BASIC FORESTRY

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INTRODUCTION

After several decades of working in forestry, it is apparent that a guide is required outlining some basic forestry concepts and principles. This is intended for landowners and students primarily, although others may be interested as well.

The first things one learns about forestry, from Dr. Seuss to Dr. Suzuki are that: forests purify the air and water, forests counteract global warming, they are the lungs of the earth, and the bogeyman of forestry is that clear cutting, and in fact, any tree cutting, is bad. This is a "box" that has been created around one's thinking. If one wants to do well in forestry, or understand it well, then one has to "think outside the box".

SOME TERMINOLOGY

The first thing one must do to understand forestry is to realize that it is an ecologically based science. A few definitions may help. Forest management, which is what foresters do, is the application of business methods and technical forestry principles to the operation of a forest property. This may or may not involve any harvesting or cutting at all, depending on what objectives are decided on in the management planning process. Regardless of the management strategies agreed on for a forested area, foresters rely on the science of silviculture. This is the art of producing and tending a forest: the application of the knowledge of silvics in the treatment of a forest: the theory and practice of controlling forest establishment, composition and growth. This science is useful for everything from developing parkland to old growth or specific habitats. It is based on the characteristics of trees, their morphology and physiology, which becomes the science of silvics. Silvics is the life history and general characteristics of forest stands, with particular reference to environmental factors. This includes such things as shade tolerance, seed and regeneration needs and characteristics, soil and site requirements, growth form and habits.

If tree harvesting, stand modification, or stand replacement for any reason, is decided on in the management planning process, then the knowledge of silviculture and silvics are melded into a silvicultural system. This is a method of silvicultural procedure worked out in accordance with the accepted sets of silvicultural principles by which tree crops constituting forests are tended, harvested, and replaced by new crops of distinctive form. Silviculture is a science that has been practised for thousands of years, going back to growing timber for wooden ships, and aboriginal practises to create farmland and manage game species.

<u>MANAGEMENT PLANNING</u>

Management planning is one of the most misunderstood things a forester does, because non foresters always assume management plans are directed at harvest cutting. Management plans are useful for everything from manipulating forests for habitat, to understory species such as wild ginseng. When one hears or sees the words "forest management", "forest values" or "management planning" one must picture what a management plan is. A management plan is a document that:

- defines the forest area: area, species, stands, soils, geology, watersheds, history, economy

- sets out objectives to be achieved from the forest area for its various "forest values": timber production including allowable harvest, wildlife habitat, fisheries habitat, hunting, trapping, rare threatened and endangered species, heritage features, recreation. All objectives for these values must be quantified with numerical goals that can be assessed for accomplishment at the end of the management period, usually twenty years.

- sets out a strategy for achieving each objective, and <u>most importantly</u> integrates the objectives and describes whether they are complementary, competitive, whether one must be achieved at the expense of the other, and <u>how these interactions will be resolved</u>.

- the resolution of the objectives and their integration becomes the <u>management system</u> for the forest.

Everything else in a management plan and forest management flows from the above. This includes things such as:

- silvicultural systems and silvicultural prescriptions: uneven-aged systems such as selection cutting or even-aged such as clear-cutting, shelterwood cutting, clear cutting with seed trees, coppice systems. Silvicultural systems and prescriptions also include logging systems such as full-tree or stem harvesting, mechanical harvesting, reduction of skid trails, engineered stream crossings, harvesting methods and specialized equipment to reduce site impact such as compaction and run-off, and logging methods that favour regeneration. Also included is tree marking and logging damage to residual trees.

- site preparation methods after logging, which prepare the site for regeneration: chains and barrels, trenchers, discs, plows, prescribed burning, herbicides.

- regeneration systems which establish the new stand: scarification, seed trees, aerial seeding, manual seeding, shelterwood cutting, advance growth, natural regeneration, planting of: seedlings, container stock, cuttings, rooted cuttings.

