Woodlot Management
Home Study Course

Module 2

Harvesting Systems

Preface

Harvesting Systems is the second in a series of Woodlot Management Home Study Courses intended to help landowners manage their woodlots. Originally written by Brian Gilbert of LaHave Forestry Consultants Ltd., it has been rewritten by Richard Brunt and Tim Whynot. Illustrations and layout have been done by Gerald Gloade.

Others modules include Introduction to Silviculture, Stand Spacing, Wildlife and Forestry, Stand Establishment, Chain Saw Use and Safety, Woodlot Ecology, Wood Utilization and Technology, and Woodlot Recreation. Each module is periodically assessed and, when necessary, revised to reflect recent developments of the subject. Also, the Nova Scotia Department of Natural Resources may periodically hold field days to present examples of the information in the most popular manuals.

Copies of these modules are available from the Nova Scotia Department of Natural Resources, Extension Services Division, P.O. Box 698, Halifax, Nova Scotia B3J 2T9, 424-5444 or Education and Publication Services, P.O. Box 68, Truro, Nova Scotia, B2N 5B8, 893-5642.

Harvesting Systems is divided into four lessons:
The Clearcut System
The Shelterwood System
The Selection System
Putting It All Together

At the end of each lesson there is a quiz or exercise to reinforce what you have learned. As well, all terms bolded the first time they appear in the text are defined in the Forestry Definitions on page 32. Other sources of information are listed on page 34.

Table of Contents

List of Illustrations

List of Tables

Introduction

Nova Scotian landowners desire many things from their woodlots. This module examines one of those objectives in detail wood production. It describes several systems for harvesting wood fibre that can be done by the landowner or under his/her direction.

Harvesting is the first step in Silviculture the art and science of growing trees and forests in accordance with a landowner's objectives. As you will see, how to regenerate and improve a future stand should be considered before harvesting.

Harvesting can affect many things in the forest, including recreation potential, wildlife, water quality, and other environmental issues. To avoid repetition, these values are not discussed in each lesson, but some are included in the final chapter "Putting It All Together". This is appropriate because most values are dealt with similarly, regardless of harvesting method. These values are also discussed more thoroughly in other modules in this series.

Forests can be harvested by clearcutting, shelterwood (including seed tree) cutting, selection cutting and high grade cutting. Clearcutting and shelterwoods produce even aged forest stands that have trees of roughly the same age.

The selection method produces and maintains uneven-aged stands with trees of several age classes and sizes.

High grading, where only the best trees are cut, is not recommended. Only poor quality trees are left to reproduce the next generation of trees.

As you read this manual you will learn how the species and health of your trees can limit the harvesting options listed above. You will not learn about individual species characteristics. These are discussed in Introduction to Silviculture - the first manual of this home study series - which should be read before taking this course.

You will also not learn about taking the wood from the stand to roadside. There are many machines and systems for doing this important job and may be the subject, of a future module.

To help ensure the world-wide survival of forests many countries are insisting that wood products they buy come from managed forests. Proper harvesting with the future stand in mind is a key to meeting this requirement and may be a necessity to sell wood in the future. The ideas presented in this manual should help you to harvest properly.

Lesson One:

The Clearcut System

General

Clearcutting is the removal of all trees from an area in a single cut, with the expectation that a new even-aged forest will be established following the harvest (Figure 1). To be considered a clearcut, the cut must be sufficiently large to increase the air and soil temperature, rate of organic matter decomposition, and decrease surface soil moisture content from the majority of the harvested area. This forest influence will not be re-established until a new forest occupies the site. The surrounding forest does, however, maintain some forest influence for some distance into the cut.

Small cuts where the forest influence is not removed belong to the shelterwood or selection systems discussed in lessons two and three. Thus, clearcut size can range roughly between 0.2 hectares (0.5 acres) and 50 hectares (125 acres) or, rarely in Nova Scotia, more.

Some trees or clumps of trees should be left for wildlife, but if excessive amounts of poor quality trees are left on site then the cut becomes more of a high grade cut. These poor quality trees should be felled and cut to make them lie close to the ground. This will speed up decomposition. Cutting these residual trees will also minimize their interference with the seeding and growth of the new forest.

It is often thought that clearcutting removes wildlife habitat. While this is true for the habitats of species that require mature forests, clearcutting also improves habitat for some wildlife species. Species that satisfy all or part of their life requirements in low vegetation and brush with -little overhead shade (ie: small rodent species and ground nesting birds) generally are abundant following a clearcut. In addition, birds of prey and other predators which eat small mice and rodents will also frequent the clearcut areas to hunt. At any rate, the effects of cutting can be reduced by following the wildlife guidelines discussed in lesson four.

Clearcutting should not be done without considering how a site will grow back with new tree seedlings. If planting and/or removal of competition for the seedlings will be required, landowners should set some money aside from wood sales to help cover these costs. Following the advice in the next section will reduce the chances of this happening.

Figure 1. *A clearcut with wildlife clumps. Notice the regeneration in the foreground.*

Generally, clearcutting should be practiced in mature or older stands that contain species that can regenerate and thrive following a major disturbance, and where it satisfies the landowner's objectives for that area. More details are given in Table 1.

The advantages and disadvantages of clearcutting are presented in Table 2.

Table 1. CHARACTERISTICS OF STANDS SUITABLE FOR CLEARCUTTING
* there is a high percentage of dead and /or unhealthy trees (stand is overmature)
* there is a high percentage of trees that are diseased and /or being attacked by insects
* there has been extensive damage by fire or wind
* stand is exposed to strong winds and/or is poorly drained
* short lived (eg. balsam fir) species and/or species that are not able to grow in the shade (eg. trembling aspen) make up more than half the stand
* where adequate regeneration of desirable trees is established or is predicted to establish after clearcutting

Clearcutting with Natural Regeneration

More than two-thirds of clearcut areas in Nova Scotia regenerate naturally, but the resulting regeneration may not have the same species mix as the forest that was removed. Thinning the stand to favour desirable species ten to fifteen years after harvest can often improve the mix and quality of the new forest. In fact, this early thinning is beneficial to most naturally regenerated stands.

But there are ways to improve the species mix that occurs following a clearcut that should be considered prior to cutting. Partial cutting systems are sometimes an option and are discussed in lessons two and three. This discussion will focus on clearcutting.

First, we need to understand where new trees come from following a cut. They can come from seeds already on the forest floor, seeds blown from trees along the cut edge, seeds from harvested trees, or from new growth from roots and stumps of harvested trees. Finally, regeneration established prior to cutting also helps to reforest some clearcut areas.

So natural regeneration depends on natural seeding before, during, or after the cut. When planning the cut, first evaluate any regeneration present. If regeneration is present, will it survive? During harvest, avoid damaging it as much as possible. Damage can be minimized by forwarding (carrying) the wood and by cutting in the winter when snow is present. However, some damage is unavoidable and is acceptable if the regeneration is very dense and spread over the whole site.

If no regeneration is present, you must rely on seed. Although it may already be present in the forest floor, seed more than a year old of most tree species is not capable of germinating. Therefore, new regeneration is usually dependent on the spreading of new seed. The chances of spreading seed are better if there are desirable tree species along the proposed cut edge, and if the cut is done when these trees and the felled trees are full of ripe cones.

A good seed bed is also important for seedling establishment. Each species has seed bed requirements that improve its chances of survival.

