

**MANITOBA
FOREST REGENERATION
SURVEY MANUAL
2010**

MANITOBA CONSERVATION
FORESTRY BRANCH
FOREST HEALTH AND RENEWAL

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1.0 INTRODUCTION

Prompt reforestation of cut-over or burnt forest lands is an integral component of forest management. Forest regeneration surveys are essential for measuring forest renewal success and developing sound forest management strategies. Data collection procedures must employ sampling and evaluation techniques which measure forest regeneration and precisely describe field conditions.

All regeneration surveyors in Manitoba must be licensed by Manitoba Conservation, Forestry Branch. The Forestry Branch offers a training program that provides classroom and field instruction as well as tests that lead to the licensing of forest regeneration surveyors. This manual is intended to provide forest regeneration surveyors in Manitoba with instructions for collecting forest regeneration quantitative and qualitative data. All survey and data recording methods outlined in this manual should be strictly followed to ensure a consistent regeneration sampling procedure throughout Manitoba.

A systematic sampling system with a random starting point is used for regeneration surveys in Manitoba. In the systematic sampling system plots are evenly distributed across an area. Systematic sampling is more commonly used by foresters than random sampling because it is more cost efficient and perceived to provide better estimates because plots are spread over the entire population (Freese, 1962). When using a systematic sample the estimate will be more precise if survey areas are pre-stratified (Corbett and McCulligh, 1989).

Circular fixed area plots of 10 metres² in size with a radius of 1.78 metres are laid out in a systematic grid. Plots are checked to see if they contain at least one acceptable seedling. If an acceptable seedling is present then the plot is considered stocked. An acceptable seedling is either a healthy conifer seedling at least three years of age or a healthy hardwood sapling greater than one metre tall. A healthy seedling cannot have any damage associated with it as indicated in section 6.13 and appendix V.

Stocking is defined as a measure of the proportion of the area actually occupied by the seedlings and is expressed in terms of stocked plots as a percentage of the total number of plots established within the survey block (Ford-Robertson, 1971). Stocking is calculated by dividing the number of stocked plots by the total productive plots in the survey (eg. $25/75 = 33\%$ stocking). In Manitoba stocking alone is used to determine if an area is satisfactorily regenerated through comparison with provincial regeneration standards. A summary of provincial regeneration standards and their requirements appears in section 3.0.

2.0 OBJECTIVES

The regeneration survey is the initial inventory carried out on an area following disturbance. The overall purpose is to document the existence of regeneration and provide a comprehensive assessment of seedling quantity, quality, health and spatial distribution.

The objectives of regeneration surveys in Manitoba are:

- a) To determine the extent of forest renewal in terms of stocking (i.e. percentage of the area occupied) and density (i.e. seedlings per hectare).
- b) To estimate height and provide a qualitative description of the conifer and hardwood seedlings present.
- c) To determine potential plot productivity and provide a qualitative description of micro site.
- d) To provide a measure of potential health problems as well as identify stands requiring additional forest health assessments and or follow up treatment.
- e) To produce a map of the survey block that shows the physical features, location and stocking status of the plots. Dwarf mistletoe infections along edges or on residuals are also mapped.
- f) To provide a process by which survey crew members can convey other observations regarding the block to forest managers.
- g) To provide a measure of forest regeneration that can be compared to provincial forest regeneration standards to determine regeneration success.
- h) To compile provincial forest renewal statistics.

3.0 PROVINCIAL FOREST REGENERATION STANDARDS

Forest managers will indicate the provincial forest renewal standard (Jeffrey R. Delaney, 1995) that each survey site is intended to achieve based upon the previous forest subtype that occupied the site before disturbance, and the treatment history on the site.

The specific standard to apply is determined by the original species occupying the site for natural regeneration and the species planted on the site for plantations. For example on naturally regenerating sites that were previously black spruce the forest renewal standard for black spruce natural regeneration is selected. On sites that have been planted with jack pine the forest renewal standard for jack pine plantations is selected.

The forest renewal standards are expressed in terms of percent stocking and have been determined from relationships between the stocking and density of forest regeneration in Manitoba. Failure to achieve the appropriate regeneration standard for the site indicates the need for reforestation activity (planting, replanting).

The standards identify the amount of regeneration required to satisfactorily regenerate forest lands, and reveal the type of forest each site could potentially develop into. The standards reflect the number of stems required at the end of the regeneration period to produce forest stands at maturity.

Three categories of standards have been identified:

- softwood sites regenerating naturally (untreated after harvest or scarified)
- sites that have been planted
- hardwood sites regenerating naturally

Stocking estimates for each survey block determine whether the block is considered satisfactorily regenerated (SR) or not satisfactorily regenerated (NSR) according to provincial forest renewal standards.

3.1 SOFTWOOD NATURAL REGENERATION

Naturally regenerating and scarified blocks must achieve the forest renewal standard that relates to the previous coertype that occupied the site. The blocks will be deemed satisfactorily regenerated if they achieve the forest renewal standard which matches the coertype of the original stand or either standard immediately above or below the original standard. If they do not achieve these standards the blocks are considered not satisfactorily regenerated even though they may be forested.

TABLE 1: FOREST RENEWAL STANDARDS FOR SOFTWOOD NATURAL REGENERATION ("S" AND "M" SITES)

Original Site	Black Spruce		Jack Pine		White Spruce	
Forest Renewal Standard	Softwood Stocking	Total Stocking	Softwood Stocking	Total Stocking	Softwood Stocking	Total Stocking
Softwood "S"	≥ 55%	≥ 65%	≥ 50%	≥ 65%	≥ 50%	≥ 65%
Mixedwood "M"	≥ 40%	≥ 70%	≥ 25%	≥ 70%	≥ 35%	≥ 70%
Mixedwood "N"	≥ 15%	≥ 75%	≥ 15%	≥ 75%	≥ 25%	≥ 75%

3.2 SOFTWOOD PLANTATIONS

The management intent for softwood and mixedwood "M" sites planted with softwoods is to regenerate the blocks back to a softwood or mixedwood "M" coertype. For that reason the mixedwood "N" and "H" standards are only used for planted blocks that were originally "N" or "H". Planted softwood or mixedwood "M" sites must achieve either the softwood or mixedwood "M" forest renewal standard or it will be classified as not satisfactorily regenerated.

TABLE 2: FOREST RENEWAL STANDARDS FOR SOFTWOOD PLANTATIONS

Original Site	Black Spruce		Jack Pine		White Spruce	
Forest Renewal Standard	Softwood Stocking	Total Stocking	Softwood Stocking	Total Stocking	Softwood Stocking	Total Stocking
Softwood "S"	≥ 75%	≥ 75%	≥ 65%	≥ 75%	≥ 65%	≥ 70%
Mixedwood "M"	≥ 50%	≥ 80%	≥ 45%	≥ 80%	≥ 55%	≥ 75%
Mixedwood "N"	≥ 15%	≥ 80%	≥ 15%	≥ 80%	≥ 25%	≥ 75%
Hardwood "H"	n/a	≥ 80%	n/a	≥ 80%	n/a	≥ 80%

3.3 HARDWOOD NATURAL REGENERATION

Naturally regenerating hardwood blocks must achieve the forest renewal standard that relates to the previous covertype that occupied the site. The blocks will be deemed satisfactorily regenerated if they achieve the forest renewal standard which matches the covertype of the original stand ("N" covertype) or either standard immediately above or below the original standard. If they do not achieve these standards the blocks are considered not satisfactorily regenerated even though they may be forested.

TABLE 3: FOREST RENEWAL STANDARDS FOR HARDWOOD NATURAL REGENERATION ("N" AND "H" SITES)

Original Site	Black Spruce		Jack Pine		White Spruce	
Forest Renewal Standard	Softwood Stocking	Total Stocking	Softwood Stocking	Total Stocking	Softwood Stocking	Total Stocking
Mixedwood "M"	≥ 40%	≥ 70%	≥ 25%	≥ 70%	≥ 35%	≥ 70%
Mixedwood "N"	≥ 15%	≥ 80%	≥ 15%	≥ 80%	≥ 25%	≥ 80%
Hardwood Sites "H"	n/a	≥ 80%	n/a	≥ 80%	n/a	≥ 80%

Certificates of Reforestation will be awarded to forestry companies by Manitoba Conservation, Forestry Branch for those blocks that are satisfactorily regenerated to the regeneration standards that approximate the forest cover type of the former stand.

If a block is regenerated to a regeneration standard that does not approximate the cover type of the former stand, it is considered not satisfactorily regenerated and a Certificate of Reforestation will not be awarded for the block. These blocks will not require additional renewal treatments; however, because they are forested.

If blocks do not achieve any forest regeneration standard they will require additional renewal treatments.

4.0 REGENERATION SURVEY PREPARATION

Forest regeneration surveyors are usually provided a map or aerial photograph indicating the size, location, orientation and shape of the block. They will also be given information regarding the covertype of the former stand, site preparation and planting activities that may have occurred in the block. The size (area in hectares) of the block indicated on the map and/or photo should be confirmed, or if absent, determined.

Survey blocks should be kept under 100 hectares. Large blocks, in excess of 100 hectares, should be partitioned into smaller logical units using features that are clearly distinguishable in the field (ie. roads, trails, streams, dramatic changes in vegetation). The pre-stratification of significantly different vegetation types within larger blocks to be surveyed helps increase the precision of survey results. This will normally be done by the regional forestry office responsible for management of the block.