- standards for the length of time to regenerate, and the composition of the new forest after harvesting and regeneration.

- tending of newly established stands: manual cleaning, aerial or ground herbicide release, pruning, thinning, influencing species composition of the developing stand, fertilization, controlling insects and disease.

- silvicultural systems and consideration for habitat and recreation management such as: silvicultural prescriptions for forest dedicated to habitat or recreational use, dispersing harvesting areas, reducing harvest area size, seasonal harvesting (summer v.s. winter), stream buffers, maintaining forest cover in critical areas, leaving den trees and snags or buffers, maintaining or creating old growth, maintaining interior nesting habitat, maintaining coldwater streams, and reducing siltation, leaving reserves on canoe routes.

- management and sivicultural prescriptions for special and heritage values: old growth, species richness, regional species diversity, rare threatened or endangered species, areas of concern, buffers.

Although things such as cleaning the air and water are benefits of forests, it is difficult to set an objective for them, as they are difficult to assign numbers to in order to gauge accomplishment at the end of a management period. However, objectives can be assigned to maintain such things as old growth. Objectives can also be assigned for carbon sequestering. Foresters call this timber production, as timber grown is 45% carbon, and maximising timber production will likewise maximise carbon sequestering. In a sense, foresters whose job it is to grow lots of timber, are also trying to sequester as much carbon as possible in the shortest length of time.

It is also not normal to set an objective for "reducing clear cutting". This can, however, be addressed in the integration and implementation of the timber objective with the other objectives, whereby the meeting of one objective must be done, or may be modified, in order to not negatively impact the other objectives.

<u>MYTH BUSTING</u>: CUTTING TREES IS BAD FOR THE ENVIRONMENT

Trees take in atmospheric oxygen, and with water absorbed by roots, create long chain hydrocarbons called wood fibre, as well as sugars and starch which fuel the functioning of the tree. Food reserves are translocated in the tree as sugar, but stored as starch. Trees also use up these food reserves to function as a plant. This is called respiration, whereby starch and sugar are broken down to form carbon dioxide and water vapour, which are given off to the atmosphere. In a normal year, photosynthesis exceeds respiration, but in a drought year, or with significant defoliation, respiration can exceed photosynthesis, and the tree can be left with a deficit. When trees die, the carbon stored in them breaks down through decay and returns either to the soil as organic matter, where it breaks down further, or directly to the air and soil as carbon dioxide and water.

One purpose of forestry is to interrupt the process whereby trees die and decay. Foresters thin stands so that trees do not crowd each other out and die, and harvest trees when their growth declines and replace them with new, faster growing ones. The wood removed is manufactured into forest products, in which the carbon continues to be "locked up" or sequestered. Models exist to show how long this sequestering lasts depending on the forest product. This can be a short time for paper products, but a longer time for structural lumber, and even longer for mine timbers. The total amount of carbon sequestered by a forest is therefore the carbon currently existing in the forest, as well as the carbon in the products that have come from the forest.

MYTH BUSTING: OLD GROWTH IS GOOD GROWTH

In northern Ontario, black spruce and jack pine are what are known as "fire dependent ecosystems", that are adapted to renewing themselves after wildfire. The average occurrence of wildfire determines the maximum age that the species normally achieves. For instance if the average fire occurrence is every 75 years, then the oldest stand will probably be in the 150 year range. When European settlers instituted fire control, they did so in order to utilize this timber before it burned. They therefore set the average fire occurrence to many times 75 years and created a lot of old growth that would not normally have occurred naturally. The result was that the forest became more susceptible to catastrophic fires, and to insect devastation, which tend to be worse in mature forest. This is a problem in parks and where houses are located in fire dependent ecosystems, because if these ecosystems do not burn, the accumulation of dead and dying timber makes them so flammable that they become powder kegs. Insect killed timber adds to this flammability, and insects often target old, non-thrifty trees. Brush fires occur every year in California in a fire dependent ecosystem, which, if not burned artificially, becomes a similar powder keg.

