not marked)

B.A. Basal Area

2 inch class includes trees 1.00 to 2.99
4 inch class includes trees 3.00 to 4.99
etc.

A,B,C Tree quality classes, A - Best, C - Worst

TALLY SYSTEM:



Prescription / Audit Form
Cambridge – west

Plots [XXXXX]

Owner GRCA

	Sp.	Saplings 2	Saplings 4	Poles 6	Poles 8	Sawlogs 10	12 A	12 B	12 C	14 A	14 B	14 C	16 A	16 B	16 C	18 A	18 B	18 C	20 A	20 B	20 C	22 A	22 B	22 C	24 A	24 B	24 C	26+ A	26+ B	26+ C
M.	p																													
R.	r																													
M	p																													
R	w																													
M	p																													
R	s																													
M	A																													
R	w																													
M	S																													
R	w																													
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R																														
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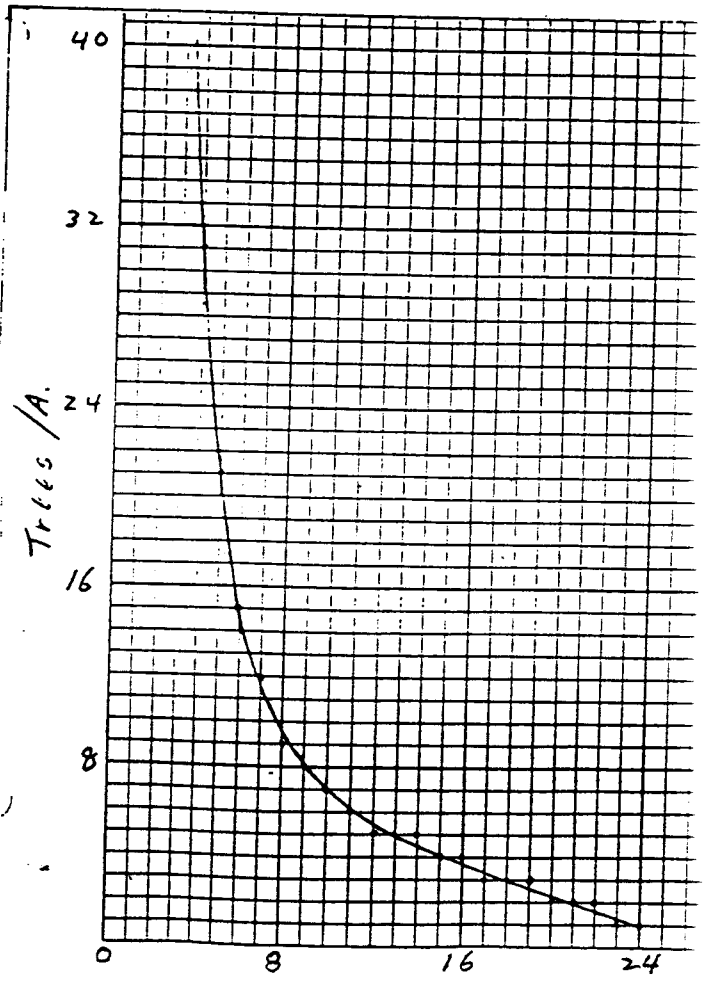
R																														
M																														
R																														
M	B.																													
R	A.																													

Owner Belwood L.

Dbh	Residual B.A.	Residual #	Residual Tot.	Marked #	Marked Tot.	Total	B.A /A.
2	.02						
4	.1	1	.1				
6	.2	4	.8				
8	.3	20	6.0				
10	.5	27	13.5				
12	.8	10	8.0				
14	1.1	3	3.3				
16	1.4						
18	1.8						
20	2.2						
22	2.6						
24	3.1						
26	3.7						
28	4.3						
30	4.9						
Total			31.7				
Total /A.			158.5				

X 5 =



CAMBRIDGE WEST

OPERATIONAL CRUISE

DATE Nov. /96 FOREST GRCA TRACT Redwood L. STAND a

HEIGHT Pw 63' Pr 65' Y.O.E. 1946 SP. COMP. Pr 6 Pw 2 Ps 1 Sw 1

DBH		SPECIES Pr #	B.A.	SPECIES Pw #	B.A.	SPECIES Ps #	B.A.	SPECIES Sw #	B.A.
2	.02								
4	.1			1	.1				
6	.2	2	.4	1	.2			1	.2
8	.3	13	3.9	4	1.2	2	.6	1	.3
10	.5	21	10.5	3	1.5	1	.5	2	1.0
12	.8	7	5.6	1	.8	2	1.6	-	-
14	1.1			1	1.1	1	1.1	1	1.1
16	1.4								
18	1.8								
20	2.2	Average diameter (d.b.h.)							
22	2.6	9.5"		8.9"		10.7"		9.6"	
24	3.1								
26	3.7								
28	4.3								
30	4.9								
			20.4		4.9		3.8		2.6	31.7
TOTAL			102.0		24.5		19.0		13.0	158.5

