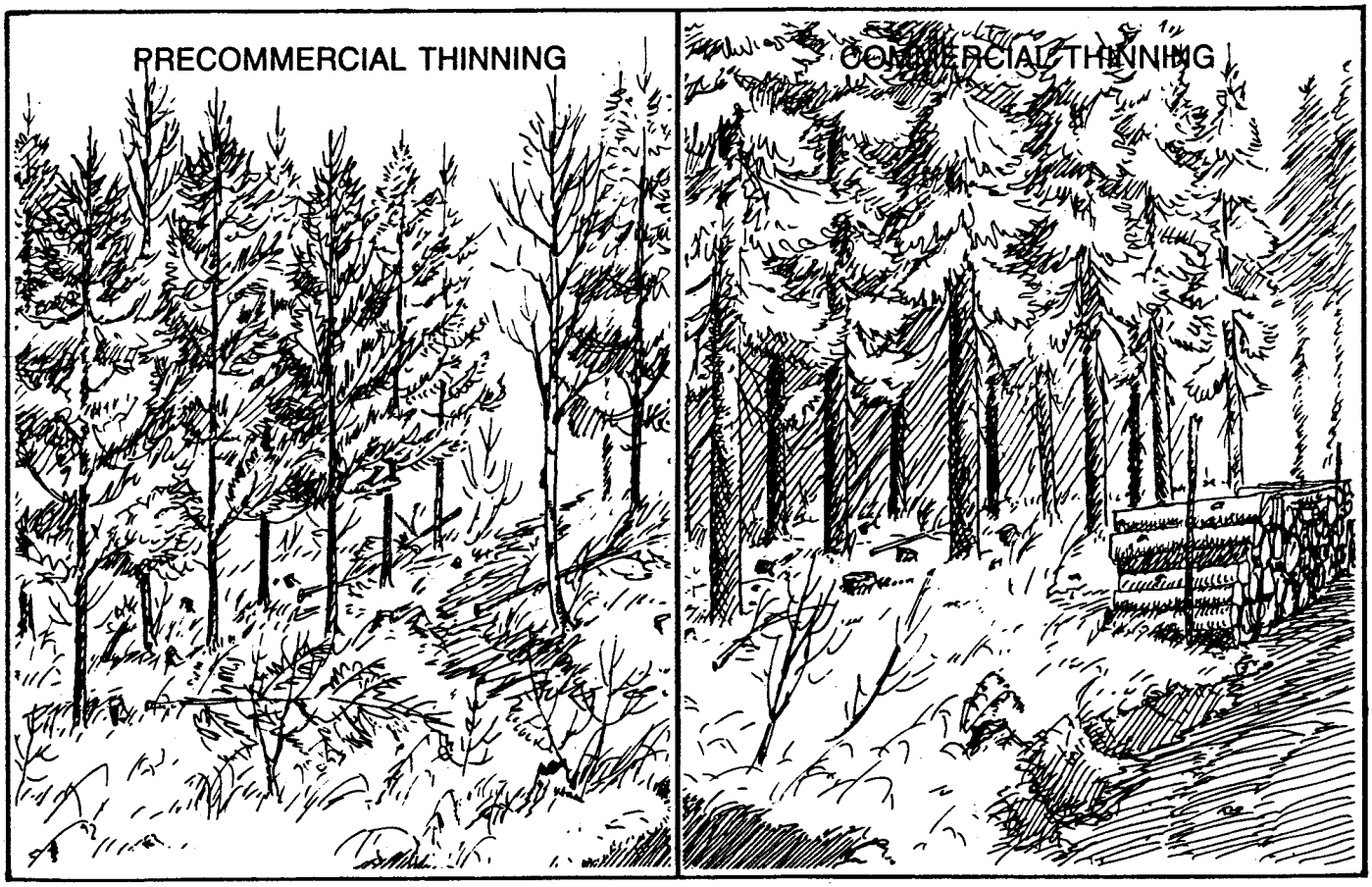
PLANTATION MANAGEMENT:

CLEANING

PRUNING

THINNING



PLANTATION MANAGEMENT

A plantation is a grouping of planted trees as opposed to naturally occurring regeneration. Plantations may require treatments over the years to maintain their health and good growth. This fact sheet provides some guidelines and pointers to help landowners plan these treatments.

THE EARLY YEARS

WEEDING AND CLEANING

Newly planted trees may be subject to competition from grasses, weeds and shrubs. Competition is normally greater the more productive or richer the site, and consequently plantations of conifer on fertile sites such as riparian or stream-side areas or hardwoods planted on the better sites can present unique problems.