White pine ecology is slightly different. It was normally subjected to fire in the same frequency as more northern species, but these fires did not destroy all the trees, some survived. A white pine old growth is therefore a stand that has many separate age classes occurring together, each one the result of a fire occurrence. When central Ontario and Algonquin Park were logged for pine, the oldest trees were taken first. When the next age class matured, it was harvested. Then the last age class was harvested when it matured. Since no fires occurred, the stands converted to sugar maple and yellow birch, which is what is there now. Only in the eastern section of the park on the sand outwash of the Ottawa valley, and in rocky areas of Parry Sound, are pine still actively managed.

"The natural forest cover of Southern Ontario is a solid tree canopy from the St. Clair River to the Ottawa River." Nothing could be further from the truth. Before the European fur traders arrived, Southern Ontario was a scattering of villages and corn fields, prairie and savannah, and forests in various stages of maturity. Aboriginal practice was to burn and clear forests for their agricultural and village use. When the game was "wiped out" in an area, the village group would move to a new area. The abandoned fields and villages would be able to regenerate with trees, while the vegetation predators or "game" species populations were depressed. This allowed the occurrence of natural shade and mid shade intolerants such as oak, hickory and white pine to maintain a toehold in the south. After the aboriginal tribes were depleted by war and disease, in the time of the French (allied with the Hurons) – English (allied with the Iroquois) wars, the forests had approximately 100 years in which to mature undisturbed until the first settlers arrived. This undisturbed forest was what the settlers and surveyors found. Many "special" or "unique" forests today are the result of aboriginal disturbance, followed by clearing and burning by settlers.

Old growth forests are forests which have grown to the point of equilibrium in terms of photosynthesis v.s. respiration and decay. While young forest is constantly adding wood volume, the old growth volume growth is matched, or often exceeded by death and decay. The sequestering of carbon is therefore minimal or negative. Foresters recognize this and when forest growth starts to decline, they call this "maturity", and set a "rotation age" for harvest. This can occur in stands as a whole, or individual trees in an all-aged stand.

This is not to say that there are not good features to old growth forest. Some wildlife species are dependent on them for survival. This is why in a management plan, some forests can be set aside for a longer rotation age, or lengthened cutting cycle. Silvicultural systems can be put in place to encourage forests to reach certain old growth features, faster than nature can do the same. Even parks must deal with old growth and stand senescence or decadence. Several years ago there were extensive catastrophic fires in Yellowstone Park, because fires had been eliminated for so long from the ecosystem. Now it is realized that fires must be somehow re-introduced as a silvicultural treatment, even in a park, in order to allow stands to renew themselves.

<u>MYTH BUSTING:</u> DIVERSITY OR SPECIES RICHNESS
(*CLEAR CUTTING IS BAD - SELECTIVE CUTTING IS GOOD*)

Some fire dependent species, which are shade intolerant, normally occur in almost pure stands with a low species richness. This is particularly true of jack pine and black spruce. Because of their cones being "serotinous" and only opened by crown fires, they do not compete well with more shade intolerant species such as balsam fir and white spruce. Similarly, shade mid-tolerant species such as white pine, oak and hickory, occur in similarly "low species richness" stands. This is because these species have a "low regeneration potential". With oak this means that there is so much predation on the seed by weevils, deer, squirrels, birds (jays and turkeys), and so much predation on the seedlings by deer and rabbits, that they require special conditions to regenerate. This was recognized thousands of years ago in Britain, in the king's forests when oak was grown for ships of the British navy. Gated enclosures, of berms and palisades, were made to grow oak, and keep deer out. In a species rich environment with maple and ash, they also cannot compete, and are replaced by the more shade tolerant species that have a "high regeneration potential." Therefore it must be recognized that in order to maintain regional "species diversity", some areas must be dedicated to specific stand types with few species present. In particular, in order to have white pine stands in southern Ontario, new ones may have to be started to replace the old ones, as the old ones generally are replaced by hardwoods as the stands mature. This was in fact the intention when plantations were planted, that the plantations would convert to hardwood with thinning treatments.

