A TRUE PICTURE

Taking Inventory of Your Woodlot

EASTERN ONTARIO
MODEL FOREST

ISBN 1-896392-48-2

Published by:
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ACKNOWLEDGEMENTS

This publication was prepared as a co-operative effort between the following partners:

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- Martin Streit, Domtar Inc., Cornwall
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- Eric Boysen, Ontario Ministry of Natural Resources, Kemptville
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Desktop publishing services were provided by Laurie Dool and Diane Downey of the LandOwner Resource Centre in Manotick.

INTRODUCTION

This is a guide for those who require a detailed inventory of their woodlot in order to develop a woodlot management plan. An inventory provides information on the composition, quality and quantity of timber and other natural features. Conducting a forest inventory is an essential step in the development of a woodlot management plan.

When using this manual, consider your needs and abilities, and how you can develop a woodlot inventory that will best meet your requirements. The product of the work described here is a management inventory that will provide a guide for decision making in an ongoing woodlot management program.

Two case studies will lead you through the process of planning and executing a forest inventory or “cruise” (as it’s known in the forest industry). The text outlines steps for obtaining or creating a base map. It gives pointers on field work and compilation procedures. It will help you design the cruise including objectives, plot size and configuration, plot interval, cruise line pattern, data collection, measurement precision, tally sheets and compilation forms.

This manual is based, in part, on a course outline prepared by Gary Murchison of Formetrics Consulting in Thunder Bay, Ontario.

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THE MANAGEMENT PROCESS

The management of any enterprise, whether it's a large corporation, a family picnic, or a woodlot, can be described as a simple, three-step process. First, where do you want to go? Set a clear goal of practical and achievable objectives. Second, how are you going to get there? Develop strategies that will help you reach your objectives. Third, do it! Build your strategy into an action plan and put it to work.

All too often, the last step in this process is the one taken first. A burst of enthusiasm creates all sorts of activity without producing a clear idea of what is to be achieved. The result is usually a series of frustrating experiences that waste time, money and effort. Action must be directed by objectives which are carefully thought out.

In managing a woodlot, taking stock by conducting a forest inventory has to be the first part of the process. It is not possible to set realistic objectives without having a clear understanding of what you have to work with. You may foresee the production of pine sawlogs, but if a closer examination of your woodlot reveals that the bulk of your timber is not pine, then you need to rethink your objectives.

Unlike a store, a forest has no aisles or product labels. Taking stock of a woodlot is a process that requires a great deal of preparation and effort. Specialized skills and knowledge are needed to develop a clear picture of the type and quantity of growing stock available.

CASE STUDIES

We will review case studies involving two woodlot owners and the different approaches they use in taking stock of their forest holdings. Each has his own set of circumstances, needs and objectives.

Mike has been a carpenter for nearly twenty years. He recently inherited the farm that has been in his family for generations. The neighbours often said, “It was never much of a farm, but it has a good bush on it.” In fact, over the years, it was often the logs and pulp from the woodlot that kept the family solvent during hard times.

In spite of the opportunity for quick money, his father and grandfather never yielded to the temptation to liquidate the woodlot. Now Mike has taken on the responsibility for the family heritage. The stewardship role appeals to him, and the profit from the woodlot will help to supplement his income during the slow winter season. However, before he can make any big plans to become a forest manager, Mike needs to know more about what he has to work with.

Our second case study involves Bill, a retired engineer. After 37 years in the petro-chemical industry, he has finally retired and followed his dream, buying about 30 hectares of land near his home.

Bill has been reading everything he can about trees and woodlots. He realizes that he needs some kind of documented plan for his property if his efforts are to have any hope of bearing fruit in the future. Again, the first step in developing his plan is to get some kind of understanding of his resources.

The job of conducting a cruise, or woodlot inventory, sounds pretty rigorous — a physically demanding task. In addition, Bill probably doesn’t have all the knowledge he needs to do the job. For example, he knows that there is a big difference in the value of sugar maple and red maple, but he is not sure that he could tell them apart. And Bill has spent a whole career analyzing numbers and using information; he is very aware of all the pitfalls and errors that are possible in data collection and analysis.

Both Bill and Mike realize that there is much more to the management of a woodlot than making dreams come true. It is a business venture with fixed overhead costs, such as taxes and boundary maintenance. Individually, these items may be small, but they get very large as they compound over time, especially if the woodlot goes through an extended period when it produces no income. As in any other business venture, the old saying is true, “If you are not going forward, you are going backward.” A regular income is necessary if the property is to produce a profit.

DO-IT-YOURSELF INVENTORY — MIKE'S STORY

Mike began reading about how to conduct a forest inventory. Some of the material was confusing to say the least. The text was sprinkled with long mathematical formulae and strange terms like "randomness" and "point sampling." Finally, he decided to look at this job one step at a time, starting with the simplest approach possible.

As a carpenter, Mike was well aware of the importance of planning his work in clear and logical steps. His first step in planning an inventory was to determine what exactly he should have when the job was done. The forestry books indicated that some specific inventory products are required to plan and manage a woodlot.

Mike would need a map of his property which would show the boundaries of his woodlot, and smaller internal compartments called stands. (These are areas where the type, age and density of tree cover are similar and can be managed in the same way.)

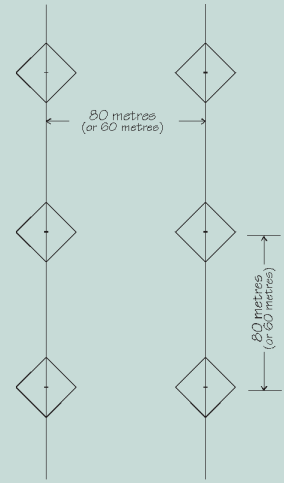
For each stand he would need information on the species, size, quantity and quality of trees. This information should allow him to determine the volume of timber he had of each species. He would also need some organized method of recording and summarizing all this information so that it made sense and could be used in making plans and decisions.

SAMPLING SYSTEM

If Mike only had to inventory that little patch of timber between the creek and the fence on the west side of his property, it wouldn't be difficult. He could simply measure all of the trees. While this approach is fine for small areas, it can't be applied to entire woodlots as it would take too long. Perhaps the solution was to measure part of the area (a sample) and multiply the findings to get an estimate for the whole stand.

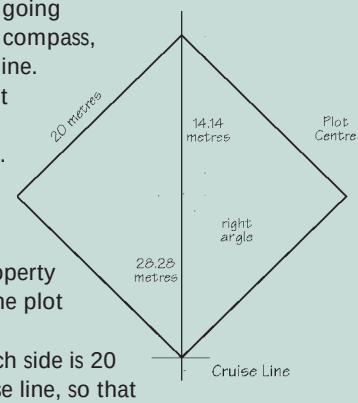
Mike thought about the work involved in marking out a one-hectare patch of his forest. It would be quite a job to measure all of the distances and angles. In most places the entire length of a one-hectare square would not be visible. And what if that one hectare was a little different from the rest of the stand, perhaps a bit wetter or drier? It would throw the estimate off. What Mike really needed was many small samples from stands scattered throughout his woodlot. He took one of the basic plans he found in a forestry book, called a plot sampling, and made a few minor changes that would allow him to sample all of his property.

PLOT SAMPLING



The plot sampling method provides a simple and effective means of sampling trees for a small woodlot inventory. In its simplest form, it involves collecting tree measurements within fixed area plots located at regular intervals along a series of uniformly spaced transect lines. All plots are the same size and shape. All the trees within each plot that are larger than a minimum size are measured. Below are instructions on how to develop a sampling plan:

- Lay out a series of parallel cruise lines 80 metres apart running from one end of your woodlot to the other end. If the tree cover in your woodlot varies considerably, reduce the interval between lines to 60 metres. If it is very uniform, increase the interval to 100 metres. Use a consistent interval throughout the project. Orient the lines to run against the contours (up and down the hills rather than along the ridges).
- Draft the cruise lines on a map of your woodlot before going out to the field. You can then use a protractor, or your compass, to determine the compass bearing before walking the line. Later, the map will become a record of where each plot was located in your inventory.
- Every 80 metres on each cruise line, mark a plot centre. If the terrain or tree cover in your woodlot is highly variable, you may choose to reduce the plot interval to 60 metres. Use the same plot interval for all plots.
- The first line is one half of the line interval from the property boundary (40 metres) and the first plot is one half of the plot interval from the start of the line (40 metres).



- Plots are 400 square metres in area and are square (each side is 20 metres long). They are oriented diagonally on the cruise line, so that two corners fall on the lines. The other corners are found at right angles to the line, opposite the plot centre.
- In the field, use a compass and measuring tape (or a rope with lengths marked on it) to locate the centre of each plot. From the plot centre, measure 14.14 metres in each direction of the cruise line to locate the corners that fall on the line. If you mark the measuring tape (or rope) that you use to measure your progress on the cruise line at 14.14 metres, and again at 28.28 metres, you can find those two points by simply continuing down the cruise line until the 14.14 metres mark reaches the plot centre. Use your compass to locate the line that lies at right angles to your cruise line from the plot centre, and measure out 14.14 metres in each direction to locate the other two corners. If the four corners are marked with flagging tape, you will be able to see the plot boundaries.

Tip: If squares plots are too difficult to lay out because of the terrain or density of the woodlot, circular plots may be easier. To lay out a circular plot with an area of 400 square metres, hold one end of the measuring tape at the plot centre, and measure out 11.28 metres in as many directions as possible, and tie a ribbon at these points. You should have a well defined circular plot by the time you make a full rotation.

FIELD MEASUREMENTS

Mike's next task was to decide what he was going to measure. Since he had thought about selling sawlogs, pulpwood or fuelwood, he would need to know about the volume of timber in his woodlot.

The forestry books and guides that he had collected told him that there were a few basic measurements he would need to take at each of his sample plots in order to come up with a good picture of his woodlot. These same measurements would also allow him to estimate the volume of timber.

Many books contain tables of timber volumes for individual trees. Typically, these provide estimates of timber volumes of trees of different diameter and height. Mike realized that if he knew the number of each kind of tree, sorted by trunk diameters, and knew how tall each species was, he could estimate timber volumes for his whole woodlot using these tables.

Measuring tree diameters is relatively easy, and Mike thought he should be able to measure the diameters of every tree in his plots. Tree heights were a different matter. Mike wondered if he needed to measure the height of every tree. After further reading, he realized that he only had to measure a sample of trees (of each type, diameter, and height), and he could use these average measurements for all the trees of that type and size.

He also thought he could streamline the measuring process by carefully noting the heights of a few trees in each plot; he could use this data as a reference to estimate the heights of other trees. Instead, Mike decided to use a table that relied on the height to the top of the highest sawlog and used a simple factor to allow for the fibre that was in the rest of the tree (this table is presented in Appendix 7a). Therefore, he needed only to measure tree heights to the nearest log length.

In his research, Mike encountered the term "basal area," a measurement used to describe the area, in square metres per hectare, of the cross-section of all the trees measured 1.3 metres above the ground. Mike knew that density is a good indication of whether the forest is ready for some cutting. He decided that since he was already collecting diameters anyway, calculating basal area was well worth the extra effort.