Conifers

Coniferous trees such as spruce, pine and larch are considered shade intolerant or mildly shade tolerant. Also, because their nutrient requirements are not as stringent as hardwoods, they will withstand some competition and overtopping by vegetation. In fact, moderate shading is advantageous to white pine as it inhibits white pine weevil and may provide some protection to planted trees by reducing dessication or drying. However, if competition is severe enough that in the fall and winter it may be laid down by snow and ice and smother the trees, or brush competition threatens to severely overtop the trees, then competition control is in order. This may be done by trampling or mowing. These treatments may have to be done several times throughout the growing season and the danger is that trees may be injured. Cultivation is a second means of weeding, providing there is sufficient room to manoeuvre between the rows of trees. Once the trees are tall enough that weed control is no longer necessary, a cover crop of a species such as white dutch clover should be seeded to prevent the re-introduction of weeds into previously cultivated areas. Mulches or herbicides can provide longer lasting control. These need not be applied on the whole plantation area but only on a 3 foot (1 metre) wide strip on the tree rows or in a 3 foot (1 metre) diameter patch around each tree. Herbicides must be applied as per the label as injury to trees or the applicator may result if materials are not used correctly.

Hardwoods

Hardwood trees, as a rule, require more nutrients than conifers and therefore competition that robs them of available nutrients will severely limit their growth. Research by the Canadian Forestry Service has shown that herbicide removal of competition provided the most benefit, cultivation was second, and mowing was of minimal advantage to the trees. Mulches were not tested. Whereas providing a 3 foot (1 metre) area clear of competition around a conifer tree was sufficient to release it, a 6 foot (2 metre) clear area is recommended for hardwoods.

AFTER THE TREES ARE ESTABLISHED

When trees are essentially free of overtopping or competing vegetation, they are considered "free-to-grow". At this time clipping may be necessary to control white pine weevil which attacks and kills the leaders (central shoot) of white pine, or to control European Pine Shoot Moth which destroys new top and lateral shoots of red pine. Even at this early stage, pruning can be started to improve the form of walnut. This involves the selection and favouring of a primary central stem of the tree and the pruning off of bad or weak forks. Trees that are obviously diseased or dead, such as those white pine infected with blister rust, or killed by root collar weevils, should be removed so that the damaging agent does not infect other healthy trees.

PRUNING CONIFERS

Pruning can be done on conifers to produce clear lumber in later thinnings. Because pruning is expensive and time consuming, it rarely pays dividends unless high value products such as sawlogs, utility poles or log house timbers are sold later in the life of the plantation. For this reason, trees to be removed in early thinnings are not pruned, and only 125 to 150 of the best trees are pruned per acre. If early thinning is to be done by removal of complete rows to provide access for thinning the plantation, care is taken to identify these rows early, so that trees in these rows to be removed are not pruned. In pruning operations a rule of thumb is that 1/3 of the length of the tree must have live green branches. Keep this rule in mind when thinning is considered. Some crowding is good to produce straight trees, shade off lower branches naturally, and in white pine, to discourage white pine weevil.

PRUNING HARDWOODS

For hardwoods, on the other hand, corrective pruning may be necessary to produce a strong leader and good form, as well as pruning of lateral branches to produce knot-free wood. With hardwoods, when pruning laterals, do not remove branches from more than 1/2 the length of the tree. When planning pruning in species such as walnut, the final spacing in a plantation may be 40 feet by 40 feet. Before the trees get to this spacing, there must be considerable selection or "picking and choosing" to favour the best trees. There is considerable genetic diversity in hardwoods and not all trees have the potential to develop good stems. For instance, trees which do not express good "apical dominance" or the ability to develop a dominant central stem, nor good wound healing properties or disease resistance can be removed in thinnings.

Previously, "flush-cut" pruning was recommended. Now, pruning that does not damage the "branch collar", or the swelling immediately around the base of the branch, is recommended as it results in less stain and decay in the stem.

THINNING

Thinning plantations is almost a forest science itself. There are as many ways to thin and opinions about thinning, as there are species and species combinations. Following are some examples of how to go about it.

Thinning Conifers

For conifers, if one were to calculate the average stem diameter at 4.5 feet above the ground (for instance, the average d.b.h. or diameter at breast height for 10 adjacent trees), and calculate the numbers of trees per acre, then one can calculate the "basal area" of the stand.