Clear cutting was intended to mimic the normal regeneration conditions of shade intolerant species such as jack pine and black spruce, creating full light conditions for the new stand. When the stand is harvested and regenerated to the pine or spruce, the harvesting and regeneration process also takes into consideration the elimination of the undesirable competing species. In other words, this gives the forester a chance to eliminate or reduce the poplar, birch and fir that might replace the pine and spruce. Selection cutting would not work in these species, as the pine or spruce cannot produce seed without a crown fire to open the cones, and the stand would convert to whatever other species was present in the understory.

Shelterwood cutting can work in white pine because they will produce seed until they reach the age of about 150 years, and the shelterwood, often with ground fires, mimics the natural means in which they regenerate after wildfire. Uniform shelterwood removes the stand in two or three harvests, allowing a new stand to establish, in partial shade, under the old one, before the final cut is done. Group or strip shelterwood means the stand is harvested in strips or patches, usually 1/3 of the stand at a time, with the last area being artificially planted or seeded. Shelterwood still creates an even-aged stand.

Selection cutting works in hardwood stands of maple and ash. However continued selection cutting will discourage any shade intolerants or mid tolerants such as cherry, oak, or hickory, and push the stand towards a less "species rich" ecosystem of shade tolerants such as sugar maple, beech and hemlock.

Therefore, in order to maintain species diversity, the needs and silvics of each species must be examined for its specific growth conditions and requirements. Simply adopting a hands off approach, or using only one silvicultural treatment method such as selection cutting, will doom species diversity.

With respect to wildlife, some animals actually prefer cutovers and even clear cuts. Moose, in northern Ontario, are hunted in old clear cuts because this is where they go to browse the new tree growth. Deer in the south are found on the edge of woodlots, or in recently harvested woodlots, where the new shoots are. In central Ontario, deer have to be shooed out of the cutovers each morning, as they browse on the yellow birch tops left by the loggers the day before.

MYTH BUSTING: PLANTATIONS SHOULD BE PLANTED IN A NATURAL FORM

Many people become upset or critical when they see trees planted in rows. Trees are planted according to a prescription. This considers matching species to the soils and drainage, stock type (seedlings, transplants, container stock) stock age, planting method, time of year, planting tool, site preparation and vegetation control, and planting arrangement (spacing). Planting arrangement, or spacing must consider what each tree needs to grow, how the plantation is to be thinned, how it is to be eventually harvested, if it is, and what it is intended to be in the next rotation, or the following stand. Trees are generally planted in rows to accommodate thinning. Usually first thinnings are row thinnings which allow access to the plantation by machinery. Subsequent thinnings are selection thinnings. If rows are not laid out correctly at the time of planting, a "cross row" thinning may be done, but this is more complicated. Also, if rows are not the correct width apart, two adjacent rows may have to be harvested to accommodate the thinning machinery.

Since forestry people tend to like things simple, regular spacing allows one to determine how many trees are needed to plant an area:

Spacing: 6 ft. X 6 ft. requires 43,560 / 36 = 1200 trees per acre (usually works out to somewhat less in real life, such as ± 1000)

Spacing: 2 m. X 2 m. requires 10,000 / 4 = 2500 trees per hectare (probably closer to 2100)

MYTH BUSTING: TREES IMPROVE WATER QUALITY AND QUANTITY

This myth raises a paradox. For the most part, trees do improve water quality and quantity by aiding infiltration of rainfall and run-off. They also slow snow melt in the spring, particularly conifer stands, and to a certain extent, reduce flooding. Conservation authorities, for this reason, prefer that there be a conifer component in the regional diversity. The exception and paradox is illustrated in soft maple swamps. In this instance, the trees can pump so much water into the air through evapotranspiration, that removing the trees in a heavy harvest cut can cause the water table to rise. This forest type is one of the most difficult to manage for this reason. Some lowland spruce stands in northern Ontario are difficult to regenerate after logging, as the water table rises, and the site must be drained to reforest it.

