Managing Your Woodland:
A Non-Forester’s Guide
To Small-Scale Forestry
In British Columbia
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Acknowledgements

This Handbook represents the care and work of many people. The project was initiated to provide basic forest management information to the many non-foresters involved or interested in managing small-scale forest lands in British Columbia, and has included representatives from this audience in all phases of its development.

Initial direction and inspiration were drawn from the many successful extension materials produced for non-industrial forestry operations in eastern Canada and the United States, most notably: “The Trees Around Us”, produced by the Nova Scotia Department of Lands and Forests in conjunction with the provincial Forest Practices Improvement Board and the Canada Department of Regional Expansion; “The Woodland Workbook”, by Oregon State University; and “The Woodland Steward”, by James R. Fazio, The Woodland Press.

Managing Your Woodland: A Non-Forester’s Guide To Small-Scale Forestry in British Columbia has been developed under the guidance of Bob Harding, B.C. Ministry of Forests and Lands; Mark Atherton, Canadian Forestry Service; and John Burch, Canadian Forestry Service; respectively, the administrators of the provincial Woodlot Licence Program, and the federal Indian and Private Forest Land Programs. The project has been funded through the Canada — British Columbia Forest Resource Development Agreement (1985-1990).

The review process has included the input of technical experts as well as individuals from the three user groups, in order to maintain a balance between accuracy and simplicity of presentation. The Handbook illustration is the work of Shirley Haines, and the typesetting was carried out by Lasting Impressions Communications Inc.

All of these people are to be thanked for their comments (and patience) throughout the production process.

The material was researched, written, and produced by Reid, Collins and Associates Limited.

Foreword

This Handbook is specific to British Columbia, where small-scale operations are different in many ways from those in other places. In part, the differences relate to the fact that B.C. is such a diverse landscape and mosaic of forest environments. In part, they relate to the fact that most of the forest land in the Province is owned by the Crown and, therefore, administered according to specific Ministry of Forests and Lands’ policies and standards.

Not surprisingly, we found that the practice of small-scale forestry is something more than a scaled down version of the large-scale operations that characterize forestry practice in British Columbia. At times it has been a struggle to provide accurate guidance to the managers of small-scale woodlands, in line with provincial standards, yet in a form consumable to those without formal forestry training. Hopefully, this material has charted a reasonable course in providing the basic information and tools to enable non-foresters to manage their woodland properties for their individual, and very different, goals.

We benefited greatly from the input and advice of many people who are actively involved in small-scale woodland management. In his review of the harvesting chapter, one of B.C.’s longtime woodland operators prescribed the following advice for would-be fellers: “If you can’t file your saw chain, forget about felling. Learn to file your saw chain first.” This is good advice, that extends beyond the context of felling. It relates to the importance of attitude, and the fact that forestry operations are part of a step by step process rather than single, unrelated actions. Furthermore, the success of each step depends on how well the preceding steps have been done.

This Handbook is about managing your woodland, one step at a time. Forestry is a long-term venture, so you are encouraged to take the time to learn and enjoy each step along the way. It is our sincere hope that this material will help you to understand the phases of managing a woodland property, and give you the information and tools you need to tackle each task.

Melissa J. Hadley, R.P.F.
Reid, Collins and Associates Limited
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Addendum

We are pleased to provide a third printing of this very popular guide. This section is provided to update the guide by providing name changes of government departments and ministries, additional references, and new information for some sections.

December 1991

INFORMATION UPDATES AND INFORMATION

Introduction

Please send any comments about the guide to:

Small-Scale Forestry Coordinator
Forestry Canada
Pacific Forestry Centre
506 West Burnside Road
Victoria, B.C. V8Z 1M5

or

Woodlot Licence Officer
Ministry of Forests
Timber Harvesting Branch
1450 Government Street
Victoria, B.C. V8W 3E7

FORESTRY BASICS

p.9 – second paragraph change “White spruce and balsam...” to Engelmann spruce and balsam...

INVENTORY

p.16 and on – The term “selectively logged” and the term “selective logging” should be referred to as “partially cut” and “partial cutting” to avoid confusion with the term selection cutting (system). Selection cutting, as defined in the Glossary, is a method of uneven-aged management with an objective to obtain good quality natural regeneration. Selective logging or selectively logged, has been associated with many cutting regimes, one of which is “high-grading” which meant the best were taken and the rest were left – not an optimal forestry practice as little consideration was given to reforestation.

HARVESTING THE TREES

p.5 – Social considerations regarding clearcutting often result from visual changes. A good reference to manage for visuals is provided in the Recommended Reference section of this section – it is “The Forest Landscape Handbook”, 1981. Publication#22-81008 available from the Ministry of Forests, Recreation Branch, 610 Johnson St. Victoria, B.C. V8W 3E7, Phone 387-1946.

p.8 – Within the Sample Faller’s Selection Guidelines the following statement should be added:

Fallers have the option to leave any tree if thought to be too hazardous to fall.

p.18 – Third paragraph – Tractors have a high (not low) centre of gravity which makes them unstable on slopes.

REFORESTING THE LAND

p.3 – Since the guide was produced much work has been done on the assessment of different mechanical site-preparation methods. Two methods which have shown good results are mounding and trenching.

A mound is a discrete raised planting spot suitable for one tree seedling. Because it is raised it may be used to increase soil temperature, improve soil drain-
age on wet sites, improve air circulation in wet, clayey, or compacted soils, as well as providing a rooting medium rich in organic matter. It is therefore most often used in wet areas or sites with cold soils.


Trenching or disc trenching creates furrows or trenches allowing seedlings to be planted in a raised site to avoid saturated soils or in the trench to be closer to groundwater. There are various types of disc trenchers and a closer look is required to match the equipment to your objectives and site conditions.


TENDING THE STAND

p.4 – Fourth paragraph. Grazing is still being tested throughout the province as a means of brush control. The critical elements are: wildlife compatibility, timing of browsing, suitability of vegetation, and logistics.

For sheep it is not necessary to wait three or four years before browsing, as mentioned in the guide. This period may be the most critical for the survival of your plantation due to vegetation competition. Choose sites where the vegetation will be eaten by the animals. For example shee prefer fireweed over many other species and can reduce seedling mortality caused by snow press in areas where fireweed growth is great. Before trying grazing as a vegetation control method talk to silviculture staff at the nearest Ministry of Forests District Office or to Forestry Canada Staff.

p.12 – If planning on juvenile spacing or commercial thinning contact the Ministry of Forests Stand Tending Forester to get the most up to date numbers on stems per ha. The numbers provided may be lower than now recommended.

p.20 – Second paragraph. If aerial fertilization is contemplated be sure to map out all watercours and plan accordingly as increased nutrients into water courses could cause unacceptable nutrient buildups downstream. This could affect drinking water quality and also affect the quality of water for fish habitat.

p.23 – Some additional references.

Forestry Canada and B.C. Ministry of Forests


The “Juvenile Spacing Manual” Workers’ Compensation Board is out of print and is being revised.
FOREST PROTECTION

A recent publication – Field Guide to Pests of Managed Forests in British Columbia by Kelly Finck, Patricia Humphreys, and Graham Hawkins is an excellent color plated guide to pests for the woodland manager. It is available from Forestry Canada at no cost.

Reference:

GETTING HELP

CAUTION – This section has not been updated. But as was mentioned in the introduction to this section: “As governments and priorities change, the focus and form of assistance programs offered by them often change as well. The specific programs listed here may no longer be offered by the time you read this, but the agencies themselves will still be a good place to start.” is still very appropriate guidance.

