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FOREST RESOURCE MANAGEMENT IN MANITOBA - HOWS AND WHYS

1. Clearcutting in Manitoba

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Thanks to the Manitoba Natural Resources, Forestry Branch staff who assisted with compiling this booklet

Introduction

In recent years, environmental issues have become a priority for people worldwide. One particular concern is destruction of tropical forests. As this issue has emerged, many Canadians have looked inwardly and asked themselves, “Are we the Amazon of the north?” Some Manitobans have been asking the same question about our forests.

The deforestation issue is not lacking for opinions. There are those who claim that Canadian forestry practices are as bad as (or worse than!) those in tropical regions. The other extreme is that our forests couldn’t be in better shape. As is the case with most controversial issues the truth probably lies somewhere in between. What makes analyzing the deforestation issue so difficult is comparing our activities to those of the tropics in light of existing information and the average person’s understanding of forestry and forest harvesting.

> *Deforestation is not only an environmental problem. To stop the destruction of forests and start using them sustainably will require understanding the issue from all sides - ecologically, economically, politically, and socially.* (Winfield and Daniels, 1990)

A dominant issue today in Canada is the forestry practice of clearcutting. To many, the word clearcutting is synonymous with deforestation. But professional foresters maintain that, in some circumstances, clearcutting is the most appropriate method for both harvesting and forest regeneration.

It is acknowledged that there are numerous legitimate concerns about the use of clearcutting. However, this booklet was developed to discuss the use of clearcutting, in part to illustrate the difference between this practice and deforestation. The issue of deforestation is not addressed directly. There is also no assessment of Manitoba’s forests or how clearcutting is actually practiced in the province. (This is an information booklet, not a position paper).

A clear understanding of clearcutting as a forestry tool should facilitate a better understanding of forest management in Manitoba. It is hoped that the information presented here will assist teachers who have an interest in Manitoba’s natural resources or wish to explore environmental issues with their class.

The Problem

Until recently, large scale human impact on the forests of the world has taken place over a long time period. However, since the 1940s, about half of the world's tropical forests have been cleared. Concerns about tropical forest destruction range from increasing the impact of the greenhouse effect to mass extinctions of plant and animal species.

Why are the tropical forests disappearing at such an alarming rate?
Many tropical countries are using their forests as a source of immediate revenue for their impoverished economies. Asian countries, such as Malaysia and Thailand have cut over 40% of their forests in two decades, primarily to sell as wood products for foreign markets.

In the Amazon region, forests are cleared to make room for ranching and farming operations. In the case of slash and bum techniques to create farmland, the end product is total land conversion. Almost all tropical countries rely heavily on wood for fuel. With rapidly growing populations in these countries demand for forested lands for fuel, revenue and agriculture has far outgrown supply. As a result many forestry activities are not based on sustainable forest use or management.

Generally the goal is to meet immediate or short term needs. Unfortunately, whether intentional or accidental, it appears that land conversion is irreversible in the short term. More information about tropical forest destruction is available in Conservation Kit number 83 of this series or in Winfield and Daniels (1990)

To see successional changes resulting from logging, visit Birds Hill Provincial Park. The dominant forest community in the park forest is trembling aspen. The large white spruce, which gave the urea its (mistaken) name of Pine Ridge, were cut to provide wood for Winnipeg in the early part of this century. Trembling aspen is a pioneer species which grows quickly after a disturbance such as fire or logging. White spruce seedlings normally begin to grow among the aspen, but at a much slower rate. A ride along North Drive in winter provides an opportunity to see this natural succession at work. Over time, the shade tolerant white spruce seedlings will overtake the aspen, once again creating a white spruce forest on the hill.

1. Successional change

Has this ever happened in Manitoba?

In the 1800s forests were removed or extensively cut along the Red and Assiniboine Rivers, and the area which is now Birds Hill Provincial Park. Some land was converted to farmland, however the majority was cut for building material and firewood. The impact on these forests, though devastating at the time, was not

permanent as most of the areas have regenerated naturally.

Many of the harvested forests which were not converted to farm land have reestablished through natural succession and planting activities; although often with different species composition than the original forests. For example, many white spruce *(Picea glauca)* forests were replaced by aspen *(Popu/us trernuloides)* forests, a natural successional change after any major disturbance (see box 1). Despite these changes, the amount of forested land in Manitoba is believed to be similar to presettlement times.

Why wasn't more forested land converted to agricultural production?