BASIC FORESTRY CALCULATIONS

To work in forestry, one must be fluently bilingual; imperial and metric. Although our federal government decreed that we use metric in Canada, lumber is still sold in imperial units. Plywood is in 4X8 sheets, lumber is in 8,10,12,14, and 16 foot lengths, boards are sold in fbm or feet board measure, one board foot being 12" X 12" X 1" thick. Houses are still built with studs on 16 inch centres. Firewood and some conifer is sold in cords, 4 X 4 X 8 feet (128 cubic feet) or face cords, 4' X 8' X 12 to 16 inch lengths (32 – 42 cubic feet). Much of the information used in southern Ontario for tolerant hardwood stands comes from the U.S.A., who, strangely enough in their republican system of government, still use the imperial system of measurement, although quarts and gallons are smaller. Interestingly, imperial is actually easier to use in forestry, since there are less decimals to deal with. So the following section may flip back and forth between the two measurement systems. Some conversion factors are listed in Appendix A.

Another basic requirement of working in forestry is that one must know basic math. Since foresters and forestry technicians are usually working covered in black flies and mosquitoes, they should also be able to do calculations in their heads, before they leave the bush to go back to their computers. Simple calculations such as: areas of circles, knowing and using the area of an acre in square feet and the area of a hectare in square metres, knowing how to switch back and forth from imperial to metric, must be second nature. This will be evident in the following sections.

The following sections will also try to show a reason for taking the measurements, so that they don't seem frivolous.

SAMPLING

Forestry makes use of two parallel sciences, mensuration and statistics. These essentially deal with the measurement and sampling of forest stands and trees. Since all trees in a forest cannot be measured, a sample is taken. One must know how to lay out the sample to allow for all the forest variations, and not produce a "biased" sample. For the purposes of an inventory for a management plan, a low intensity .1% sample is used. For operating plan surveys, a 2 or 3% sample is used. These are taken using sample plots which are random, systematic or mechanical, or a combination of these. Plots are square, rectangular, or circular and usually 1/10 acre or 1/20 hectare in size. Circular plots are easiest because they require only one point to establish or reestablish them. They have less circumference than a rectangular plot of the same size, and they are therefore slightly more accurate as, with a circular plot, it is easier to establish whether a border tree is "in" or "out". A prism uses a plotless sample based on the probability that a tree will be "in" or "out" according to its size and the distance from the prism. These plots are useful for basal area, but only basal area, whereas fixed area plots can be used for structural curves and density calculations, as you will see below. More prism plots must also be established to gain the same "confidence" as fixed area plots, as the sample size in a prism plot is usually less than a fixed area plot (less trees are measured per individual plot).

TREE HEIGHT

Tree height is normally measured with a hypsometer or any number of sticks using simple mathematical relationships. A common tool is the Suunto clinometer, a Finnish instrument. When using these tools, one must know which scale to use, and how to use it, as many of these tools have multiple scales on them. Examples are:

% scale for use 100 feet from the tree with the answer in feet. This scale can also be used 50 feet from the tree dividing the reading by two. A % scale is approximately the same as a 1/30 metre metric scale. These imperial scale results can be converted to metres by dividing by 3.3.

Chain scale (surveyors chain), 66 feet from the tree with the answer in feet.

1/15 scale for use 15 metres from the tree with the answer in metres. This is close to the 50 foot scale if the answer is converted to feet.

1/20 scale for use 20 metres from the tree with the answer in metres. This is the same as the chain scale if the answer is converted to feet.

1/30 scale for use 30 metres from the tree with the answer in metres. This is the same as the % scale if the answer is converted to feet.

1/15, 1/20 and 1/30 scales can be converted to feet by multiplying the answer in metres by 3.3.