4.1 EQUIPMENT

Standard forest survey equipment is required to conduct the regeneration surveys accurately. The equipment should be kept in good repair and supplies of exhaustible items in good supply.

Other survey tools or instruments may be substituted for the recommended list below:

hip chain	survey manual
compass	maps, photos
five metre tape	protractor
tally book	hip chain string
tally sheets	flagging tape
plot centre stake	felt pen marker
plot radius cord	pencils

4.2 MAPS AND AERIAL PHOTOGRAPHS

Forest stand maps and aerial photographs are used by surveyors to locate blocks and determine survey boundaries. The most commonly used scale of the photos and maps is 1:15840. At this scale four inches on the map equals one mile on the ground and one inch on the map equals 20 chains (400 m) on the ground. The edge of a Silva Ranger compass displays inches that are marked off in 20^{ths} of an inch. Each 1/20th of an inch graduation equals 20 metres or one chain. This 1/20th scale is useful for measuring distances on maps, to help locate blocks and for estimating the number of survey lines and plots per line in a particular survey.

The Province of Manitoba is divided into townships, ranges and sections (Figure 1). Townships are numbered beginning with 1 at the southern border of the province and ascend north to Manitoba's border with the Northwest Territories. Range numbers commence at Range 1 west

and Range 1 east on both sides of the Principal Meridian and continue in both the west and east directions from this point.

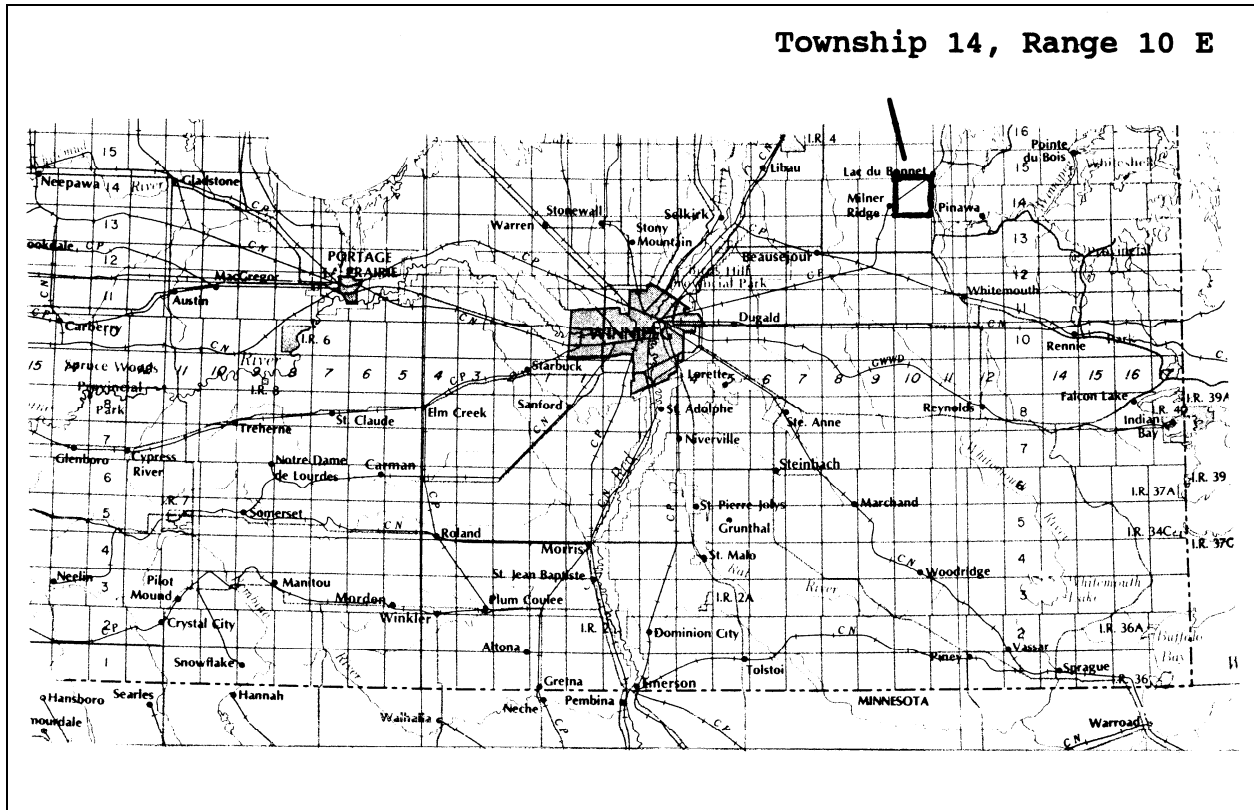


FIGURE 1: MANITOBA TOWNSHIPS

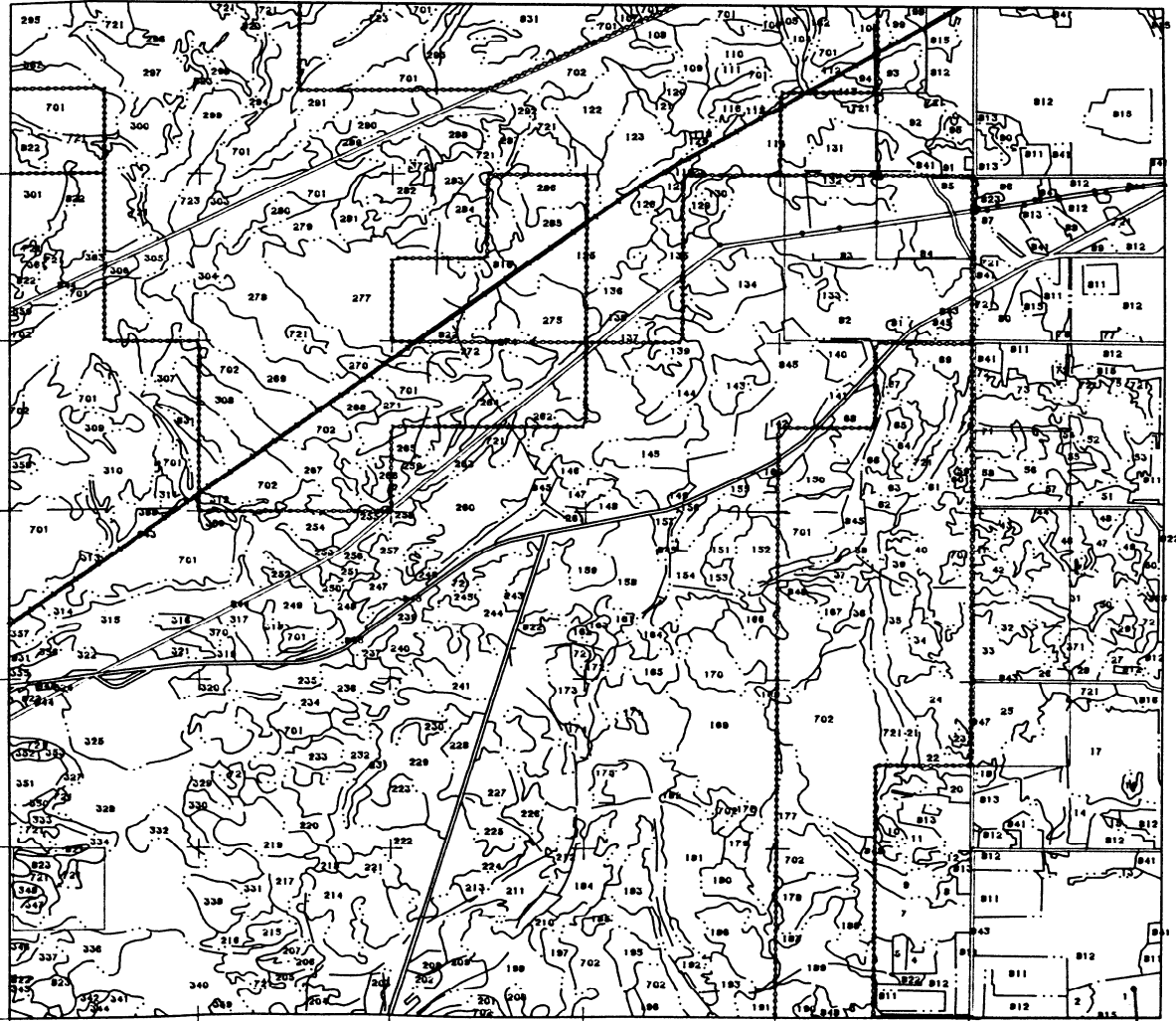
A township is six miles by six miles or 36 square miles in size. Townships are subdivided into 36 sections each one mile square. Sections are numbered consecutively beginning at 1 in the southeast corner of a township continuing to 36 in the northeast corner.

Productive forest stands in a township are numbered from 1 - 699 (Figure 2). If a forest stand crosses a township or range line into an adjacent township, the area of the stand in each township would be identified by a different number. Non productive forest stands are numbered from 700 - 799 and non forested areas are numbered from 800 - 899.

T 14 R 10 E P

MANAGEMENT UNIT NO 23

SCALE: 1:63360 Plotting date: 04 Apr 90



section # 1

31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1

sections numbered in this pattern

FIGURE 2: EXAMPLE OF FOREST RESOURCE INVENTORY STAND MAP

4.3 SURVEY GRID PATTERNS

The design and selection of the survey grid pattern is dependent on the size of the block to be surveyed. The survey grid is comprised of a network of plots evenly spaced along survey lines and a control line to ensure proper spacing of survey lines and alignment of plots. The distance between survey lines must not be more than twice the distance between plots.