Unlike eastern North America, the need to remove trees for agricultural land in Manitoba (on a provincial scale) wasn't great, since a significant portion of the province was prairie. Tall grass (or true) prairie was subjected to land conversion by early settlers at a magnitude which far exceeds present activities in the tropical forests.

How was our exploitation of the Great Plains similar to/different than that of tropical regions?

Was our early use of forest resources similar or different?

2. Questions for discussion

Present Forest Management Issues

Resource management, including forestry, has evolved significantly since the province was given jurisdiction in 1930. In the early years of management, land use conflicts were more easily solved; one resource user would simply go elsewhere. Single-use management was common. Competition for a finite land base by a growing population, with increasing needs, makes resource management considerably more challenging than even 20 years ago.

The present mission of the Forestry Branch (and the Manitoba office of Forestry Canada) is to achieve sustainable development of Manitoba's forests. To achieve this goal while competing with other interests in forested lands, ranging from hydro development (subsequent land loss through flooding and corridors) to ecological reserves, integrated management is seen as the way of the future. *Integrated management is managing for several resource values on a given land base.* This usually requires compromise by all parties and a willingness to work together.
Forest harvesting can have significant impacts on other resources. Wildlife habitat is altered, recreation areas lose their aesthetic appeal and erosion or water quality loss may be a problem.
Clearcutting in particular can affect other resource values. In recent years this

Background to Manitoba's Forest Resource Development

Our forest resources were first used on a small scale by the Paleo-Indian ancestors of present day Native Indians, perhaps as long as 8,000 years ago. These people used various species of wood for manufacturing weapons and for domestic needs, such as clothing, transportation, food, medicine and spiritual nourishment.

When Europeans began to settle Manitoba in the early 1800s, forest clearing for *timber* and fuel far exceeded native use and was unregulated. Unregulated timber harvesting continued until the 1870s, when the Dominion of Canada began to administer Manitoba's forest resources. Dominion Land officials regarded Manitoba as prairie, therefore treating forest resource as a means for immediate development of the province. Forests were not treated as a permanent, self-sustaining resource. The colonization policy which dictated most decisions of the last century has been summarized by the following statement:

The ravages of the portable saw mill, the hard driven settler, and the lumber operator alike threatened to denude whole areas of forest growth which by every principle of sound forestry ought to have been conserved with every precaution known to science (source unknown).

Despite this negative historical view of the forestry administration, some positive developments occurred during the period. A Forestry Branch was established in the federal Department of the Interior and a number of statutes, including the *Dominion Land Act* (1872) and *Forest Reserve Act* (1906), were enacted. Forest reserves were set aside to ensure a continued and sustained supply of timber for the growing population. Crown dues were charged, forest nurseries developed for forest renewal and harvesting permits were instituted to control resource depletion.

Since 1930, when the Federal Government gave the provinces jurisdiction over most natural resources through the *Natural Resources Act* Manitoba Natural Resources, Forestry Branch (as it is now called) has been in charge of managing our forest resources. The primary role of the Forestry Branch has, from the beginning, been economic development. The mission of the Forestry Branch, as described in the Department's *Missions and Roles Statements* (1989), is:

> *To ensure sustainable development of provincial resources for present and future generations of Manitobans.*

Toward that goal, the Forestry Branch's early activities concentrated on forest fire control, forest inventory, reforestation, and establishment of forest reserves. Provincial Forests (as they are now called) were established to prevent the land base from being cleared for agricultural purposes.

A responsibility added later was pest management to monitor insect and disease activity, and mitigate tree loss to introduced or native organisms.

In recent years management and resource development activities have been supported through a series of Forestry Agreements between the Government of Canada and the Provincial Government.

harvesting technique has been highly criticized as an ugly and environmentally dangerous practice. On the west coast of Canada and the United States large clearcuts, especially on steep slopes, have been blamed for a variety of environmental problems including land slides and siltation of water bodies. Elsewhere, including Manitoba, foresters have been accused of indiscriminate use of clearcutting. Despite the arguments against clearcutting, this method is still used. The following will examine clearcutting as a harvesting technique and management tool in Manitoba.

Clearcutting - Deforestation or Management Tool?

What is clearcutting?

Clearcutting is as it sounds; cutting down of virtually all trees from a stand of forest. A more ecologically based definition of clearcutting is; removal of all the trees from an area sufficiently large that the “forest influence” is removed from the majority of the harvested area (Kimmins, 1991).