Forestry Canada is implementing the Small-Scale Forestry Program (formerly the Private Forest Lands Program) which would be a good place to begin looking for information – their address is:

Small-Scale Forestry Program
Forestry Canada, Pacific Forestry Centre
506 West Burnside Road
Victoria, B.C.V8Z 1M5
Phone (604) 363-0600

or

Small-Scale Forestry Program
Forestry Canada
Agriculture Experimental Farm
RR #8, Site 25, Comp. 10
Prince George, B.C. V2N 4M6
Phone (604) 963-8631

Other sources of information can be obtained from the various departments and ministries listed.

Ministry of Forests regional or district offices will be able to provide information on Woodlot licences and other management questions.

APPENDIX I GLOSSARY

The definition given to Old Growth has been expanded since the first publication. Old growth is not merely a stand of mature or overmature timber but instead is a complex and dynamic ecosystem with no simple definition. If you are interested in obtaining more information on “Old Growth” contact the Integrated Resources Branch of the B.C. Ministry of Forests, Victoria, B.C.

APPENDIX III HELPFUL EXTRAS

CAUTION – This section has not been fully updated, phone numbers and addresses may have changed.

Here are some helpful hints:

The B.C. Ministry of Forests and Lands is now the B.C. Ministry of Forests.

Canadian Forestry Service is now Forestry Canada.

For addresses and phone numbers of government ministries or agencies look in the blue pages of your phone book.

For provincial government phone numbers there is a Telephone Directory for the Government of British Columbia, available for a charge, from Crown Publications Inc., 546 Yates Street, Victoria, B.C. V8W 1K8. Phone (604) 386-4636; Fax (604) 386-0221.
This Handbook has been written for non-foresters. Its intent is to make the practice of forestry understandable, profitable and fun.

This is a guidebook to the management of small-scale forest lands in British Columbia – for the production of forest products, and the enhancement of wildlife, fisheries, recreational or aesthetic values. It will provide you with an overview of the steps involved in the practice of forestry, the types of decisions you will need to make, the kind of work to be done, and where you can get help. It will not tell you everything there is to know about forest management, but it will tell you what you need to get started and to take the next steps in managing your woodland.
What Is This Handbook For?

- to answer some of your questions and get you started in managing your woodland
- to give you an overview of the policies and regulations that govern forestry practices in B.C. and help you through the basic management phases
- to encourage you to clarify your goals for managing your woodland
- to help you find alternative ways of achieving them
- to provide directions to where you can get more information, assistance and advice

And to stimulate further interest in small-scale forestry in British Columbia.

How Do I Use It?

This Handbook deals with the process of managing a small woodland property primarily for timber production, with consideration given to the safeguarding or enhancement of other resource values. Each chapter deals with one of the phases in woodland management. Together, they provide you with the information needed to develop a Forest Management Plan for your woodland. For specific management techniques for non-timber resources such as fisheries, wildlife, or recreation, you will be referred to other handbooks and source materials.

Most chapters are structured in two parts. They begin with a discussion of the ‘whats and whys’ of the particular subject, such as a forest inventory, and end with more specific information on ‘how to go about it’ depending on the type of woodland operations you have in mind.

The book begins with a chapter on “Forestry Basics” to introduce you to how trees grow, how forests develop over time, and how they are managed in British Columbia. Forest and forest land classification systems are outlined, and the concepts of sustained yield and integrated resource management are introduced.

A chapter on “Management Planning” walks you through the steps of developing a Forest Management Plan, and provides a sample plan for your reference. The remaining chapters provide the ‘what, why and hows’ of each of the management phases that make up the Forest Management Plan. In addition, you will find information on how to develop a Business Plan and an accounting system for your woodland; where to get financial, technical and training assistance; and what taxes and other charges are applied to the forest products and revenues you produce.

Forest management is an ongoing process. Each of you will enter this process at different places in the management cycle, and with different needs. Whether you have a mature crop of trees or a bare piece of land, you should begin with a review of your forest inventory, since it will tell you what you will be managing. This will help you to determine the appropriate phase (and chapter) at which to start developing your Forest Management Plan (such as reforestation, stand tending, harvesting). Keep in mind that each phase builds on decisions made in the phases preceding it, and though you may start your planning at the harvesting phase, you will be making choices that affect the reforestation and stand tending phases of the next crop.
Why Small-Scale Forestry?

Forestry in British Columbia is a big area, big business, activity. It is the Province’s number one resource, employer of 20% of the provincial labour force, and generator of over one quarter of our provincial revenue. It has built a reputation for large-scale operations, hauling some of the world’s largest and most valuable timber from some of the roughest terrain, and has created a ‘bull of the woods’ mythology around the people who work in its isolated camps.

So where does small-scale forestry fit in British Columbia? Is it hobby tree-farming? What are the opportunities and what are the rewards?

Over 52 million hectares of British Columbia’s 95 million hectare land area, are covered in forest. About half of this forest land is currently classified by the Ministry of Forests and Lands as being productive, accessible, and covered in tree species suited to commercial timber production. In area, the small-scale forest land category (including small, scattered parcels of Crown land, Indian Reserves, and private lands) covers only 8% of the provincial forest land base. But in a Province the size of B.C. that represents a lot of forest – approximately 4 million hectares.

With a conservative, generalized provincial average of 350 cubic metres of timber produced per hectare of forest land at rotation age, these ‘small-scale’ lands can contrib-
employment and timber production, and contribute to community stability. To the owners and operators of these lands, it means even more.

Small-scale forestry brings people into closer touch with their environment and their values. For some it is a secondary income, for most a lifestyle. Land stewardship and the production of non-timber resources are the goals of many small-scale woodland operators.

Who Owns The Forests?

The majority (94%) of B.C.’s forest land is owned by the provincial Crown (that’s you and me), and rights to its timber and other resources are made available to users through a system of land tenure, or licencing agreements. Some tenures, such as Tree Farm Licences and Woodlot Licences, require the licensee to reforest areas after harvesting, while others simply transfer to the licensee the rights to harvest a specific timber crop. A few ‘special use’ tenures provide permits for individuals to cut firewood, collect scientific specimens, and produce Christmas trees or carry out other, small area, activities on Crown land.

Approximately 1% of the forest land base is regulated by the federal Crown; these forest lands include the national parks, lands associated with the Department of National Defence, and Indian Reserves. Another 5% of the provincial forest land is owned privately. Together, these lands have considerable potential for forest management which presents an opportunity to increase future timber supply, land values, personal incomes and employment in the Province.

Who Plans And Manages Our Forests?

Due to the diverse nature of B.C. forests, forest land use planning is often a complicated process, involving governments, associations, corporations and the general public. Since most of the forest land is held by the Crown, the provincial Ministry of Forests and Lands takes the lead role in the planning process.

Two major pieces of legislation, the provincial Forest Act and Ministry of Forests Act, govern the practice of forestry and forest management on Crown land in the Province. A number of policy and regulation manuals explain in further detail the day-to-day decision-making and operations within the forest.

Periodically, the Ministry of Forests and Lands produces an extensive Forest and Range Resource Analysis to assess the provincial forest resources and review the opportunities for their future use. The Resource Analysis includes a resource inventory, describes Ministry of Forests and Lands’ programs, analyzes trends in resource use, forecasts demand and supply of forest products, and discusses questions of public policy related to the use and management of forest resources.

Based on this information, a Forest and Range Resource Program is developed to outline the government’s management intentions for a specified five-year period. This plan is updated yearly to reflect current goals and policies. The accomplishments of Ministry programs, in terms of the goals set by the five-year plan, are reviewed yearly in an Annual Report.

The federal government, through the Canadian Forestry Service, provides scientific and technical leadership in research programs covering forest protection, growth, renewal, and forest development. Protection programs
include forest insect and disease surveys and studies investigating particular pest problems. The forest renewal and environmental research programs seek to improve regeneration systems and investigate the impact of forestry operations on other resources. Forestry development work focuses on improving the way we practice forestry, by transferring research findings into field practice, developing economic guidelines for forestry decision-making, and providing extension services and funding to private forest landowners and Indian Bands in the Province.