Blocks less than five hectares

Blocks less than five hectares in size do not require a regeneration survey.

When small blocks are located close to one another they may be amalgamated, or combined with a larger block, to produce a survey area greater than ten hectares in size. This will permit the measurement of small blocks providing the amalgamated blocks are reasonably close to one another and the original stand characteristics were similar.

The amalgamation of small blocks is to be done prior to the survey and reflect the similar management intent of the blocks. The combined area of the smaller blocks is used to determine the intensity of plot establishment. (ie. establish three plots per hectare if combined survey area is greater than or equal to ten hectares and less than or equal to 40 hectares).

Blocks greater than or equal to five hectares and less than ten hectares

On survey blocks of more than five hectares and less than ten hectares a minimum of 30 plots must be established across the block.

To determine the survey grid size to use, the area of the survey block (metres²) is divided by 30 plots to determine the area represented by one plot. A square or rectangular grid pattern is chosen that approximates the area represented by one plot ensuring that the distance between survey lines (Dl) is not greater than twice the distance between plots (Dp). For example a 7.3 hectare block requires surveying.

$$7.3 \text{ hectares} = 73,000 \text{ metres}^2$$

$$\text{Area represented by one plot } (73,000 \text{ m}^2 / 30 = 2433 \text{ m}^2)$$

Acceptable Grid Patterns	70 m x 35 m = 2450 m ²
	60 m x 40 m = 2400 m ²
	50 m x 50 m = 2500 m ²

When the survey is completed, if fewer than 30 plots have been established the surveyor must complete more plots by adding another survey line between lines 1 and 2. If the 30 plot minimum is still not met another survey line is added between lines 2 and 3.

Survey blocks greater than or equal to five hectares and less than ten hectares may be amalgamated with the same provisions indicated for blocks less than five hectares.

Blocks greater than or equal to ten hectares & less than or equal to forty hectares

For blocks greater than or equal to ten hectares and less than or equal to 40 hectares in size at least three plots per hectare must be established. A rectangular grid of 80 metres between survey lines and 40 metres between plots is used.

$$\begin{aligned} \text{Grid Pattern} &= \text{distance between survey lines (Dl)} \times \text{distance between survey plots (Dp)} \\ \text{for 3 plots/ha} &= 80 \text{ m (Dl)} \times 40 \text{ m (Dp)} \end{aligned}$$

$$\begin{aligned} \text{Area represented} &= 3200 \text{ m}^2 \\ \text{by one plot} & \end{aligned}$$

Blocks greater than forty hectares & less than or equal to one hundred hectares

For blocks greater than 40 hectares and less than or equal to 100 hectares in size at least two plots per hectare must be established. A rectangular grid of 100 metres between survey lines and 50 metres between plots is used.

$$\begin{aligned} \text{Grid Pattern} &= \text{distance between survey lines (Dl)} \times \text{distance between survey plots (Dp)} \\ \text{for 2 plots/ha} &= 100 \text{ m (Dl)} \times 50 \text{ m (Dp)} \end{aligned}$$

$$\begin{aligned} \text{Area represented} &= 5000 \text{ m}^2 \\ \text{by one plot} & \end{aligned}$$

5.0 FIELD ORIENTATION

Once the grid pattern for the survey block is selected, the crew determines where to start the survey. The precise location of the start of the survey is chosen to accommodate the proper orientation of the control line. Normally this start-point falls on or marks the beginning of a control line. The control line is a line of reference drawn through the survey block that divides the block approximately in half. Survey lines are oriented perpendicular to the control line and intersect the control line at the predetermined inter-line distance (Dl).

Surveyors establish tie-points describing, through the use of bearings and distances, how to relocate the survey start point. The tie-points should be readily identifiable in the field and accurately located on a map or photo. Trail intersections, swamps and residual stands make good tie-point references. The tie-point description for each survey is recorded on the reverse side of the field map sheet. Often it is more convenient and practical to establish the tie-points after the survey is completed when surveyors are leaving the survey block.

5.1 CONTROL LINES

Once the survey crew is at the start-point one member of the survey crew (usually two people in a crew) can proceed to flag in the control line throughout the length of the block. The control line assists in the accurate field location of the survey grid and facilitates accurate compassing.

The control line is normally established in a north-south or east-west direction in an attempt to divide the block along its longest axis. The control line may have to be established in an alternative direction if the shape and orientation of the area makes this necessary.

One surveyor then proceeds to lay out the control line. The first survey line intersection will be marked on the control line, with a ribbon, one-half the inter-line distance (DI) from the start point. Subsequent line intersections are located at the inter-line distance (DI) along the control line. The surveyor records the crossing line number on the ribbon which is then fastened such that it is visible from a distance. The marking of control lines and survey line intersections in the field will help surveyors in their compass work and allow them to accurately map the location of plots, survey boundaries, physical features and health concerns.

5.2 SURVEY LINES

While one surveyor is establishing the control line the other will begin establishing plots along the first survey line numbering the plots consecutively beginning with plot number one. Once the surveyor establishing the control line has completed that task he/she begins establishing plots along survey lines at that end of the block. The surveyor should begin numbering these plots with a number large enough so that it will not be duplicated by his/her partner (ie. 101). Both surveyors will establish plots working progressively toward the centre of the survey grid and each other.

Plots are established along the survey line at the inter-plot distance (D_p) from one another. There is no minimum distance that a plot must be located from the block's edge; however, no portion of the plot itself is allowed to fall on the survey boundary.

Once a survey line is completed the surveyor crosses to the next survey line. It is sometimes necessary or easier to walk out of the block before proceeding to the next survey line (Line 9 - Figure 3). A survey line may also begin outside the block if you leave the block when moving to the next line (Line 3 - Figure 3). To maintain the proper spacing between plots an unmarked ribbon is placed at the beginning of a survey line if it is outside the block.

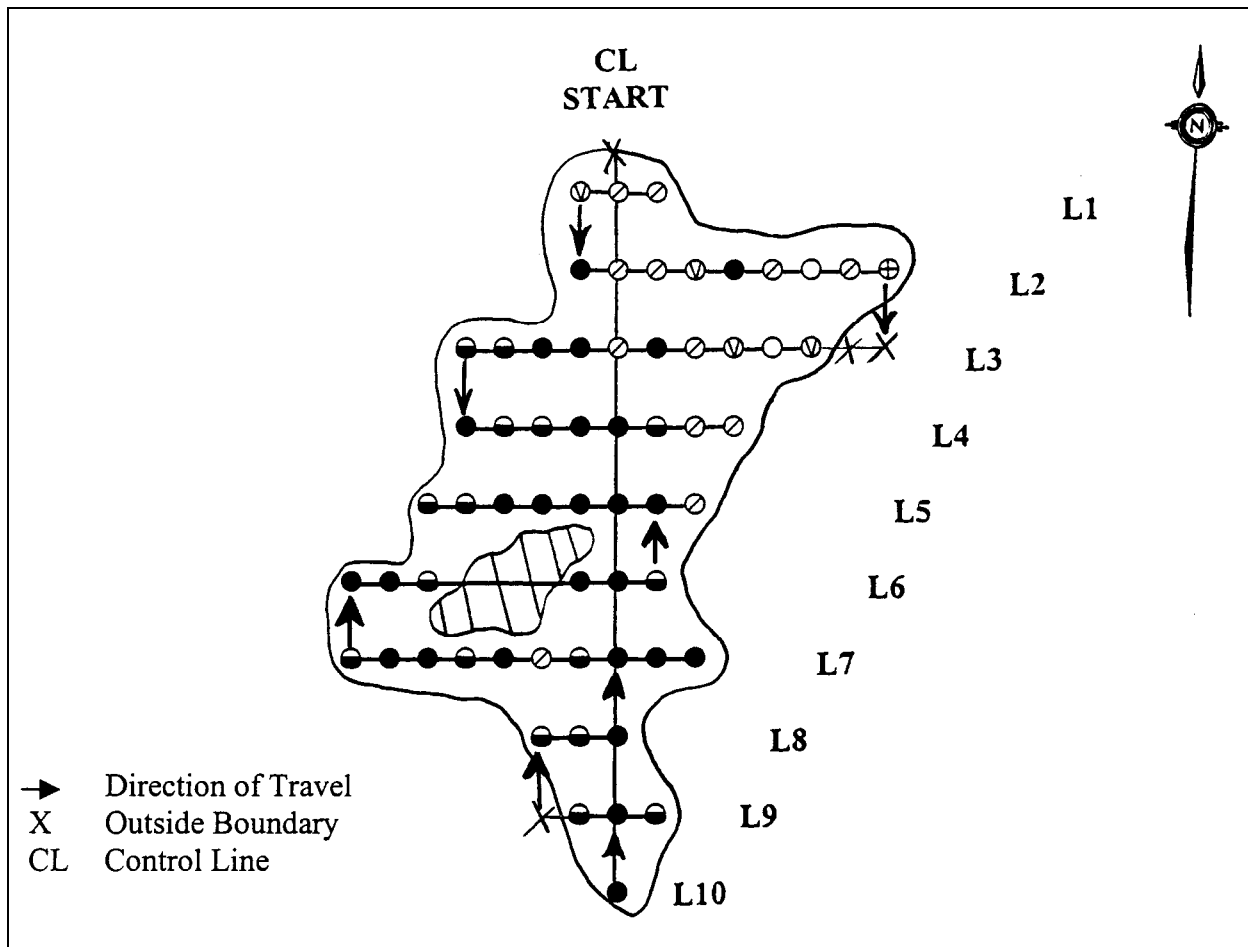


FIGURE 3: REGENERATION SURVEY GRID PATTERN

6.0 PLOT ESTABLISHMENT

At each plot location a centre stake (with plot radius cord attached) is pushed into the ground to establish plot centre, enabling the surveyor to determine the plot boundary accurately. The base will be the centre from which the plot radius of 1.78 metres will be measured. Poorly established plot centres or boundaries may result in a failed regeneration survey because the check surveyor may relocate plot centre in a different position and observe different regeneration results.