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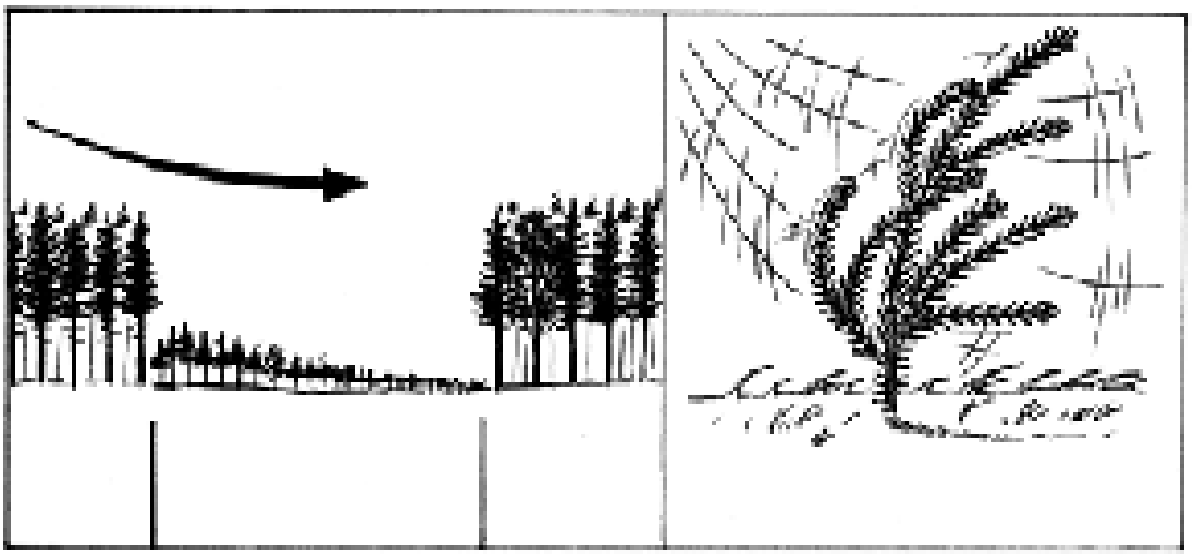

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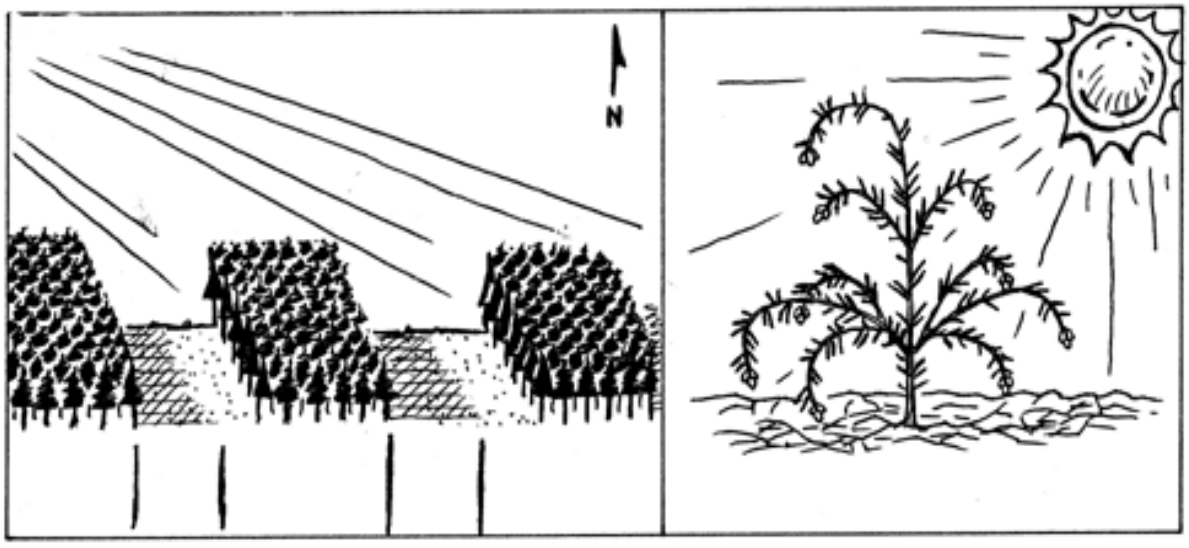

Figure 2. *If possible, strips should be laid out to take advantage of the prevailing winds(a) and/or Northwest to South*east to reduce seedling exposure to sun(b).

However, mixing the soil and upper organic layer is helpful for most species. It is essential for species such as yellow birch. Mixing can be done by skidding (dragging) wood to roadside during summer, spring, and fall. More specialized mechanical equipment can also be used after any harvest to improve the seed bed.

Seed coverage can be improved by limiting cut size, by taking advantage of prevailing winds, and by making irregular edges.

More seed is dropped along the leeward side of a cutover than along its windward side (Figure 2a). If practical, lay out any long edges at right angles to the prevailing winds. In Nova Scotia, the prevailing winds generally come from between Northwest and Southwest.

Also, more seed is dropped near an edge than towards the centre of a cut. Besides improving seed distribution, irregular edges usually look better and are better for wildlife (see lesson four).

Variations of clearcutting have been developed to take advantage of edge and prevailing winds. These strip and patch cuts involve removing a stand in several cuts, usually over a period of five to ten years.

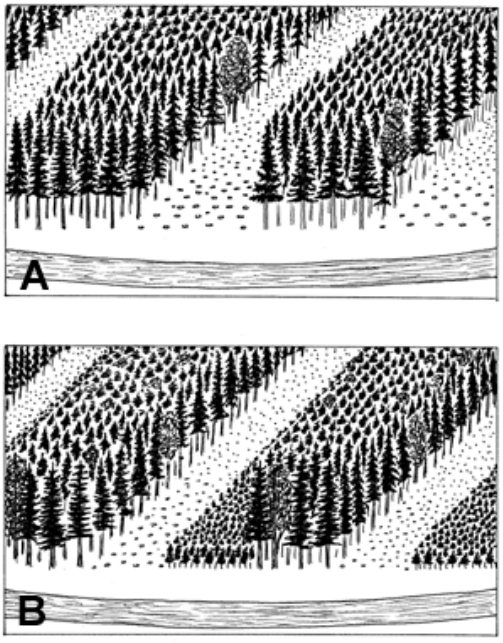

Figure 3. Strip cutting in (a) alternate and (b) progressive strips.

Clearcutting in Alternate Strips

One method that takes advantage of edge and prevailing winds is the alternate strip method (Figure 3a). The area to be cut is first divided into several equal width strips by marking the strip boundaries with flagging tape. Then every other strip is cut.

The leave strips provide seed for the cut strips and protect them from too much sun and wind. If practical, they should be laid out at right angles to the prevailing winds and/or in a northwest to southeast direction to minimize exposure of the seedlings to the sun (Figure 2b).

A good rule of thumb is to keep the strips narrower than twice the height of the average seed-bearing trees. A common strip width is 20 metres (66 feet). The leave strip should be wide enough to be windfirm, and have enough desirable trees to provide adequate seed. If the cut strip is very narrow (less than half the average height of the stand), then the harvest might be called a strip shelterwood cut (see page 12).

Before removing the leave strips, make sure the cut strips are regenerated. Then decide how to regenerate the leave strips. In windfirm stands, a light shelterwood cut (see lesson two) can be used to encourage the development of natural regeneration within the leave strips. In some cases fill planting may be required to re-establish a forest cover.

Clearcutting in Progressive Strips

Clearcutting in progressive strips is the removal of the stand in three successive cuts over a five to fifteen year period (Figure 3b). In contrast to alternate strip cuts, every third strip is cut. The advantage of this is that at least two thirds of the area is regenerated before the final strips are cut. Otherwise the two methods are very similar.

Clearcutting in Patches

Clearcutting in patches involves harvesting the stand in a series of small clearcuts. It is recommended where:

* aesthetics are very important
* uneven ground limits accessibility
* marketable timber occurs in small clumps scattered throughout the stand (common in Nova Scotia due to past cutting practices)
* there is a high risk of blowdown, preventing partial cutting
* there is a hot spot of insect attack (eg. hemlock looper)

Because the cuts are small they should receive good seed coverage and adequately regenerate in a few years. Following this, future harvests can enlarge the patches and/or create new ones. To keep the seedlings growing fast and to develop an even-aged forest, the entire area should be cut within 10 to 20 years of the first cut.

Clearcutting with Artificial Regeneration

If natural processes are unable to adequately regenerate a harvested area, it must be regenerated artificially. Attempts to seed cuts artificially generally have not been successful in Nova Scotia. Therefore, planting is the most effective option.

Planting an entire area (full planting) can cost $1,000/hectare ($400/acre) or more due the costs of site preparation, seedling purchase, planting and weeding. This is why we said on page 2 that money should be set aside to help cover these expenses.

If parts of a cut regenerate naturally, only the areas where no trees are growing need to be planted. This fill planting technique ensures that the area is fully stocked with trees, but it saves on site preparation and seedling purchase costs.