MEASURING EQUIPMENT — TREE HEIGHT AND DIAMETER

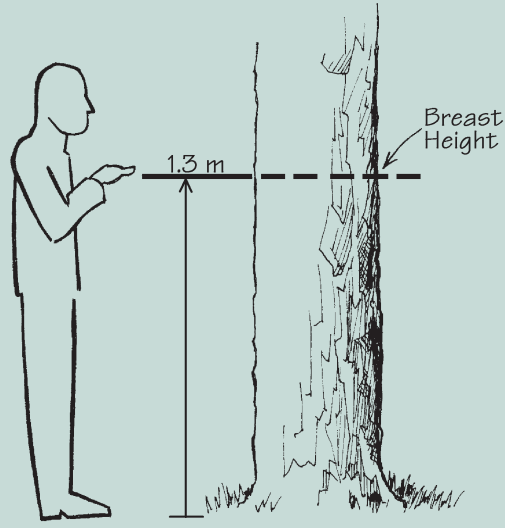
Mike had made progress in figuring out how to do an inventory of his woodlot. He knew how to organize himself efficiently and what numbers he needed to collect. The next question was how to collect those numbers?

The forestry books refer to diameter tapes and tree calipers (costly equipment), but they also mention something called a "biltmore stick." This device is cheap, easy to use, and you can make it yourself. Similarly, there is a whole range of tools for measuring heights. However, a simple staff hypsometer is something you can make yourself. It gives reasonably accurate data, if you take the time to learn how to use it properly and are careful in your work.

TREE MEASUREMENTS

In systematic plot sampling, all trees within the plots that are larger than a certain minimum size are measured. The most common threshold is 10 centimetre trunk diameter measured at a height of 1.3 metres off the ground. For each tree sampled, there are several basic pieces of information that should be collected in any woodlot inventory. These are:

- **Tree Species** Record the species of tree, such as sugar maple or red maple. In some cases separating the species may be difficult or not important, (willows for example). In these cases you may choose to record the tree family (genus) only.
- **Tree Diameter** Tree diameters are always measured at a standard height of 1.3 metres (breast height). Diameter at Breast Height (DBH) is often recorded in two classes (trees from 9.1 to 11.0 centimetres in class 10, trees from 11.1 to 13.0 centimetres in class 12, etc.). Appendix 1 contains a table of all the two centimetre DBH class limits and their equivalent circumference measures. DBH can be measured using a tape graduated for diameter measurement, tree calipers or other tools such as a biltmore stick (see Appendix 2 to learn how to make and use a biltmore stick).
- **Tree Height** The height of the whole tree may be measured, or alternatively, the height of the merchantable portion of the tree may be measured. Whole tree heights are often recorded to the nearest one metre. Merchantable height is recorded to either the nearest one metre, or in sawlog lengths (2.5 metres). A variety of tools are available for measuring heights (generally called hypsometers). Appendix 2 contains instructions on making and using a staff hypsometer.
- **Tree Quality** Individual trees have qualities or defects that may make them less suitable for specific products, or indicate that they are in decline. Others may have attributes that may make them valuable for timber or syrup production, or as nesting sites. The quality or special features of each tree should be assessed and classified. The type of classification used will depend on the objectives of the inventory (for example, where timber value is important you may class trees simply as acceptable, if you think that their future value will increase over time, or unacceptable, if you think that their value will not increase over time).



BASAL AREA

If you cut a tree off at breast height (1.3 metres), and measure the surface area of the stump, that is the basal area of the tree. It is usually expressed in units of square metres (m^2). The sum of the basal areas of all the trees on one hectare is the basal area per hectare for that spot. It is usually expressed in square metres per hectare (m^2/ha).

Basal area per hectare (BA) is a useful measure of the levels of crowding of trees in a stand. The BA of a stand can be compared to an optimum BA figure. If the stand BA is greater than the optimum, the stand may be overcrowded and need thinning. It is important to note that stands of different species and ages have different optimum BA values. Appendix 1 contains a table of basal areas for trees of different DBH.

The Basal Area of a single tree

The Basal Area of six 12 cm trees is equal to 0.0679 square metres

The Basal Area of three 24 cm trees is equal to 0.1357 square metres

The Basal Area of one 72 cm tree is equal to 0.4072 square metres

Appendix 2 includes instructions on how to build and use a cruising stick which combines a biltmore stick with a staff hypsometer.

QUALITY ASSESSMENT

Although Mike had made a good start, he still felt he needed more information. The dimensions of a piece of lumber are important, but they are not the whole story. Mike needed some kind of a quality description. He settled on a fundamental method — simply looking at a tree and deciding if it would gain or lose value in the future.

A straight, healthy tree with enough leaves to make it grow, and no sign of rot or major injuries, is considered “Acceptable Growing Stock.” Trees with poor crowns, broken limbs, conks, cat faces or bumpy stems will lose value in the future and are “Unacceptable Growing Stock.” This simple, two-class system will tell Mike what kind of values he has in his forest, and

where he needs to do some work. It would also be a useful way to measure the relative improvement in his forests health and quality after any management work has been conducted.

QUALITY CLASSES

Acceptable Growing Stock are trees that appear to have a future. If left to grow, they will increase in value over time. They may be any size or species. Acceptable Growing Stock is usually referred to as "AGS" or tallied as simply "A."

"Unacceptable Growing Stock" are trees that do not appear to have a future, often due to disease, die back in the crown or old age. Whatever the reason, if a tree appears to be losing vigour, it is coded as "UGS" or simply "U."

COLLECTING OTHER DATA

Mike also thought it would be a good idea to record information about other features of his woodlot while he conducted his tree tally. He knew that once he actually began to develop his management plan, he would need information about the general forest canopy, soil types and understory vegetation. Mike was also interested in preserving habitat for wildlife. He knew that the shrubs and herbs growing beneath the trees were important for many different types of animals, so he included a space to describe these plants on his tally sheet. He would also use the Notes section on his tally sheet to record the location of good nest or den trees, or other places where birds or animals had made their homes in the woodlot.

MAKING A TALLY SHEET

Mike spent an entire evening designing his tally sheet so that it would contain all of the information that he wanted, but would still be easy to use (see his design in Appendix 3).

TALLY SHEET

A concise easy-to-use tally sheet is an important tool needed to complete a woodlot inventory. You may choose to use an existing sheet, or customize your own. An example of a completed tally sheet from Mike's cruise is shown on the next page. A blank copy for you to use in your own woodlot is included in Appendix 3.

- Mike's tally sheet allows him to fit the data for as many as three plots on one sheet.
- The first line has a place to identify what property was surveyed, in what compartment the plots were located, who did the work and when. There is a place to number the sheet and record the total number of sheets used in each compartment.
- There is a section to write in the plot number and location.
- Cover type is a list of the main species in the stand in order of predominance.
- Before Mike circles the "coarse" or "fine" designation under "soil texture," he digs

down to the mineral soil and rubs some of it between his fingers. If it feels gritty or sandy, he will call it a coarse soil. If it feels slippery, it is a fine texture.

- "Aspect" refers to the direction a slope is facing (north or south).
- Mike's tree tally space has four columns. He has a column where he labels each tree he measures with a number, just to be able to keep track of it when he is doing his compilation. To record tree species, he uses the two-letter codes found in Appendix 4. In the quality column, he will write in "A" for Acceptable Growing Stock or "U" for Unacceptable Growing Stock. In the "DBH" and "No. logs" columns, he will record the tree measurements collected using his cruising stick and estimating eye.
- If Mike has too many trees on a plot to fit into the space allowed, he will simply continue tallying into the next plot space and use two sections of his tally sheet for one plot.
- Near the bottom of the sheet there is space for a description of shrubs and herbs. The three main species will be listed in order of predominance, and their density rated. The number of saplings of various tree species will be included in the shrub tally to indicate the young trees growing in the stand. The presence and density of various herbs and shrubs can indicate site quality, difficulty of regeneration, and potential for attracting wildlife.
- Mike left space at the bottom of the sheet for short notes to record other useful information.

MAKING A MAP

Mike had figured out his sampling system. He knew what numbers he was going to collect and how he was going to get them. All he needed now was a woodlot map. The map would be used to lay out his cruise lines and to locate the boundaries of the compartments within the woodlot.

PREPARING YOUR MAP

Land survey maps are normally attached to the title documents of most properties. Most township offices will have assessment maps that are accurately drawn to scale, and have necessary survey information on them. They may also have copies of surveyors' maps, prepared for municipal projects such as drains or road construction. These maps often contain useful information such as fence and building locations, in addition to the basic survey lines. If the township office doesn't have any maps, try the county or regional office of planning, assessment or registry.

BASE MAP

Mike knew that maps are available from a number of government sources. The federal government sells topographic maps, and the provincial government produces large forest inventory maps. However, due to the scales used on these maps, his property appears to be about the size of a postage stamp. After thinking about it, Mike came up with a plan to make his own map to suit his needs.

There are a number of information sources around to help with the job. The provincial government has aerial photos of the countryside which are fairly detailed. Survey maps prepared for land transactions can be useful. Mike also obtained a copy of a map produced by the municipality for taxation purposes. He converted the scale on the township map from 1:2,400 to 1:2,000 so that it would be simpler to use (see the next page for instructions on doing this).

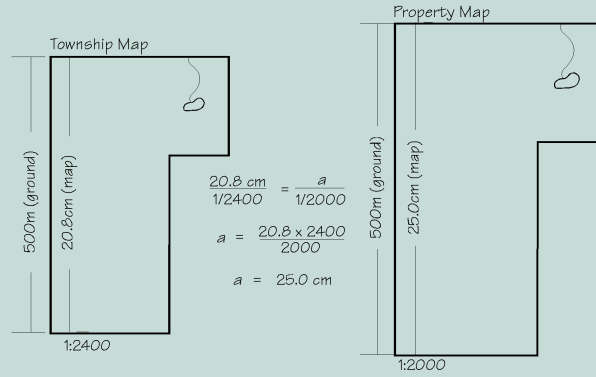
PRELIMINARY WOODLOT MAP

Now Mike had his base map. He used light paper because he knew he would be tracing a number of things from one map to another. Mike made a photocopy transparency of the provincial forest-resource inventory map that covered his property. Then he used the overhead projector to transfer information from it to his woodlot map, as he had done for his base map. The provincial map gave him a good starting point for filling in information on his preliminary map.

Next he examined the aerial photos of his property. He located the beaver pond and checked to see if it was on his map. Sure enough, the inventory map had shown the same pond, but the more recent aerial photo showed it to be much larger than it appeared on the older map. After

GETTING YOUR MAP TO THE SCALE YOU WANT

Maps need to be drawn to scale. A scale of 1:2,000 is generally suitable for woodlot mapping. This means that one centimetre on the map will represent 2,000 centimetres (or 20 metres) on the ground. Maps that are available as information sources will often be at a much smaller scale such as 1:15,000.