After establishing plot centre, the plot is thoroughly searched for the presence of established regeneration which (if present) is recorded on the tally sheet provided. Great care should be taken when the seedling is near the plot boundary to determine if it is within the plot.

A plot centre marker is erected using logging debris or branches found nearby. A ribbon, upon which is recorded the line number and the plot number, is attached to the marker. The

ribbon should be clearly visible and the base of the plot marker firmly embedded or anchored securely. The plot centre must be clearly marked and firmly in place so that a subsequent check survey does not find the original survey in error. **Do not attach the numbered ribbon to any existing vegetation.** The tendency to move plot centre to existing vegetation may cause a bias in the survey by including stems that otherwise would have been outside the plot.

If necessary an unmarked flag may be tied in a visible location to draw attention to plot centre which is accurately marked by a shorter stake and a numbered ribbon. The labeled ribbon confirms the plot centre when check surveys are carried out.

Residual trees present in the block often obstruct the establishment of the survey grid and individual plots. If the map or photo submitted for the block indicates the presence of a group (or groups) of residual trees the survey grid will exclude these areas and plots will not be established there. If there is no indication of residual groups on the map or photo they will be mapped as they are encountered. Occasionally the surveyor may be required to advance beyond what is believed to be the block boundary to ensure that it is not residual timber obscuring additional cut over area (Line 6 - Figure 3).

6.1 STOCKING

On the tally sheet there are two lines associated with each plot. The top line is where stocking information is recorded. If one or more acceptable seedlings are located in a plot then the surveyor indicates on the tally sheet that the plot is stocked to those species. If no acceptable seedlings are found in the plot then a line is drawn through the blanks. If the plot is empty it is checked for site productivity (section 6.2) and then the area surrounding the plot is checked to determine if a void exists (section 6.3).

6.11 Standards For Acceptable Regeneration

A live undamaged seedling which exhibits good vigour and health at the time of survey is said to be an acceptable seedling and eligible for tally. Seedlings that are dead or damaged are recorded with the appropriate health codes.

The forest regeneration survey training program offered by Manitoba Conservation, Forestry Branch includes the physical descriptions of a healthy seedling. This is explained in detail using field samples to ensure continuity among surveyors when field evaluations of seedling eligibility and condition are made.

Acceptable softwood regeneration includes healthy:

- three year old seedlings
- advanced growth up to 20 years of age from the year of depletion
- black spruce layering
- seedlings and trees must be free from Forest Health Damage Codes
- all merchantable coniferous tree species

Acceptable hardwood regeneration includes healthy:

- hardwood seedlings or saplings greater than 1.0 metres tall
- advanced growth up to 20 years of age from the year of depletion
- seedlings and trees must be free from Forest Health Damage Codes
- all merchantable deciduous tree species

6.12 Acceptable Species

TABLE 4: ACCEPTABLE SPECIES

SOFTWOODS	
Jack Pine	Black Spruce
Scots Pine	White Spruce
Red Pine	Balsam Fir
White Pine	Eastern White Cedar
Tamarack	
HARDWOODS	
Trembling Aspen	Eastern Cottonwood
Balsam Poplar	American Elm
White Birch	Manitoba Maple
Black Ash	Bur Oak

Exceptions to the species included in calculating stocking can be made by Forest Companies with approval from the Head of Forest Health and Renewal.

6.13 Forest Health

The average annual growth and mortality volume losses in Manitoba forests due to insects and diseases is estimated at 246,000 m³ with Dwarf Mistletoe alone accounting for 15,000 m³ of these losses (Brandt, 1995). Volume losses to decay are estimated at 2,714,000 m³ annually. The collection of the Forest Health Damage codes in regeneration surveys is an important step in identifying damage conditions that are affecting renewed forests in Manitoba. This information will help to identify blocks with potential or existing health concerns and lead to management recommendations.

Three types of forest health information are recorded by the surveyor: plot information, general impression, and mapping of significant forest health concerns (ie. dwarf mistletoe). Table 5 lists the damages, host species and the corresponding code which is used for all three types of forest health information collected.

TABLE 5: FOREST HEALTH DAMAGE CODES

DAMAGE OBSERVED	HOST SPECIES	CODE
1. DEAD	ALL SPECIES	D
2. GALLS - MAIN STEM	JP, SP ONLY	G
3. DWARF MISTLETOE	JP, WS, BS	DM
4. LEAN	ALL SPECIES	L
5. CHLOROSIS	ALL CONIFERS	C
6. POOR VIGOUR	ALL SPECIES	V
7. BROWSE	ALL SPECIES	BR

On the tally sheet there are two lines associated with each plot. The second line is where forest health observations within the plot are recorded. Critical insect, disease or mechanical damage that meet the criteria in appendix IV are recorded. If a seedling is dead and the cause of death can be determined, record the cause of death rather than dead (example: tree killed by main stem gall record "G"). Seedlings with forest health damage must not be tallied as an acceptable seedling.

On stocking plots if unacceptable damage is observed on one or more seedlings in the plot the corresponding forest health code is written in the space beneath the damaged species. Up to two codes per species can be entered.

On density plots (every fourth plot) the species, number of seedlings damaged and the forest health damage code are recorded for each species in the space provided (JP-1-DM).

The “general forest health” section at the top of the header sheet is intended to convey the surveyors general impression of the block based on what he or she sees while walking between lines and plots. This is not a plot tally. One of the following codes is entered below each damage code, by tree species affected, listed on the header sheet to provide additional information on the health of the entire survey block.

Nil - /, Light - L, Moderate - M, Severe - S

The general information collected in this box is extremely important in selecting stands that may require a more thorough assessment. For example, if dwarf mistletoe is present on the site (edge infection or scattered residual trees) it should appear in the “general forest health” section as well as on the map even if there is no occurrence of it in the plots.

6.2 PLOT PRODUCTIVITY

At every plot a determination is made on stocking. If the plot is stocked with an eligible seedling it must be classified as productive.

The site productivity of plots not stocked to acceptable seedlings is evaluated. If a plot can, in the estimation of the surveyor, support a seedling, or is plantable it is deemed productive. The "Non Prod" column on the tally sheet is left blank for productive plots that do not contain live seedlings.

Plots are considered non-productive if, in addition to the lack of eligible seedlings, 50% of the plot is non-productive (ie. unsuitable soil). If a plot is non-productive it requires further evaluation to determine whether this is a temporary or permanent condition. Plots that could be made productive through the application of available site preparation techniques are classified as temporary non-productive. Plots incapable of being rendered productive by any means are considered as permanent non-productive.

Density calculations will include **all** density plots, non-productive and productive alike. The calculation of stocking will **only** include productive and temporary non-productive plots. Permanent non-productive plots are excluded from stocking calculations.

This information will assist silvicultural planners to estimate the potentially productive hectares that might require silvicultural treatment such as site preparation or planting.

Codes to be used in the "Non Prod" column are illustrated in Table 6. If plots are unproductive due to more than one factor select the one occupying most of the plot.

There is also a temporary non-productive code for grass (99). If in the opinion of the surveyor grass is so dense that it is preventing regeneration of seedlings on more than 50% of the plot use the grass code. In no circumstances is grass considered a permanent non-productive condition.

TABLE 6: NON-PRODUCTIVE CODES

TEMPORARY CODE	PERMANENT CODE	NON-PRODUCTIVE EXPLANATION
11	21	mill site
N/A	22	rock
13	23	flooded
14	24	roads, trails or landings
15	25	heavy slash
99	N/A	grass

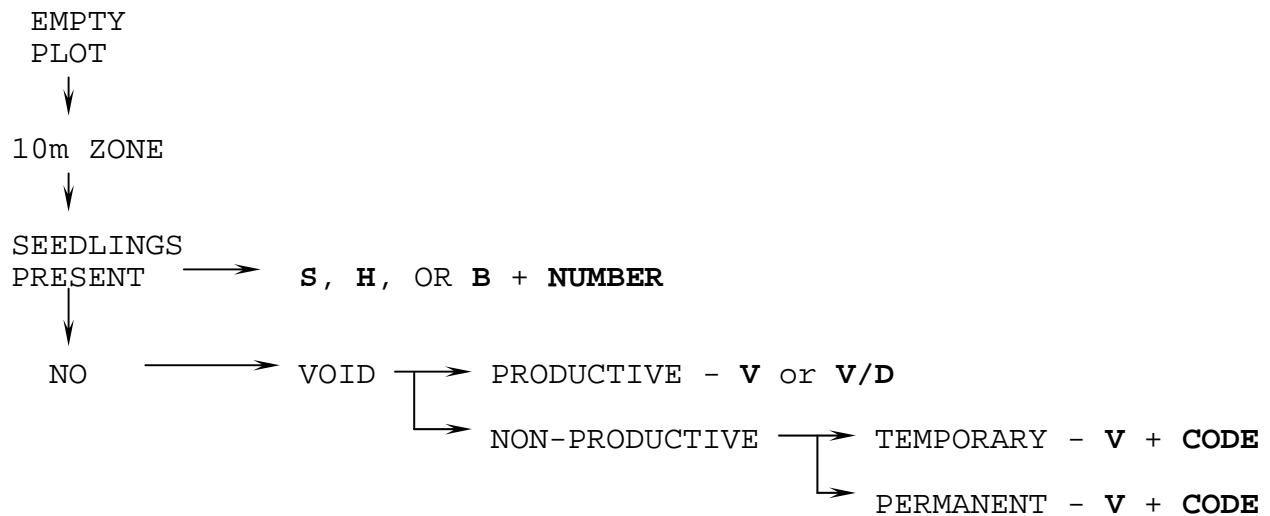
6.3 TEN METER ZONE

If no softwood or hardwood regeneration exists within the plot a 10m radius from plot centre (ten meter zone) is quickly searched for a live seedling. If a seedling is found the 10m zone is considered stocked. If no seedling is found, the 10m zone is considered "void". The flow chart in this section should make the process of assessing the 10m zone and filling out the tally sheet easier to understand.