Degree scale for measuring slope in degrees. This is similar to none of the others.

As you can see, someone versed in both imperial and metric can use any scale and come up with a right answer.

Height of the tree, or merchantable height to the base of the crown is one step in calculating tree volume. Total height of the tree is also used in calculating site index. Basically, site index means that a more productive site will grow a taller tree in the same number of years. Usually 50 years is used as a standard, although there is another way to apply it to young plantations. The best sites will vary in their productivity for different species. Generally the better site is called a "1" and the poor one a "5" with other sites graded in between. Site index is used as a basis for silvicultural prescription decisions. For instance, different silvicultural decisions are recommended for oak stands, based on the site index of the stand.

DIAMETER, BASAL AREA AND VOLUME

The Importance of Diameter

A conifer tree is essentially a cone with branches. The merchantable section of any tree, from the stump to just below the crown, is a cylinder with one end smaller than the other, and parabolic rather than straight sides. Since the volume of a cylinder is: area of the base times the height, the simplest way of calculating tree volume is to average the top and bottom areas, and multiply by the length of the stem.

Obviously the first step in calculating tree volume then is to measure the tree diameter. This is done in forestry at dbh, or diameter breast height: 4.5 feet from the ground in imperial, and 1.3 metres in metric. This avoids the flair at the stump, and avoids foresters and forestry technicians from bending down, particularly in the snow. Tree diameter can be measured with a number of instruments: calipers, biltmore stick, diameter tape. A diameter tape is a tape with the increments every 3.1415 (pi) inches or 3.1415 (pi) centimetres, so that it reads in diameter rather than circumference. It is also in tenths rather than halves, quarters and eighths as measuring tapes are.

Tree diameters are used for many purposes besides volume, one being to calculate the basal area of the tree at dbh, and the basal area of the stand, which is the total of the basal areas of the trees in the stand. A shortcut to measuring basal area is to use a prism, either in metric or imperial units. Once the area of the base is obtained, or the basal area, several uses are made of it.

Once you have diameter and basal area of a stand, several things are possible:

	Basal Area		Trees	Avg. Tree
Average diameter	per tree	per unit area	per unit area	Spacing
12 inches	.79 sq. ft.	160 sq. ft.	202/A.	14 feet
30 cm.	.071 sq m.	37 sq. m.	521/Ha.	4 metres

These are useful calculations in a plantation, preparing for a thinning. Knowing a couple of these factors, you can calculate the others. Of course, you have to know how to calculate the area of a circle, and how many square feet are in an acre, and how many square metres are in a hectare.

Basal area is also the measurement used to calculate species composition of a stand, from the basal area of each individual species in the stand.

Basal Area and Stocking and Stocking Curves

As conifer stands mature, they are managed using stocking curves which define the upper and lower levels of basal area or stocking between which the stand is maintained for best growth. Different stocking curves can be used for growing different products from the stand, as different stocking levels produce different tree characteristics such as form or taper, and denser stocking reduces tree branchiness and therefore knots in the wood. For instance, in a red pine plantation, the stand may be allowed to grow until the basal area approaches 200 square feet per acre or 45 square metres per hectare, then reduced by thinning to 120 square feet or around 25 square metres per hectare. The amount removed or the difference, represents a thinning volume. Most thinnings are planned to remove 1/3 of the basal area and ½ the stems. This works out, since smaller stems are usually cut before larger ones, and the thinning actually serves to raise the average tree diameter of the remaining stand.