In the tropics, the term clearcut most often refers to areas which have been permanently deforested. Deforestation and clearcutting are seen as one and the same by some; both result in areas which are denuded of trees. However, clearcuts are usually reforested. Deforestation implies

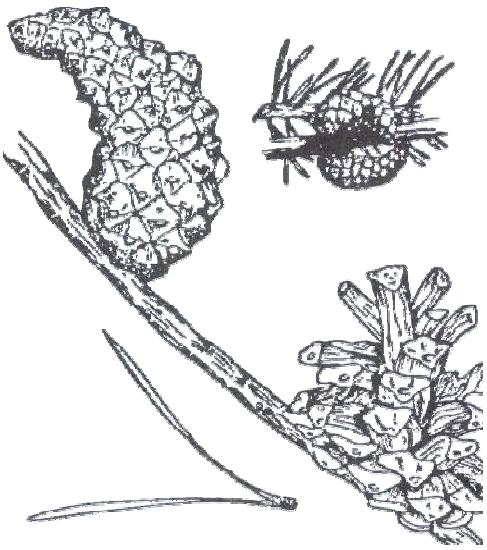
Jack pine clearcut in Manitoba

that land will be used for other purposes such as farming or ranching. From a forestry perspective, clearcutting has two functions. As a harvesting method, clearcutting is a cost and energy efficient way to secure a high volume of wood, usually from an even-aged stand of trees. As a silviculture method, clearcutting is a step in the regeneration process. By removing a complete stand and reseeding, either by natural or artificial means (e.g. broadcast seeding, tree planting), the area is, from a commercial (and, to a certain extent, ecological) perspective, once again productive.

By looking at a tree species commonly harvested by clearcutting-the jack pine-forestry management principles are placed in context with regard to the use of this method for harvesting and renewal in Manitoba.

Life History of Jack Pine

Different tree species react differently to traumatic events, such as fire, insect infestation and clearcutting. Forest harvesting and management treatments are planned to imitate natural events and subsequent conditions which maximize regeneration. In Manitoba one species which is clearcut on that basis is jack pine *(Pinus banksiana).*



Jack pine cones and needle

The ecological biomes which make up Manitoba are the northern plains, the boreal forest and the aspen parkland (a transition zone). Native vegetation, including trees, in these biomes have evolved with the constant presence of fire. Generally, forest stands in Manitoba have been subject to firekill every 75 to *125* years since the last ice age. As a result they are fire tolerant and, in some cases, fire dependent. Due to the vast size of many forest fires, resulting stands of fire dependent species are usually extensive, uniform in age and often lack other tree species (see box 4).

> *"[Boreal forests] are almost invariably 'born of fire' in the sense that there are virtually no second generation stands of climax species self-reproduced without the aid of fire. ... The largest forest fire complex ever recorded, 14. million hectares, burned in Siberia during the summer of 1915 (Shostakovich 1925). Individual fires larger than a half million hectares have not been unusual in any of the boreal forests during this century (Lutz: 1956). On these high-intensity burn sites, all standing trees are usually destroyed. The forest regenerates as an even-aged stand, either directly or through a successional series, depending on the availability of stored seed or seed sources". (Chandler et al. 1983)*

4. Fire in the boreal forest

Jack pine is perhaps the most fire dependent species in Manitoba. The serotinous cones which contain jack pine seed generally require substantial heat (46.5°C) to release seed for regeneration. Forest fires are a common heat source for opening cones, sometimes up to *25* years after formation. Seed can also be released if cones fall on exposed mineral soil since the micro-climate at ground level can exceed 47°C.

Jack pine is classified as a shade intolerant species. Without full sunlight jack pine seedlings rarely survive to maturity. Following a severe crown fire, i.e. when most of the mature tree tops are destroyed,

remaining jack pine seed has ideal sunlight and soil conditions. This is a fairly normal and expected occurrence in Manitoba.

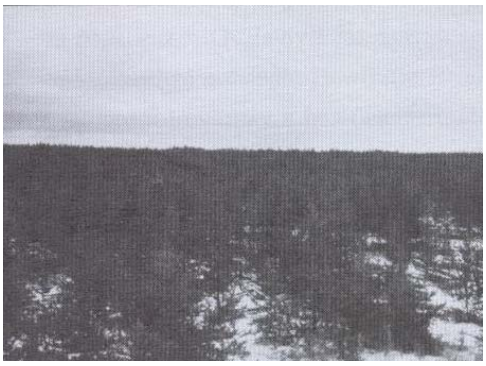
Natural regeneration sites are often thick stands of young jack pine, growing in the absence of any other tree species, i.e. a natural monoculture (see box *5).* The historical success and health of these stands is one reason why most areas are not replanted after a fire even if they are accessible.