At an empty plot the first question is whether or not a void exists. If the answer is no, the appropriate code and an estimate of seedling numbers is entered in the "10m ZONE" column and the surveyor moves to the next plot. A softwood seedling is recorded as S, a hardwood seedling is recorded as H and if both are present then a B is recorded in the "10m ZONE" column. The approximate number of seedlings is recorded as a total for all species present (hardwood and softwood seedlings combined). If fewer than ten seedlings are present simply record the number. If more than ten seedlings are present estimate the number in multiples of ten (10, 20, 30 etc.).

If a void does exist the surveyor must determine if it is productive or non-productive. If the void area is productive enter V. Any dead seedlings present in the 10m radius are recorded as D in the "10m ZONE" column. Other types of damage located within the void are not tallied by plot, but a general assessment of the entire survey area is recorded on the header sheet at the completion of the survey.

If the void is non-productive it must then be determined if this is a temporary or permanent condition. The non-productive codes in Table 6 are to be used in the "10m ZONE" column on the tally sheet, with the letter V as shown in Figure 4. A void or temporary non-productive void is identified on the field map as a circle with a V in it. A permanent non-productive void is mapped as a circle with a plus sign (+) in it.



6.4 DENSITY

At each density plot there are three lines on the tally sheet to record information on density, health and height. At every **fourth** plot, in addition to determining stocking, the number of established seedlings present on the plot are counted. An estimate of density (the number of seedlings per hectare), can then be estimated. Each species found within the plot area is tallied independent of the other. A precise count of each species is required up to ten seedlings. When more than ten seedlings are found their number is estimated in multiples of ten (ie 10, 20, 30...90). The maximum number of seedlings of each species tallied at each density plot will not exceed 90.

On the forest health line at density plots a count of each type of damage found by species is required (ie. JP-1-D to identify one dead jack pine).

6.5 SEEDLING HEIGHT

Average seedling height is determined at every **fourth** plot (density plot) and recorded on the third line at each density plot. Height estimates are averaged to determine the height of each species within the block. Heights are estimated to the nearest ten centimetres if they are less than two metres tall and to the nearest half metre if they are greater than two metres tall. Ten centimetre graduations marked on the plot centre stake will assist in determining seedling height.

6.6 FOREST MANAGEMENT RECOMMENDATIONS

At the completion of a regeneration survey, the surveyors have an opportunity to recommend silvicultural treatments they feel may be necessary. The surveyors should consider many factors such as presence of conditional seedlings, advanced regeneration, existing seed source, mineral soil exposure, ground cover and age of cut. For example, a surveyor may recommend that a survey block needs to be site prepared and planted because conifer stocking is very low, few conditional seedlings are found and available seed source is limited seven years after harvest. Other possible recommendations may include that part of an existing plantation should be refilled or a treatment is required to release conifer seedlings from hardwood competition.

7.0 TALLY SHEETS

The following outline describes the procedure for filling out regeneration survey tally sheets correctly. Only one header sheet is required per survey (Figure 4). Much of the top part of a header sheet, form RS-1/97, can be filled out before beginning the survey from information provided to the surveyors.

7.1 HEADER INFORMATION

The header information is filled out in the following manner:

BLOCK # - ten digit number used to locate and identify survey areas. The first six digits indicate the township, range and section in which the survey is located. The last four digits is an identifier number assigned to the cutover, used to distinguish between blocks in the same township, range and section.

DEPLETION - enter depletion activity and year of activity from submission form

SITE PREP - enter site preparation activity and year of activity from submission form

PLANTED - enter planting activity, year of activity and species planted from submission form

TENDING - enter tending activity and year of activity from submission form.

SUBTYPE - enter original subtype code for survey block, from submission form

V - TYPE - enter Forest Ecosystem Classification V - type from submission form

ECO-DIST - enter forest eco-district from submission form

FMU - enter the Forest Management Unit where survey is located, from submission form

AREA - enter area in ha to one decimal place from submission form

D - M - Y - enter date of survey - day, month and year

CREW - enter initials of crew members performing survey

7.2 PLOT INFORMATION

The line and plot number and stocking information is filled out at each plot as follows:

LNE # - enter survey line on which plot is located

PLT # - enter plot number

SEEDLING STOCKING DATA - at each plot a check mark is entered on the top line, in the column for each species located within the plot (to indicate stocking).

The number of seedlings present is entered at each density plot (every 4th plot). One black spruce at a density plot would be entered as 1 in the BS column. Ten black spruce would be entered as 10 in the BS column. At each density plot the average height of each species in the plot is entered on the line below, in metres.

FOREST HEALTH - at each plot a health code is entered on the second line, if unacceptable seedlings exist in the plot. The code is entered in the appropriate column depending on species. (ie. A plot that contained a jack pine with a gall on the main stem and several trembling aspen with extreme foliage loss would be recorded with a "G" in the JP column and "V" in the TA column on the line below the stocking information. If area has been herbicided do not record herbicide killed hardwoods as dead in the forest health component.

At density plots (every 4th plot), identify the number of unhealthy seedlings present ie. JP-4-D / BS-1-C to identify four dead jack pine and one chlorotic black spruce. If two damage codes apply to one seedling, the code that best identifies the damage is recorded (for example a JP killed by main stem gall, record G instead of D).

NON PROD - if the plot is unstocked and deemed to be non-productive, then a non-productive code (from Table 6) is entered into this column. If the plot is unstocked but the site is deemed productive this column is left blank.

10m ZONE - if a plot is stocked this column is left blank. If the plot is unstocked and seedlings are present in the 10m zone then one of the following codes is entered in the 10m ZONE column, depending on the species: S-softwood, H-hardwood, or B-both. The approximate number of seedlings present is also recorded in this column. If the 10m zone contained 5 BS and 4 TA enter B/9 in the 10m ZONE column. If greater than ten seedling are present estimate their number in multiples of ten.

If a plot is empty and the 10m zone is also empty, a void exists and a V is placed in this column.

Any dead seedlings located within the void are identified on the tally sheet by placing a D in the 10m ZONE column.

If the void is non-productive (ie. rock) the Non-Productive codes from Table 6 are used along with a V in the 10m ZONE column.

7.3 HEADER INFORMATION FILLED OUT AFTER SURVEY

After the survey is completed (while still in the field) the remaining sections of the header sheet are filled out as follows:

PLOTS - enter the total number of plots established in the survey

DOMINANT SOFTWOOD - enter the species symbol (Appendix III), height (metres) and age of dominant softwood species. The dominant species will represent a large portion of the seedlings present and occupy a significant position in the canopy.

DOMINANT HARDWOOD - enter the species symbol (Appendix III), height (metres) and age of dominant hardwood species. The dominant species will represent a large portion of the seedlings present and occupy a significant position in the canopy.

COMPETITION INFORMATION - this section is filled out immediately following the completion of a survey. Provide a description of grass and shrub competition present on site. Record major shrub species beside the Shrub Species heading using species symbols from Appendix III. Enter the average height (in metres) for each species beside the Shrub Height heading. Enter one of the following codes beside the Cover Class heading for each major species:

None	<10% cover
1-light	10 - 35% cover
2-moderate	35 - 60% cover
3-severe	>60% cover

Use back of header sheet if more room is needed. This information will be written on the reverse side of the final map so be sure description is complete.

GENERAL FOREST HEALTH - this section is filled out immediately following the completion of a survey. One of the following codes is entered below each of the damage codes listed on the header sheet, by species affected. It is not a summary of information collected at plots, but is based on the surveyors impression of the entire block: /-Nil, L-light, M-moderate or S-severe.

MANAGEMENT RECOMMENDATIONS - this section is filled out immediately following the completion of a survey. Input is needed from all surveyors. Four selection boxes appear on tally sheet as follows:

REFILL - refill all or part of an existing plantation

SIP & PLANT - site prepare and plant all or part of survey area

THIN - reduce density of conifers on site to provide more growing space for remaining trees (ie. natural regeneration after fire)

RELEASE - release conifers from hardwood competition

COMMENTS - Provides space for additional comments related to forest management. If more room is needed use the back side of header sheet.