Most commercial forestry production is carried out by a small number of large, integrated forest companies. The term integrated refers to the fact that they both produce logs and manufacture them into lumber, pulp and other wood products. In this way, forestry is practiced as a partnership; regulated by the provincial government and carried out by the private sector.

In addition to the large forest companies, there are opportunities for others to become involved in the practice of forestry through the provincial Small Business Enterprise Program, as Woodlot Licensees, as Indian Bands, or as private owners of forest land. These are the small-scale forest users for whom this Handbook is written.

Forests And Our Future

Directly, as owners or licensees, and indirectly, as voters, each of us in British Columbia is a woodland manager. We have a responsibility to understand what forestry is all about in order to make informed decisions regarding the use and management of our provincial forest lands.

The management of small-scale woodlands is an exciting opportunity for the people of British Columbia to profit and to learn from direct involvement with their number one resource. It can bring the practice of forestry and forest management to more people in the Province, including those without formal forestry training. In the following pages you will find the basics of forest management in B.C. — what you need to know to start managing your woodland property to meet your goals, and where and how to find help.

The first edition of this Handbook has been produced with the benefit of considerable input from many of the intended users. As it is used, we expect it will generate many more suggestions for improvement. Small-scale woodland management is something of a new frontier in B.C., and we all have a lot to learn. If you have comments on this material or ideas you’d like to share, we’d like to hear from you. Send your feedback to the Timber Policy Branch, Ministry of Forests and Lands, 1450 Government St., Victoria, B.C. V8W 3E7.

Recommended References:

*Crown Publications Inc., Victoria
“Forest Act”. 1979
“Ministry of Forests Act”. 1979

B.C. Ministry of Forests and Lands
“Forest and Range Resource Analysis”
“Five-Year Program”
“Annual Report”
The word 'forest' brings a host of images to mind. Trees, birds, animals, and activities such as fishing, photography, camping, cutting firewood, and more. Forests are systems that offer a variety of products and special experiences. As a result, there is a lot to know about them.

This chapter will overview some forestry basics such as how trees grow, how forests develop, and how they are classified and managed for timber production and other resources. Other helpful materials are attached as Appendices to the Handbook, including a glossary, conversion tables, helpful organizations and addresses, and tree volume tables.
How Trees Grow

Trees, like people, grow upward and outward as they mature. Each year, a tree adds new growth at the tips of its branches and the top of its crown. Each year, a new layer of wood cells is added to the outer edge of the tree, just beneath the bark. Growth is generally fastest in the early years of a tree’s life, and slows down as the tree reaches maturity.

There are three major parts to a tree, each of which serves a different function. The roots provide anchorage and support; the crown manufactures the food to fuel growth, and the trunk provides mechanical support for the crown and acts as a pipeline for water and sap. Though the roots of most coniferous species do not grow deep into the earth like the ‘taproot’ of a carrot, they form extensive systems that increase in size and length each year. In general, the roots of a mature tree spread out in an area about the same distance as the tree’s crown, and individual roots have been known to reach three to four times the tree’s height.

As the roots branch out in search of water, they subdivide into finer and finer roots. At their tips, an army of single-celled root hairs act like sponges, absorbing water and dissolved nutrients.

From the roots, the water travels into the tree’s water pipeline, the ‘xylem’ cells, and is transported up into the trunk and distributed throughout the tree. Water drawn into the leaves is used by the tree in the production of food, through a process called ‘photosynthesis’, that takes place in the green cells of the tree’s leaves. The cells are green due to the presence of ‘chlorophyll’, a pigment which captures sunlight energy. Fuelled by the energy of the sun, the tree manufactures carbon dioxide and water into sugar, releasing oxygen as a by-product. The sugar produced in this process moves from the leaves into the branches and down to other parts of the tree through a separate food pipeline called the ‘phloem’. The larger the surface area of the crown and the more leaves on the tree, the greater its food-producing capability.

In addition to housing the tree’s food manufacturing factories, the leaves and crown of the tree serve other important functions. On the undersides of the leaves, or needles, are the tree’s breathing apparatus, the ‘stomata’. Each stoma is an opening, ringed by special cells that act like lips, opening to admit air and closing to prevent moisture loss. The crown also serves to shade the tree and the forest around it. As a result, trees create ‘microclimates’ within a forest. (Try walking into a stand of trees from a road or other open area on a hot day and feel the difference in temperature).

Looking to the inside of a tree, we can see a series of circles within circles. These are the annual growth rings of the tree. In the spring of each year the tree creates new cells in a special area, called the ‘cambium’, just inside the bark of the tree. This single row of cells encases the tree in a sheath from its roots to its branch tips, and has the amazing capacity of growing in two directions at the same time.
Cells which grow towards the bark are the ‘inner bark’, phloem cells which carry the tree’s sap and sugars. As they are pushed outwards by new cells, they gradually thicken and die and become part of the tree’s ‘outer bark’. The bark acts as a protective skin to the tree in much the same way that our skin (also composed of dead cells) protects us. The cells which the cambium produces on its inside edge, form the xylem or waterway of the tree, known as the ‘sapwood’. As the tree grows in diameter, the innermost cells of the sapwood lose moisture and become clogged with resins, oils and gums, and this portion of the sapwood becomes the ‘heartwood’. The xylem cells, both the living sapwood and dead heartwood, form a kind of skeleton that provides mechanical support to the tree. This skeleton is what we know and love as wood. At the centre lies a soft, pulpy core known as the ‘pith’ which marks the oldest part of the tree.

Each growth ring represents one year in the tree’s life, and it is possible to interpret the tree’s life history by reading these rings. The width of the ring tells us something of the tree’s growing conditions that year – how much light, water, and nutrients were available, and whether there might have been other plants competing for these resources. The supply of light, water, and soil nutrients determines the rate at which the tree grows. Trees in rich, moist soil environments grow faster than those on poorer, drier sites. A series of narrow growth rings often indicates that the tree was under severe competition or shading from other plants or trees. One or two narrow rings could suggest a year or two of drought or of insect attack that reduced the number of needles and therefore the amount of food produced. Severe frost can create ‘frost rings’ which are a distortion of normal xylem cells.

Other events, such as fire or injuries can also leave their marks. The illustrations on the following page tell another story. When a tree has been dislodged from its upright position, its annual growth rings compensate over the next few years to correct the lean and bring the tree back to its vertical position. The diagram on the left shows ‘compression’ rings that develop in conifer species as the tree grows to effectively ‘push’ itself upright. The diagram on the right shows the ‘tension rings’ that deciduous trees produce in order to ‘pull’ themselves upright.
The annual growth ring is made up of two bands of cells, those formed early in the growing season and those formed at the end of the season as the tree is slowing down to prepare for its winter dormant period. The 'springwood' cells develop early in the growing season when water is plentiful. Growth is rapid and the cells created are large and have relatively thin walls. The later 'summerwood' cells develop under less favourable conditions; growth is slower and the cells are smaller and thicker-walled. The thicker-walled summerwood cells are stronger than their thin-walled springwood companions. So in comparing two pieces of lumber, the one with the greater proportion of summerwood will be the stronger, all else being equal.
Family Trees (Identification)

Like the rest of us, trees have families too. They have parents and siblings who they resemble, family traits that they exhibit and, depending on their birthplace, prefer some environments over others. Trees even have family names – the pines, the firs, spruces, hemlocks, oaks, maples, birches and arbor-vitae (!), to name a few. Trees have common names (Douglas-fir) for those who know them well, and formal names (*Pseudotsuga menziesii*) for those who don’t. Tree classification systems have been developed to help you identify individual trees on the basis of their family and individual characteristics.