Dense natural jack pine reseeding can be seen along the Trans Canada Highway about 71 km east of Winnipeg. The dense pine forest, which extends for 9 km, is the progeny of trees which were destroyed during a fire in 1955.

5. Natural jack pine regeneration

Once mature, jack pine trees face a number of threats to survival. Diseases such as heart rot, dwarf mistletoe *(Arceuthobiurn americanum)* and a variety of insects (e.g. boring beetles, jack pine budworm) can wipe out entire stands of jack pine. Despite the variety of parasites and decomposers in a mature stand, under natural conditions fire is the primary force for successional change.

A jack pine stand destroyed by fire is an excellent site for a new forest. The earth is warm and the nutrients are broken down, therefore accessible to freshly germinated seedlings. With no mature trees to shade the seedlings, they can grow unimpeded. Fire often sterilizes burn areas of any diseases which may have stressed the previous generation of trees. Insect pests also would have been destroyed (and recolonization would not occur until trees were established on the site).



Jack pine forest regeneration 10 years after clearcutting (see page 5)

Jack pine trees do grow naturally without the assistance of fire, however the large stands of this species found in the boreal forest are usually the result of fire or other major disturbance.

What do these facts have to do with clearcutting?

Forest harvesting methods are aimed at duplicating natural processes. Clearcutting jack pine stands followed by appropriate treatments (e.g. scarification, see box 6) result in a *similar* situation to a major fire. The area is opened up to full sunlight, and natural seeding or planted seedlings replace the cut trees.

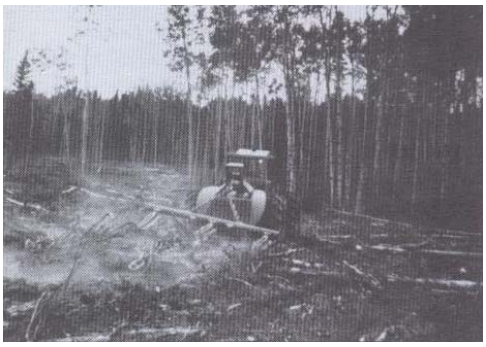
Scarification is a method of preparing land for regeneration. The unincorporated organic matter (leaves, twigs, etc. which have not yet decayed) which is usually on the forest floor does not make a good seed bed for species like jack pine. Scarification involves removal of the forest floor material or mixing it with the mineral soil by mechanical action. Though considered an acceptable preparation method, improper application can result in excess nutrient removal, resulting in nutrient deficient tree and plant growth.

6. Scarification

Under natural conditions, cones on burnt trees open and the seed is widely dispersed over exposed mineral soil. To imitate that situation equipment, such as anchor chains, is used to overturn the organic layer, and mix the slash (tree remains which include branches which hold the cones) into the mineral soil.

Several conditions must be created for proper simulation of a natural burn. To open, the pine cones must be at or near soil level where temperatures are sufficient to melt the sticky resin which binds them together. Once open, the released seed needs to have access to mineral soil in order to grow. By churning up the soil and redistributing the slash with site preparation equipment, seed is dispersed throughout the treated portion of the cutover area.

This type of seed dispersion is generally not as complete or effective as occurs from a fire, however scarification can provide an opportunity to control where, and to what extent reseeding occurs. If the seed source is inadequate or other regeneration problems are anticipated, seedlings may be planted.



Scarification using anchor chains

Regeneration after a fire is often so dense that trees are crowding each other within the first few years of growth. In preservation areas, where ecological processes are not actively managed, crowding is not a concern. But in areas designated for future harvesting crowding results in slower growth, requiring a longer time to reach commercial size.

Does clearcutting jack pine stands for regeneration always work?

No. Several factors can prevent forests from reestablishing on both clearcut and burned sites. The challenge of using clearcutting as a forestry tool is knowing when to use it. Forest management, like most resource management, is not a simple science. Foresters have learned from both past successes and past mistakes.

One lesson was the reintroduction of (or failure to eliminate) dwarf mistletoe on cutover sites (see box 7).

Dwarf mistletoes are parasitic plants which attack conifers. Two species of dwarf mistletoe are found in Manitoba. Eastern dwarf mistletoe is a parasite of black spruce and tamarack. Jack pine mistletoe is specific to our most common pine species.