REGENERATION SURVEY FORM												Page 1 of 5			
64-24-20-D1		CLEAR CUT			88	BRACKE	89	HAND BAREROOT		89	85				
BLOCK #		ACTIVITY YR DEPLETION		ACTIVITY YR SITE PREP		ACTIVITY YR PLANTED		SPP							
-		15		18		359		60		20.3					
ACTIVITY YR TENDING		SUBTYPE		V-TYPE		ECO-DIST		FMU		AREA (ha)					
21-06-97		SH, LH		61		85--66-7		TA-1.6-7							
D / M / Y SURVEY DATE		CREW		PLOTS		SP HT AGE DOMINANT SOFTWOOD		SP HT AGE DOMINANT HARDWOOD							
SHRUB SPECIES		R.A. B.A.		PEST SEVERITY		D G DM L C V BR		GENERAL FOREST HEALTH							
SHRUB HT (m)		1.0 2.0		HOST SPECIES		BS JP JP									
COVER CLASS		1 2													
MANAGEMENT RECOMMENDATIONS															
<input checked="" type="checkbox"/> REFILL		<input type="checkbox"/> SP & PLANT		COMMENTS: Very low conifer stocking in Northeast part of block											
<input type="checkbox"/> THIN		<input type="checkbox"/> RELEASE													
SEEDLING STOCKING DATA												NON PROD		10 m ZONE	
LNE #	PLT #	JP	RP	BS	WS	BF	TL	EC	WB	TA	BA	AS	NON PROD	10 m ZONE	
1	1								✓	✓	✓	✓			
2	2								✓	✓					
3	3													✓	
4	4								1	2					
Height (m)		.9 .7				1.4 1.8									
5	5								✓	✓					
6	6								✓	✓					
7	7									✓				✓	
8	8									2					
Height (m)		.8				1.6									

REGENERATION SURVEY FORM												Page 2 of 5		
LNE #	PLT #	JP	RP	BS	WS	BF	TL	EC	WB	TA	BA	AS	NON PROD	10 m ZONE
2	9			L						✓				
	10	G												B6
	11			D					✓	✓				
	12												21	✓
Height (m)														21
3	13									D				14
	14													H4
	15													13
	16									2	1			
Height (m)										1.5 1.1				
	17	✓		✓					✓					
	18									✓				
	19			✓						✓				
	20			2						1				
Height (m)				.8						1.2				
	21			✓										
	22	✓		✓										
4	23			✓							✓			
	24									3				
Height (m)														
	25	✓		✓							✓	✓		
	26			✓							✓	✓		
	27			✓							✓	✓		
	28	1		1										
Height (m)		.5		.8										

FIGURE 4: COMPLETED TALLY SHEETS - FORMS RS-1/97 AND RS-2/97

RS-297		REGENERATION SURVEY FORM											Page 3 of 5			
LNE #	FLT #	SEEDLING STOCKING DATA											NON PROD	10 m ZONE		
		JP	RF	BS	WS	BF	TL	EC	WB	TA	BA	AS				
4	29								✓	✓						
	30									✓						
5	31			✓						✓	✓					
	32	1		2					2	4						
Height (m)	.5		.8						1.1	1.6						
	33	6		✓					✓							
	34			✓												
	35			✓												
Height (m)																
Height (m)																
Height (m)																
Height (m)																
Height (m)																
Height (m)																
Height (m)																
Height (m)																
Height (m)																

RS-297		REGENERATION SURVEY FORM											Page 4 of 5			
LNE #	FLT #	SEEDLING STOCKING DATA											NON PROD	10 m ZONE		
		JP	RF	BS	WS	BF	TL	EC	WB	TA	BA	AS				
10	51			✓					✓	✓						
9	52			✓												
	53	✓		✓						✓	✓					
	54			3												
Height (m)			.7													
8	55	DM		✓							6					
	56			✓												
	57			✓					✓	✓						
7	58	1		2		1					3					
Height (m)	.4		.6	.2						1.4						
	59			✓						✓	✓					
	60			✓						✓	✓					
	61			✓		✓										
	62								2	8						
Height (m)									1.1	1.5						
	63			✓		✓				✓						
	64	✓		✓							D					
	65			✓						✓						
	66	1		4						2	15					
Height (m)	.6		.75						1.2	1.7						
	67	G		✓												
6	68			✓						✓	✓					
	69			✓		✓					✓					
	70			2		BB										
Height (m)			.7	.5												

RS-297		REGENERATION SURVEY FORM											Page 5 of 5			
LNE #	FLT #	SEEDLING STOCKING DATA											NON PROD	10 m ZONE		
		JP	RF	BS	WS	BF	TL	EC	WB	TA	BA	AS				
6	71	✓		✓					✓	✓						
	72			✓						✓						
	73			✓												
5	74	2		3					1	8						
Height (m)	1.6		.4						1.1	1.6						
	75			✓												
	76									✓						
Height (m)																
Height (m)																
Height (m)																
Height (m)																
Height (m)																
Height (m)																
Height (m)																
Height (m)																

FIGURE 4: COMPLETED TALLY SHEETS - FORMS RS-1/97 AND RS-2/97(continued)

8.0 MAPPING

Each surveyor prepares a field map indicating the location of control lines, survey lines, plots, block boundaries and other physical features such as trails, residual stands, streams, and rock outcrops. Tie points are recorded on the back of the field map in space provided to help relocate survey start point. Field maps are used to create a final map and assist locating plots during check surveys.

8.1 FIELD MAPPING

Prior to the actual survey, the survey crew agrees on the scale to be used for the field map (Figure 5). It is important for each member of the survey crew to use the same scale in the field because the individual maps will be joined to produce a single map of the entire survey.

For blocks ≥ 10 and ≤ 40 hectares in size a scale of one centimetre = 80 metres is recommended. For blocks greater than 40 hectares in size a scale of one centimetre = 100 metres is recommended. These scales correspond to the survey grid dimensions required for blocks of these sizes and should permit the entire block to be mapped on one sheet of metric graph paper.

The location of the control line is drawn on the field map with the survey line intersections indicated. The surveyor proceeds along the predetermined survey grid, recording on graph paper, the physical features encountered. Plot locations and their stocking status are indicated and block boundaries drawn. Dwarf mistletoe infections (edge and residual trees) are mapped and the host species indicated (Figure 5).

- Stocked to Conifer and Hardwood
- ◐ Stocked to Conifer
- ◑ Stocked to Hardwood
- Non Stocked
- ⊙ Void
- ⊕ Nonproductive Void

The survey grid must be strictly adhered to and the surveyor must check his/her location every time the control line is crossed. When the surveyor crosses the control line the surveyor should be at the intersection or very close to the ribbon marking the nearest control line - line intersection point. Any deviation should then be corrected by continuing the survey from the correct intersection point. The surveyors will continue surveying and mapping until they encounter each other at some point along the survey grid.

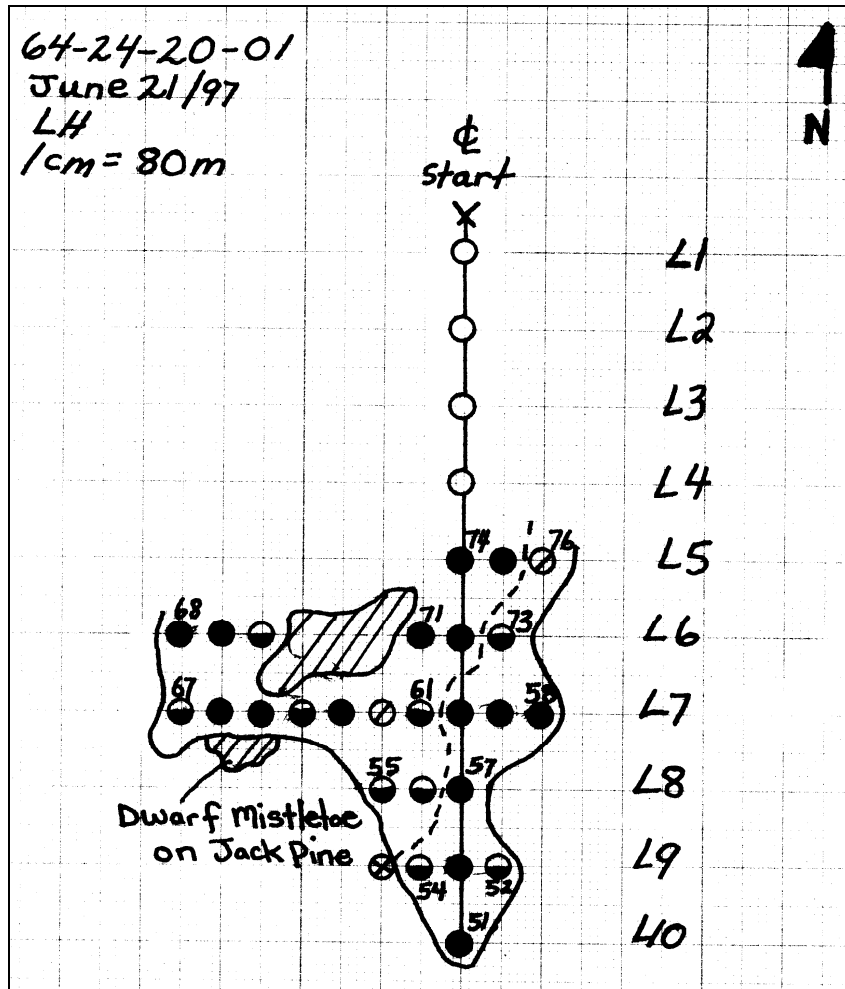


FIGURE 5: REGENERATION SURVEY FIELD MAP

8.2 FINAL MAP PREPARATION

Upon completion of the survey, a final map is prepared. The final map will be a composite of field maps, drawn to a scale that will permit the entire block to be drawn on one map sheet. The same metric map scale chosen for the field map should be used in preparation of the final map to assist the accurate location of plots along the survey grid. All line numbers should be indicated along with every fifth plot number and the number of each plot at both ends of the survey lines.