A transparency of the source map, projected onto your map sheet with a borrowed over-head projector, can be used to enlarge the source map to the scale you want. Pick two parallel straight lines, or ones at right angles to each other in opposite corners of the source map, for reference points. Calculate how long they will be, and how far apart, on your woodlot map.

Draw them accurately on your woodlot map. Project the transparency of the source map onto the woodlot map sheet so that reference lines in both maps match. All other information will then be at the correct scale and orientation. Transfer any notations on bearings or distances since they will provide references when laying out your cruise lines. Don't forget to transfer the north arrow and scale ladder. Measure the scale ladder to check your work.

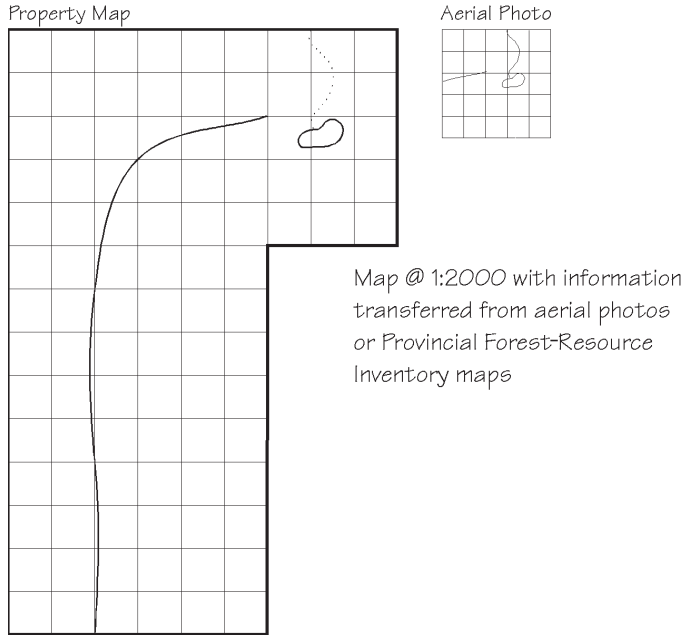
For a map that has only a few lines on it, use the following formula:

$$\frac{\text{Dimension on Source Map}}{\text{Scale of Source Map}} = \frac{\text{Dimensions on New Map}}{\text{Scale of New Map}}$$

drawing grid lines on both maps, Mike transferred the new, larger picture of the pond from the photo to his map. He was also able to pick out the old bush road and he drew tentative lines around some of the timber stands which he knew the large-scale map had not separated out. He used this technique to fill in as much on his map as he could; in pencil only, since everything was tentative and still needed to be checked by walking through the woodlot.

The last thing Mike did to his map was to lay out his cruise lines. He picked out one of the property boundaries that tended to run across the contours (up and down the hills rather than along the ridge tops) and put in his cruise lines parallel to it. This way, he would cover all the major site changes on each line and be less likely to miss something because it had fallen between the cruise lines. His cruise lines were 100 metres apart, and he marked the plot centres at 80-metre intervals on each line. He found that

a handy way to do this job was to simply tape a piece of metric squared paper on the back of his map, with one of the lines lined up with the property line that he was using to draw the parallels. Then he simply traced the lines that fell at the appropriate intervals.



Map @ 1:2000 with information transferred from aerial photos or Provincial Forest-Resource Inventory maps

FIELD WORK

COMPASS SKILLS

One thing Mike needed was a new compass. He purchased a ranger-type compass with a mirror in the lid, a gunsight sighting device, a liquid dampened needle and an adjustment for setting declination.

BOUNDARY LOCATION

With the planning work completed, it was time for Mike to head to his woodlot. However, before data collection could begin, Mike needed to mark his property boundaries. In most cases this isn't problem as the remains of an old fence, or something to show the boundary, can usually be found. However, in a couple of spots, Mike found no markings of any kind. He knew from his map what the bearing and distance were supposed to be, so he went out with his hand compass to the last point where the boundary was marked and compassed across to the next point where it was marked, hanging up markers to show where he had gone. He then asked his neighbours to check the boundaries to make sure they agreed with the locations. The final step was to paint coloured rings around all the trees that stood on every boundary line (using tree marking paint will ensure the marks remain visible over time).

SOME NEEDED COMPASS SKILLS

Setting a Compass Course With a ranger-type compass, or any compass with a rotatable dial, you set the bearing that you are going to follow opposite the "direction of travel" arrow, or the line on the mirror in the compass lid. When you align the compass needle and the arrow on the compass face, your gunsight (or the direction of travel arrow) will point in the direction that you want to go.

Following a Compass Course Be sure that the declination is set correctly or that you are running magnetic bearings. Set the bearing that you will be following. Sight on the farthest object that you can pick out through the gunsight (while lining up the needle and the arrow in the mirror). Travel in a straight line to the object and repeat the procedure. Be careful to hold the compass level, and ensure that you don't have any iron or steel (a jackknife for example) in your shirt pocket.

Finding a Bearing Cruise lines will be easier to work with if they run parallel, or at right angles, to a property line with a known bearing. If however, this approach doesn't work well, lay out your compass line and then use a protractor to measure the angle between your line and the north line. That value, or the difference between it and 360 degrees is your compass bearing. Adding 90 degrees to the bearing of the cruise line with give you the bearing of a line at right angles to the right of the surveyed line; sub-tracting 90 degrees will give you one to the left. Adding or subtracting 180 degrees will give you the opposite direction.

Declination The north that the needle of the compass points to, and the direction to the north pole, are not quite the same. The legend of a topographic map of your area will tell you how much different they are. Read the note carefully; the discrepancy changes over time. Think carefully when making the correction. If you correct the wrong way you are doubling your error. West declination means that the compass needle is pointing to the west of true north, therefore you need to adjust your direction of travel to the east the required amount. If you are using a compass that allows you to set the declination, make the correction, then set your direction of travel at 360 degrees, or north. The compass needle should be pointing slightly to the west (left) of travel direction. If your compass does not allow you to adjust for declination, note the magnetic directions on your map and make them the working bearings.

CRUISING

While he was out marking the boundaries, Mike measured out and marked the points where the cruise lines would end on the north fence line. This gave him a place to start his lines and a check on the accuracy of his compassing.

Finally, Mike was ready to start putting in plots and measuring trees. One of his children helped. With one person compassing and tallying, and the other measuring trees, things went smoothly. Corners were marked with plastic flagging tape. Any plots that fell on clearly visible stand boundaries were skipped. Diameters were measured, and one or two heights were taken with the cruising stick. Height estimates were made for each diameter class of each species. For species names, abbreviated codes were used. (These codes are listed in Appendix 4.)

An important part of the job is mapping. Observations made along each cruise line should be added to the map. Note things such as seasonal water courses, beaver ponds, rock outcrops, etc.

The cruise line gave a reference for mapping, and distances off the line were estimated by pacing. Mike determined that 13 of his strides covered 20 metres. As the distance between plots was measured, Mike was careful to note on the map any distinct changes in the type, size and density of the trees. Later, he used these marks to determine where to draw the boundaries between the compartments (or stands) in the woodlot.

One of the things that Mike considered when deciding the location of compartment boundaries was operational efficiency. Often it made sense to put a stand boundary along a trail or natural break, even if the timber was the same on both sides. It was just a handier unit to work with over the long term. Each compartment would be treated as a unit, with logging, silvicultural, and other management work carried out the same way, at the same time, on the whole compartment area. He would complete this process as he compiled his final woodlot map.

Another consideration was compartment size. He found it was easy to get carried away by splitting out every little pocket of different tree species so he tried to keep his minimum compartment size to one hectare. But, if some smaller patch was particularly significant, like the clump of huge old trees down on the edge of the marsh, he kept it separate.

Mike carefully organized the information that he collected. Before leaving each plot, he thoroughly reviewed the tally sheet to make sure that he hadn't missed anything. An example of one of Mike's completed tally sheets is provided on page 9.

COMPILATION

When the cruise was finished, Mike had a stack of tally sheets plus a handful of map sheets. The first thing he did was to transfer all of the information from his field maps to his permanent woodlot map. At that time, he made the decision on where to place the final compartment boundaries. When drawing his compartment lines, Mike reviewed his field notes on the density, age and species of trees, soil type and the location of natural features. His lines often followed roads or natural boundaries such as streams or ridge tops. He numbered each compartment and copied the compartment numbers on the tally sheets. He used a sheet of graph paper to determine the area of each compartment. One square on the graph paper covered an area of two millimetres by two millimetres (4 mm^2). He traced the outline of the compartment onto his sheet and then did a count of the squares by marking a large "x" through each block of 25 full squares, and a dot on all remaining full squares. He then added one half of all partial squares to the count of full squares. Since his map was at a scale of 1:2,000, each full square represented a

SAMPLE HEIGHT SUMMARY

The Sample Height Summary sheet is used to calculate the average tree height for each tree species of each diameter class in each compartment.

- Record the compartment number at the top of the sheet.
- Fill in the code of the first species sampled in the compartment.
- In the DBH column of each row, fill in the DBH classes sampled for that species.
- In the Sample Heights column, fill in the heights of each sample tree of that species and diameter class in the compartment; if there are more than eight, use two rows. If you tallied in log lengths, enter the number of 2.5 metre logs.
- In the Sum column record the sum of the heights for that species and DBH class. If you tallied logs, record the total number of logs across all trees.
- In the Count row fill in the number of sample trees for that diameter class.
- Calculate the mean by dividing the sum by the count. Round to the nearest metre. If you tallied in log lengths, round the result to the nearest whole number of logs.

SUMMARY OF SAMPLE HEIGHTS

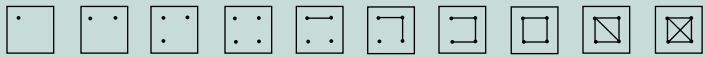
Compartment	3										
Species:	Hard Maple										
DBH	Sample Heights (logs)								Sum	Count	Mean
22	1								1	1	1.0
24	1	1							2	2	1.0
28	2	2	2						6	3	2.0
30	2	2							4	2	2.0
32	2								2	1	2.0
34	2	2	3						7	3	2.3
36	3	3							6	2	3.0
38	3	4							7	2	3.5
40	4								4	1	4.0
42	4								4	1	4.0

ground area of four metres by four metres (16 m^2) or 625 squares to one hectare. The area of each compartment was marked on the map.

Now Mike had to deal with that big pile of data sheets. He sorted the pile by compartments, so that all of the tally sheets for each compartment were in one bundle. Quite a few tally sheets ended up cut in two so that one

COMPARTMENT SUMMARY SHEET

- Fill in the compartment number at the top of the sheet.
- Gather all the tally sheets for plots in that compartment.
- Count the number of trees in each species, quality class and DBH class for all plots. Use a dot tally to do this. A dot tally is a simple method of writing numbers as the count builds up without having to erase or cross out the previous number. It looks like this:



- Record the plot number from each sheet in the far right column.
- Once all sheets have been summarized, write out the number of trees counted in each cell.

plot could go in the bundle for one compartment, and the others somewhere else. Any plots that fell exactly on one of the final compartment boundaries were discarded.