Heavily infected stands of jack pine are normally clearcut. Where residual infections surround the stand, an alternate species may be planted or a 60 m buffer may be left. Other control techniques include herbiciding and (in areas of light infection) pruning infected branches.

More information about dwarf mistletoes is available from the Manitoba Forestry Branch or Forestry Canada.

7. Dwarf mistletoe

Attempts to eliminate that problem have had mixed results. Replacing jack pine with red pine *(Pinus resinosa),* another native pine which is not susceptible to mistletoe, has failed in some areas due to other diseases. The most notable are Armillaria root rot and stem cankers. Red pine, when planted on dry jack pine sites, is often vulnerable to these diseases. There are still some remaining red pine plantations in southern Manitoba which illustrate this problem.

Other factors which have resulted in jack pine clearcuts failing to regenerate are drying out of a site, and the quality or types of seedling stock used for replanting.

Do clearcut or burn areas always regenerate immediately?

No. Site changes, natural or man-caused, can result in no or little regeneration. Natural climatic changes which occur over the life of a tree can result in an environment unsuited to its progeny. This is particularly common on ecologically marginal areas or at the extreme edge of a tree's natural range. Manitoba has marginal forest land throughout the province and several tree species are at the northern limit of their range. Clearcutting decisions have not always been made with these considerations in mind. However, even the worst of these areas generally have some type of vegetative cover and are

expected to grow some tree species in time.

Another situation which can result in slow tree regeneration is fire. Particularly intense forest fires can burn so hot (i.e. when there is abundant leaf litter and other fuels) that nutrients and natural seed sources are destroyed. Under these circumstances a burnt area can take years to re-establish trees.

Are other species clearcut as well?

Yes, black spruce *(Picea mariana)* and trembling aspen are both commonly clearcut. Like jack pine, black spruce and aspen are pioneer species that are shade intolerant, often regenerate as a single species stand and are highly adapted to fire (or other disturbance). A burned or cut aspen forest will quickly regenerate from its roots (or stems). Aspen also sends out lateral suckers, resulting in entire stands of trees which are genetically identical, having regenerated from as few as one or two clones. Unlike pure jack pine stands which are derived from a relatively large seed source, aspen “monocultures” have a very small gene pool.

Is clearcutting the best method for all tree species?

No. Some tree species, such as white spruce and many of the hardwoods (or deciduous trees) are generally harvested through other methods. Selective cutting, block cutting and shelterwood cutting are recommended for harvesting these species (see following page). As with the decision to clearcut, these methods are usually based on ecological responses of the species. An example of a tree species which is not clearcut is the basswood *(Tilia americana),* a hardwood species which is used extensively for wood carving.

Life History of Basswood

The basswood, or Linden, is a deciduous tree found along riverbanks in the agricultural zone of southeastern Manitoba.
Unlike jack pine, basswood is often found in mixed stands along with American elm *(Ulmus americana),* green ash *(Fraxinus pennsylvanica),* Manitoba maple *(Acer negundo),* eastern cottonwood *(Populus deltoides),* etc.

Basswood leaves and seed

Under natural conditions mixed forests, such as those found in southern Manitoba, are made up of various aged trees. Presently many private woodlots consist of even-aged trees (see box 8). Depending upon the species composition (see previous section) clearcutting may be an option. Otherwise selective cutting may most effectively simulate life cycles of the existing forest.