EXAMPLE 1

For example, in a first thinning which might occur at age 25 to 30, assuming plantation spacing is 6 feet X 6 feet, there would likely be 1000 trees per acre originally planted. (the math works out to 1200 but this never happens in the real world). Assuming 85% survival, this leaves 850 trees.

If the average diameter is 6.6 inches and the basal area 200 square feet, then in a fourth row thinning, every fourth row (25% of the volume or basal area: 50 square feet and 25 % of the trees: 212 trees per acre) could be removed. This would leave 638 trees: 75% of 850 and 150 square feet per acre: 75% of 200).

In addition, every third remaining tree (these are small trees averaging 3.7 inches in diameter, which would amount to 8% of the basal area: 16 square feet, or another 212 trees per acre) for a total thinning of 1/2 the trees: 424 or 1/3 the stand basal area: 66 square feet.

The total thinning would leave 426 trees per acre and 134 square feet of basal area, well above the minimum 100 square feet recommended for young plantations. Because 212 of the smaller trees in the stand were removed in the selection process, the average stand diameter would now be higher than the original 6.6 inches: 7.6 inches, effectively increasing the average tree size.

EXAMPLE 2

In a later thinning, if the average stem diameter for 10 trees is 12 inches, then the basal area of one average tree is:

(radius squared X pi or $(1/2 \text{ foot})^2$ X 3.1415) = .78 square feet.

If the stand has been thinned and the spacing is 12 feet by 12 feet (every other row and every other tree removed), then there are:

12 X 12 = 144 square feet per tree or

43,560 square feet per acre / 144 = 302 trees per acre.

Multiply this times the basal area per tree or:

302 trees per acre X .78 square feet per tree = 236 square feet of basal area per acre

for the stand. For later thinnings such as this example, where diameters are 12 inches, the basal area should not fall below 120 feet per acre. Therefore, the heaviest thinning that could be done in this stand would be the removal of every second tree. The thinning might therefore leave approximately:

150 trees per acre at an average spacing of 18 feet (12 ft. X 24 ft.) and:

120 square feet basal area.

The exception to this recommendation would be if the smaller trees in the stand were removed and the better, larger trees kept, then slightly more than half of the trees could be removed to still leave the required basal area or stocking.

Other Conifer Thinning Choices

Early thinnings of young conifer plantations (20 to 40 years) are usually row thinnings removing every fourth or every third row, sometimes removing "selected trees" of poor quality, as well. A rule of thumb is that when row thinning and removing the worst and smallest trees in the "selection" of the remaining rows, thin when you can remove 1/2 the total trees, removing 1/3 the volume (because the smaller trees are being removed their individual basal areas are lower) while still leaving 100 square feet per acre of basal area.

Some species such as spruce, because of dense branching, do not lend themselves to selection thinning in three rows. (you can't get the trees to fall as their neighbours hold them up). Therefore, thinning can be adjusted to remove every third row, leaving two, and thinning only every 6th tree in the selection process.

If row spacing is very close and does not allow sufficient access when only one row is removed, then two adjacent rows can be removed. For instance 2 out of every five rows could be removed, or in spruce, two out of 4, providing that additional selection did not reduce the stand below the required 100 square feet.

When thinning pine stands, stumps must be treated with borax powder. This is a fungicide which prevents infection of the stump by *Fomes annosus* root rot. If the stump is infected, the fungus may spread to adjacent living trees and kill them.

Thinning Hardwoods

When thinning hardwoods, calculate the diameter of the stem in feet, at d.b.h. Multiply this by 20 and this gives the necessary width of crown, or tree spacing. For instance, for 6 inch trees, crown width should be:

.5 feet X 20 = 10 feet.

Maximum numbers of trees per acre would be:

5 X 5 (crown radius ^{2}) X 3.1415 (pi) = 78 square feet of square feet per crown.

43,560 square feet per acre / 78 = 558 trees per acre at an average spacing of 24 feet X 24 feet (square root of 558).

A further thinning control for hardwoods, is that once trees reach 3.5 inches diameter, that basal area not fall below 80 square feet.

Economics of Thinning

In general, first thinnings may not yield any marketable forest products. If a market is found, this is a bonus. Trees can be left unthinned to try and grow them to a size where a product can be marketed, however after crowding becomes excessive, growth on individual trees will slow down and mortality may occur. Also, a severe thinning after trees have been crowded for a long period may result in trees that suffer wind or ice damage and stem breakage. Some plantations have been planted as alternate rows of spruce and pine, or two different types of pine. This will often result in one species outcompeting or crowding out the other. The result is a natural thinning with no effort. Also, black walnut has been planted in alternate rows with white pine, planning for the walnut to kill the pine through toxic chemicals produced by the walnut. This chemical competition is called allelopathy.