The next task was to come up with an average height for each diameter class of each species in each compartment. An example of the Sample Height worksheet Mike used to calculate average heights is shown below. A blank copy of the same sheet is included in Appendix 5.

Next, Mike used a Compartment Summary sheet to summarize the tree count in each plot by compartment number. A copy of this sheet is provided in Appendix 6. Instructions on how to complete it are provided below.

Mike then turned to the Data Compilation sheets (Appendix 8). Filling out these sheets is mainly a matter of taking information from existing sources, or from a table, and multiplying to get answers for the appropriate boxes. In order to complete this step, Mike needed a volume table that provided estimates of the merchantable timber volume for each tree size class in his sample.

The table which Mike used to determine volumes is from a book on woodlot management. This one table is for all species and splits the volume into sawlog and fibre components. There is a supplementary table that has the same information in board feet and cords (see Appendix 7).

Mike finished his compilation work by completing summary sheets for each compartment (Appendix 9). The information on soils, topography, saplings and minor vegetation was summarized by scanning the field sheets and picking out trends.

Mike now had all of the information required to develop annual work plans for his woodlot. He could use the data and his knowledge of current markets to guide him in deciding what tasks to undertake. He could estimate the volumes of wood involved and monitor changing conditions. And he has all the information he needs for future decision making. As a result, his inventory is a dynamic, ever-changing record of his woodlot.

COMPILATION SHEET

All of the information on tree samples is brought together on the Compilation Sheets. One or more sheets are completed for each species in each compartment by using the following instructions:

1. At the top of the sheet, identify the woodlot compartment to be summarized.
2. In the Sample Size box, enter the total number of valid sample plots within the compartment and the sample area in hectares.
3. Each sheet is divided into two columns; Acceptable Growing Stock (AGS) trees are summarized on one side and the Unacceptable Growing Stock (UGS) on the other.
4. Enter the number of trees in each DBH class for AGS and UGS from the Compartment Summary sheets dot tally in the No. Trees column.
5. For each DBH and Quality class, multiply the No. Trees by the BA/tree (basal area per tree) figure and enter the product in the BA sample column.
6. Enter the average height from each DBH and quality class in the Avg. Ht. column from the calculations made on the Sample Height Summary sheet (if log heights were tallied, enter the average number of 2.5 metre logs).
7. Using one of the volume tables in Appendix 7, look up the figure that corresponds to the DBH class and average height row on the Compilation Sheet. If you tallied height to the nearest metre, use the Merchantable Height Volume Table. If you tallied heights by log length, use the Log Lengths Volume Table. Enter the figures in the Vol./tree column.
8. Multiply the Vol./tree figure by the No. Trees figure for each DBH and quality class and enter the result in the Vol. sample column.
9. Divide the No. Trees figure in each DBH and Quality class by the Sample Size (written in at the top of the page), and enter the result in the Stems Per Hectare column. This is the stems per hectare for trees of that species, DBH class and quality class in the compartment.
10. Divide the BA Sample figure in each DBH and quality class by the Sample Size and enter the results in the BA Per Hectare column. This is the basal area per hectare for trees of that species, DBH class and quality class in the compartment.
11. Divide the Vol. Sample figure in each DBH and quality class by the Sample Size and enter the result in the Volume per Hectare column. This is the merchantable volume per hectare for trees of that species, DBH class and quality class in the compartment.
12. Sum the per hectare values for number of stems, basal area and volume for DBH and quality classes from 10 through 24 and enter the result in the Poles row.
13. Similarly, sum the per hectare values for number of stems, basal area and volume for DBH classes from 26 through to 38 and enter the results in the Small Logs row. Sum values for DBH classes from 38 to 48 and enter the results in the Medium Logs row. Sum values for DBH classes from 50 to 60 and enter the results in the Large Logs row. Sum all values over 60 centimetres DBH and enter the result in the Oversize row. Sum values for poles, small logs, medium logs, large logs and oversize and enter the results in the row.
14. At the bottom of each column, enter the total area of the compartment in hectares (determined for your map).
15. Calculate the total number of stems, basal area and volume for the compartment by multiplying the per hectares value by the compartment areas, and enter the results in the Total/Stand row.

COMPARTMENT COMPILATION SHEET

Compartment #: 05 | Sample Size: (No. 7 x .04 hectares / plot) = 0.28 hectares | Page 1 of

Species : Red Oak — AGS

DBH	No. Trees	BA / tree	BA sample	Avg. Ht. Logs	Vol. / tree	Vol. sample	Per Hectare: Stems	Per Hectare: BA	Per Hectare: Vol.
10		0.0079							
12		0.0113							
14		0.0154							
16		0.0201							
18		0.0254							
20		0.0314							
22	1	0.0380	0.0268	1	0.3	0.3	5.6	0.14	0.89
24	1	0.0452	0.0456	1	0.45	0.45	5.6	0.16	0.46
Poles						0.24	7.1	0.50	0.55
26	1	0.0531	0.0265	1	0.15	0.15	5.6	0.19	0.54
28	1	0.0616	0.0662	2	0.54	0.54	5.6	0.22	1.21
30	1	0.0707	0.071	2	0.4	0.4	5.6	0.25	1.45
32		0.0804							
34		0.0908							
36		0.1018							
Small Logs						0.89	10.7	0.66	5.18
38	2	0.1134	0.227	3	0.98	1.86	7.1	0.81	6.64
40	2	0.1257	0.251	3	1.06	2.06	7.1	0.90	7.36
42	3	0.1385	0.416	4	1.44	4.32	10.7	1.48	15.45
44	2	0.1521	0.304	4	1.68	3.36	7.1	1.09	11.29
46	2	0.1662	0.332	4	1.75	3.5	7.1	1.9	12.50
48	1	0.1810	0.181	4	1.89	1.89	5.6	0.65	6.75
Medium Logs						16.79	41.8	6.12	59.97
50		0.1963							
52		0.2124							
54		0.2290							
56		0.2463							
58		0.2642							
60		0.2827							
Large Logs									
Oversized Logs									
Total /Hectare:							61	7.08	64.00
Compartment Area: 0.6				Total / Stand :			354	58.9	340.0

Species : Red Oak — UGS

DBH	No. Trees	BA / tree	BA sample	Avg. Ht. Logs	Vol. / tree	Vol. sample	Per Hectare: Stem	Per Hectare: BA	Per Hectare: Vol.
10		0.0079							
12		0.0113							
14	1	0.0154	0.015	0	0	0	5.6	0.08	0.00
16		0.0201							
18		0.0254							
20		0.0314							
22	1	0.0380	0.0268	2	0.22	0.22	5.6	0.14	0.79
24	1	0.0452	0.045	2	0.25	0.25	5.6	0.16	0.89
Poles						0.47	10.7	0.58	1.68
26		0.0531							
28	1	0.0616	0.062	2	0.34	0.34	5.6	0.22	1.21
30	1	0.0707	0.071	2	0.4	0.4	5.6	0.25	1.45
32		0.0804							
34	1	0.0908	0.091	3	0.74	0.74	5.6	0.51	2.64
36	2	0.1018	0.204	3	0.84	1.68	7.1	0.78	6.00
Small Logs						3.16	17.9	1.62	11.28
38		0.1134							
40		0.1257							
42		0.1385							
44		0.1521							
46		0.1662							
48		0.1810							
Medium Logs									
50		0.1963							
52	1	0.2124	0.212	4	1.41	1.41	5.6	0.76	8.61
54		0.2290							
56		0.2463							
58	1	0.2642	0.264	4	1.79	1.79	5.6	0.94	9.96
60		0.2827							
Large Logs						5.2	7.1	1.70	18.57
Oversized Logs									
Total /Hectare:							56	5.87	51.65
Compartment Area: 0.6				Total / Stand :			136	19.6	175.4

COMPARTMENT DESCRIPTION

PROPERTY LOCATION:	Lot 15 / Con. IV. Dunlop Twp					
COMPARTMENT NUMBER:	05			NUMBER OF PLOTS:	5	
AREA OF COMPARTMENT:	5.5 ha.			DATE CRUISED:	June 30/96	
COVER TYPE:	Oak-Maple-Beech					
Soil Depth	deep	1	plots	Predominant Shrubs	Spp 1	Beaked Hazel
	moderate	3	plots		Spp 2	Ironwood
	shallow	4	plots		Spp 3	Service Berry
Aspect	northern	4	plots		Spp 4	Nat. Maple
	southern	4	plots		Density	High
Soil Texture	coarse	3	plots	Predominant Herbs	Spp 1	Beech fern
	fine		plots		Spp 2	Sarsaparilla
					Spp 3	Aster
					Spp 4	Bracken Fern
					Density	High

Spp.	Qual	Regn.	Poles		Small Logs		Medium Logs		Large Logs		Oversized		Total	
			BA / ha	Vol /ha	BA / ha	Vol /ha	BA / ha	Vol /ha	BA / ha	Vol /ha	BA / ha	Vol /ha	BA / ha	Vol /ha
Or	AGS		0.50	0.85	0.66	5.18	6.12	89.97					7.08	64
	UGS		0.56	1.68	1.82	11.28			1.7	18.67			3.87	31.63
Wh.	AGS	✔	2.14	1.08	2.56	18.04	1.80	17.82					6.5	55.89
	UGS	✔	0.82	0.59	0.79	4.45							1.61	4.82
Ba	AGS		0.84	1.08	0.41	4.25							0.96	6.28
	UGS		1.08	1.68	0.47	5.08	0.94	9.82					2.44	14.78
Σ AGS			2.98	2.91	3.45	22.47	7.92	77.79	0	0	0	0	14.55	108.17
Σ UGS			1.9	3.75	2.78	18.99	0.94	9.82	1.7	18.67	0	0	7.52	51.15
TOTAL			4.88	6.66	6.23	41.46	8.86	87.61	1.7	18.67	0	0	21.66	159.3

HIRING A PROFESSIONAL — BILL'S STORY

Bill, a retired engineer, put a great deal of thought into the problem of obtaining an inventory for his woodlot. Part of the reason he had acquired the property was to keep himself active; he realized, however, that after 35 years of sitting at a desk, he wasn't physically prepared to walk through his woodlot every day.

Bill also knew that many mistakes could be made during a timber cruise. Some species, for example, are difficult to identify. During the winter it is hard to differentiate between a tamarack and a dead black spruce. Also, what would happen if height measurements were consistently inaccurate? Bill did a few calculations to test the consequences of these errors and the results frightened him. Finally, after a lot of soul-searching, he decided that the best way was to hire a professional to do the job.

FINDING THE RIGHT PERSON

This did not mean Bill looked in the telephone book under "forestry consultants" and hired the first person listed. He knew that some background knowledge would allow him to "speak the language" and get better value from his consultant. He made himself familiar with concepts like basal area, sampling systems and volume tables. He also did a lot of his own preliminary work, such as finding his property boundaries. In his case, he didn't have to dig far to find survey information, as an accurate description of the property was required when he had bought it.

Once Bill felt comfortable with his new forestry knowledge, he began to ask about consultants. The local woodlot owners' association and the provincial natural resources office provided him with names. Bill chose the consultant who seemed to have the most experience on private land in his area.