Prior to a full planting, site preparation is usually necessary. This involves the rearrangement and/or crushing of brush and tops to make planting easier and to reduce the fire hazard. Sometimes driving a loaded forwarder over the site is sufficient to do this. Planting can also be made easier by mixing the soil and upper organic layer. This can be accomplished to a limited degree by dragging (skidding) the wood out.

In addition, special site preparation equipment can be used to do the same things. Less often, special ploughs can be used to improve the drainage of the site.

Once the site is ready, it is desirable to plant soon. This would allow the planted seedlings to get a head start on competing plants and take advantage of nutrients being released from decaying branches and organic litter.

However, because of the threat of damage from the seedling debarker weevil, mixed wood and softwood sites should not be planted for at least two years from the date of harvest. Aging makes the stumps and slash less attractive to the weevil.

Container stock grown in plastic trays is most commonly used for planting in Nova Scotia. It is available for most commercial species. Bare root stock used in the past is no longer readily available.

In general, clearcuts are difficult environments for newly planted seedlings. Therefore, seedlings must be chosen and planted carefully. Species should be carefully matched to site (eg. white pine on dry, deep sandy site and black spruce on moist, shallow soils). These are discussed in more detail in Module Five in this series.

Table 2. MERITS OF THE CLEARCUTTING SYSTEM

ADVANTAGES
* It is the most economical harvest method if planting is not required
* Regeneration has complete overhead light which increases the growth of most species and is critical for the species that cannot grow in shade such as red pine, larch, and white birch
* Less road distance is required per volume of wood removed
* Genetically superior nursery stock can sometimes be planted
* Machinery does not have to operate around residual trees, reducing the risk or tree damage
* It is simpler than the shelterwood and selection systems; less supervision and training is required
DISADVANTAGES
* Exposure to the sun and wind may dry out new seedlings
* Regenerating trees are more exposed to frost damage
* In some cases, planted seedlings may not be adapted to local conditions
* Resultant even-aged stands may be more susceptible to insect and disease attacks, although resistant species may be planted in some cases
* Aesthetics are often undesirable but can be improved with proper landscape design
* Competition from undesirable species for water, sunlight, and nutrients is often increased

Lesson One Quiz

Answer - True or False

1. Clearcutting produces uneven-aged stands.

T F

2. Clearcutting is the only way to regenerate species that can grow in the shade.

T F

3. Clearcutting is sometimes practiced without considering regeneration.

T F

4. Orienting strips from Northwest to Southeast reduces drying caused by prolonged exposure to the sun.

T F

5. When clearcutting in strips, it's a good rule of thumb to keep the cut strips narrower than four times the height of the seedbearing trees to ensure adequate natural regeneration.

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T F

6. The main difference between clearcutting in progressive strips and clearcutting in alternate strips is the time period over which you harvest the stand.

T F

7. On clearcuts to be planted, site preparation is not required.

T F

8. When artificial regeneration is needed it's advisable to wait for two years after cutting because of the threat from the debarking weevil

T F

9. Clearcutting does not affect air or surface soil temperature over most of the cut.

T F

10. Patch cutting is sometimes preferred over strip cutting when aesthetics are a prime consideration.

T F

Lesson Two:

The Shelterwood Harvesting System

General

Shelterwood harvesting is an even-aged system used to establish and develop desirable natural regeneration. By removing a mature stand in two to three cuts over five to 20 years, more sunlight reaches the forest floor to stimulate seedling development. The overstory provides seed and shelter for seedlings that can grow under partial shade.

Increased sunlight and the protective overstory give existing or new regeneration a better chance to grow and develop. The shelter encourages water to remain in the organic layer, reducing the risk of seedlings drying out.

The stand is thinned, removing poor quality species and trees as a seed source. This provides space for the remaining better quality trees to increase crown and seed production and their growth rate. Ideally, the first two cuts should be done when the trees have lots of seed. Table 4 gives the minimum and optimum ages for seed production and the time between good seed crops for all commercial species occurring in Nova Scotia.

The shelterwood system is recommended for long-lived species that can grow in partial shade like red spruce, eastern hemlock, white pine, yellow birch, or, white ash, sugar maple. However, it also works in poorer quality stands that are made up of least 30 percent of these species.

Table 3 lists stand characteristics which lend themselves to the shelterwood method. Although primarily used in even-aged stands, it may also be used in some uneven-aged stands when even-aged regeneration is desired.

Shelterwood harvesting is usually the most difficult and costly during the initial cut when the poorest quality trees are removed. However, revenue produced by the wood extracted during the release and final cuts will reduce the financial impact and should result in a positive financial gain for the land owner.

Shelterwood cuts are considered more attractive than clearcuts. By removing a stand gradually, the area always has either some mature forest cover and/or a new, developing forest on the site. This approach also reduces the impact on resident wildlife.

Table 3. STAND CHARACTERISTICS FOR SHELTERWOOD SYSTEMS
*Healthy mature stands with well-developed crowns
*Stands made up of at least 30 percent long-lived species that can grow in partial shade such as red spruce, eastern hemlock, white pine, sugar maple, white ash and red oak
*Sheltered stands on well drained, deep soils
*High volume stands which make the operation(s) more economically feasible

Uniform Shelterwood Method

The Initial Cut

The main idea behind this cut is to allow sunlight to reach the forest floor. It should also encourage tree crown enlargement and an increase in seed production for the remaining trees. Twenty-five to forty percent of the total basal area (similar to wood volume) is removed.

Sometimes this cut is not necessary if regeneration is already present. This may occur where previous thinnings left some openings or where trees have died, creating natural openings.

As with all cutting, creating a good seed bed is important. Therefore, where possible it is best to drag or skid the wood to mix the organic and soil layers. If this is not possible, some other site preparation might be needed.

Lay out wood extraction trails through the stand during the initial cut. The trails will then be in place for the release and final cuts and may continue to provide access into the stand for many uses. Lay out trails to minimize any damage to the stems or roots of standing trees.

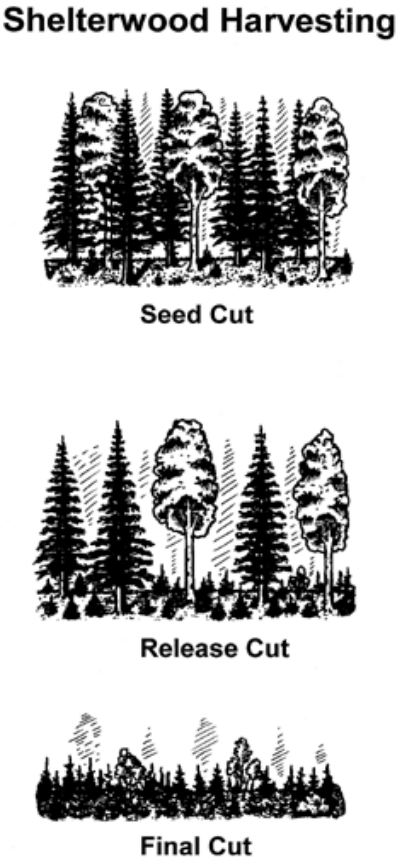

Figure 4. *Stages of uniform shelterwood method.*

To avoid confusion, we will discuss commercial thinning, a treatment done the same way as the initial cut. Unlike a shelterwood harvest, this stand tending treatment is generally applied in stands less than 50 years old. The objectives of commercial thinning are to increase yields by harvesting trees that would normally die and to promote the growth and quality of crop trees. It does not try to promote regeneration.

The Release Cut

When adequate regeneration is present, thirty to forty percent of the remaining volume is removed, again leaving desirable species such as red spruce and yellow birch. The idea of this

cut is to release the young trees by giving them more light, water and nutrients. This encourages them to push their roots through the organic layer and into soil.

Since damage to some of the established regeneration is often unavoidable during the final cut, remove as many overstory trees as possible while still maintaining adequate seedling protection, and a seed source if necessary.

Uncut trees should preferably be left uniformly scattered throughout the stand, but can be left in clumps.

If regeneration is not present five to ten years following the release cut, consider site preparation to better prepare the seed bed. In some cases, planting may be necessary.

On the other hand, if the roots of the regeneration pushed into the mineral soil following the initial cut, you may skip the release cut and harvest the remaining standing timber in one cut.