Native tree classification systems begin by separating trees into two groups, based on whether the trees keep their leaves year-round, or shed them before winter. The evergreens, or conifers, keep their leaves for two years or longer; the broadleaved, or deciduous trees keep their leaves for only one season before being shed. Other differences between the two groups include:

**Conifer**
- leaves are needle or scale-like
- many needle-like seed leaves
- seeds develop in cones
- wood is soft and resinous

**Deciduous**
- leaves are broad
- 2 broad seed leaves
- seeds develop in flowers
- wood is hard and non-resinous

*Exceptions to the Rule*

- Western Yew is an evergreen that bears its seeds singly, inside a small red berry, instead of a cone. Note that its needles are poisonous to horses and cattle, especially when cut and piled to rot.
- Larch is a conifer that is not evergreen – watch its needles next fall.
- Arbutus is a broadleaf evergreen that sheds its bark instead of its leaves.
- And yes, some softwoods are harder than their hardwood cousins.

Tree identification is often based on the shape, size, texture, and colour of each species’ leaves, cones, and bark. Tree silhouettes can also be used for identification. Since trees are a major life-form in your woodland, and most of your forest management practices will be developed based on the species composition and age of your trees, you need to become familiar with the faces, names, and characteristic behaviours of species and family groups. You are strongly advised to obtain a copy of “Native Trees of Canada” for reference to help you in this task.

In British Columbia, the conifers are the major commercial tree group and eight families have most of the industrial favourites within them. Another four deciduous families contain most of the species commonly encountered in forest land operations. You can begin to sort out the family trees on your woodland by looking at their branches and leaves. The list of species you are most likely to encounter, along with some clues for their identification, their common and formal (scientific) names, family (genus) symbol, and species symbol, is found on page 7.
CONIFEROUS (softwoods)

Lodgepole pine

Western white pine

Ponderosa pine

Needles joined in bundles

Larch

Single needles (cones hang downward)

Douglas-fir
Single needles (cones hang downward) - cont'd

Western Hemlock

Sitka Spruce

Balsam

Single needles (cones are upright)

DEICDUOUS (hardwoods)

Maple

Aspen

Alder

Leaves with coarse lobes  Finely-toothed leaves  Coarsely-toothed leaves
### Trees of British Columbia

<table>
<thead>
<tr>
<th>What To Look For</th>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Family Symbol</th>
<th>Species Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conifers (softwoods)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scaly, needle-like leaves</td>
<td>Western Red Cedar</td>
<td>Thuja plicata</td>
<td>C</td>
<td>Cw</td>
</tr>
<tr>
<td></td>
<td>Yellow Cedar (Cypress)</td>
<td>Chamaecyparis nootkatensis</td>
<td>Y</td>
<td>Yc</td>
</tr>
<tr>
<td>Needles joined in bundles</td>
<td>Lodgepole Pine</td>
<td>Pinus contorta</td>
<td>P</td>
<td>Pl</td>
</tr>
<tr>
<td></td>
<td>Ponderosa (Yellow) Pine</td>
<td>Pinus ponderosa</td>
<td>P</td>
<td>Py</td>
</tr>
<tr>
<td></td>
<td>Western White Pine</td>
<td>Pinus monticola</td>
<td>P</td>
<td>Pw</td>
</tr>
<tr>
<td></td>
<td>Alpine Larch</td>
<td>Larix lyallii</td>
<td>L</td>
<td>La</td>
</tr>
<tr>
<td></td>
<td>Tamarack</td>
<td>Larix laricina</td>
<td>L</td>
<td>Lt</td>
</tr>
<tr>
<td></td>
<td>Western Larch</td>
<td>Larix occidentalis</td>
<td>L</td>
<td>Lw</td>
</tr>
<tr>
<td>Single needles</td>
<td>Douglas-fir</td>
<td>Pseudotsuga menziesii</td>
<td>F</td>
<td>Fd</td>
</tr>
<tr>
<td>(cones hang downward)</td>
<td>Mountain Hemlock</td>
<td>Tsuga mertensiana</td>
<td>H</td>
<td>Hm</td>
</tr>
<tr>
<td></td>
<td>Western Hemlock</td>
<td>Tsuga heterophylla</td>
<td>H</td>
<td>Hw</td>
</tr>
<tr>
<td></td>
<td>Black Spruce</td>
<td>Picea mariana</td>
<td>S</td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td>Engelmann Spruce</td>
<td>Picea engelmannii</td>
<td>S</td>
<td>Se</td>
</tr>
<tr>
<td></td>
<td>Sitka Spruce</td>
<td>Picea sitchensis</td>
<td>S</td>
<td>Ss</td>
</tr>
<tr>
<td></td>
<td>White Spruce</td>
<td>Picea glauca</td>
<td>S</td>
<td>Sw</td>
</tr>
<tr>
<td>Single needles</td>
<td>Alpine Fir (Balsam)</td>
<td>Abies lasiocarpa</td>
<td>B</td>
<td>Bl</td>
</tr>
<tr>
<td>(cones are upright)</td>
<td>Amabilis Fir (Balsam)</td>
<td>Abies amabilis</td>
<td>B</td>
<td>Ba</td>
</tr>
<tr>
<td></td>
<td>Grand Fir (Balsam)</td>
<td>Abies grandis</td>
<td>B</td>
<td>Bg</td>
</tr>
<tr>
<td><strong>Deciduous (hardwoods)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaves with coarse lobes</td>
<td>Broadleaf Maple</td>
<td>Acer macrophyllum</td>
<td>M</td>
<td>Mb</td>
</tr>
<tr>
<td>Finely-toothed leaves</td>
<td>Trembling Aspen</td>
<td>Populus tremuloides</td>
<td>A</td>
<td>At</td>
</tr>
<tr>
<td></td>
<td>Black Cottonwood</td>
<td>Populus trichocarpa</td>
<td>A</td>
<td>Ac</td>
</tr>
<tr>
<td></td>
<td>Balsam Poplar</td>
<td>Populus balsamifera</td>
<td>A</td>
<td>Ac</td>
</tr>
<tr>
<td>Coarsely-toothed leaves</td>
<td>Red Alder</td>
<td>Alnus rubra</td>
<td>D</td>
<td>Dr</td>
</tr>
<tr>
<td></td>
<td>White Birch</td>
<td>Betula papyrifera</td>
<td>E</td>
<td>Ep</td>
</tr>
<tr>
<td><strong>Other favourites...</strong></td>
<td>Western Yew</td>
<td>Taxus brevifolia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dogwood</td>
<td>Cornus nucifera</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arbutus</td>
<td>Arbutus menziesii</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Douglas Maple</td>
<td>Acer glabrum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vine Maple</td>
<td>Acer cinnatum</td>
<td></td>
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</tbody>
</table>
Forests As Collections Of Stands

The basic management unit of a forest is a stand, or community of trees with common characteristics. Each stand represents a set of relationships between the soil, water, plants, animals, insects, birds, and other life-forms that live together. Stands are like the ethnic and cultural groups that make up a society. Each is distinguishable, and on the basis of its membership we are able to make some generalizations about its needs and behaviour. In forestry, these generalizations relate to how the trees grow and how they will react to different management practices. Such forecasts are important to the process of planning, since they help us choose a management system suited to the particular species and age class structure of a stand.

As a forest develops naturally, its stands follow a growth cycle of a number of steps from establishment to maturity, through death and re-establishment. Individual trees and even parts of the stand will die and new forms of vegetation will appear and grow in the openings created. Forests may be separated into two broad classes based on the degree to which the trees are "in step" as they grow; that is, whether or not the trees grow old as a group, or as individuals at different stages in the growth cycle.

Even-aged stands are those in which the growth cycle is generally in-phase. Usually, one species will dominate. Trees are of the same general age class (within 10 to 20 years), and the same general height. Even-aged stands, as a result, tend to look flat on top. Despite similarities in age, even-aged stands can display a range of diameter classes, so even-aged status should not be determined simply on the range of diameters. Even-aged forests, both coniferous and deciduous, predominate in the northern hemisphere following large-scale disturbances such as logging or fire.