WORKING WITH A CONSULTANT

The first thing Bill and the consultant did was sit down to talk about what Bill expected, and what the consultant could do for him. The consultant explained that his usual method of setting up a cruise was to randomly select ten coordinates in each stand and do a "prism sweep" at each one. He explained that the point sampling system that uses prism sweeps is based on mathematical approaches that make it possible to get the same value of information from less measuring than using the fixed-area plot method.

The consultant had a set of three local volume tables which covered the site conditions in the area. Therefore, he only had to measure the heights of a small number of trees in each stand to determine which table he should be use.

Bill's next question was about the stand boundaries the consultant was using to separate different types of forest. "Where did they come from," he asked? The consultant's reply was that he normally used the stand boundaries from the provincial inventory maps. Bill wanted to know how good those lines were. "Well, in this area, not too bad, for stand boundaries, although they sometimes tended to throw an awful lot of different stuff in one stand," replied the consultant.

Bill wanted to know if there was any way he could get a better "typing job" done on his woodlot before the whole inventory was done on the basis of stand designations that were too broad to be of much use to him. The consultant offered to retype the photos himself if Bill was interested in paying the extra costs. Bill decided that it would be money well spent, and the consultant suggested that perhaps they should do it together so that Bill would get a better idea of the nature of his property. This impressed Bill and he knew that he had picked the right person for the job.

As he watched his consultant work on the photos, drawing grease pencil lines and explaining what he was doing, Bill realized that some of the stands on his woodlot were a lot bigger than he was prepared to deal with at one time. He asked that the stands be divided into smaller units that would be easier to handle, based on convenient boundaries and some relatively minor shifts in stand composition. These would be the compartments that would provide the framework for Bill's management activity.

By the time they were finished, Bill felt that he was now much more familiar with his property, even if there were parts of it that he had never seen. Bill was now comfortable with his inventory project and very glad that he had spent some time learning about forest inventory.

A couple of weeks later the consultant arrived at Bill's door with a complete woodlot inventory, a map and an invoice. This map was not as detailed as the one Mike had done; a similar map would have been prohibitively expensive. But it told Bill enough that he could make his plans with confidence. The inventory data had a page for each of the compartments that Bill and his consultant had designated. Each compartment had a description of the soil, the topography, the shrubs and herbs and the timber. The timber in Bill's inventory was described by species and size using three quality classes that gave him an idea of what kind of product each tree would produce. He was able to do his planning each year using his map and compartment descriptions to set priorities for environmental protection, wildlife habitat and timber, knowing that he wasn't missing any areas that were badly in need of attention, or any opportunities to optimize his benefit.

Bill was convinced that hiring someone to do his woodlot inventory had been a wise decision. Not only had he avoided the risk of generating inaccurate information, he had saved himself a great deal of work and a lot of time.

MAKING EFFECTIVE USE OF A CONSULTANT

1. Develop a clear idea, in your own mind, of what you expect a consultant to do for you.
2. Shop around. Look for someone with experience in woodlot work and a good reputation among his clients. Remember that you tend to get what you pay for, and that you aren't likely to find your consultant in an advertising section. Most good consultants don't need to advertise very much.
3. Stay in touch with your consultant, particularly in the planning stages of the work. He needs a thorough understanding of your needs. Once the field work begins, things are more or less on automatic and there really isn't much opportunity to make changes.

SUMMARY

Mike and Bill both wanted to manage their woodlots carefully with thoughtful goals and objectives, based on a good knowledge of their resources. Just as the successful retailer needs to know what's on the shelves, and the number and nature of his potential customers, the manager of a forest needs to know what he has in the woods, and the nature and potential of his markets.

Similarly, Mike and Bill can use their inventories to identify areas in their woodlots where there are a lot of trees whose value is static or decreasing, and devise means of replacing them with vigorous, fast growing trees for which there is a market demand. They both know that the value of trees of high-value species will increase at a rate comparable to any other good investment.

Woodlot management is a business that is similar to any other; there are, however, a few important differences. The return is over the long term, often extending over two or more generations. Unlike the usual factory or store, a woodlot is a fully integrated enterprise that will produce a range of benefits: timber, wildlife, recreation and natural environment, for a number of markets, some of which are not used to paying for the benefit.

In addition, the system that generates these products is extremely complex. It requires a special effort to understand and benefit from your woodlot without endangering its ability to maintain production. The many organisms and nonliving factors interacting with each other create an extremely complex system that never stops changing. In order to see opportunities or problems as they emerge, it is necessary to have a clear, unbiased record of what's in your woodlot. For Mike and Bill, their inventory is a large step towards developing some of the necessary understanding of this complex and fragile system.

SUMMARY

Planning

A good inventory plan should specify expected end products are and clearly define the sequence of tasks necessary to produce these products.

1. What is the inventory expected to show? What are the expected products?
2. How much time and money do you have available to conduct the inventory? Are you willing to do the work yourself or are you more comfortable hiring a consultant?
3. What are the basic steps you will follow to complete the inventory and what methods will be used to complete each step?
4. What tools and resources are needed (maps, aerial photos, field equipment, tally sheets, reference material, etc.)? What are the tools and resources you have available to you?

Steps in Doing a Plot Cruise

1. Determine desired results;
   a) intensity of sample;
   b) plot size and configuration;
   c) cruise line and plot interval;
   d) cruise line pattern (orientation);
   e) data to be collected and how much, diameters, heights, quality information, new growth, wildlife factors, minor vegetation, site information, tombstone data;
   f) precision of data to be collected, size classes, measurement, controlled estimate, visual estimate, subjective appraisal;
   g) design tally sheet and make copies;
   h) plan compilation procedures, how information will be organized and computed to yield the required information.
2. Obtain a good base map, accurately drawn to scale, that shows property boundaries, a north arrow (or equivalent), major water features, roads and other significant man-made features.
3. Pencil in, on the map, any information obtainable from aerial photos or other sources that will help to give a complete picture of the forest: stand boundaries, roads, trails, any water features, barren areas, etc.
4. Decide on minimum stand size.
5. Plan the field cruise. Organize the field work. Carry out the cruise, collecting field data and add information to the map.
6. Produce final map.
7. Compile cruise data and report it in a usable format.

Woodlot Inventory Update

Forests are constantly changing and human activity in the forest generally accelerates the rate of change. As time passes your inventory, if left alone, will eventually become out-of-date and inaccurate. Once you have completed a woodlot inventory, you may wish to consider how you will maintain and periodically update the information in the future. Every five years should be sufficient for most woodlots.

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APPENDIX 1

Diameter and Circumference Limits and
Basal Areas for Two Centimetre DBH Classes

Diameter at Breast Height Class (cm)	Diameter at Breast Height Class Limits (cm)	Circumference at Breast Height Class Limits (cm)	Basal Area (m^2)
10	9.1 to 11.0	28.6 to 34.6	0.0079
12	11.1 to 13.0	34.7 to 40.8	0.0113
14	13.1 to 15.0	40.9 to 47.1	0.0154
16	15.1 to 17.0	47.2 to 53.4	0.0201
18	17.1 to 19.0	53.5 to 59.7	0.0254
20	19.1 to 21.0	59.8 to 66.0	0.0314
22	21.1 to 23.0	66.1 to 72.3	0.0380
24	23.1 to 25.0	72.4 to 78.5	0.0452
26	25.1 to 27.0	78.6 to 84.8	0.0531
28	27.1 to 29.0	84.9 to 91.1	0.0616
30	29.1 to 31.0	91.2 to 97.4	0.0707
32	31.1 to 33.0	97.5 to 103.7	0.0804
34	33.1 to 35.0	103.8 to 110.0	0.0908
36	35.1 to 37.0	110.1 to 116.2	0.1018
38	37.1 to 39.0	116.3 to 122.5	0.1134
40	39.1 to 41.0	122.6 to 128.8	0.1257
42	41.1 to 43.0	128.9 to 135.1	0.1385
44	43.1 to 45.0	135.2 to 141.4	0.1521
46	45.1 to 47.0	141.5 to 147.7	0.1662
48	47.1 to 49.0	147.8 to 153.9	0.1810
50	49.1 to 51.0	154.0 to 160.2	0.1964
52	51.1 to 53.0	160.3 to 166.5	0.2124
54	53.1 to 55.0	166.6 to 172.8	0.2290
56	55.1 to 57.0	172.9 to 179.1	0.2463
58	57.1 to 59.0	179.2 to 185.4	0.2642
60	59.1 to 61.0	185.5 to 191.6	0.2827
62	61.1 to 63.0	191.7 to 197.9	0.3019
64	63.1 to 65.0	198.0 to 204.2	0.3217
66	65.1 to 67.0	204.3 to 210.5	0.3421
68	67.1 to 69.0	210.6 to 216.8	0.3632
70	69.1 to 71.0	216.9 to 223.1	0.3848

APPENDIX 2 — MAKING AND USING YOUR OWN CRUISING STICK

A cruising stick is simply a strip of hardwood with biltmore stick graduations on one side and markings for a staff hypsometer on the other side. Exactly how far apart the graduations will be depend on something called your "arm's reach." If you stand with your shoulders squared and reach out in front of you with your hand held at breast height, the fist lightly clenched and the thumb on top, the distance from the first joint of your thumb to your eye on the same side of your body is your arm's reach.

A cruising stick should probably be about a metre long. It will need to be sanded clean and smooth. Measure your arm's reach and use the tables of calibrations provided at the end of this Appendix.

The graduations on the biltmore stick show the boundaries of two centimetre diameter classes. The space between 9.1 and 11.0 centimetres, for instance, is the 10 centimetre diameter class. The 22 centimetres diameter class runs from 21.1 centimetres to 23.0 centimetres.

On the hypsometer, similarly, the nearest mark indicates the height of the tree. The zero point for the biltmore stick will likely be at one end of the stick, so you simply need to hook the end of your metric tape over the end of the stick and carefully mark the graduations in progression up the stick as indicated by the table.

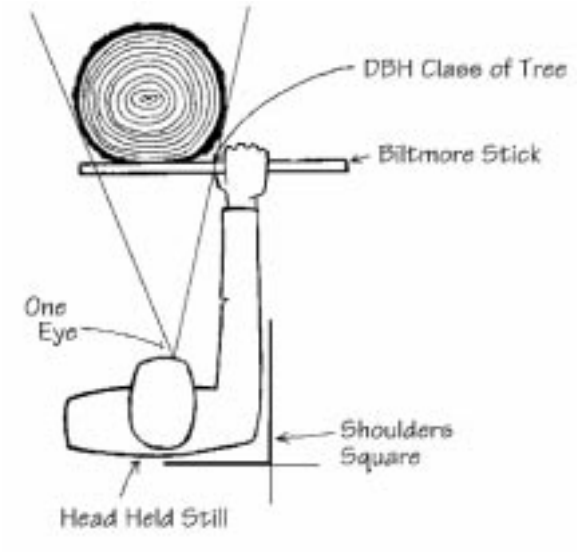
For the hypsometer, mark the scales for both 10 and 15 metres from the tree on the stick. This will give you the flexibility of measuring heights from either distance. Some people prefer to have the zero end of the scale a little distance up the stick so they can hold their hand at the zero point and sight over their thumb to the base of the tree. Apply a couple of coats of varnish to protect your cruising stick.