Table 4. SEED PRODUCTION CHARACTERISTICS OF OUR NATIVE SPECIES

TREE SPECIES	OPTIMUM AND (MINIMUM) SEED PRODUCING AGES (years)	TIME BETWEEN GOOD SEED CROPS (years)
Red spruce	70 - 120 (30)	3 - 8
Black spruce	100-200 (10)	4-6
White spruce	30-60 (10)	2-6
White pine	90-200 (60)	3-5
Red pine	30 (50-150)	3-7
larch	50-150 (15)	3-6
balsam fir	25-60 (15)	2-4
Eastern hemlock	40	2-3
Red maple	50	1-3
Yellow birch	70 (40)	1-2
Red oak	50 (25)	2-5
White ash	60 (20)	2-3

The Final Cut

Once the seedlings are firmly rooted in mineral soil and have attained a height of approximately 20 cm (8 inches) all the remaining trees can be removed.

Although some damage will likely occur during this harvest, it can be minimized by carrying the wood and harvesting in winter. Winter cuts reduce seedling damage because often the regeneration is protected by a blanket of snow and ice.

The final cut can be done in stages. Some areas may need release sooner than others. In some cases, residual trees may be left longer to increase their value, or the removal of remaining trees may be gradual to reduce the shock to the regeneration.

The Strip Shelterwood Method

The strip shelterwood method consists of cutting narrow strips and uniformly thinning the uncut strips between the harvested sections (Figure 5). Cut strip widths can vary between six to eight metres (20-25 feet) while residuals can vary between seven and twenty metres (22-60 feet). A maximum width for cut strips of eight metres is recommended to maintain the shelterwood effect.

As with strip clearcutting there are three things to consider when laying out strips:

1. Orient the strips northwest to southeast so that the shade from standing crop trees protects any new seedlings from the hot sun during the summer.

2. Locate the long side of the cut at right angles to the prevailing winds to promote even seed distribution.

3. Accessibility and layout in relation to roads. There is no orientation that is good for all situations.

The stages are the same as for the uniform system.

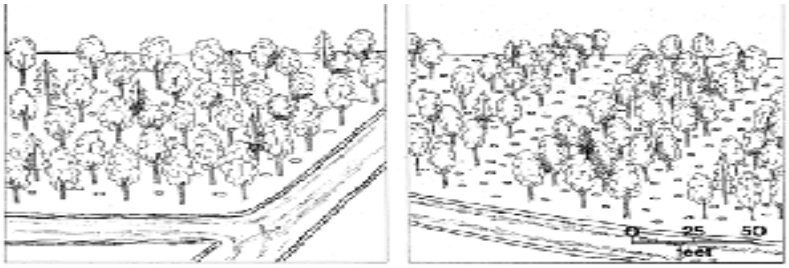

Figure 5. *A comparison of uniform and strip shelterwood methods.*

The Seed Tree Method

An open shelterwood is called seed tree cutting (Figure 6). The seed tree cut leaves only a few standing trees, individually or in groups with the goal to obtain regeneration. It can be a cost effective way to obtain quality regeneration. Selected seed trees provide a seed source and are usually (although not always) harvested after the crop of new young trees has become established. They can also be left to develop into cavity trees for wildlife.

Unfortunately, seed trees will work only with some species and site conditions. Seed tree cuts are currently recommended for stands of white pine, yellow and white birch and sugar maple.

They are not generally recommended for shallow-rooted species such as spruce and eastern hemlock which are prone to blowdown. However, recent observations indicate that groups of deep-crowned red spruce trees can work on sheltered sites. These groups are less likely to be blown over by the wind, and might survive long enough to provide adequate seed for the next stand.

The seed tree method should not be used for red maple or poplar/aspen. Trees from stumps and roots of cut maples and aspen will "out compete" and smother the new crop of regenerating seedlings (if not controlled).

Regardless of species, seed trees should be healthy, windfirm, quality stems, and at a good seed producing age (Table 4). Leave enough seed trees to ensure adequate seed is spread over the treated area. Each species requires a certain spacing according to its ability to spread seeds; for white pine leave 20-30 trees/hectare (eight to ten per acre) and for birches and maples leave 15 trees/hectare (six per acre).

As with other natural regeneration techniques, the harvesting operation should mix organic and mineral soil to help new seedlings become established.

Table 5 presents the advantages and disadvantages of the shelterwood methods. Many disadvantages can be overcome by proper training.

Figure 6. *Seed tree cutting. Skidder dragging logs will help mix the organic and mineral soil.*

Table 5. MERITS OF THE SHELTERWOOD SYSTEMS
ADVANTAGES
* Regeneration of species that can grow in the shade is more likely
* Seedlings are less subject
* Because the seed source code is native to the area, seedlings are usually well adapted to the site
* Better quality uncut trees provide most of the seed for the new seedlings
* Undesirable competition such as pin cherry and grey birch is minimized due to shading
* Initial and release cuttings use wood which may die before the final cut
* Due to increased growing space, uncut trees grow faster
* Because the old crop is removed gradually, there are aesthetic and wildlife benefits
DISADVANTAGES
* Higher risk of blowdown
* More roads needed per volume of wood removed; roads must be maintained for future cutting
* Silviculture workers require greater skills than those required in clear cutting:
- extra precautions must be taken to prevent damage to remaining trees and regeneration
- choosing trees to cut requires a good understanding of the shelterwood process
* Low quality wood produced by the initial and release cuttings may be difficult to market diameter, poor quality trees without damaging remaining trees and regeneration

LESSON TWO QUIZ

ANSWER - True or False

1 . Shelterwood cutting removes the entire stand in one cut.

T F

2. Shade-tolerant regeneration should result from harvesting a stand with the shelterwood system.

T F

3 . Shelterwood cutting is well suited to stands that have low volume and are exposed to the wind.

T F

4. The shelterwood method may involve an initial cut, a release cut and a final cut that occur over a 5 to 20 year period.

T F

5 . During the initial cut, it's wise to plan wood extraction routes which can also be used during the release and final cuts.

T F

6. If regeneration has not established I 0 years after a release cut, site preparation should be considered to develop a better seed bed.

T F

7. All remaining trees should be removed in the final cut when the seedlings are firmly rooted in mineral soil.

T F

8. Two major types of the shelterwood system are uniform and strip.

T F

9. The shelterwood method is an uneven-aged system.

T F

10. Shallow rooted species are best for a seed tree treatment.

T F

Lesson Three:

The Selection System

General

If the landowner wants a more or less continuous harvest from a particular stand or location in the woodlot, the selection system should be considered. Selection cutting allows a regular harvest of trees from several age classes without ever removing the entire canopy. It is often favoured by woodlot owners who do not want to clearcut.

Selection cutting removes poor quality, mature and immature trees and provides space and seedbed conditions for the establishment and development of new trees. As in a shelterwood the best trees are left for seed and shelter.

Stand tending and harvesting are done at the same time. It encourages the development and maintenance of several age classes in the stand. Stands suited to selection cutting are presented in Table 6.

Selection harvesting is not appropriate for all stands. For example, stands made up of short-lived species that do not grow well in partial shade and/or poor quality trees may benefit more from a clearcut that is properly regenerated.

Also, even-aged stands containing young, healthy, good quality, long-lived species (ie. red spruce) are more suited to a commercial thinning (see page 10) than a selection harvest. However, these stands may become more suitable as they mature. Although it is an uneven-aged system selection cutting can also be used to make an even-aged stand uneven-aged.

If not properly done, selection harvesting can turn into "high-grading" or selective cutting. As discussed in the introduction, high grading takes only the biggest and best trees and leaves the less desirable trees. An expression used in Nova Scotia sums it up as "... take the best and leave the rest! ". This problem is compounded because new trees are regenerated by an inferior seed source.

To ensure continual harvesting of a stand, wood should not be cut faster than it can be grown. For example, if a stand increases in volume by 5.5 cubic metres per hectare per year (one cord per acre per year), you may choose either to harvest this amount every year or to cut ten cords per acre every ten years from that stand.

If wood is cut faster than it is grown, the mature usable timber will eventually be used up. If, however, the stand contains a high proportion of over mature trees, more wood can be cut during some cuts to use all mature timber and gradually develop the younger age classes.

On the other hand, if the growth rate is undercut, eventually there will be an excess of mature to over mature trees in the stand and trees will die. Periodically examining and cutting accordingly, should ensure cutting balances growth.