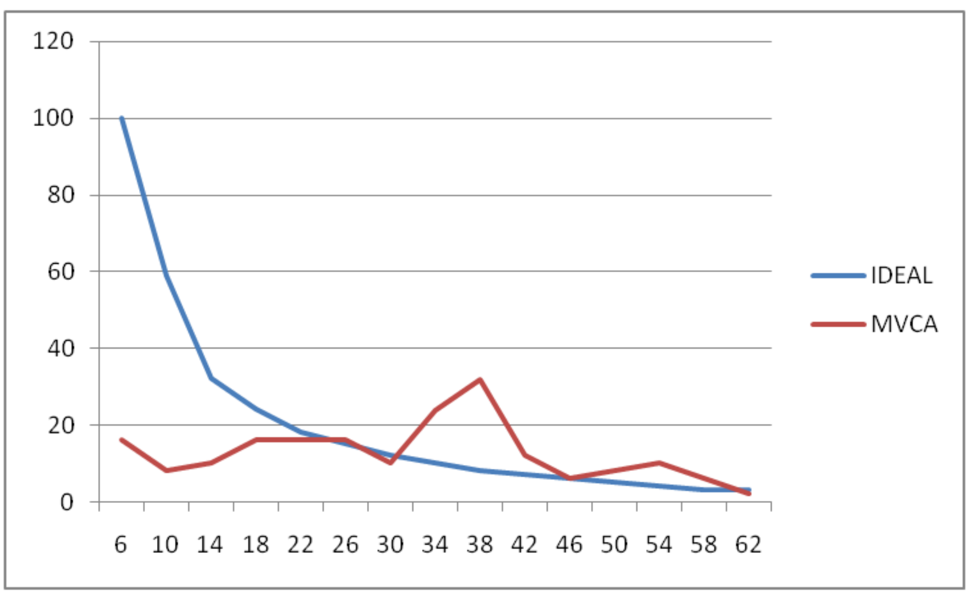
Basal Area and Volume

In imperial units there is a rule of thumb that states (for a 50 foot high stand of red or white pine) that if you divide the basal area by four this will equal the cords in the stand. Therefore a basal area of 180 is 45 cords per acre, and removing 60 square feet to bring it to 120 will be a 15 cord per acre thinning. The factor of 4 varies with stand height: smaller for taller trees, larger for shorter trees. Obviously this shows the direct correlation between basal area and volume. (I have never converted this rule of thumb to metric as cords don't exist in metric, although in this case if the metric basal area were divided by 1.1, a cordage answer would result. (JRI))

In hardwoods, using selection harvest and all-aged silvicultural systems, basal area and stocking must be correlated with tree diameter and stand structure. This means, simply, that a model is constructed of a stand that defines how many small trees, medium sized trees, and larger trees should be present in an "all-aged" stand. This is based on a mathematical formula called a "q" value. Essentially the relationship between the number of trees in one diameter class compared to the next smaller diameter class is a constant, which is the "q". This works best in imperial units, as the curves were developed with a "q" applied to one inch diameter classes. In metric, because of the different measurement unit size, the curves formulation is more difficult. One can see how this must be calculated using fixed area plots which measure tree diameter, rather than a prism, which is biased by its own design, to measure larger trees.

One French forester hypothesized that stands, if left on their own, would approach their own natural "q" value. Different "q" values and residual stocking levels can be chosen to accomplish different objectives for a stand. For instance, a low "q" value produces a flat curve, and with a higher residual basal area, this will approximate an old growth forest. However, this will also severely restrict stand growth, and restrict the resulting stand to shade intolerant species.

When tree numbers are plotted on the "Y" axis and tree size on the "X" axis, a reverse "J" curve is formed. This is shown on the following graph with the blue line. The graph is from another report, and was converted for that report to a metric curve. The red line is an actual stand, plotted over the blue "ideal stand". The red line stand would have some of the trees in excess of the blue line removed in a harvest. Repeated harvests would bring this stand in close approximation to the "ideal" stand. Once again, these curves can also be used to picture specific stand structures that represent a specific habitat type. If one stand is harbouring wildlife of a certain type, then stands of similar structure can be located, or created by appropriate silvicultural systems.



TREES PER HECTARE BY DBH IN CENTIMETRES

Further to the above curve, and built into its formulation, hardwood stands are broken down into three components, saplings, polewood and sawlogs. Each component should be at its own desired stocking and tree numbers.