VOLUME FACTOR 2.9

G.M. VOL./A. (CORDS)	35	8	7 x.6 = 4	4	51

STAND B.A. 158.5 Thinning 158.5 - 120 = 38.5 sq. ft = 24 %

PRISM B.A. _____

Thinning Volume	8	2	1	1	= 12

Prescription / Audit Form

Cambridge - west

Hardwood

Plots ☒☒☒☒☒

Owner ______

	Sp.	Saplings 2	4	Poles 6	8	Sawlogs (Class C includes cull class D) 10	12 A	12 B	12 C	14 A	14 B	14 C	16 A	16 B	16 C	18 A	18 B	18 C	20 A	20 B	20 C	22 A	22 B	22 C	24 A	24 B	24 C	26+ A	26+ B	26+ C
M.	Mh			••	•••	•		•	•			•								••	•			•						•
R.	Mh	☒☒ ••	☒ ••	•••	••••	|:	••	•		•	•		•			•			•	•			•							
M	Be													•	•			••									••			
R	Be	•••	••••										•				•													
M	Aw																													
R	Aw		•••	••••		•••	•			•••				•		•														
M																														
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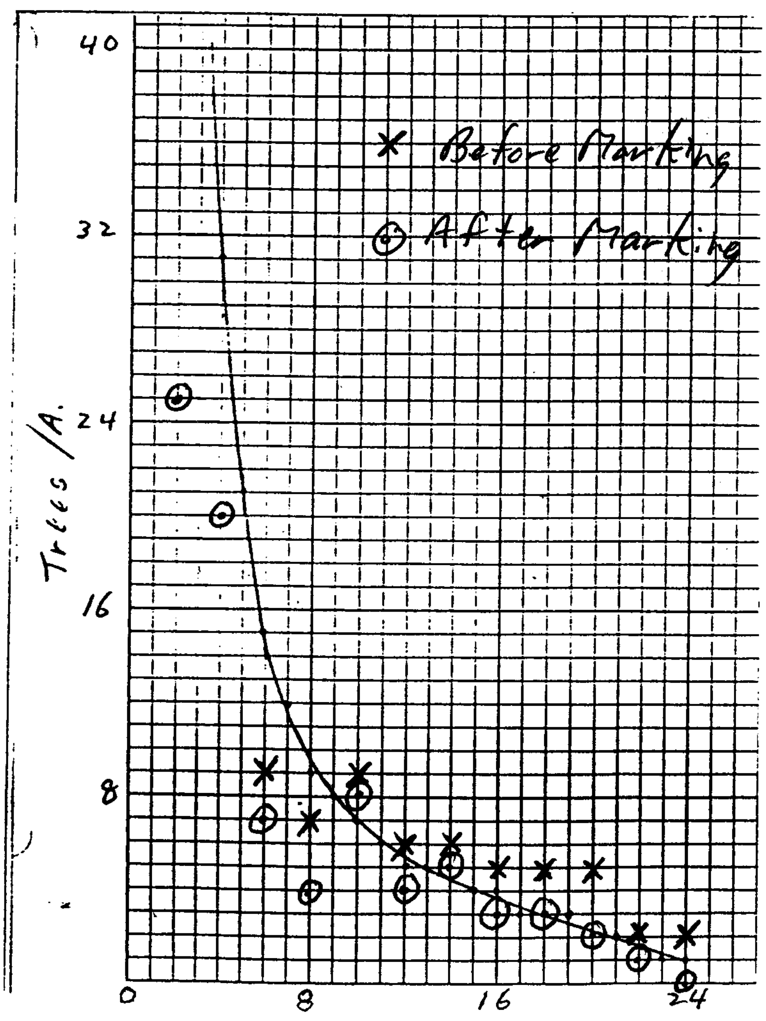
Dbh	B.A.	Residual #	Residual Tot.		Marked #	Marked Tot.	Total	B.A/A.
2	.02	25	5.0					
4	.1	20	2.0					
6	.2	7	1.4		2	.4		
8	.3	4	1.2		3	.9		
10	.5	8	4.0		1	.5		
12	.8	4	3.2		2	1.6		
14	1.1	5	5.5		1	1.1		
16	1.4	3	4.2		2	2.8		
18	1.8	3	5.4		2	3.6		
20	2.2	2	4.4		3	6.6		
22	2.6	1	2.6		1	2.6		
24	3.1	0			2	6.2		
26	3.7							
28	4.3							
30	4.9							
Total			39.9			26.3		
Total /A.			79.8	+		52.6		

X2

= 132.4



Prescription / Audit Form
Cambridge – west

Plots

Owner ____________

		Saplings		Poles		Sawlogs (Class C includes cull class D)																								
	Sp.	2	4	6	8	10	12 A	12 B	12 C	14 A	14 B	14 C	16 A	16 B	16 C	18 A	18 B	18 C	20 A	20 B	20 C	22 A	22 B	22 C	24 A	24 B	24 C	26+ A	26+ B	26+ C
M.																														
R.																														
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R																														
M	B.																													
R	A.																													

Dbh	B.A.	Residual #	Residual Tot.		Marked #	Marked Tot.	Total	B.A./A.
2	.02							
4	.1							
6	.2							
8	.3							
10	.5							
12	.8							
14	1.1							
16	1.4							
18	1.8							
20	2.2							
22	2.6							
24	3.1							
26	3.7							
28	4.3							
30	4.9							
Total								
Total / A.