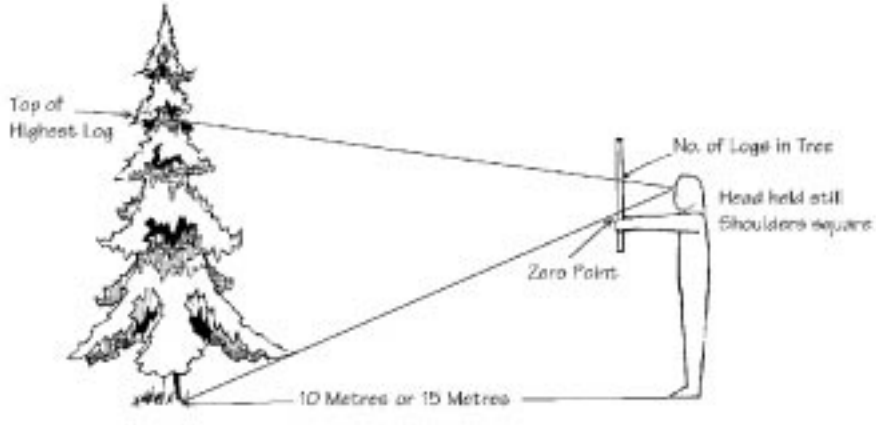
To use a biltmore stick, simply hold your stick against the tree at breast height, parallel to the ground and stand back at arm's reach. Be sure to keep your shoulder square. Sighting with one eye, line up the zero point of the biltmore stick with the edge of the tree. Using the same eye, sight across the stick to the other edge of the tree stem. Be careful not to move your head. The line from eye to edge of tree will cross the stick on the correct diameter class designation.

The staff hypsometer is used by simply standing 10 or 15 metres back from the tree (15 metres for taller trees), lining up the bottom of the tree with the 0 point on the staff and reading off the section of the appropriate scale that lines up with the top of the top log. The nearest number below the top of the highest log is the number of logs. If you are measuring in one metre height classes, select the nearest graduation. The staff must be held vertical, your shoulder kept square to your body and your head held still, in

order to get accurate measurements and avoid the repeated type of error that will badly affect the accuracy of your data.

Both the staff hypsometer and the Biltmore stick are considered to be suitable for making rough estimates only. Their inaccuracies stem from the fact that it is very easy to make an error that is repeated over and over again if you do not concentrate on holding your arm and body in the same position, and on keeping your head still each time you make a measurement.





CALIBRATIONS OF BILTMORE STICK

Distance from the zero point on the stick to the point marking the lower limit of a given diameter class.

DBH		Arm Reach in centimeters					
Class	Lower Limit (cm)	56	58	60	62	64	66
10	9.1	8.44	8.46	8.48	8.50	8.51	8.53
12	11.1	10.14	10.17	10.20	10.22	10.25	10.27
14	13.1	11.79	11.83	11.87	11.90	11.94	11.97
16	15.1	13.40	13.45	13.50	13.54	13.58	13.62
18	17.1	14.97	15.03	15.08	15.14	15.19	15.24
20	19.1	16.49	16.57	16.63	16.70	16.76	16.82
22	21.1	17.98	18.07	18.15	18.23	18.30	18.37
24	23.1	19.44	19.54	19.63	19.72	19.80	19.88
26	25.1	20.86	20.97	21.08	21.18	21.27	21.36
28	27.1	22.25	22.37	22.49	22.61	22.71	22.82
30	29.1	23.61	23.75	23.88	24.01	24.13	24.24
32	31.1	24.94	25.09	25.24	25.38	25.51	25.64
34	33.1	26.24	26.41	26.57	26.73	26.87	27.01
36	35.1	27.52	27.70	27.88	28.05	28.21	28.36
38	37.1	28.77	28.97	29.16	29.34	29.52	29.68
40	39.1	30.00	30.22	30.42	30.62	30.81	30.98
42	41.1	31.21	31.44	31.66	31.87	32.07	32.26
44	43.1	32.40	32.64	32.88	33.10	33.32	33.52
46	45.1	33.57	33.83	34.08	34.31	34.54	34.76
48	47.1	34.71	34.99	35.25	35.51	35.75	35.98
50	49.1	35.84	36.13	36.41	36.68	36.94	37.18
52	51.1	36.95	37.26	37.55	37.83	38.10	38.36
54	53.1	38.04	38.37	38.68	38.97	39.26	39.53
56	55.1	39.12	39.46	39.78	40.09	40.39	40.68
58	57.1	40.18	40.53	40.87	41.20	41.51	41.81
60	59.1	41.22	41.59	41.95	42.29	42.61	42.93
62	61.1	42.25	42.64	43.01	43.36	43.70	44.03
64	63.1	43.27	43.67	44.05	44.42	44.78	45.12
66	65.1	44.27	44.69	45.08	45.47	45.84	46.19
68	67.1	45.26	45.69	46.10	46.50	46.88	47.25
70	69.1	46.23	46.68	47.11	47.52	47.92	48.30
72	71.1	47.19	47.66	48.10	48.53	48.94	49.33

CALIBRATION OF A MERRIT STAFF HYPSOMETER

The two tables below provide the distance from the zero point to point marking top of the uppermost log on the staff for various arm reaches. The difference between the tables is the distance from the tree that the heights will be measured from.

Distance from the tree is 10 metres						
No of 2.5m Logs	Arm Reach in centimeters					
	56	58	60	62	64	66
1	14.0	14.5	15.0	15.5	16.0	16.5
2	28.0	29.0	30.0	31.0	32.0	33.0
3	42.0	43.5	45.0	46.5	48.0	49.5
4	56.0	58.0	60.0	62.0	64.0	66.0
5	70.0	72.5	75.0	77.5	80.0	82.5
6	84.0	87.0	90.0	93.0	96.0	99.0
7	98.0	101.5	105.0	108.5	112.0	115.5
8	112.0	116.0	120.0	124.0	128.0	132.0

Distance from the tree is 15 metres						
No of 2.5m Logs	Arm Reach in centimeters					
	56	58	60	62	64	66
1	9.3	9.7	10.0	10.3	10.7	11.0
2	18.7	19.3	20.0	20.7	21.3	22.0
3	28.0	29.0	30.0	31.0	32.0	33.0
4	37.3	38.7	40.0	41.3	42.7	44.0
5	46.7	48.3	50.0	51.7	53.3	55.0
6	56.0	58.0	60.0	62.0	64.0	66.0
7	65.3	67.7	70.0	72.3	74.7	77.0
8	74.7	77.3	80.0	82.7	85.3	88.0

APPENDIX 3 — SAMPLE TALLY SHEETS

Field Data Sheet - Fixed Area Plot 400 square metres

Pg of

Property: Compartment: Cruiser: Date:

Plot:	Line:	Dist.:	Plot:	Line:	Dist.:	Plot:	Line:	Dist.:
Cover Type:			Cover Type:			Cover Type:		
Soil Depth:	deep / moderate / shallow		Soil Depth:	deep / moderate /		Soil Depth:	deep / moderate / shallow	
Soil Texture:	coarse / fine		Soil Texture:	coarse / fine		Soil Texture:	coarse / fine	
Soil Moisture:	wet / moist / fresh /		Soil Moisture:	wet / moist / fresh /		Soil Moisture:	wet / moist / fresh /	
Aspect:	northern / southern		Aspect:	northern / southern		Aspect:	northern / southern	

Tree No.	Tree Species	Qual. Cls.	DBH (cm)	Height ( )	Tree No.	Tree Specie	Qual. Cls.	DBH (cm)	Height ( )	Tree No.	Tree Specie	Qual. Cls.	DBH (cm)	Height ( )

SHRUBS				SHRUBS				SHRUBS			
SPECIES	Dense	Moderate	Sparse	SPECIES	Dense	Moderate	Sparse	SPECIES	Dense	Moderate	Sparse

HERBS				HERBS				HERBS			
SPECIES	Dense	Moderate	Sparse	SPECIES	Dense	Moderate	Sparse	SPECIES	Dense	Moderate	Sparse

NOTES:

APPENDIX 4 — CODES FOR TREE SPECIES NAMES

HARDWOODS

trembling aspen	Pt
largetooth aspen	Pl
balsam poplar	Pb
poplar, all	Po
white birch	Bw
yellow birch	By
grey birch	Bg
sugar maple	Ms
red maple	Mr
silver maple	Msi
maple, all	M
beech	Be
basswood	Bd
ironwood	Iw
hickory	Hi
white elm	Ew
white ash	Aw
black ash	Ab
ash	A
black cherry	Ch
red oak	Or
white oak	Ow
bur oak	Ob
oak, all	O
black walnut	Wn
butternut	Bn

SOFTWOODS

white pine	Pw
red pine	Pr
jack pine	Pj
Scots pine	Ps
pine, all	P
black spruce	Sb
white spruce	Sw
red spruce	Sr
spruce, all	S
larch	La
hemlock	He
balsam fir	Bf
cedar	Ce
conifers, all	C

APPENDIX 5 — SUMMARY OF SAMPLE HEIGHTS

Summary of Sample Heights

Compartment Number:											
Species:											
DBH	Sample Heights								Sum	Count	Mean
Species:											
DBH	Sample Heights								Sum	Count	Mean

APPENDIX 6 — COMPARTMENT SUMMARY SHEET

Compartment Summary Sheet

Compartment Number:					Number of Plots:				Page of	
DBH Class	Species: AGS	UGS	Species: AGS	UGS	Species: AGS	UGS	Species: AGS	UGS	Species: AGS	UGS
10										
12										
14										
16										
18										
20										
22										
24										
26										
28										
30										
32										
34										
36										
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40										
42										
44										
46										
48										
50										
52										
54										
56										
58										
60										

APPENDIX 7a

Approximate Gross Merchantable Volume of Standing Trees in Cubic Metres, Using Log Lengths **Appendix 7a**

(Based on Smalian's Formula Form Class '#79)