Size class	Lower Basal Area Limit		Upper Basal Area Limit	
	Sq. Ft./A.	Sq. Metres/Ha.	Sq. Ft./A	Sq. Metres/Ha.
Saplings	8	2	No upper limit specified	
Polewood	16	5	No upper limit specified	
Sawlogs	68	16	90	21
Total	92	23		

When the upper basal area limit in sawlogs is reached, a harvest is scheduled, and again, the harvest is guided by a prescription. The prescription must spell out the trees and species to be harvested how many, season of operation, and special equipment considerations, and must provide for regeneration. In selection forestry, every harvest must start a new age class. The prescription also must provide for special considerations such as: habitat, nesting sites, and nesting season, leaving snags and mast species, buffers on special areas of concern such as streams, and non introduction of invasive exotics on logging equipment. No harvest should remove nutrients, soils, alter water tables, or otherwise, make the site unsuitable for regenerating the next stand.

If the stand is allowed to exceed the maximum level, mortality and volume loss results in the stand. Usually, harvests are scheduled every 10 to 15 years. A further rule of thumb is that if you remove 22 sq. ft. of sawlog basal area in a harvest, this will result in approximately 2,200 fbm (board feet) of a harvest per acre (ranges from 75 to 125 fbm per square foot of basal area depending on tree size and merchantable height (logs per tree)). (Another imperial rule of thumb (JRI)). Obviously then, if the harvest is taking place ten years from the last one, then the growth in the ten year period has been 220 fbm per acre per year and 2.2 square feet per acre or .5 square metres per hectare, per year.

SUMMARY

This is an educational document; hence there are no conclusions to be drawn. The author hopes the above information puts into perspective the basics of how forestry works. Hopefully I have fostered an understanding of the science and how it links to other sciences and how it tries to accommodate related forest and ecological concerns that landowners and students might have.

APPENDIX A

CONVERSION FACTORS

1 metre = 3.2808 feet
1 foot = 0.3408 metres
1 Acre = .40407 hectares
1 Acre = 43,560 square feet
1 Hectare = 2.471 acres
1 Hectare = 10,000 square metres
1 Square foot per acre of basal area = 4.356 square metres per hectare
1 Square metre per hectare of basal area = .2296 square feet per acre
1 Square foot per acre of sawlog trees = 75 – 125 fbm of lumber depending on tree size
Therefore, **1 square metre per hectare of sawlog trees** = 327 – 545 fbm of lumber
1 Square foot of basal area per acre represents .25 stacked cords (50 foot tall plantation)
Therefore, **1 square metre per hectare** represents 1.1 stacked cords (50 foot tall plantation)
1 cord (stacked) = 4 ft. X 4 ft. X 8 ft. = 128 cubic feet stacked (wood, air, and bark)
1 cord = 85 cubic feet of solid wood
1 cord stacked = 3.64 cubic metres
1 cord (85 cubic feet) = 2.4069 cubic metres
1 cubic metre = .4155 cords (there is no "stacked" measure in cubic metres)
1,000 board feet of sawlog trees yields 1.5 cords firewood from tops
1,000 board feet of sawlogs is the equivalent volume of 2 cords of firewood.
1 board foot (fbm) = 12 inches X 12 inches X 1 inch thick lumber
1 cubic foot of log yields 5.35 board feet of lumber (allowing for loss of slabs and sawdust)
1 cubic metre of logs yields 227 board feet of lumber or 4.41 cubic metres per 1000 board feet
Gross Total Volume - total volume of the tree.
Gross Merchantable Volume - the total volume of a tree(s) (gross total volume) less the top and stump. For tree harvesting, stump height should be a maximum of 12 inches or the diameter of the stump to a maximum of 24 inches. Top diameter for hardwoods is normally 10 inches and for conifers, 4 inches.
Net Merchantable Volume - the total volume of the tree(s) (gross total volume) less the top and stump, (gross merchantable volume) and less cull (rot) = net merchantable volume.