Uneven-aged stands are composed of trees with at least three age classes, and often many species. Trees mature, grow old, and die according to individual timetables influenced by species and environmental factors. Young trees, that can grow in the shade of other trees, will grow up to replace the older trees. Uneven-aged stands appear ragged on top, exhibit a variety of shapes and sizes of trees, different kinds of foliage, and many shades of green.

Stands are managed differently, depending on whether they are uneven or even-aged. The silviculture and reforestation systems for both types of forest are discussed in later chapters ("Harvesting The Trees", "Reforestation The Land", and "Tending The Stand").

How Forests Develop

Uninterrupted, a forest expresses itself in different stages as it grows and develops. Each of these is known as a seral stage, and the process of development is called succession. Depending on water and soil conditions, a forest progresses through four or five distinct phases. We recognize and identify these stages by the dominant species of plant life. Though these growth stages take place over too long a period to follow in one forest, we can often see
them expressed in different forests in a region. The timetable of forest succession varies for different forest environments with changes in climate and landscape.

As it develops, a forest will move towards a state of stability. This stage is characterized by a dominant tree species that can reproduce indefinitely in its own shade. When a forest reaches this point it is known as a climax forest. In this state the rate of change is very slow and the climax species will remain dominant until environmental conditions change. The climax species will depend on the site and location of the forest. For example, cedar and hemlock are climax species on the Coast and in the Interior, for the sites on which they occur. White spruce and balsam are climax species in the Interior high elevation sites, and black spruce is a climax species for many northern swampy sites.

The process of natural forest succession begins with bare ground, when the trees and other vegetation have been removed by fire, logging, landslides or similar clearing events. Pioneer plants such as herbs, grasses, moss or ferns are the first species to green up the area. These plants are short-lived, and as they die they provide nutrients and organic material to enrich the soil and help it hold moisture for the plants that follow.

Soon afterwards, another distinct form of plant life begins to dominate the area. Woody-stemmed plants such as huckleberry, salmonberry and salal are found on the Coast; and fireweed, Saskatoon, thimbleberry and twinberry appear in the Interior. As these species populate a site, their roots help bind the soil and protect it from erosion, while their branches and leaves provide windbreaks and shade for smaller plants on the ground.

Within a decade, pioneer tree species may begin to take over the site. On the Coast, species such as alder, maple, and aspen are pioneer species; in the Interior, pioneer species of cottonwood, aspen, birch, lodgepole pine and Interior Douglas-fir predominate. The roots of these pioneer trees further stabilize the soil and break up underlying rock as they grow down in search of water.

The pioneer species can reign for 50 to 100 years, as invader conifers, growing slowly up through the shade of their forefathers, begin to appear. Balsam (grand fir, amabilis fir), pines (white, ponderosa), and Coastal Douglas-fir slowly take their place in the sunlight, eventually overtopping and outliving the pioneers. This stage in the development of a forest can last for up to 500 years.

Though it is often hard to detect, the forest continues to develop, and if growth is not interrupted by man or nature, eventually a climax species will become established. Unless the environmental conditions change, the only thing that gets the better of these trees at this point is old age. Though individuals die, the species continues to
dominate the forest landscape as new seedlings develop under the shade of the trees that seeded them.

Nature keeps forests in various stages of succession by interrupting the process with outbreaks of insects, disease, and fire. People, likewise, disrupt succession through harvesting and other management techniques. In some cases, we manipulate forests to keep them at a particular stage of succession because we value the products that are produced by stands at this stage.

A knowledge of forest succession provides insight to management decisions. Activities such as harvesting change the conditions within a stand or forest and influence the species that can regenerate on the area. When a forest is cleared, it often takes a step backward to an earlier stage in the succession process, though not necessarily to the beginning. For instance, on the Coast, if a stand of hemlock is clearcut and burned, the area may move back to an earlier seral stage, suited to a pioneer species like alder. This process can be short-circuited by planting the area with a more advanced, invader species (like Douglas-fir) suited to the cleared and burned condition.

How Forests Are Classified

Based on our knowledge of how forests grow and develop, we devise different management techniques to shape them to meet our needs. Managing a forest must take into account a number of factors including the land base, its elevation, soil, water, and other resources. We have developed classification systems to help sort through all this information in order to:

- determine the best management system for a particular forest
- identify those sites where we should focus our most intensive management efforts to obtain the best results
- decide which treatments are appropriate to particular stands at a given point in time.

For instance, the forest land base can be classified according to its ability to produce commercial wood in a set period of time. Such a system that rates forest sites as good, medium, poor or low, is useful in setting priorities for forest management activities. Forests are also classified according to their growing stock—the species, age class, height, number of trees per hectare (stocking), and extent to which they fully occupy a forest site (crown closure). This is the kind of inventory information found on forest cover maps (see the chapter “Forest Inventory”). In addition to looking at individual characteristics such as species and site, it is also important to look at forest systems.

Ecology is the science of relationships between organisms and their environments. The ecological classification of forest lands makes it possible to project tree growth, as well as the potential impacts of activities such as harvesting or site preparation, on the forest system. Such classification helps resource managers to prescribe appropriate management treatments for species growing under a variety of environmental conditions.

Of the 31 different coniferous tree species that grow in Canada, 23 grow commercially in British Columbia. These include pines, larches, spruces, hemlocks, Douglas-fir, true firs, cedars, junipers, cypress and yew. An ecological classification system has been developed to help sort out the variety of forest environments in which these grow, and to provide a framework for planning forest management in the Province. The classification system is based on differences in vegetation (bio), soil (geo), and climate (climatic). There are 13 zones in this biogeoclimatic classification system. Most of the zones are named for one or more of the dominant, shade-tolerant tree species they support (e.g. Coastal Douglas-fir Zone).

The value of the system lies in the framework it provides for the collecting and classifying of information that affects resource management strategies. The Ministry of Forests and Lands has produced a variety of information to help field people recognize ecosystem units on the ground, and develop management schemes for the treatment of these areas. Guidelines have been established for harvesting, reforestation and stand tending systems. These materials are a good starting point for woodland operators when planning the management strategy for
their woodlands. For more information, contact your local office of the Ministry of Forests and Lands.

The Ministry of Forests and Lands has recently piloted two research projects to investigate an ecological approach to organizing stands for small-scale woodland management. The success of this approach depends on detailed information about the woodland property. While much of the initial classification can be based on the biogeoclimatic zone manuals available from the District Offices of the Ministry of Forests and Lands, professional input will most likely be required for the detailed ecological classification. For more information, refer to the "Lasqueti Island Pilot Study" listed in the reference section at the end of the chapter.

How Forests Are Managed

Forest management involves a continuous cycle of activity. As forests are cleared by human and natural forces, they are re-established by natural seeding or planting. The new stands are tended to enhance their growth rate and improve their quality. Silviculture systems are designed to extract one crop while preparing the site and seedbed for the next. Throughout the cycle, the forests are monitored and protected against insects, fire and disease.

Forest management in British Columbia has developed around the principle of 'sustained yield' which is the practice of harvesting timber in amounts that are offset by the annual growth of the forest. Timber harvesting is regulated through the adoption of an 'allowable annual cut' (AAC) calculated for specific areas of the Province (called 'Timber Supply Areas') so that the annual wood losses within that area from harvesting, insects, disease and fire are balanced against the area's annual wood growth. In this way, the government seeks to maintain the forests of the Province while supporting the forest industry. Although the concept of sustained yield is simple, its implementation is difficult because of imprecise forest inventory information, changing technology, and changing market conditions.

The growing and tending of forests is called silviculture - 'silvi' for trees and 'culture' for cultivation. Basic silviculture activities, including surveys (to assess naturally regenerated and planted areas), site preparation, planting and brushing are required on almost all tenured Crown lands. Woodlot Licensees must carry out these activities to the satisfaction of the Ministry of Forests and Lands in order to maintain their tenures.