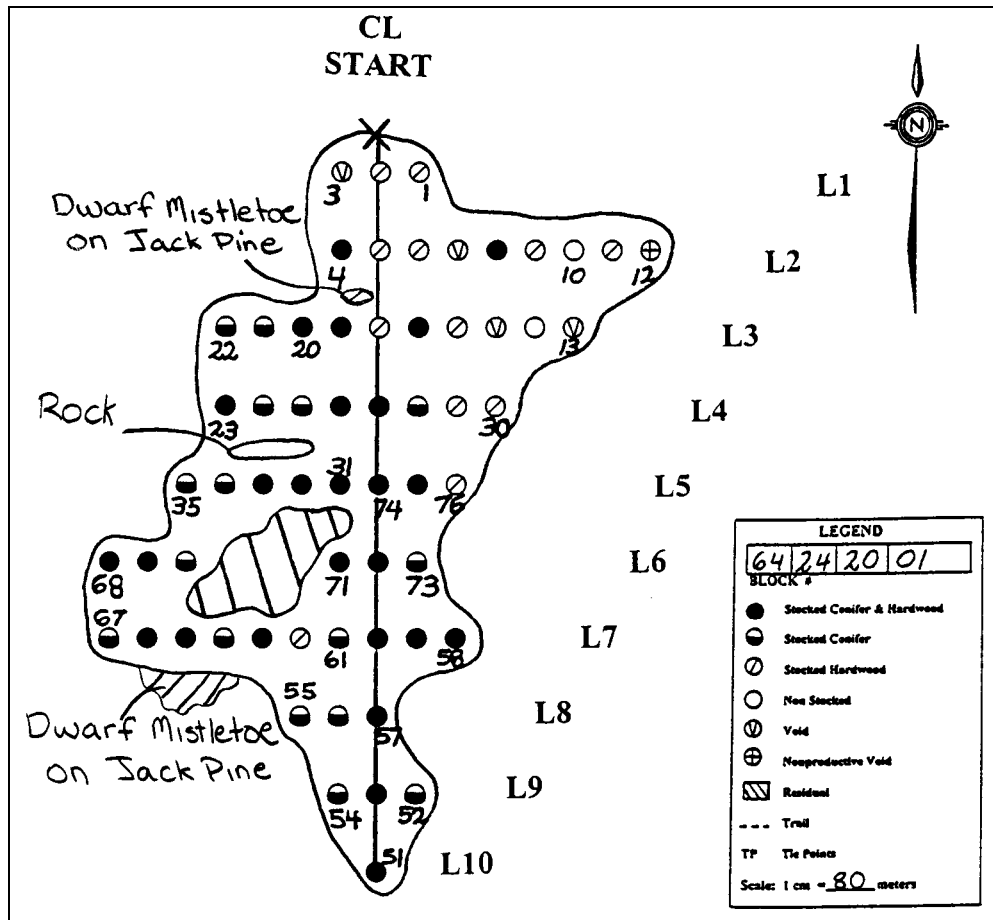


FIGURE 6: REGENERATION SURVEY FINAL MAP

9.0 DATA ENTRY AND CALCULATIONS

A computer program has been written to facilitate survey data entry, editing and the summary of stocking and seedling densities. All completed tally sheets are entered onto computer at which time the data should be free of errors and omissions.

Data entry usually takes place shortly after the completion of the survey. This is done to ensure that any questions regarding the survey data may be answered by the survey crew prior to data entry.

Although all calculations are carried out by computer, examples of the methods used are presented here to provide a basic understanding of how stocking, density and current forest description are determined.

9.1 CALCULATION OF STOCKING PERCENTAGE

Stocking percentages are calculated for each species, softwoods, hardwoods and for total stocking.

The data used in this example is taken from the survey example presented in Figure 4. One of the sixty-one plots established in the survey is permanently non-productive, therefore only sixty are used for stocking calculations (ie. 61-1 = 60 productive plots).

$$\text{stocking \%} = \frac{\text{number of stocked plots}}{\text{total number of productive plots}} \times 100$$

$$\text{Softwood Species Stocking \% BS} = (41/60) \times 100 = 68\%$$

$$\text{JP} = (12/60) \times 100 = 20\%$$

$$\text{BF} = (6/60) \times 100 = 10\%$$

$$\text{Softwood Stocking(S)}^1 = (42/60) \times 100 = 70\%$$

$$\text{Hardwood Species Stocking \% TA} = (33/60) \times 100 = 55\%$$

$$\text{WB} = (21/60) \times 100 = 35\%$$

$$\text{BA} = (7/60) \times 100 = 12\%$$

$$\text{Hardwood Stocking(H)} = (38/60) \times 100 = 63\%$$

$$\text{Total Stocking (softwood \& hardwood)} = (54/60) \times 100 = 90\%$$

¹ A total of 42 plots were stocked to softwood seedlings. Most plots with JP or BF also have BS seedlings present.

9.2 CALCULATION OF SEEDLING DENSITY

At each density plot the number of acceptable seedlings is recorded by species. Every fourth plot is a density plot.

$$\text{stems/ha by species} = \frac{\text{total tallied by species}}{\text{number of density plots}} \times 1,000$$

$$\begin{aligned}\text{Softwood Stems/ha} \quad \text{BS} &= (24/14) \times 1000 = 1714 \text{ stems/ha} \\ \text{JP} &= (7/14) \times 1000 = 500 \text{ stems/ha} \\ \text{BF} &= (5/14) \times 1000 = 357 \text{ stems/ha}\end{aligned}$$

$$\text{Total Softwood Density} = ((24+7+5)/14) \times 1000 = 2571 \text{ stems/ha}$$

$$\begin{aligned}\text{Hardwood Stems/ha} \quad \text{TA} &= (44/14) \times 1000 = 3143 \text{ stems/ha} \\ \text{WB} &= (9/14) \times 1000 = 643 \text{ stems/ha} \\ \text{BA} &= (1/14) \times 1000 = 71 \text{ stems/ha}\end{aligned}$$

$$\text{Total Hardwood Density} = ((44+9+1)/14) \times 1000 = 3857 \text{ stems/ha}$$

$$\begin{aligned}\text{Total Seedling Density} &= (\text{softwood} + \text{hardwood}) = \text{total} \\ &= 2571 + 3857 = 6428 \text{ stems/ha}\end{aligned}$$

9.3 CURRENT FOREST DESCRIPTION

The charts in Appendix VI are used to describe the current state of forest regeneration on regenerating blocks. These charts are based on the number of softwood and hardwood stems per hectare required at seven years of age to produce mature forest stands. The charts incorporate the results from the regressions performed on regeneration survey data and use stocking values to indicate the type of forest that currently occupies the site.

To determine the current forest description of a specific block select the appropriate set of charts, the set for **naturally regenerated** blocks or the set for **planted** blocks. Next, select the individual graph that corresponds to the dominant species in the original cover type for natural regeneration, or the species planted. The section of the graph where the softwood and hardwood stocking values for a specific survey intersect, indicates the cover type that currently describes that block.

A subtype code for each block is generated by the computer program. The first number of the subtype code indicates the covertime (ie. 0 - 3 identifies softwood sites, 4 - 7 identifies mixedwood "M" sites, 8 identifies mixedwood "N" sites and 9 identifies hardwood sites). The second number of the code indicates the subtype, an expression of species composition (ie. A subtype 50 indicates a covertime "M" with white spruce 51%+).

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APPENDIX I

SILVICULTURE ACTIVITY CODES

			CODE
		RIPPER TOOTH	055
		CHOPPER/TRENCHER	056
		C & H PLOUGH	057
		BARRELS & CHAINS	058
		BRACKE	059
		TTS DISC TRENCHER	060
		BARRELS ONLY	061
	MECHANICAL	ANCHOR CHAINS	062
	TREATMENT	BLADE	063
		PLOUGH	064
		DRUM & CHOPPING	065
SITE		DRUM & BARREL	066
PREPARATION		DRUM & CHAIN	067
		DRUM & BLADE	068
		SHEAR BLADING	069
		BURN ONLY	071
	NON-MECHANICAL	BURN & MECHANICAL	072
	TREATMENT	BURN & CHEMICAL	073
		CHEMICAL ONLY	081
		CHEMICAL & MECH.	082
		BAREROOT STOCK	091
	UNPREPARED SITE	CONTAINER STOCK	092
		REFILL CONTAINER	093
	PREPARED SITE	BAREROOT STOCK	094
HAND		CONTAINER STOCK	095
PLANTING		BAREROOT	097
	WITH	CONTAINER	098
	SPOT SCALPING		
	PREPARED SITE	REFILL BAREROOT	099
		REFILL CONTAINER	100
	UNPREPARED SITE	BAREROOT STOCK	101
MACHINE		CONTAINER STOCK	102
PLANTING	PREPARED SITE	BAREROOT STOCK	103
		CONTAINER STOCK	104
	CONE BEARING	ANCHOR CHAIN	131
	SLASH	TTS DISC TRENCHER	132
NATURAL		BARRELS & CHAINS	133
REGENERATION		UNPREPARED	134
	STANDING SEED	ANCHOR CHAIN	135
	SOURCE	BARRELS & CHAIN	136
		UNPREPARED	138

APPENDIX II

DEPLETION ACTIVITY CODES

		CODE
	entire stand	001
	fringe	002
clear	block	003
cut	strip	004
	single seed tree	006
	seed tree plots	007
depletion activity	partial cut	005
	wind loss	011
	drought	021
salvage	flood	031
	insect	041
	disease	051
	fire	052
	burned	053

APPENDIX III

TREE SPECIES SYMBOLS AND CODES

<u>SPECIES</u>	<u>SYMBOL</u>	<u>CODE</u>
Jack Pine	JP	04
Red Pine	RP	03
Scots Pine	SP	09
White Pine	WP	02
Black Spruce	BS	11
White Spruce	WS	13
Balsam Fir	BF	21
Tamarack	TL	31
Eastern White Cedar	EC	41
Trembling Aspen	TA	61
Balsam Poplar	BA	63
Eastern Cottonwood	CO	64
White Birch	WB	71
Manitoba Maple	MM	85
Black Ash	AS	91
American Elm	E	95
Bur Oak	BO	98

NOTE: Additional symbols and codes apply to other species, not considered in regeneration surveys.