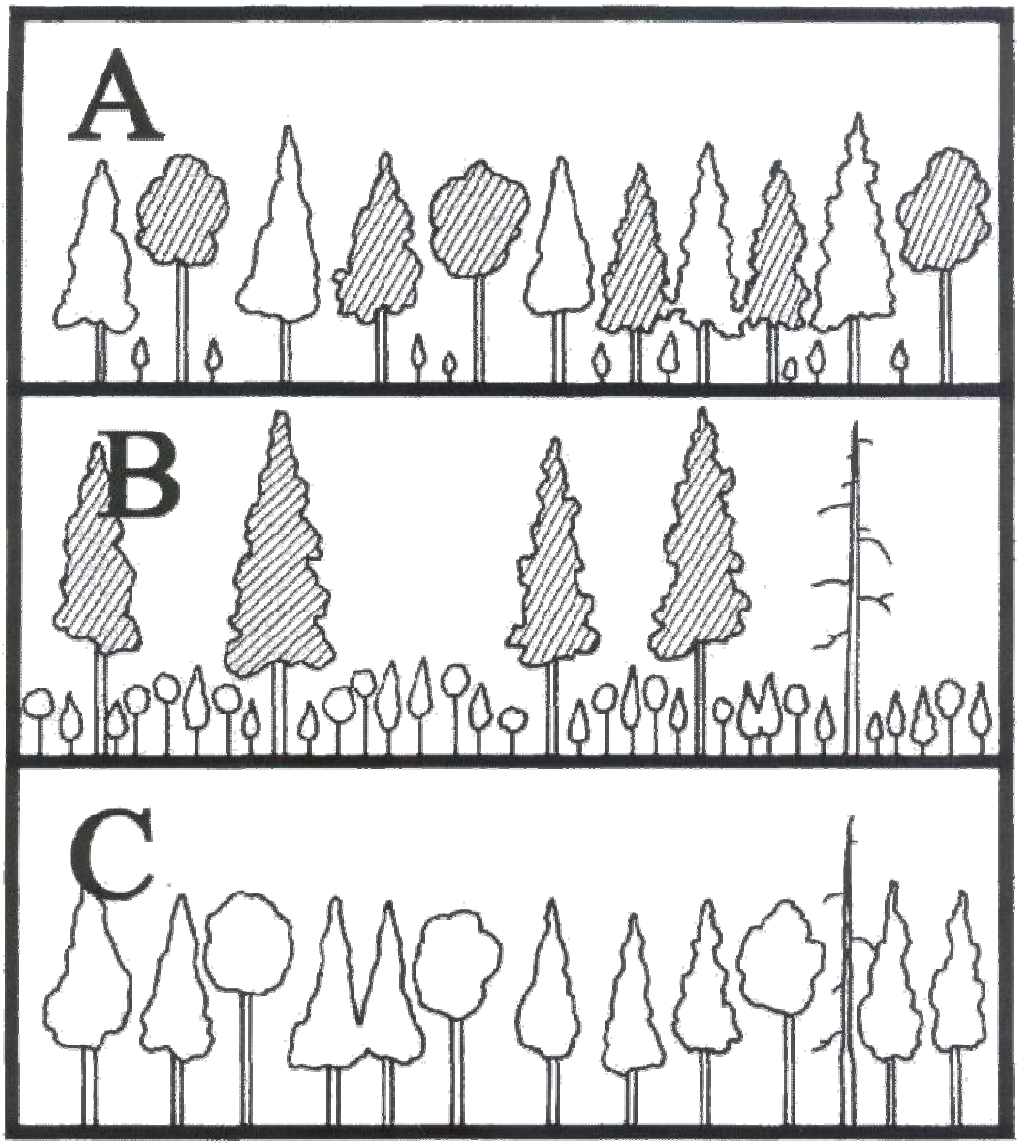
In riparian (riverside) hardwood forests of southern Manitoba, fire is often not as much of a factor as in the boreal forest. Traditionally, wildfire burned these forests, but likely not as regularly or as completely as in eastern and northern Manitoba.

Annual spring flooding ensured that in all but the driest years, the ground around these trees would retain some moisture, reducing the potential of devastating fires. The mixture of tree species was relatively diversified for Manitoba and age composition was varied. Unlike jack pine forests where fire often wipes out large portions of a stand, mixed forest trees mature and die at different rates.

Throughout Manitoba fire prevention has had a dramatic effect on the amount of timber lost to wildfire. Fire prevention has also changed the composition and age structure of woodlots. In an area that normally had uneven aged stands of trees are now forests of trees of virtually the sonic age. Though hardwoods are seed *producers (i.e. flowering plants) they rely heavily on propagation through suckering. Areas of beaver activity often demonstrate the success of stem suckering. With the root systems in place, the trees can regrow more quickly than seed grown trees.*

8. Effects of fire prevention

Imitating the life cycle of a mixed riparian forest in agricultural Manitoba is best achieved by selective cutting. Trees are harvested on a small scale, i.e. on an individual basis or small blocks of trees. Rather than replanting, hardwoods such as basswood can regenerate by the suckers which develop from the cut stump. A walk through any hardwood forest in southern Manitoba which has basswood will likely reveal trees with two or more trunks growing from the stump. These are



• Shading indicates removal.

• A separate prescription is required for each stand, which could include retention of snags for wildlife and would require specified amounts of supplemental spruce planting and tending, particularly release from aspen competition.