More intensive silviculture activities are carried out to maintain the forest lands of the Province in a productive state and enhance their growth. A current target of these silviculture treatments on Crown land is the planting of forest land which has been cleared by harvesting or natural forces, but is currently not satisfactorily restocked (NSR). The accumulation of such lands is known as 'backlog'. Another target is to improve the growth and value of immature forests through treatments such as conifer release, spacing, thinning, pruning and fertilization. These activities are discussed more fully in the chapter "Tending The Stand".

But forest management is more than timber production. The forest lands of the Province are managed according to an overall principle of integrated use which requires
that all resource uses be taken into consideration in the planning of an area. For the integration of resource uses to be possible, one must know what resource values are present and how the management of each will impact on the others. Compatible uses may be conducted in the same area at the same time, or in the same area at different points in time, i.e. a rotation of uses. Forestry practices are carried out in consideration of specific guidelines and policies designed to safeguard and enhance the non-timber values.

Managing For Non-Timber Resources

For the small-scale woodland operator, aesthetic, recreation, range, wildlife and soil values will likely be the major non-timber interests.

Recreation values may include the topographical, biological and cultural features that you wish to protect and develop on your woodland. The choice and level (as well as style!) of recreational development is largely a personal matter. Many woodland owners are interested in developing trails, viewing platforms or blinds for wildlife, or special camping sites for family outings. The major timber-related concerns in maintaining or developing the aesthetic and recreational potential of your area will likely involve the separation of harvesting noise and visibility from recreation trails or sites, and the protection of watersheds and soils. In addition to the private recreation values that you may enhance, small-scale woodland operations often have the potential for community recreation development. Forestry awareness and demonstration are opportunities that some woodland operators are beginning to explore with youth groups (such as Junior Forest Wardens) and others in their communities. The Recreational Officers in the District Offices of the Ministry of Forests and Lands may be a good source of information to woodland operators interested in developing the recreational potential of their woodlands.

The grazing of domestic livestock is an important forest land use in the Interior of the Province, and range management is part of the mandate of the Ministry of Forests and Lands. Special range land and forest management programs are in effect in a number of regions, supported by the forest industry, government, cattlemen and other forestry and range agencies. Re-seeding of clearcuts is a fairly common practice to provide good quality forage, and fire is being used as a management tool to improve forage production in some areas. Selective cutting practices are being used to open dense stands for grazing.

Wildlife management is largely a practice of habitat management. It relies on an understanding of the food, water, and shelter needs of different wildlife species and the options for manipulation of habitat to provide for these needs. Habitats can be manipulated directly, through practices such as prescribed burning to stimulate production of browse vegetation, or indirectly, through the modification of forest practices, such as selection cutting.

One of the early steps in managing your area for wildlife will be to determine what types of animals and birds might be using the woodland. To help you with this assessment, Regional Habitat Maps for some areas of the Province are available from the Wildlife Branch of the Ministry of Environment and Parks. Using a biogeoclimatic subzone classification, the maps indicate the habitat types in different areas, and their potential to support a variety of wildlife and bird species. Consult with the Conservation Officer at your local office of the Ministry of Environment and Parks to determine what species your
woodland might house, and how you might protect and enhance their habitats.

Once you have identified the wildlife potential of your area, you will need to determine what forest management modifications will be necessary in order to accommodate both wildlife and timber production on your woodland property. Most of the costs of managing forests for wildlife will be in the form of reduced harvesting, with some direct costs, such as prescribed burning or the seeding of logged areas and roadsides.

As a general rule, timber harvesting benefits wildlife species such as deer, quail and rabbits that browse or seek shelter in low-growing plants, by opening stands to more sunlight and stimulating the growth of shrubs and other understory species. The following table summarizes some of the positive and negative impacts of forestry practices on wildlife populations.

<table>
<thead>
<tr>
<th>Positive Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>• logging creates early stages of plant succession, favourable to some species</td>
</tr>
<tr>
<td>• clearing for roads, etc. creates more forest 'edge'</td>
</tr>
<tr>
<td>• reforestation accelerates production of dense forest cover valuable as shelter</td>
</tr>
<tr>
<td>• fire prevention preserves wildlife habitat</td>
</tr>
<tr>
<td>• new roads provide access to game</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Negative Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>• logging removes habitat important to some species</td>
</tr>
<tr>
<td>• excessive runoff or soil compaction can create barren areas</td>
</tr>
<tr>
<td>• rapid reforestation closes out open area species</td>
</tr>
<tr>
<td>• fire control may reduce natural creation of game ranges</td>
</tr>
<tr>
<td>• roads may disturb breeding grounds or initiate killing of species determined to be ‘undesirable’ or dangerous by the public</td>
</tr>
</tbody>
</table>

Likewise, though less pronounced, the presence of wildlife has both benefits and costs to forestry practices. On the benefit side, predatory wildlife species such as owls, cougars and coyotes help to control rodents and deer which eat seed or browse on seedlings. Birds and rodents can help to control insect populations and the growth of competing vegetation. On the cost side, birds and rodents may damage or eat or destroy seed, while larger species, such as deer may damage seedlings by browsing or trampling.

The provincial government has established departments within and outside of the Ministry of Forests and Lands to deal with the management of non-timber resources.
Industry, likewise, may have fisheries, wildlife, recreation and watershed specialists (in addition to professional foresters) on staff as part of their planning team. Specific Acts and Regulations deal with the management of non-timber resources (see Appendix III), and handbooks are available on subjects such as road building, streamside protection, watershed sensitivity rating, ground skidding, mule deer habitat and other forest land activities. Many of these are referred to and listed as reference material in the appropriate chapters of this book. More general forestry information is available from the Ministry of Forests and Lands and the Canadian Forestry Service offices in Victoria and elsewhere in the Province (see Appendix III).

At The Ground Level

Because of its influence on the growing and harvesting of trees as well as other resource values, soils will be an important consideration to the woodland manager. Three major factors influence soil quality: drainage, organic material, and texture. If you can identify these and understand how they influence tree growth and soil behaviour, you will have made a good start toward assessing the potential of your site, and planning for its use.

Soil Drainage

In well-drained soils, excess water drains away steadily, but not rapidly. Often the soil will be dusty red or brown from iron compounds and humus, the organic matter of decomposing leaves and branches. Plant growth is good in well-drained soils, and roots (if they can be seen) will be well developed. In poorly-drained soils, the roots are often waterlogged and root systems will be shallow and stunted. At the other extreme, very dry, often rocky, fast-draining soils will leach out (lose) nutrients quickly and also result in poor tree growth.

Organic Material

The amount of leaf, needle, and branch litter on the surface of the soil indicates how quickly decomposition is taking place and, as a result, how quickly nutrients are being released back into the soil. More than 10 cm of organic material, as can often be found on swampy sites, indicates that tree growth will be slow.

Soil Texture

The texture of the soil beneath the organic layer depends on the size of the soil particles. Sand has the largest particle size, followed by silt and then clay. Sand is gritty; silt is floury when dry and slightly gritty, almost soapy when wet; while clay is very fine and floury when dry and very sticky when wet. Generally speaking, sandy or gravelly soils are most suited to pines, Douglas-fir and cottonwood, whereas soils with sand and silt are favoured by the true firs (amabilis, grand, sub-alpine) and the cedars. Silty soils with some clay provide a good base for spruce, while hemlock enjoys well-drained soils with a top layer of organic material. Most tree species are tolerant of a wide range of soil types.

Soil stability is greatly influenced by the presence of tree and other plant roots that help to hold it in place and drain it of water. Major site disturbances, such as extensive road building and clearcutting, which remove this natural support and drainage system must provide compensating drainage structures, such as culverts and ditches, to protect exposed soil. Roots, insects and small animals create pores in the soil in which air and water are held. When these are greatly reduced or removed, as happens under heavy equipment traffic, the soil becomes
more dense and ‘compacted’. Soil compaction reduces drainage, hampers seedling establishment and slows down tree growth. It can lead to problems of excess surface runoff which may cause instability and soil erosion.