In theory, an uneven-aged stand has the potential to produce more wood fibre than an even-aged stand because the irregular canopy occupies more growing space and wood is salvaged on a regular basis. This is not fully proven.

Landowners unfamiliar with the selection system will find it easier to mark trees prior to harvesting. This will allow them to visualize what the stand will look like after the harvest,

Table 6. STAND CHARACTERISTICS SUITABLE FOR SELECTION SYSTEMS
*Mature, with most trees of similar age, and made up of least half long lived , trees that can grow in shade
*At least three age classes present (eg. seedlings, pole sized, and mature trees)
*Sheltered and wind firm
*Where wildlife, recreation and watershed management considerations prohibit clearcutting

It can take several harvests before a stand that started out in poor condition will consistently yield good quality timber with each harvest.

The most common approaches to selection harvesting are single tree selection and group selection (Figure 7). Often, operations are a combination of both.

Advantages and disadvantages of the selection methods are presented in Table 8.

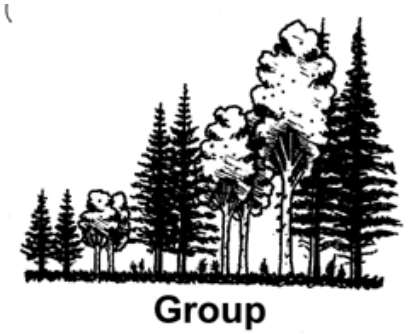

Figure 7.. *Group and single tree selection methods.*

Single Tree Selection

With single tree selection, trees are removed individually and each tree is judged on its own merit. Table 7 lists characteristics of trees to leave or cut.

Choosing trees to remove also depends upon the age class distribution of trees in the stand (Figure 8). Trees larger than a certain maximum diameter and a percentage of total stand volume are removed. The most important thing is that the best trees are left with room to grow and that trees are removed from all age classes.

Because only small openings are created, this method favours shade tolerant species that can thrive in low light conditions.

Table 7. TREE EVALUATION GUIDE FOR SINGLE TREE SELECTION	
TREES TO LEAVE	**TREES TO CUT**
desirable species	undesirable species
healthy	unhealthy
good quality or form	poor quality
growing by itself	competing with better trees
suitable for wildlife use	not useful for wildlife
tree is less than specified maximum size	tree is greater than specified maximum size

Considerations for selecting trees to cut or leave while practicing single tree selection. All these things should be considered before making a decision. If a tree meets any one of the conditions on the right it should be cut, unless it creates a large opening.

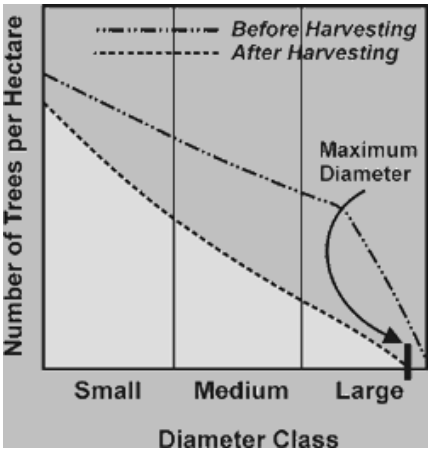

Figure 8. *Example of a stand with several age classes showing trees to cut.*

Group Selection

Group selection is the harvest of small groups or clumps of trees rather than single trees. The openings created allow the regeneration of some species that cannot grow in the shade.

Although similar to small patch cuts, these openings do not remove the effect of the surrounding trees from most of the harvested area. In addition, the openings are too small to be managed as even-aged stands. As with patch cutting, group selection is suited to many of the patchy stands created by cutting habits of many Nova Scotia landowners.

Group selection has several advantages over single tree selection. It is less expensive because the harvested trees are concentrated in patches. Tree marking and felling take less time. Assessing the regeneration quality is easier because regeneration is concentrated in clumps. Finally, early thinnings are easier to define and carry out.

As in the single tree method, thinning and harvesting should be done at the same time. The new trees regenerating in the clearings are considered part of the larger stand that contains trees of many ages.

Table 8. MERITS OF THE SELECTION SYSTEM
ADVANTAGES
* Continuous seed source and cover improve the chances of desirable regeneration: thus, no cash outlays are required for site preparation and planting
* Continuous cover maintains stable conditions and diversity within the stand
* Uneven canopy produces more wind-free trees
* Selection cuts look better than clearcuts to most observers
* Plants competing with seedlings are generally not a problem
* Insects and disease attacks usually only affect the older trees in a stand: these trees can usually be harvested before they become unsaleable
* Small regular harvests are possible allowing landowners to regularly harvest on their woodlots
* Combines harvesting and stand tending
* It maintains habitat for wildlife species that thrive in a mature forest: however, disturbances are more frequent
DISADVANTAGES
* Timber marking is necessary for new workers; choosing trees to cut can be difficult
* First cut is usually expensive because most trees removed are of poor quality
* Assessing and thinning regeneration is often difficult with single tree selection
* Damage to remaining trees can be a problem, making choose of extraction equipment important
* Because less wood is removed in any one area, road costs per volume cut can be high
* Large areas of early successional stage, required by some wildlife species, are not created
* It cannot be done in all stands
* If done over a large area, forest diversity is decreased
* Trees tend to have more taper and branches as they develop in more open conditions

Lesson Three Quiz

Answer - True or False

1. Selection harvesting allows a more or less continual harvest of trees from a range of age groups.

T F

2. Stands best suited for selection cutting should be made of tolerant, long lived species, preferably representing several age classes from seedlings to mature trees.

T F

3. Selection harvesting is the same as high grading where only the biggest, best trees are cut and the less desirable trees are left for seed.

T F

4. To ensure continual harvesting of a stand is possible, the volume cut should not be more than the volume that is added to the stand through growth.

T F

5. When using single tree selection, fixed costs per unit wood volume harvested are low.

T F

6. Group selection is more economical than the single tree method because the trees to be harvested are concentrated in patches.

T F

7. The selection method removes trees from only the stand's oldest age class.

T F

8. The selection method is the only harvesting method which establishes and maintains an uneven-aged stand.

T F

9. Selection cutting maintains continuous cover which results in stable germination and growth conditions over time.

T F

10. Selection cutting may easily be done by inexperienced cutters as there is little chance that such a harvest will result in a high grade cut.

T F

Lesson Four:

Putting it All Together

Planning for Multiple Objectives

Public attitudes toward forests and the environment are changing. Forests must serve the wide range of society's needs and desires. Wood must be cut in a responsible, "environmentally friendly" manner with consideration for wildlife and other natural resources within and outside the woodlot (such as watercourses).

However, the landowner's personal objectives will always play a big role in how the woodlot is managed. Woodlot owner surveys show recreation and non-timber uses in many cases significantly exceed goals of timber production and profit from their woodlands.

In most cases, the key to realizing your objectives is proper planning. Doing a management plan or having one done will help you plan effectively. It will also ensure that you understand where your boundary lines are. Of course, knowing where your woodlot boundaries are is vital before you begin harvesting.

Wildlife

The Forest/Wildlife Guidelines and Standards for Nova Scotia introduced in 1989 identifies guidelines to protect and provide for wildlife. Although not required by law on private woodlots, these pertain to all forest operations.

These guidelines refer to clearcut size and shape, operating near water, leaving trees or clumps and travel corridors specifically for wildlife. Woodlot owners and operators should become familiar with and follow these guidelines. Some of the more important guidelines are presented in Table 9.

For example, before cutting areas larger than two hectares (5 acres), woodlot owners should plan to leave clumps of potential cavity and snag trees for the benefit of wildlife. Cavity trees provide necessary nesting or perch sites for birds and den sites for mammals. Clumps offer food and shelter for a variety of wildlife. As per the wildlife guidelines, I 0 trees/hectare (4 trees/acre) are recommended for this purpose. **This applies to all harvesting systems.**

Landscape Design or Aesthetics

Harvesting has a great impact on the landscape, especially roads, trails and large cuts. The shape of a clearcut greatly affects how it looks. The more irregular the shape, the better it looks (especially for larger clearcuts). As well, it is a good practice to remove a few trees from uncut edges to soften them. Wildlife clumps and corridors scattered throughout clearcuts also improve their appearance. There are many other techniques to improve the way harvests look (see references).