DBH (cm)	Trees With Fibre Only		NUMBER OF 2.5 METRE LOGS																							
			One Log (2.5m)			Two Logs (5.0m)			Three Logs (7.5m)			Four Logs (10.0m)			Five Logs (12.5m)			Six Logs (15.0m)			Seven Logs (17.5)			Eight Logs (20.0m)		
	Stwd	Hrdwd	Log	Fibre	Total	Log	Fibre	Total	Log	Fibre	Total	Log	Fibre	Total	Log	Fibre	Total	Log	Fibre	Total	Log	Fibre	Total	Log	Fibre	Total
10	0.04	0.03																								
12	0.06	0.05																								
14	0.10	0.07																								
16	0.13	0.02																								
18	0.17	0.13																								
20	0.21	0.18	0.05	0.04	0.09	0.10	0.08	0.18	0.14	0.11	0.26	0.18	0.14	0.32	0.21	0.17	0.38	0.23	0.18	0.41	0.26	0.21	0.46	0.27	0.22	0.49
22	0.27	0.22	0.06	0.05	0.11	0.12	0.10	0.22	0.17	0.14	0.31	0.22	0.18	0.40	0.25	0.20	0.46	0.28	0.22	0.50	0.32	0.25	0.57	0.33	0.26	0.59
24	0.35	0.27	0.07	0.06	0.13	0.14	0.11	0.25	0.21	0.16	0.37	0.26	0.21	0.47	0.31	0.24	0.55	0.34	0.27	0.61	0.38	0.30	0.68	0.40	0.32	0.72
26	0.42	0.31	0.08	0.07	0.15	0.17	0.14	0.31	0.24	0.19	0.43	0.30	0.24	0.54	0.36	0.29	0.65	0.40	0.32	0.72	0.45	0.36	0.81	0.48	0.38	0.86
28	0.50	0.35	0.10	0.08	0.17	0.19	0.15	0.34	0.28	0.22	0.50	0.35	0.28	0.63	0.42	0.34	0.76	0.47	0.38	0.85	0.53	0.42	0.95	0.56	0.45	1.01
30	0.58	0.42	0.11	0.09	0.20	0.22	0.18	0.40	0.32	0.26	0.58	0.41	0.33	0.74	0.49	0.39	0.87	0.55	0.44	0.99	0.61	0.49	1.09	0.64	0.51	1.15
32	0.66	0.50	0.13	0.10	0.23	0.25	0.20	0.45	0.37	0.29	0.66	0.46	0.37	0.83	0.56	0.44	1.00	0.63	0.50	1.13	0.70	0.56	1.26	0.75	0.60	1.35
34	0.73	0.58	0.14	0.11	0.25	0.28	0.22	0.50	0.41	0.33	0.74	0.52	0.42	0.94	0.63	0.50	1.13	0.71	0.57	1.28	0.80	0.64	1.43	0.85	0.68	1.53
36	0.83	0.68	0.16	0.13	0.29	0.32	0.25	0.58	0.46	0.37	0.84	0.59	0.47	1.06	0.71	0.57	1.27	0.80	0.64	1.44	0.90	0.72	1.62	0.96	0.77	1.73
38	0.96	0.80	0.18	0.14	0.32	0.35	0.28	0.63	0.52	0.41	0.93	0.66	0.53	1.19	0.79	0.63	1.42	0.89	0.72	1.62	1.01	0.81	1.82	1.08	0.86	1.94
40	1.14	0.92	0.20	0.16	0.35	0.39	0.31	0.70	0.57	0.46	1.03	0.73	0.58	1.31	0.88	0.70	1.58	1.00	0.80	1.80	1.13	0.90	2.03	1.21	0.97	2.18
42	1.32	1.06	0.22	0.17	0.39	0.43	0.34	0.77	0.63	0.51	1.14	0.80	0.64	1.44	0.97	0.78	1.75	1.10	0.88	1.98	1.25	1.00	2.25	1.34	1.07	2.41
44	1.48	1.20	0.24	0.19	0.43	0.47	0.38	0.85	0.69	0.56	1.25	0.88	0.70	1.58	1.07	0.85	1.92	1.22	0.98	2.20	1.38	1.10	2.48	1.48	1.18	2.66
46	1.63	1.34	0.26	0.21	0.47	0.52	0.42	0.94	0.76	0.61	1.37	0.97	0.78	1.75	1.17	0.94	2.11	1.33	1.06	2.39	1.51	1.21	2.72	1.63	1.30	2.93
48	1.83	1.49	0.28	0.23	0.51	0.56	0.45	1.01	0.83	0.66	1.49	1.05	0.84	1.89	1.28	1.02	2.30	1.46	1.17	2.63	1.65	1.32	2.97	1.78	1.42	3.20
50	2.04	1.62	0.31	0.25	0.55	0.61	0.49	1.10	0.90	0.72	1.62	1.15	0.92	2.07	1.39	1.11	2.50	1.56	1.26	2.84	1.79	1.44	3.23	1.94	1.55	3.49
52	2.26	1.75	0.33	0.27	0.60	0.66	0.53	1.19	0.97	0.78	1.75	1.24	0.99	2.23	1.50	1.20	2.71	1.72	1.38	3.10	1.92	1.53	3.45	2.10	1.68	3.78
54	2.48	1.88	0.36	0.29	0.64	0.71	0.57	1.28	1.05	0.84	1.89	1.34	1.07	2.41	1.62	1.30	2.92	1.86	1.49	3.35	2.11	1.69	3.79	2.28	1.82	4.10
56	2.69	2.01	0.38	0.31	0.69	0.77	0.62	1.39	1.13	0.90	2.03	1.44	1.15	2.59	1.75	1.40	3.15	2.00	1.60	3.60	2.27	1.82	4.09	2.46	1.97	4.43
58	2.95	2.16	0.41	0.33	0.74	0.82	0.66	1.48	1.21	0.97	2.18	1.55	1.24	2.79	1.88	1.50	3.38	2.15	1.72	3.87	2.44	1.95	4.39	2.64	2.11	4.75
60	3.28	2.32	0.44	0.35	0.79	0.88	0.70	1.58	1.30	1.04	2.33	1.66	1.33	2.99	2.02	1.61	3.63	2.31	1.85	4.16	2.61	2.09	4.70	2.83	2.26	5.09
62	3.67	2.52	0.47	0.38	0.85	0.94	0.75	1.69	1.38	1.11	2.49	1.77	1.42	3.19	2.16	1.73	3.89	2.46	1.97	4.43	2.80	2.24	5.04	3.03	2.42	5.45
64	4.04	2.72	0.50	0.40	0.90	1.00	0.80	1.80	1.48	1.18	2.66	1.89	1.51	3.40	2.30	1.84	4.14	2.64	2.11	4.75	2.99	2.39	5.39	3.25	2.60	5.85
66	4.15	2.90	0.53	0.43	0.96	1.07	0.86	1.93	1.57	1.26	2.83	2.01	1.61	3.62	2.45	1.96	4.41	2.81	2.25	5.06	2.89	2.16	4.85	3.47	2.78	6.25
68	4.66	3.05	0.57	0.45	1.02	1.13	0.90	2.03	1.67	1.33	3.00	2.14	1.71	3.85	2.61	2.09	4.69	2.99	2.39	5.38	3.39	2.72	6.11	3.69	2.95	6.64
70	5.18	3.30	0.60	0.48	1.08	1.20	0.96	2.16	1.77	1.41	3.18	2.27	1.82	4.09	2.77	2.21	4.98	3.18	2.54	5.72	3.60	2.88	6.48	3.91	3.13	7.04
72	5.51	3.56	0.64	0.51	1.14	1.27	1.02	2.29	1.87	1.50	3.36	2.40	1.92	4.32	2.93	2.35	5.28	3.37	2.70	6.07	3.81	3.05	6.87	4.15	3.32	7.47
74	5.81	3.83	0.67	0.54	1.21	1.34	1.07	2.41	1.98	1.58	3.56	2.54	2.03	4.57	3.10	2.48	5.58	3.56	2.85	6.41	4.03	3.23	7.26	4.39	3.51	7.90

APPENDIX 7b

Approximate Gross Merchantable Volume of Standing Trees in Cubic Metres, Using Merchantable Height **Appendix 7b**

(Based on Smalian's Formula Form Class #79)