Recognizing the capabilities (and limitations) of the soils on your woodland, and organizing forestry operations to minimize problems will be an important task in the development of your Forest Management Plan. Alternative harvesting methods, specific equipment options, as well as seasonal considerations are discussed in the “Harvesting The Trees” chapter.

Safety In The Woodland

Managing a woodland can be an intense and time-consuming activity. It can also be very dangerous. So the first step in being safe is knowing that you are at risk and what you can do to prevent accidents.

Part of safety is protecting yourself, and an effective wardrobe of protective gear is readily available. There is no acceptable excuse for not being prepared. Your personal gear is as important as the hardware you use for a job. Shown below are the basic elements of the safe (and long-lived) woodland operator.

The practice of forestry takes place on a large scale— even in ‘small-scale’ operations. It uses powerful equipment that can easily harm or kill, and relies heavily on situation-specific judgement. The active logging phases are
the most dangerous activities you will encounter. If you plan to be anywhere near a chainsaw, it is strongly advised that you read the “Fallers’ and Buckers’ Handbook” and “Juvenile Spacing Manual” produced by, and available at cost from the Workers’ Compensation Board. Take them with you into the woodland even before you plan to cut. Check out the trees in your stands and look for some of the potential danger situations described. Think out the steps involved in felling specific trees and how you would handle different situations. The time cost is small in terms of the life-saving pointers you may pick up. Be ready to learn – from others with more experience, from special reference materials, and from your own experiences. Know when to ask questions and when to ask for help.

Equipment is, of course, extremely important. You know the old saying that you can cut yourself just as easily on a dull knife as on a sharp one. Take care of your equipment so that it can take care of your needs, and so that you can depend on it. Learn what maintenance is required, what you can do yourself and what is best left to professionals. “The Chainsaw – Use and Maintenance” provides an excellent overview on everything you should be aware of in the care and feeding of a chainsaw (see end of chapter for reference).

As important as knowing your equipment and how it works is knowing your body, its rhythms, its strengths and limitations. Pacing your work is often something that non-professionals need to learn. Listen to your body and work with it. It’s the only one you have and it’s worth taking care of. Operator fatigue is one of the major causes of accidents – work or play. Know when to call it a day.

Included in your toolkit, should be a reference on basic first aid and a first aid kit. At minimum, carry a whistle and a pressure bandage. Don’t work alone. You should know first aid basics, such as how to stop bleeding and treat shock. Always let someone know where you are going and when you expect to return and leave a note in your vehicle if your plans change.

Safety is, in large part, a state of mind. Your attitude and actions are of prime importance. Be alert. Be prepared. Be careful..........And stick around for the second crop.

Recommended References:

B.C. Ministry of Forests and Lands

B.C. Ministry of Environment and Parks
“Wildlife Habitat Handbooks for British Columbia”

Workers’ Compensation Board
“Fallers’ and Buckers’ Handbook”
“Juvenile Spacing Manual”

Other Sources
“Native Trees of Canada”. 1969. R.C. Hosie
“Basic First Aid”. St. John Ambulance, Vancouver
In order to manage a forest you need to know its character — the plants and animals it supports, their age, location, and condition, and the form and capability of the land itself. The purpose of an inventory is to acquaint you with the character of your woodland and help you to plan how best to protect, manage and use it.

This chapter outlines the type of inventory information you need to manage your woodland, and suggests where and how you might collect it. The basic skills of timber cruising and compilation are discussed, and a 'do-it-yourself' section describes how to conduct a quick and informal cruise of your woodland.
What Is A Forest Inventory?

An inventory is a record of things in stock. A forest inventory collects information on the land characteristics, trees, and other resource values in a forest area. It will help you to determine what is physically possible and financially realistic in managing your woodland property. You will use the forest inventory to set your management goals, develop your Forest Management Plan, and schedule your on-the-ground forestry operations.

Though the same type of information is needed for each of these purposes, the level of detail and precision of the information required is quite different. For example, to define your personal goals for the woodland, you just need a ‘sense’ of what’s out there, while to develop a Forest Management Plan you need to know such things as: when the different stands will be ready for cutting, what stand tending operations are necessary in the meantime, which stands are infested with insects or diseases, and where water is available in case of fire. To schedule the forestry operations for specific Management Areas on the woodland, you need even more detailed and precise information.

What Information Is Available?

Much of the initial information you will need to prepare a Forest Management Plan is available from government agencies. General forest inventory information for the Province is available from the Ministry of Forests and Lands. The provincial forest land base has been stratified (divided) into forest ‘types’, or groupings of stands that are similar in species, heights and stocking. Each type is described in terms of its:

*species composition*: species are listed in order of their percentage occurrence, with the dominant species first, e.g. F.L.PI (Douglas-fir, larch, lodgepole pine)

*age class*: 20 year age classes up to 140 years, then 141-250, 251+

*height class*: 9 m height classes (Class 1 is 0-10.4 m; Class 2 is 10.5-19.4 m; Class 3 is 19.5-28.4 m; etc.)

*productivity*: the ability of the site to produce commercial tree crops, expressed as ‘site class’ (good, medium, poor, low, and non-productive forest land)

*crown closure class*: the amount of ground area ‘covered’ by the canopy of trees; (measured in 5 or 10% crown closure classes; 100% crown closure means that the crowns of the trees all touch, and the stand is referred to as ‘closed’; 50% crown closure means that only half of the ground area is covered by tree crowns, and that there is still lots of room for the trees to grow before their crowns touch)

*stand density (or stocking class)*: the number of stems per hectare above a minimum diameter. Estimated to the nearest 10 or 100 stems per hectare (Class 0 is immature; Class 1 is mature, with >76 stems/ha of 27.5+ cm dbh; Class 2 is mature, with <76 stems/ha of 27.5+ cm dbh)

*history*: records the kind of disturbance, and silvicultural activities (site preparation, stand tending and regeneration) that have taken place on the area

*environmental sensitivity*: all forest land is classified for its environmental sensitivity and for other significant resource values. There are 7 categories of sensitivity, for: soil, plantation and regeneration, snow avalanche, recreation, wildlife habitat, watershed, and fisheries. The ESAs (Environmentally Sensitive Areas) are rated according to whether or not any harvesting can take place, and if so, under what constraints.

*inoperable problem areas*: strata which contain merchantable or potentially merchantable timber but are considered inaccessible in terms of current harvesting technology (canyons, hanging valleys, parks, highways, etc.)

*ecological classification*: biogeoclimatic zones and variants.

This information is recorded in ‘forest inventory and planning files’ (FIPs) and can be retrieved on a specific area basis on request to the Ministry of Forests and Lands’ Inventory Branch. More detail on these classifications can be found in the Ministry’s “Forest and Range Inventory Manual” (reference at end of this chapter).
Approximately 7,000 forest cover maps and associated data files have been produced from the interpretation of aerial photographs and information collected in field surveys. The forest cover map shown below is a simplified illustration, showing the forest type lines and only a few type labels. A lot of information is coded into forest cover maps, and they can look quite intimidating to the inexperienced eye. However, each map comes with an extensive legend to help you interpret the symbols. Once you figure out what the different symbols represent, interpretation is just a matter of practice.