When thinning, branches need not be removed from the plantation, nor piled. Removal of branches including green foliage will remove nutrients from the site that the trees need. Piling will slow down decomposition.

VOLUME MEASUREMENT

It takes the following numbers of trees to make a cord (128 cubic feet) of wood:

TREE DIAMETER IN INCHES	NUMBER OF HARDWOOD TREES	NUMBER OF SOFTWOOD TREES
7	15	20
8	11	13
9	8	10
10	6	8
11	5	7
12	4	6
13	3.5	4.5
14	3	3.7
15	2.5	3
16	2	2.5
17	1.7	2.1
18	1.5	1.9
19	1.3	1.6
20	1.2	1.5
21	1.0	1.4
22	.9	1.2
23	.8	1.1
24	.7	1.0
25	.6	.9
26	.58	.8
27	.5	.77
28	.44	.7
29	.43	

To calculate stand volume, basal area can also be used. A rule of thumb is that for 65 foot tall trees, divide the basal area by 3 to give cords: i.e. 200 square foot / 3 = 67 cords per acre. This is the resultant cordage after the trees are topped at 4 inches diameter, which is normally the smallest size, 4 inches at the top end, that wood is cut for pulpwood. For trees 50 feet tall, the factor is 4. For trees 40 feet tall, the factor is 5: i.e. 200 square feet / 5 = 40 cords per acre. Note: these factors work for white and red pine and reasonably well for white and norway spruce. For Scots and jack pine, reduce them by 40 %: i.e. multiply the resultant cordage by 0.6.

To calculate board feet of lumber in a log, a rule of thumb is to calculate the surface area of each end in square feet, using the diameter inside the bark, and average the two areas. Multiply this figure by the length of the log in feet. This is the volume of the log in cubic

feet. Multiply this figure by 5.35 to convert cubic feet to board feet. NOTE: This does not allow any deduction of volume for defect i.e. decay, crooked logs etc.

For example:

Diameter at top end: 19 inches
Area: $(19/12/2)^2$ X 3.1415 = 2.48 square feet

Diameter at large end: 24 inches
Area: $(24/12/2)^2$ X 3.1415 = 3.14 square feet

Average diameter: 2.48 + 3.14 / 2 = 2.81 square feet

Log length: 16 feet

Volume: 16 X 2.81 = 44.96 cubic feet

Volume: 44.96 X 5.35 =240.5 board feet

Don't forget that when cutting trees into lengths, always allow extra length for trimming off the product. Wood cut into boards must be trimmed, and this extra length must be left on the log. This is why standard length for 8 foot logs is 100 inches. For 16 foot logs, it would be wise to cut them 16.5 feet long. Also bear in mind that it is wise to search out markets before cutting trees. Each mill has their own specifications for logs length and minimum or maximum log size. Also, hardwood left lying around too long in summer will stain quickly. Conifer wood will be attacked by wood borers unless peeled.

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October 12, 1993

THINNING SEQUENCE EXAMPLE - White Pine

AGE	HEIGHT	DBH	#/A.	B.A.	VOLUME REMOVAL/A.
25	32 ft.	5.5	1000	175	4rth row - 6 cords
t.			250	45	
at.			750	135	
30	42	6.25	750	160	50% removal of stems
t.			375	50	33% of volume - 11 cords
at.			375	110	
35	50	8.25	375	145	Selective removal of
t.			65	25	25 sq. ft. - 7 cords
at.			310	120	
40	60	9.5	310	160	Selective removal of
t.			78	40	40 sq. ft. - 8.0 cords
at.			232	120	39 poles
45	65	11.0	232	160	Selective removal of
t.			50	40	40 sq. ft. - 10 cords
at.			182	120	30 poles
50	70	12.5	182	160	Selective removal of
t.			40	35	35 sq. ft. - 40 poles
at.			142	125	

t. - thinning
at. - after thinning

Based on Site Index 75

Value of wood — $4-8.00 per cord (pulp or pallets) depending on stem size.
$100-125.00 per 1000 fbm
$20-50.00 per pole

$$PV = \frac{V}{(1+i)^r} - \frac{C}{(1+i)^n}$$

PV = Present Value
V = The expected harvest value
C = The cost of the silvicultural effort
i = The interest rate (true interest i.e. total interest earned minus inflation)
r = The Rotation age to harvest
n = The time of silvicultural expenditure where the present is defined as year zero

J. Irwin, May 1989, Revised, January 1991.