Table 9. IMPORTANT FOREST / WILDLIFE GUIDELINES
* Clearcut areas should not exceed 50 hectares (125 areas) in size
* Irregular boundaries provide more edge effect for wildlife than straight boundaries
* Special management or riparian zones must be left to protect water
* Machines cannot go closer than 10 meters (30 feet) to any water course marked on topographic maps; they cannot go closer than 5 m to any other stream
* To provide cavity nesting birds suitable nest sites, a minimum of 10 trees per hectare (four per acre) should be left
* Special wildlife areas such as deer wintering yards and raptor nesting sites should be protected and not disturbed

Erosion Control

Poor road construction has proven to be the major cause of soil erosion and stream siltation. Road construction is a major subject that cannot be adequately covered in this harvesting systems module. However, woodlot owners should be aware that roads and access trails should be carefully planned and constructed. (see Woodlot Roads Stream Crossings). Help is available from provincial natural resources and environment departments.

Hauling wood across small streams can cause soil to be washed into the stream and must be avoided. An operator can be charged for causing damage to fish populations. If streams must be crossed, portable bridges must be used. These can be made by chaining several logs together. For more information on this, see Saint Mary's River Project Fact Sheet on Pole Bridges in the reference section. Of course, buffer zones as mentioned in Table 1 0 should be followed.

Rutting and erosion on slopes can also be reduced by using mud logs (see Saint Mary's River Project Fact Sheet on Mud Logs). These are placed across hauling trails to divert run off into surrounding, undisturbed vegetation. Piling brush on your trail is also very effective if your forwarding machine has enough clearance. Wide tires on the extraction machine also help to reduce rutting. A conscientious machine operator can also make a big difference.

Erosion can also be reduced by not hauling during soft periods, especially in the spring. Winter and summer operations are generally the best.

Hiring a Contractor

If your plan indicates that parts of your woodlot should be cut, the next question is will you do the work yourself or will you hire a contractor?

Harvesting requires a fair amount of skill, over and above understanding which harvesting system to use. Basic chain saw skills, getting wood to roadside, and knowing how to sell it are just a few.

Some of you may have the necessary skills or would like to obtain them. Information on chain saw use and wood markets can be found in other modules in this series. The book The Forest Professional - a code of practice for the Stewards of tomorrow's forests is an excellent reference for standards of safe forest practice.

However, many landowners lack the time and/or expertise to do their own harvesting. Therefore, hiring a contractor is often the best option.

The basic principles discussed in this course apply regardless of who does the work. But when you are employing a contractor you lack the same degree of control as when you do the work yourself. The additional knowledge and experience of some contractors may help you with your stand recommendations, but make sure any advice you get is sound.

So how can you find a suitable contractor? If you do not know of any,, a good place to start is at a local Department of Natural Resources office. They should have a list of contractors in your area.

Once you have a list, check out the promising ones. Ask for references. Besides a strong forestry knowledge, the contractor should have strong ethics and good business practices. He/she should have a strong sense of stewardship for the land. Contractors with these credentials will be pleased to provide references.

All arrangements should be confirmed with a written contract. This protects both you and the contractor.

A contract can specify:

1. That cutting is done in accordance with the Forest/Wildlife Guidelines and Standards for Nova Scotia. You should provide a copy to the contractor.

2. That harvested wood is scaled by a licensed scaler, independent of the contractor or that you will be paid based on mill scale.

3. Prices and how you will be paid (eg. by the cord and how often).

4. That ruts not be larger than a certain maximum.

5. That roads be left in good condition.

6. That the contractor is covered by Workers Compensation; otherwise you could be liable in case of an injury.

7. The harvesting system(s) to be used and where.

8. Beginning and end dates for the contract.

9. That felled trees will be properly utilized to a specified size.

A contract should also include a description of your woodlot, clearly indicating area(s) to be cut. It is also a good idea meet the contractor on your woodlot to show the contractor the boundary lines of your property and/or the area to be harvested.

When you employ a contractor to work for you, the Occupational Health and Safety Act requires that employers and employees take every reasonable precaution to ensure safety in the woodlot. You should ensure that proper safety equipment is being used and that the workers know how to use it.

Your agreement with your contractor should ensure that the he/she is familiar with and will implement the standards in The Forest Professional a code of practice for Stewards of Tomorrows Forests. More information is available from the Nova Scotia Department of Labour.

Estimating Volume

Before hiring a contractor or harvesting yourself you should have a good estimate of standing wood volume and volume to be cut. Unfortunately, this requires some specialized tools and calculations. It is too complex to deal with in this course but may become the subject of a future manual.

Therefore, it is a good idea to have someone cruise your property (or area to be cut) to give you an idea of volume, by-product to be cut. Some contractors offer this service as well, but it is a good idea to hire someone independent of the contractor. This combined with an independent scale following harvest should let you rest assured that you are being paid for the amount of wood cut. As discussed earlier, this is known as stumpage.

Choosing a Harvesting System Exercise

This section asks you to make recommendations for eight forest stands (see Table 10). These examples have been taken from small woodlots in Nova Scotia. The following assumptions apply to each stand:

* Stands are even-aged unless otherwise specified

* All stands are over two hectares (five acres) in size

* Unless otherwise stated, tree species are uniformly scattered throughout the stand

* There is close to complete forest cover

* A harvest is only economical when at least 89 cubic metres per hectare (10 cord per acre) will be removed in any one cut

* Merchantable volume is calculated for trees which have at least an average diameter at breast height of I 0 centimetres (four inches) ; saw logs must have a minimum diameter of 20 centimetres (eight inches)

* Factors not given are to be considered as “normal” or average within Nova Scotia stands

* Objectives are to maintain environmental quality, minimize the impact on resident wildlife, and to produce wood products where possible

* Wildlife guidelines will be followed in all cases

For each example determine if harvesting is necessary and if so which system should be used. Do not limit yourself to the systems described in this book.

Although these systems can be applied to most situations, there are always other possibilities or modifications. Creativity and imagination are two keys to harvesting a woodlot.

Use the information presented in the previous lessons, the course references, the Harvest Methods Key provided on the next page (Figure 9), and common sense. After you have decided on a stand's treatment, compare it to the recommendation found at the end of the lesson. Don't be disappointed if your choices are different than the recommendation, as long as you make an informed decision based on the objectives and the stand conditions.