A. Harvest of a proportion of the crop taking most aspen and selected spruce to prepare stand for new regeneration and replace existing advanced spruce regeneration.

B. The regenerating stand ready for removal of remaining larger spruce to encourage growth of younger trees.

C. Regenerated stand returning to condition in “A”.

Example of a shelterwood cutting system in a boreal mixedwood.

Other Related Issues

Size of clearcuts: The clearcut areas of the tropics are infamous for their enormous size and the subsequent impacts on wildlife. Another concern is the effect of large scale clearcuts on global warming. The long term impact of clearcutting anywhere is not completely understood.

Forestry harvesting guidelines in Manitoba vary according to the management prescription for the forest stand and the topography of the area to be cut. Normally, cut blocks vary in size up to 100 ha. Larger areas are harvested under certain conditions, e.g. salvage harvesting after a major fire, insect/disease infestation or blowdown. Forestry companies who are cutting on crown land are required to comply with these guidelines.

Clearcutting and loss of wildlife habitat: There is no doubt that forestry practices significantly alter wildlife habitat. The impacts are varied according to different wildlife species and their habitat requirements. Climax species, such as woodpeckers and marten are negatively affected by harvesting (and other destruction of) mature stands. Early successional species, such as white-tailed deer, moose and some of the warbler and raptor species benefit from the subsequent regeneration.

In theory the effects of a large clearcut should not be significantly different than those of a large bum. However, there is very little information on the long term effects of clearcutting versus fire on wildlife populations.

Should we fight all forest *fires* or allow natural, events to occur unimpeded? What are the implications of not fighting fires to wildlife, habitat, global environmental quality, human safety property and commercial wood supply? What we the positive and negative effects of forest fires? (see **Project Wild - Smoky Said What)**

9. Questions for discussion

Limiting wood harvesting in Manitoba: Our provincial economy is dependent upon the forest industry and its products. However, in order to ensure sustained yield it is important to control the amount of wood which is cut.

Annual Allowable Cut (AAC) is the amount of timber that can be cut from Manitoba's forests over a one year period to provide a sustained yield. AAC is calculated to be equal to annual forest growth, assuming that cutovers will fully regenerate after harvesting and *fire.* The intent is to use this annual increment

and still maintain the current level of growing stock. The AAC concept is similar to spending the interest earned from a bank without reducing the principal.

AACs are constantly being reviewed and revised. Increases can occur as the effects of intensive forest management (e.g. stand tending practices such as thinning and spacing) increases the growing stock. Reductions in the AAC may result from significant losses due to fire, insects or diseases. Reallocation of forest lands for non-forestry uses such as agriculture, hydro projects, ecological reserves, etc. may also reduce the AAC. Some of the commercial timber which is calculated into the AAC is in remote areas of the province which are not presently accessible. As a result foresters consider Manitoba to have an excess of timber; that is, only 27% of the softwood and 7% of the hardwood AAC is being harvested *(Forestry Report, Manitoba, 1987).*

Conclusion

The initial effect of clearcutting is the same in Manitoba as deforestation in tropical areas; removal of the 'forest influence'. However, the long term environmental impacts of clearcutting are largely a result of the subsequent land use. Land conversion of clearcut areas, particularly for agricultural purposes, has been a concern in Manitoba and continues to be a major issue in tropical countries. Presently, the major challenge for Manitoba is to ensure that clearcutting is used appropriately and that forest regeneration is allowed to occur.

As a management tool clearcutting can be used to simulate natural life cycle events in the forest. Regardless of how clearcutting is used there are numerous resource management issues that need to be resolved. These include: soil erosion, loss of biodiversity and wildlife habitat, global warming, failure to regenerate (or insufficient regeneration), impacts of road construction on wildlife habitat, stream and river buffers and loss of recreation potential.

The issues listed above go beyond the scope of this booklet. But, in order to properly examine forest management issues, a basic understanding of the principles which dictate practices such as clearcutting is necessary. It is hoped that this booklet has provided that understanding.

What are the similarities and differences between clearcutting practices for forest management and land conversion?

Does clearcutting have a role in forest management in Manitoba? Why/why not?

10. Questions for discussion

References

Chandler, C., Phillip, C., Thomas, P., Trabaud, L., and D. Williams, 1983. *Fire in Forestry, Forest fire Behaviour and Effects* (volume 1).
John Wiley and Sons, Toronto, Ontario.