COMPETITION SPECIES SYMBOLS

<u>SPECIES</u>	<u>SYMBOL</u>
Raspberry	RA
Beaked Hazel	BH
Willow	WI
Dwarf Birch	DB
Alder	AL
Rose	RO
Choke Cherry	CC
Pin Cherry	PC
Red-Osier Dogwood	DW
Saskatoon	SA
Mountain Maple	MO
Grass	GR

APPENDIX IV

Regeneration Survey Forest Health Damage Codes

Pest/Damage & Host	Sample Tree Unacceptable If:	Signs and Symptoms
<p>Dead – D</p> <p>All Species</p>	<p>Unknown cause of death</p>	<p>Foliage on entire crown dead or missing. Stem broken at base.</p>
<p>Galls – G</p> <p>Jack Pine Scots Pine</p> <p>NOT TA</p>	<p>Gall on main stem. Branch gall within 10 cm of main stem. Multiple laterals infected (5 or more branch galls)</p>	<p>Perennial globose galls on stem or branch. Orange yellow spores on surface of galls in May to June.</p>
<p>Dwarf Mistletoe – DM</p> <p>Jack Pine, Spruces, Tamarack</p>	<p>Any visible infection.</p> <p>*Map & comment on data sheets if DM is on residual or bordering trees.</p>	<p>Witches broom. Branches or stem swelling. Aerial shoots-greenish yellow, up to 10cm in length on Jack Pine and green to brown up to 3cm on Spruce. Basal cups remaining from dead aerial shoots</p>
<p>Lean - L</p> <p>All conifers</p>	<p>Improper planting (J-shaped roots) Leaning from snow loading, wind, root collar weevils etc.</p>	<p>Greater than 45 degree angle from base of tree (root collar). Base of tree must be inside of plot</p>
<p>Chlorosis - C</p> <p>All conifers</p>	<p>Can indicate flooding, nutrient deficiency, Root Collar Weevil, root collar girdling, armillaria etc. Can occur in pockets with dead and dying trees.</p>	<p>Foliage on entire crown is yellow or grey green.</p>
<p>Poor Vigour - V</p> <p>All species</p>	<p>Tree has extreme foliage loss, very suppressed or stunted. Poor vigour only chosen if tree doesn't fit into any other category or has multiple damages.</p>	<p>Thin crown, stunted shoot growth, dead shoots, low height. Causes include extreme competition (grass, shrubs), flooding, repeated frost damage.</p>
<p>Browse - B</p> <p>All species</p>	<p>Buds and shoots clipped off. Adventitious budding. Loss of main stem dominance. Rabbits, mice, voles, deer, moose etc.</p>	<p>Feeding/clipping damage to 2/3rds of crown</p>

APPENDIX V

The following is a list of key diagnostic features to help identify seedlings of common tree species in Manitoba.

CONIFEROUS

JACK PINE: Leaves - cluster of 2, 3/4 to 2 inches long, stiff, can be twisted or straight, with persistent brown sheath at base. Buds - 1/4 inch long, with many small brown sticky scales.

RED PINE: Leaves - cluster of 2, 4 to 6 inches long, persistent brown sheath at base. Buds - up to 3/4 inch long, with many reddish brown, loosely overlapping scales.

SCOTS PINE: Leaves - cluster of 2, 2 to 4 inches long, end of branches appear cut off.

WHITE PINE: Leaves - cluster of 5, 2 1/2 to 5 inches long, very soft, deciduous brown sheath at base. Buds - 1/4 to 1/2 inch long, sharp pointed, with overlapping reddish brown scales.

WHITE SPRUCE: Leaves - single, sharp-pointed, needle like, very stiff, 3/4 inch long, four sided. Crushed leaves have pungent smell. Buds - 1/4 inch long, bud hairs don't extend to top of bud, many bud scales.

BLACK SPRUCE: Leaves - single, needle like, softer and shorter than WS, 1/2 inch long. Crushed leaves have faint lemon smell. Buds - 1/8 inch long with bud hairs extending to tip of bud.

BALSAM FIR: Leaves - single, flat, twisted at base, soft, rounded or notched at tip, 3/4 to 1 inch long, usually spreading into one plane. Bark - smooth grey bark with resin blisters.

TAMARACK: Leaves - 12 to 20 per whorl, 3/4 to 1 1/4 inches long, very soft and flexible in summer, turn yellow in autumn and fall from tree.

EASTERN WHITE CEDAR: Leaves - scale like, paired, overlapping, short, 1/8 to 1/4 inch long, tight against twig.

HARDWOODS

TREMBLING ASPEN: Leaves - alternate, simple, egg-shaped to nearly circular, abruptly pointed, fine toothed, 1 1/2 to 3 inches long, flattened stocks. Bark - smooth, greenish - grey to white. Buds - pointed, several scales, terminal 1/4 inch long.

BALSAM POPLAR: Leaves - alternate, simple, oval, tapering to tip, rounded at base, fine toothed, 3 to 6 inches long. Bark - smooth, whitish to greyish - brown. Buds - terminal 1/2 to 1 inch long, very gummy with fragrant odour.

WHITE BIRCH: Leaves - alternate, simple, usually triangular, coarse double toothed, 1 1/2 - 4 inch long. Bark - thin, smooth, reddish - brown at first becoming creamy white, separates into papery layers. Twig - new twigs have numerous small circular lenticels, reddish brown, shiny. Buds - sharp pointed, 1/4 inch long, terminal curved.

APPENDIX VI

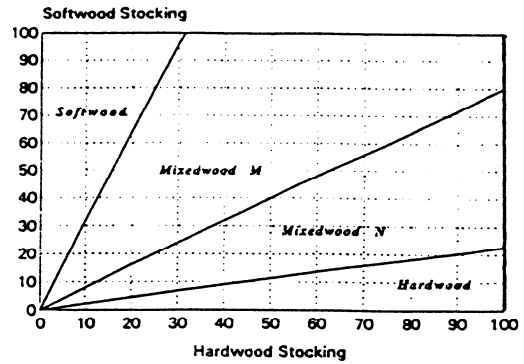
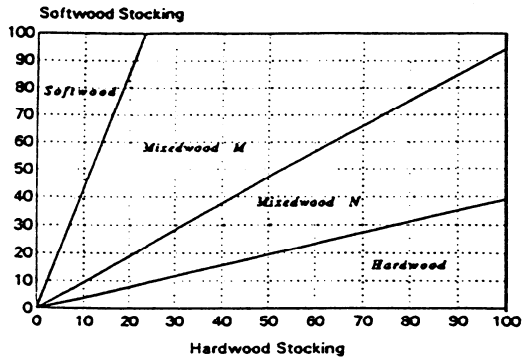
CURRENT FOREST DESCRIPTIONS:

Softwood Plantations

Naturally Regenerating Sites

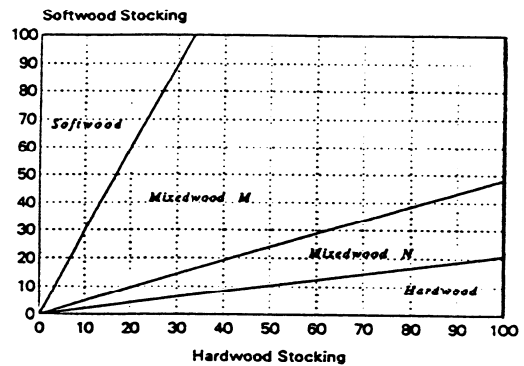
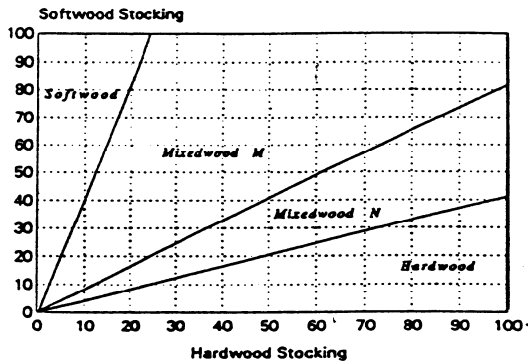
BLACK SPRUCE PLANTATIONS

BLACK SPRUCE NATURAL REGENERATION



JACK PINE PLANTATIONS

JACK PINE NATURAL REGENERATION



WHITE SPRUCE PLANTATIONS

WHITE SPRUCE NATURAL REGENERATION