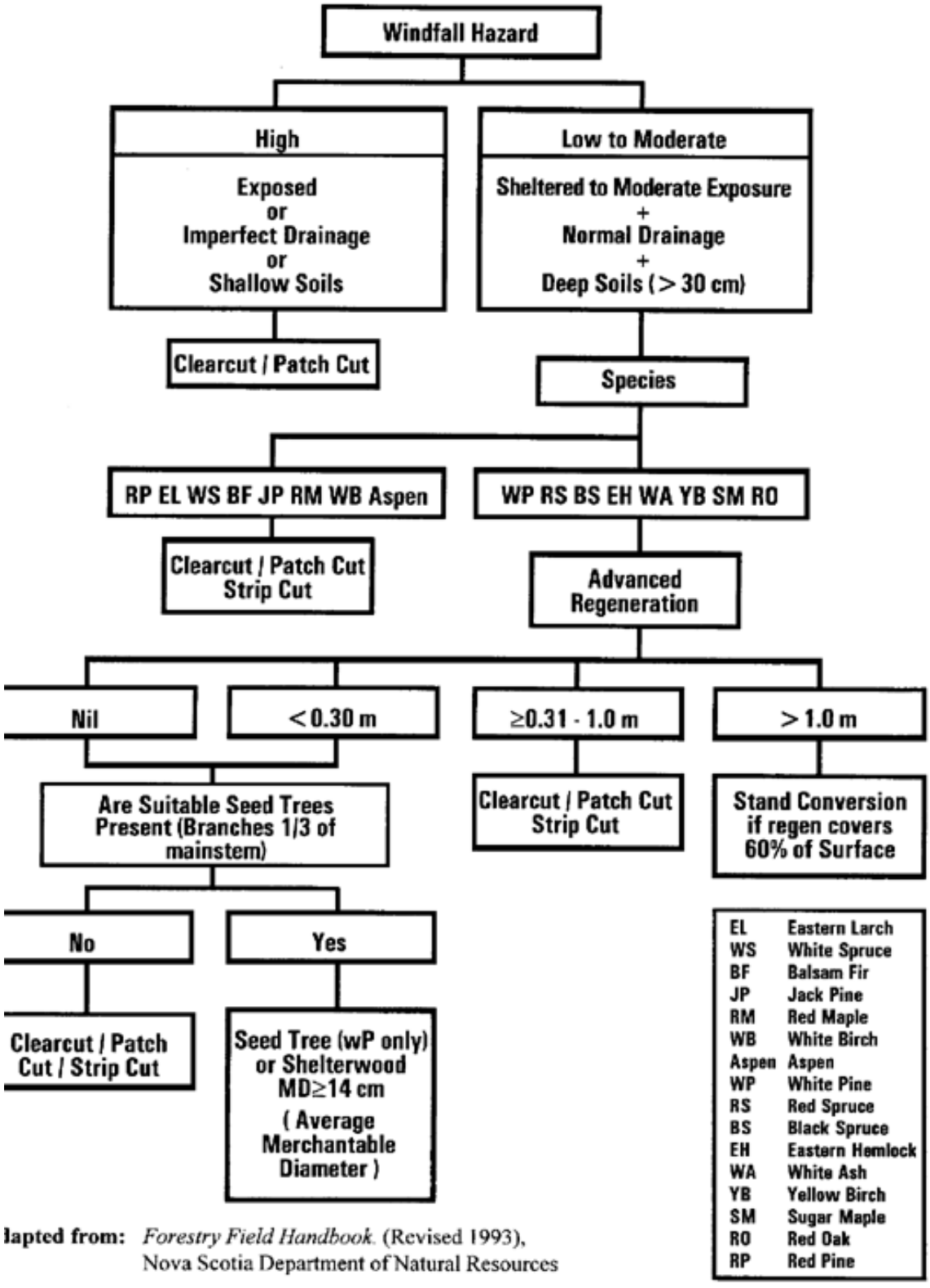

Figure 9. *Harvesting Methods Key.*

Table 10. Stand examples for harvesting system exercise.

Stand	Species	Percent of Stand	Avg Age (yrs)	Height m (ft.)	Diameter cm (in.)	Other
1	balsam fir	40	80	17 (56)	20 (8)	*Exposure*: moderate Well drained *Volume:* 357 m³/ha (40 cd/acre) *Regeneration:* scattered balsam fir less than 0.3 m (1 foot) tall
	red spruce	20	70	16 (52)	30 (12)	
	red maple	30	70	15 (49)	18 (7)	
	trembling aspen	10	70	17 (56)	25 (10)	
Recommendations						
2	red spruce	60	50	13 (43)	18 (7)	*Exposure:* moderate Well drained *Volume:* 268 m³/ha (30 cd/acre) *Regeneration:* none
	balsam fir	10	70	17 (56)	22 (9)	
	yellow birch	20	50	14 (46)	18 (7)	
	red maple	10	60	16 (52)	15 (6)	
Recommendations						
3	balsam fir	40	60	13 (43)	20 (8)	*Exposure:* moderate Poor drainage *Volume:* 268 m³/ha (30 cd/ac) *Regeneration:* none *Other Notes:* lots of branches on white spruce and heavy budworm damage in stand
	white spruce	30	60	12 (39)	26 (10)	
	red spruce	20	70	13 (43)	22 (9)	
	trembling aspen	10	60	16 (52)	26 (10)	
Recommendations						

Stand	Species	Percent of Stand	Avg Age (yrs)	Height m (ft.)	Diameter cm (in.)	Other
4	balsam fir	40	60	17 (56)	20 (8)	*Exposure:* high Average drainage Volume: 312 m³/ha (35 cd/ac) *Regeneration:* adequately stocked with 0.5m (2 ft) balsam fir and red spruce *Field Notes:* yellow birch is dieing back, creating openings; small brook crosses the stand
	red spruce	40	70	20 (66)	30 (12)	
	yellow birch	20	70	20 (66)	26 (10)	
Recommendations						
5	yellow birch	30	70	15 (50)	18 (7)	*Exposure:* moderate Well drained *Volume:* 224 m³/ha (25 cd/acre) *Regeneration:* scattered balsam fir and a few red spruce *Other Notes:* most trees are healthy
	red maple	30	60	14 (45)	15 (6)	
	red spruce	30	70	18 (60)	20 (8)	
	balsam fir	10	60	12 (40)	15 (6)	
Recommendations						
6	white spruce	60	60	8 (26)	36 (14)	*Exposure:* moderate Well drainage, dry site *Volume:*107 m³/ha (12 cd/ac) *Regeneration:* clumps of yellowish balsam fir *Other Notes:* older balsam fir appears in clumps and is very unhealthy
	balsam fir	30	65	9 (30)	20 (8)	
	red spruce	10	70	10 (33)	28 (11)	
Recommendations						

Stand	Species	Percent of Stand	Avg Age (yrs)	Height m (ft.)	Diameter cm (in.)	Other
7	balsam fir	30	50-80	11 (36)	18 (7)	*Exposure*: moderate Poor Drainage *Volume:* 340 m³/ha (38 cd/ac) *Regeneration:* scattered balsam fir and layered black spruce *Other Notes:* balsam fir is slowing in diameter growth; red maple is of good quality; each species occurs in small clumps
	black spruce	20	60-90	10 (33)	16 (6)	
	red maple	20	30	6 (20)	8 (3)	
	white birch	20	30	6 (20)	8 (3)	
Recommendations						
8	red spruce	40	89	21 (70)	25 (10)	*Exposure:* high Moderate Drainage *Volume:* 357 m³/ha (40 cd/ac) *Regeneration:* scattered with 20% balsam fir, 50% eastern hemlock, 30% red spruce *Other Notes:* rocky site
	eastern hemlock	40	90	21 (70)	30 (12)	
	white pine	20	100	24 (80)	36 (14)	
Recommendations						

Recommendations

STAND #1

Since the balsam fir and aspen are nearing the end of their expected life span, they should be harvested. Because the stand is even-aged and less than 40 percent is shade tolerant and long-lived, a clearcut system to encourage more natural regeneration establishment is suggested.

A strip cut may be better than a patch cut because of the uniform species distribution. Since the fir and spruce have shallow, lateral roots, narrow strips are recommended to reduce

chance of blowdown. The strips should run in a north-west to south-east direction to reduce sun exposure - if practical. If aesthetics are a major concern, small patch cuts should be considered.

Consider leaving any healthy red maple to reduce problems with sprouts from the cut stumps. Similarly, to avoid suckers from roots consider leaving any healthy aspen.

It would be a good idea to mark off small clump(s) of trees that contain the longer-lived red spruce and aspen and maple. Choose trees that are sheltered with deep crowns to ensure that the clump(s) is windfirm.

STAND #2

Since the red spruce and yellow birch are still young, they should be left to grow to saw log diameter. The stand can be left to develop on its own. Or because it is well drained and moderately exposed, it can be commercially thinned (see page 10 or module 3 in this series), by removing the balsam fir and red maple. As well, some of the poorer quality spruce and birch can be removed to ensure that the remaining trees have enough room to grow.

In another 20 to 30 years the stand should be considered for a shelterwood cut, once the spruce and birch are consistently producing seed.

Wildlife clumps should contain yellow birch and maple to develop into cavity trees, and spruce and fir for cover.

STAND #3

Unless the budworm attack is stopped, the stand should be clearcut to use the trees before they die. If the site requires planting, the heavy slash will have to be crushed or redistributed to make planting easier. Therefore, be sure to save some income from stumpage for these costs.

Try to leave red spruce and aspen in the wildlife clumps. If the cut is to be more than 50 hectares (125 acres) be sure to leave uncut strips to provide cover for wildlife travel. Also, try to keep the cut edges irregular to provide better habitat for wildlife.

STAND #4

Because regeneration is established, the stand can be clearcut. It should not be partially cut, because of the high risk of blowdown.

A minimum 20 m (66 foot) special management zone should be left along the stream.

Make it wider if there is more than 10 degrees of slope. Any partial cutting along the stream would be very risky. Wildlife clumps should contain at least one yellow birch which makes very good cavity trees.

STAND #5

This stand gives us lots of options.