Kricher, J. C. and G. Morrison, 1988. *Eastern Forests,* Peterson field guides series no. 37. Houghton Mifflon Co. Boston, Mass.

Hirsch, M. no date. *Rain Forests.* Conservation Kit no. 83. Manitoba Forestry Association Inc., Winnipeg, Manitoba.

Kimmins, J. P. 1991. Clearcutting: Responsible forest management or environmentally- destructive forest exploitation in *Forestry on the Hill - Clearcutting (special issue),* Canadian Forestry Association (eds.), Ottawa, Canada. Pages 5-17.

Manitoba Natural Resources, 1990. *Manitoba Natural Resources 1930 - 1990* (60th anniversary biography). Winnipeg, Manitoba.

Oswald, E. T. and F. H. Nokes. *Field Guide to the Native Trees of Manitoba.* Manitoba Natural Resources, Winnipeg, Manitoba (french).

Smith, D. M., 1962. *The Practice of Silviculture.* John Wiley and Sons, Toronto, Ontario.

Spur, S. H. and B. V. Barnes, 1980. *Forest Ecology* (3rd ed.). John Wiley and Sons, Toronto, Ontario.

Winfield, N and L. Daniels, 1990. *Students as Advocates: Involving Students in Action to Save the World's Forests.* RAIN, Winnipeg, Manitoba.

Glossary

Biome: an extensive community of plants and animals whose makeup is determined by soil and climate.

Clone: an asexually produced genetically identical offspring.

Even-aged stand a natural or planted stand of trees which are approximately the same age and size.

Pioneer species a plant or animal which first appears on a barren or disturbed site, reinitiating an ecological succession cycle.

Serotinous descriptive of fruits that ripen late, or later than those of other species in the same genus; also of cones that remain closed long after the seeds inside are ripe, e.g. jack pine.

Silviculture the art and science of growing trees, including the renewing of forests (burnt and harvested) and subsequent tending of tree crops.

NOTE: Scientific names used in this publication have only the Latin name, e.g. white spruce *(Picea glauca).* Proper nomenclature requires the identifying authority, e.g. white spruce *(Picea glauca* [Moench] Voss). For the complete scientific names of trees listed refer to the *Field Guide to the Native Trees of Manitoba* (listed in Reference section).

Reading and Information Sources

American Forest Institute, Inc. *1975. Project Learning Tree.* Contact the Manitoba Forestry Association, Winnipeg, Manitoba.

Canadian Council of Forestry Ministers, 1990. *Canada's Forest Heritage.* Distributed to all Manitoba school libraries on behalf of the Minister, Manitoba Natural Resources (contact Manitoba Forestry Branch, Winnipeg 945-8238).

Canadian Forestry Association (editors), 1991. *Forestry on the Hill - Clearcutting (special issue)* Ottawa, Canada. Limited quantities available for about $8.00 (including postage and GST).

Canadian Forestry Service, 1987. *Manitoba's forests.* Forestry Report no. 32 (March 1987), Northern Forestry Centre, Edmonton, Alberta.

Forestry Canada, Ontario Ministry of Natural Resources, 1990. *Focus on Forests.* Ministry of Natural Resources, Toronto, Ontario.

Forestry Canada, 1991. *The State of Forestry in Canada, 1990 Report to Parliament.* Minister of Supply & Services Canada 1991, catalogue no. Fol-6/1991E. Ottawa, Ontario.

Lean, G. Hinrichsen, D. and A. Markham, 1990. *Atlas of the Environment.* Prentice-Hall Press.

Kricher, J. C. and G. Morrison, 1988. *Eastern Forests,* Peterson field guides series no. 37. Houghton Mifflon Co. Boston, Mass.

Manitoba Natural Resources, 1990. *Manitoba Natural Resources 1930 - 1990* (60th anniversary biography). Winnipeg, Manitoba.

Oswald, E. T. and F. H. Nokes. *Field Guide to the Native Trees of Manitoba.* Manitoba Natural Resources, Winnipeg, Manitoba (French version available).

Manitoba Environment, 1991. *State of the Environment Report for Manitoba.* Winnipeg, Manitoba.

Province of Manitoba, 1990. *Sustainable Development Land and Water Strategy, Workbook on Forests.* Winnipeg, Manitoba.

Western Regional Environmental Education Council, 1990. *Project Wild.* Contact Manitoba Natural Resources, Wildlife Branch.

World Commission on Environment and Development, 1987. *Our Common Future.* Oxford University Press, Toronto, Ontario.