DBH	MERCHANTABLE LENGTHS IN METRES																		
(cm)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
20	0.039	0.059	0.078	0.098	0.117	0.134	0.150	0.165	0.178	0.192	0.204	0.214	0.223	0.230	0.247	0.254	0.259	0.263	0.267
22	0.047	0.071	0.095	0.119	0.142	0.163	0.182	0.200	0.216	0.234	0.248	0.261	0.273	0.283	0.303	0.312	0.319	0.325	0.329
24	0.057	0.085	0.113	0.141	0.168	0.194	0.217	0.238	0.259	0.280	0.298	0.314	0.328	0.341	0.364	0.376	0.386	0.393	0.399
26	0.066	0.099	0.133	0.166	0.198	0.227	0.255	0.280	0.304	0.330	0.352	0.371	0.388	0.404	0.432	0.445	0.457	0.467	0.476
28	0.077	0.115	0.154	0.192	0.229	0.264	0.296	0.325	0.353	0.385	0.410	0.433	0.453	0.472	0.504	0.521	0.536	0.546	0.559
30	0.088	0.132	0.177	0.221	0.263	0.303	0.340	0.374	0.405	0.443	0.472	0.499	0.524	0.547	0.579	0.599	0.616	0.631	0.644
32	0.100	0.151	0.201	0.251	0.300	0.345	0.387	0.426	0.463	0.506	0.540	0.571	0.600	0.626	0.667	0.691	0.711	0.730	0.746
34	0.113	0.170	0.227	0.283	0.338	0.390	0.438	0.482	0.524	0.573	0.611	0.647	0.680	0.711	0.757	0.784	0.809	0.830	0.849
36	0.127	0.191	0.254	0.318	0.379	0.437	0.491	0.542	0.588	0.644	0.687	0.728	0.766	0.801	0.853	0.885	0.913	0.938	0.960
38	0.142	0.212	0.283	0.354	0.423	0.487	0.547	0.604	0.656	0.719	0.768	0.814	0.857	0.897	0.958	0.994	1.027	1.056	1.082
40	0.157	0.235	0.314	0.392	0.468	0.540	0.607	0.668	0.727	0.798	0.853	0.904	0.952	0.996	1.069	1.110	1.148	1.181	1.212
42	0.173	0.259	0.346	0.432	0.516	0.595	0.669	0.739	0.803	0.881	0.942	1.000	1.054	1.104	1.183	1.230	1.272	1.310	1.345
44	0.190	0.285	0.380	0.475	0.567	0.654	0.735	0.812	0.883	0.969	1.037	1.100	1.160	1.216	1.302	1.354	1.401	1.444	1.483
46	0.207	0.311	0.415	0.519	0.619	0.715	0.804	0.888	0.967	1.060	1.135	1.205	1.271	1.333	1.427	1.484	1.537	1.584	1.628
48	0.226	0.339	0.452	0.565	0.675	0.778	0.876	0.968	1.055	1.156	1.238	1.315	1.388	1.456	1.557	1.620	1.678	1.731	1.779
50	0.245	0.368	0.490	0.613	0.732	0.845	0.951	1.052	1.146	1.256	1.345	1.430	1.509	1.584	1.693	1.762	1.826	1.883	1.936
52	0.265	0.398	0.530	0.663	0.792	0.914	1.030	1.139	1.241	1.360	1.457	1.548	1.634	1.717	1.837	1.912	1.981	2.045	2.103
54	0.286	0.429	0.572	0.715	0.854	0.986	1.111	1.229	1.340	1.468	1.573	1.673	1.765	1.855	1.987	2.069	2.145	2.214	2.278
56	0.307	0.461	0.615	0.769	0.919	1.061	1.196	1.323	1.443	1.580	1.696	1.803	1.905	2.001	2.144	2.233	2.315	2.391	2.466
58	0.330	0.495	0.660	0.825	0.985	1.138	1.283	1.420	1.550	1.699	1.823	1.939	2.050	2.154	2.301	2.396	2.485	2.567	2.643
60	0.353	0.529	0.706	0.882	1.056	1.218	1.374	1.521	1.660	1.822	1.956	2.081	2.200	2.313	2.463	2.566	2.661	2.749	2.832
62	0.377	0.565	0.754	0.942	1.126	1.301	1.467	1.625	1.774	1.948	2.091	2.226	2.354	2.457	2.635	2.746	2.848	2.944	3.031
64	0.402	0.602	0.803	1.004	1.200	1.387	1.564	1.733	1.892	2.077	2.230	2.375	2.512	2.641	1.817	2.937	3.048	3.151	3.246
66	0.427	0.641	0.854	1.068	1.276	1.475	1.664	1.844	2.014	2.210	2.373	2.528	2.675	2.813	3.006	3.134	3.254	3.365	3.468
68	0.453	0.680	0.907	1.133	1.355	1.566	1.767	1.958	2.140	2.350	2.525	2.690	2.846	2.994	3.194	3.331	3.459	3.578	3.688
70	0.480	0.721	0.961	1.201	1.436	1.660	1.873	2.076	2.269	2.495	2.680	2.856	3.023	3.180	3.387	3.533	3.670	3.797	3.915
72	0.508	0.762	1.016	1.271	1.519	1.756	1.982	2.198	2.402	2.642	2.839	3.026	3.203	3.370	3.589	3.742	3.887	4.022	4.148
74	0.537	0.805	1.074	1.342	1.605	1.855	2.095	2.323	2.539	2.792	3.000	3.199	3.386	3.564	3.791	3.956	4.110	4.254	4.387
76	0.566	0.849	1.133	1.416	1.693	1.957	2.210	2.451	2.680	2.946	3.166	3.376	3.575	3.763	4.002	4.176	4.339	4.491	4.633
78	0.596	0.895	1.193	1.491	1.783	2.062	2.328	2.583	2.825	3.107	3.341	3.563	3.773	3.973	4.225	4.413	4.587	4.753	4.901
80	0.627	0.941	1.255	1.569	1.876	2.169	2.450	2.719	2.973	3.273	3.520	3.755	3.978	4.190	4.461	4.659	4.844	5.017	5.179
82	0.659	0.989	1.318	1.648	1.971	2.279	2.575	2.857	3.125	3.441	3.702	3.950	4.186	4.413	4.697	4.907	5.104	5.288	5.460
84	0.692	1.038	1.384	1.729	2.068	2.392	2.702	2.999	3.281	3.612	3.886	4.148	4.397	4.633	4.935	5.156	5.364	5.559	5.740
86	0.725	1.088	1.450	1.813	2.168	2.508	2.833	3.144	3.441	3.787	4.075	4.350	4.612	4.862	5.178	5.411	5.631	5.836	6.027
88	0.759	1.139	1.518	1.898	2.270	2.626	2.966	3.290	3.602	3.970	4.273	4.562	4.838	5.101	5.431	5.677	5.908	6.125	6.327
90	0.794	1.191	1.588	1.985	2.374	2.748	3.106	3.449	3.777	4.157	4.479	4.779	5.069	5.348	5.691	5.950	6.194	6.422	6.639
92	0.830	1.245	1.660	2.074	2.481	2.872	3.247	3.606	3.950	4.348	4.682	5.002	5.307	5.598	5.956	6.228	6.485	6.725	6.951
94	0.866	1.299	1.733	2.166	2.590	2.998	3.390	3.766	4.126	4.544	4.894	5.230	5.551	5.857	6.223	6.509	6.779	7.033	7.271
96	0.904	1.355	1.807	2.259	2.702	3.126	3.536	3.929	4.304	4.744	5.111	5.463	5.800	6.122	6.496	6.797	7.080	7.347	7.598

Fibre Volume(cubic metres) = Sawlog Volume (cubic metres) X .8

APPENDIX 7c

Approximate Gross Merchantable Volume of Standing Trees in Board Feet, Using Log Lengths **Appendix 7c**

Log volumes are estimated in Thousand Board Feet (FBM), fibre volumes are estimated in cords

DBH (cm)	TREES WITH FIBRE ONLY		NUMBER OF 2.5 METER LOGS											
			One Log (2.5 m)		Two Logs (5.0 m)		Three Logs (7.5 m)		Four Logs (10.0 m)		Five Logs (12.5 m)		Six Logs (15.0 m)	
	Softwood (cords)	Hardwood (cords)	Log (FBM)	Fibre (cords)	Log (FBM)	Fibre (cords)	Log (FBM)	Fibre (cords)	Log (FBM)	Fibre (cords)	Log (FBM)	Fibre (cords)	Log (FBM)	Fibre (cords)
10	0.016	0.014												
12	0.025	0.020												
14	0.040	0.028												
16	0.055	0.010												
18	0.069	0.052												
20	0.088	0.074	9	0.016	19	0.033	23	0.047	27	0.060	30	0.069	31	0.076
22	0.113	0.092	12	0.020	24	0.040	30	0.057	35	0.073	40	0.085	43	0.093
24	0.144	0.111	14	0.023	29	0.047	38	0.068	45	0.086	51	0.102	56	0.113
26	0.176	0.129	17	0.028	35	0.057	46	0.080	55	0.100	64	0.120	70	0.133
28	0.209	0.144	21	0.032	42	0.063	55	0.093	67	0.116	77	0.140	86	0.156
30	0.242	0.175	24	0.037	49	0.073	65	0.107	79	0.136	93	0.161	103	0.183
32	0.271	0.206	28	0.042	57	0.083	76	0.122	93	0.153	109	0.185	122	0.210
34	0.304	0.241	32	0.047	65	0.093	88	0.137	108	0.173	127	0.209	142	0.236
36	0.346	0.281	37	0.053	74	0.106	101	0.154	124	0.196	146	0.235	164	0.266
38	0.397	0.331	41	0.059	84	0.116	114	0.172	140	0.219	166	0.263	187	0.299
40	0.475	0.383	46	0.065	94	0.130	128	0.190	158	0.243	188	0.292	212	0.333
42	0.547	0.441	52	0.072	104	0.143	143	0.210	177	0.266	210	0.323	238	0.366
44	0.614	0.500	57	0.079	116	0.156	159	0.231	197	0.292	235	0.355	266	0.406
46	0.678	0.557	63	0.086	127	0.173	176	0.252	218	0.322	260	0.389	295	0.442
48	0.739	0.617	69	0.094	140	0.186	193	0.275	240	0.349	287	0.424	326	0.486
50	0.846	0.675	76	0.102	153	0.203	212	0.299	263	0.382	315	0.461	358	0.525
52	0.937	0.727	82	0.110	166	0.219	231	0.323	288	0.412	344	0.500	391	0.572
54	1.029	0.779	89	0.119	180	0.236	251	0.348	313	0.445	374	0.540	427	0.619
56	1.118	0.837	97	0.128	195	0.256	272	0.375	339	0.479	406	0.581	463	0.665
58	1.227	0.897	104	0.137	210	0.273	293	0.402	366	0.515	439	0.625	501	0.715
60	1.361	0.968	112	0.147	225	0.292	316	0.431	395	0.552	474	0.671	541	0.768
62	1.526	1.046	120	0.157	242	0.312	339	0.460	424	0.588	509	0.718	582	0.818
64	1.678	1.130	129	0.167	259	0.332	363	0.490	455	0.628	546	0.765	625	0.878
66	1.723	1.203	137	0.177	277	0.356	388	0.522	486	0.668	585	0.815	669	0.935
68	1.937	1.298	146	0.188	295	0.378	414	0.554	519	0.711	624	0.867	714	0.994
70	2.153	1.371	156	0.200	313	0.399	440	0.587	552	0.754	665	0.920	761	1.058
72	2.291	1.478	165	0.211	332	0.422	467	0.621	587	0.798	707	0.975	810	1.121
74	2.333	1.591	175	0.223	352	0.445	496	0.656	623	0.844	750	1.030	860	1.184

APPENDIX 8

Compartment Compilation Sheet

COMPARTMENT #:				Sample Size: (No. plots				X .04 ha/plot) =			hectares	Page of		
Species : AGS									Species : UGS									
DBH	No. Trees	BA / tree	BA sample	Avg. Ht.	Vol. / tree	Vol. sample	Per Hectare			DBH	No. Trees	BA / tree	B.A. sample	Avg. Ht.	Vol. / tree	Vol. sample	Per Hectare		
							Stems	B.A.	Volume								Stems	BA	Volume
10		0.0079								10		0.0079							
12		0.0113								12		0.0113							
14		0.0154								14		0.0154							
16		0.0201								16		0.0201							
18		0.0254								18		0.0254							
20		0.0314								20		0.0314							
22		0.0380								22		0.0380							
24		0.0452								24		0.0452							
Poles										Poles									
26		0.0531								26		0.0531							
28		0.0616								28		0.0616							
30		0.0707								30		0.0707							
32		0.0804								32		0.0804							
34		0.0908								34		0.0908							
36		0.1018								36		0.1018							
Small Logs										Small Logs									
38		0.1134								38		0.1134							
40		0.1257								40		0.1257							
42		0.1385								42		0.1385							
44		0.1521								44		0.1521							
46		0.1662								46		0.1662							
48		0.1810								48		0.1810							
Medium Logs										Medium Logs									
50		0.1963								50		0.1963							
52		0.2124								52		0.2124							
54		0.2290								54		0.2290							
56		0.2463								56		0.2463							
58		0.2642								58		0.2642							
60		0.2827								60		0.2827							
Large Logs										Large Logs									
Oversized Logs										Oversized Logs									
Total Hectare:										Total Hectare									
Compartment Area: Total / Stand :										Compartment Area: Total / Stand :									

APPENDIX 9

Compartment Description

PROPERTY LOCATION:			
COMPARTMENT NUMBER:		NUMBER OF PLOTS:	
AREA OF COMPARTMENT:	ha.	DATE CRUISED:	
COVER TYPE:			

SITE DESCRIPTION			
Soil Depth	deep		plots
	moderate		plots
	shallow		plots
Aspect	northern		plots
	southern		plots
Soil Texture	coarse		plots
	fine		plots

UNDER STORY VEGETATION		
Predominant Shrubs	Spp 1	
	Spp 2	
	Spp 3	
	Spp 4	
	Density	
Predominant Herbs	Spp 1	
	Spp 2	
	Spp 3	
	Spp 4	
	Density	

TIMBER DESCRIPTION

Species	Qual	Regn.	Poles		Small Logs		Medium Logs		Large Logs		Oversized Logs		Total	
			BA / ha	Vol /ha	BA / ha	Vol /ha	BA / ha	Vol /ha	BA / ha	Vol /ha	BA / ha	Vol /ha	BA / ha	Vol /ha
Σ AGS														
Σ UGS														
TOTAL														

NOTES

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