The mature red spruce and yellow birch can be regenerated by a shelterwood cut. Since the species are uniformly distributed throughout the stand, a uniform shelterwood cut should be carried out, removing 30 percent of the volume. Most of this cut will be comprised of balsam fir and red maple.

A second option would be to do a single tree selection cut. Like the initial cut of the shelterwood, the first cut would allow light to reach the forest floor to stimulate regeneration. Future cuts would further thin the overstory, but would not remove it.

Small patch cuts should also produce acceptable regeneration.

Regardless of the option chosen, it would be a good idea to do the first cut during the summer with a machine that drags the wood to mix the organic and mineral soil layers. This is vital to obtain yellow birch regeneration. A machine that carries the wood would probably be more appropriate for future cuts.

Make sure that the wildlife clumps contain yellow birch or leave a few scattered yellow birch for cavity trees.

STAND #6

The balsam fir should be harvested before it deteriorates. A clearcut is necessary to economically harvest the area. A comparison between height and age indicates slow growth in the stand. Because the site is dry and best suited to pines, or other species with deep rooting systems, the stand should be clearcut and planted with pine. It would probably be difficult to regenerate naturally.

Wildlife clumps should contain the longer lived red spruce. The clumps should be large to reduce risk of blowdown. Some seeding may result from these clumps.

STAND #7

The clumped, uneven-aged balsam fir and black spruce lends itself to group selection. It may regenerate to predominantly balsam fir but the stand also contains longer-lived red spruce. The younger red spruce, white birch, and red maple patches should be thinned while harvesting.

If the patches are larger than 0.2 ha (0.5 acres), clearcutting in patches might be the best option.

Because it is poorly drained, it should be harvested in winter. Wildlife clumps should contain several species, if possible.

STAND #8

This stand should be replaced by a stand of similar species. Because the stand is highly exposed to the wind, a white pine seed tree cut might work best. Red spruce and hemlock are more susceptible to blowdown than white pine.

Wildlife clumps should be left around the white pine seed trees.

Conclusions

Since you have decided to do this course, you already realize that the decision to harvest on your woodlot should not be taken lightly. A lot of thought is required to decide where, how much, and how to harvest.

Where and **how much** to harvest depends heavily on your goals for your woodlot. For example, how much income do you want versus how much forest you want to leave untouched for other reasons. However, your goals should be realistic for your woodlot.

How you harvest - that is, which system(s) you choose - depends more on stand conditions than your goals. For instance, a sheltered stand with lots of long-lived, shade tolerant species is more suited to shelterwood or selection cutting than clearcutting, but gives you several options. In contrast, a stand with old, unhealthy balsam fir or shade intolerant aspen is a better candidate for clearcutting.

Species makeup, age, shade tolerance, health, and wind firmness of a stand greatly influence your choice of harvesting system. You have to work with what you have. In cases where there are several good options, let your goals and objectives for your woodlot guide you.

Do not limit yourself to the options presented in this module. There are many variations of the systems discussed - only the most common options are covered in this manual.

Every situation is different. Be creative, but no matter which system you choose, harvesting must be done in a way to ensure that the forest is reproduced to desirable species and that values important to you and society will not be negatively affected.

When you are not sure how to harvest, get advice. Your local Natural Resources office is a good place to start. Happy harvesting!

Forestry Definitions

advanced regeneration - seedlings that have become established naturally in a mature forest prior to any harvest

age class - any interval into which the age range of trees or stands is divided for classification and use - commonly 15 or 20 years artificial regeneration - establishing a new forest by planting seedlings or by spreading seed

bare root stock - seedlings whose roots are removed from soil in which they were grown prior to planting

blow down - trees uprooted by high winds, also commonly called wind throw

canopy - more or less continuous cover of branches formed by the crowns of trees

cavity trees - a tree greater than 30cm (12 inches) in diameter, which can have natural or excavated holes

co-dominant - those trees whose crowns form the general level of the canopy and receive full light from above, but comparatively little from the sides

container stock - seedlings whose roots are contained in the soil in which they were first planted

crown - the live branches and foliage of a tree

crown closure - the ground area covered by crown

deciduous - any plant that sheds all its leaves each year

density - concerning trees, the number of trees per unit area

diversity - variety and number of living organisms in a forest environment

dominant - trees with crowns extending above the general level of the canopy and receiving full light from above and from the side

ecosystem - an interrelated and interdependent community of living and non-living organisms and their habitats

edge - a zone where two successional stages meet

even-aged - a stand composed of trees with only small differences in age; by convention, the maximum age differences allowable is 1020 years

erosion - washing or wearing away of soil

flush - a fresh growth of new leaves or needles

green belt - an uncut area along water or a road

habitat - a place where a plant or animal lives

high grading - the removal of only the best trees from a stand, often resulting in a poor quality remaining stand and poor seed for the next generation

intermediate - trees in a stand which receive a little light from above but none from the sides

intolerant - plants and trees that do not grow well in the shade

mature - having reached a state of maxi-mum development; the stage before decline

mineral soil - soil containing a high percentage of inorganic material such as rock, sand, clay and silt

monoculture - a crop of a single species, generally even-aged

organic layer - layer of leaf, twig, and other litter on top of mineral soil; not yet incorporated into soil

pre-commercial thinning - spacing treatment done in young natural stands to remove competition from desired trees

raptor - a bird of prey; hawks, ospreys, and eagles are prime examples in Nova Scotia

reforestation - the natural or artificial restocking (ie: planting & seeding) of an area with forest trees

riparian zone - refers to a zone of vegetation usually next to water (see green belt)

selection cutting - an uneven-aged silvicultural system in which trees are harvested individually or in small groups at relatively short intervals

site preparation - preparation of a site for planting and for seedlings; should make site easier to plant and improve survival and growth of seedlings

shelterwood cut - the removal of the mature timber in a series of cuttings which extend over a relatively short period of the rotation; establishment of even-aged seedlings is encouraged under the partial shade of seed trees.

siltation - the washing of fine soil particles by water into waterways

silviculture - the growing and tending of forests to meet goals of landowner

slash - the residue left on the ground after harvesting, including unused wood, branches, and tree tops

snags - a standing dead or dying tree valuable to wildlife as a perch, or a source of insects

stand - group of trees sufficiently uniform is species, size, age and condition to be separable from another group

stocking - an expression of the percentage of a site occupied by trees

tolerance - the ability of a tree to survive and grow under shade

uneven-aged - stand of trees with considerable age differences representing at least three age classes ; uneven-aged stands usually contain large, older trees as well as young trees

viable seed - seed capable of germinating.

weeding - removal or suppression of undesirable competition from young trees.

FURTHER READING

The other home study courses in this series (see preface)

A Series of Silviculture Manuals produced by the Nova Scotia Department of Natural Resources:

Tree Planting Manual
Merchantable Thinning Manual Softwoods
Hardwood Thinning Manual
Shelterwood Harvesting Manual

A series of Forest Practice Pamphlets produced by the Nova Scotia Department of Natural Resources on several harvesting systems:

Commercial Thinning
Harvesting Systems: Shelterwood Method
Harvesting Systems: Clearcut Method
Harvesting Systems: Release Cutting
Harvesting Systems: Selection Method
Harvesting Systems: Seed Tree Method

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Matthews. J.D. 1989. *Silvicultural Systems*. Clarendon Press - Oxford. 284 pp.

Saint Mary's River Project Fact Sheets: *MudLogs,*
Pole Bridges
Saint Mary's River Project Videos: 1. Stream Crossings and Forwarder Operations 2. Forestry, Wildlife and Water Courses, Wildlife Cavity Trees in Forestry Operations.
For copies write Julie Towers, Nova Scotia Department of Natural Resources, P.O. Box 698, Halifax, Nova Scotia, B3J 2T9

Snow, K. 1980. *Regeneration Survey*. Nova Scotia Department of Natural Resources.

Answers to Quiz Questions

Lesson 1:	**Lesson 2:**	**Lesson 3:**
1. False	1. False	1. True
2. False	2. True	2. True
3. True	3. False	3. False
4. True	4. True	4. True
5. False	5. True	5. False
6. True	6. True	6. True
7. False	7. True	7. False
8. True	8. True	8. True
9. False	9. False	9. True
10. False	10. False	10. False
	11. False	