<table>
<thead>
<tr>
<th>43</th>
<th>Polygon (stand) no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(h)</td>
<td>Cedar (20% and over in volume) (Hemlock - less than 20% by volume in the stand)</td>
</tr>
<tr>
<td>9</td>
<td>Age class 9 (251 years+)</td>
</tr>
<tr>
<td>6</td>
<td>Height class 6 (46.5-55.4 metres)</td>
</tr>
<tr>
<td>1</td>
<td>Stocking class 1</td>
</tr>
<tr>
<td>m</td>
<td>Medium site</td>
</tr>
<tr>
<td>7</td>
<td>Crown closure class (66-75%)</td>
</tr>
</tbody>
</table>

- Silviculture opening no. 155 Polygon (stand) no. NSR Not sufficiently restocked /m Medium site GL87 Logged 1987 PBB Planted 1988 60(88) Sample plot number and year sampled
Forest Inventory

Forest cover maps, at scales of 1:20 000 (and sometimes 1:10 000), are available from the Inventory Branch of the Ministry of Forests and Lands in Victoria. Although they are not detailed enough to provide all the information required by small-scale woodland operators, they are a good starting point in getting to know your land.

Aerial photographs have been periodically taken over most of the Province during the past thirty to forty years. Photos are currently available at scales of 1:20 000, and 1:15 000, and occasionally 1:10 000 for special situations. Chances are good that your woodland has been covered in the flight lines and that recent photographs will be available. When ordering, request the latest photographs, in the largest scale available. The addresses for ordering mapsheets and aerial photographs are listed at the end of this chapter.

Map scales are based on relationships where one measurement unit (such as an inch or centimetre) on the map represents a different measurement unit (such as a mile or a kilometre) on the ground. These relationships are described as a ratio, for example 1:25 000, where 1 cm on the map represents 25 000 cm, or 250 m on the ground. The smaller the second number in the ratio, the larger the scale of the map, and the smaller the area covered by the map. A map scale of 1:10 000 is a larger scale map than 1:250 000. The larger scale will provide you with greater detail for your particular area. Map scales of 1:5 000 or 1:10 000 are recommended for the small woodland.

Other inventory type information is available from a number of sources. Contour maps, at scales ranging from 1:500 000 down to 1:50 000, are available from the Department of Energy, Mines and Resources’ offices in Vancouver, Victoria or Ottawa. The larger scale, 1:50 000 is the most useful for planning purposes. The B.C. Ministry of Environment and Parks is currently engaged in a five-year program to produce computerized contour maps at a scale of 1:25 000 throughout B.C. Enquiries regarding the availability of these maps for a particular area should be directed to the Ministry of Environment and Parks in Victoria, or to local District Offices of the Ministry of Forests and Lands.

The inventory of non-timber resources is also important, since it identifies special areas for personal pleasure, such as camping, hiking, fishing, and hunting, as well as business opportunities such as trapping, cone collection, or the production of salal, ferns, or holly for local florists.

Much initial information on non-timber resources such as wildlife or soils can be obtained from resource agencies or government offices. For instance, the Canada Land Inventory provides broad classifications of land and soil capabilities for forestry, wildlife, outdoor recreation and agriculture. Wildlife habitat information is available from the Wildlife Branch of the Ministry of Environment and Parks. Since many habitat reports are region-specific, check with the local office of the Ministry of Environment and Parks for reference to regional materials and expertise.

Management plans for many Crown land tenures require that non-timber resources are specifically addressed, and that plans for their protection and/or enhancement are clearly set out. As information is collected, it can be added to the map of your woodland. A series of transparent overlays, one for each resource, is a very effective way of 'building' a picture of the resource potential of the woodlot. It can also help to identify potential use conflicts early in the planning stages, before work begins on the ground. At minimum, information on soils, water, topography and roads should be added to your forest cover map.

Building a Map Folio:
1. On separate sheets of overhead transparency, map out the major zones for each resource. For instance, the sheet on forest cover will show different forest types. Recreation potential may be divided by different use zones; soil may be separated to show areas of rock, sand, swamp, silt, or clay; and wildlife may indicate summer and winter range zones.
2. By laying the resource sheets on top of each other, it is possible to visualize the effects of proposed forestry activities on the other resources in the area.
3. Sheets can be updated to show annual changes, such as cut-over areas, new roads or other developments.

![Diagram of Topography, Elk habitat, Forest cover]
What Kind Of Information Do I Need?

For purposes of long-term planning and management you will need to describe your woodland with respect to:

- species distribution
- stand age
- stand height
- stand stocking
- stand volumes
- site quality
- environmental sensitivity
- other resource values
- history of disturbance
- condition of the forest

The provincial forest inventory can be used as a starting point to obtain information. However, since the information was collected for planning on very large areas of forest land, it may not be accurate when applied to small woodland areas. Information should be checked by field inspection and modified where necessary. You will likely want to supplement it with more detailed information about the timber and other resources on your area. The more you know about what you have to work with, the better you will be able to plan your woodland operations (and the fewer the surprises and disappointments down the line). As a general rule, you should plan to supplement the provincial forest inventory information with field data from your woodland.

The process of collecting information is called timber cruising. The amount and type of information you collect will vary according to the purpose of your cruise. The following table summarizes the level of information recommended for different forest management purposes on Crown and private lands.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Land Ownership</th>
<th>Recommended Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Goals</td>
<td>Private / Indian</td>
<td>Provincial inventory supplemented by informal reconnaissance (limited number of plots)</td>
</tr>
<tr>
<td>Forest Management Plan</td>
<td>Woodlot Licence Private / Indian</td>
<td>Provincial inventory supplemented by additional plot cruise to minimum MOFL inventory standards</td>
</tr>
<tr>
<td>Cutting Permit or Sale of Timber</td>
<td>Woodlot Licence Private / Indian</td>
<td>Formal operational timber cruise to MOFL operational cruise design standards</td>
</tr>
</tbody>
</table>

Once you have determined the information you need to plan and carry out operations on your woodland, you must then decide whether to conduct an inventory that meets all your information needs, or to do it in two steps— the first for planning purposes, and the second prior to harvesting. This decision will be influenced by whether the land is Crown or private, the cost of contracting the job (or your ability to do it yourself), and the estimated time lag between the cruise and the time of harvest. For Woodlot Licences, an operational cruise is required to obtain a cutting permit, and the permit is only in effect for up to 5 years. For private lands, an operational cruise may
only be necessary in cases where the standing timber is to be sold and the cruise information will be used as the basis of the sale.

In most cases, particularly where the information collected must meet Ministry of Forests and Lands’ standards, a person with little or no experience in cruising should consider contracting the timber cruise out to professionals. For those of you who want to develop your own expertise or at least understand the process of timber cruising, the rest of this chapter summarizes the steps involved in designing the cruise, measuring the plots, and compiling the cruise data. At the end of the chapter, information is provided on how to do an informal reconnaissance with home-made equipment. This will not provide you with inventory information to the Ministry of Forests and Lands’ cruising standards; it is meant more to give you a low-cost means of becoming familiar with the process of timber cruising, and help you get to know your woodland personally.

Where Do I Begin?

Regardless of the size of your woodland, and whether it is Crown or private land, you must know its physical boundaries, land characteristics, and what is growing there in order to manage it. Once you have the forest cover map, aerial photos and other basic information from the appropriate agencies, it’s time to head to the bush and see what things look like on the ground.

To carry out an inventory of your woodland you will need to master some skills in measuring distance and direction as well as tree heights, diameter and age. The measurement of direction and distance, and the marking of woodland boundaries are discussed below; the measurement of trees is dealt with in the section on Measuring Cruise Plots.

Measuring Direction

A compass is used to determine the direction travelled. If you have not yet purchased a compass, one with a mirrored lid that covers the compass face (as illustrated) is recommended. The hinged lid has a notch at the top that is useful for sighting through when taking a bearing, and the mirror makes it easier to read the bearing while sighting.

There are three parts to a compass: the magnetic ‘floating’ needle which is attracted to the magnetic North Pole; the graduated, movable dial with which you read direction; and the base plate (with or without a hinged mirror) which is marked at the top centre (index marker point) to indicate the line of travel.

A hand compass should be held with both hands, and with arms outstretched in front of the body at eye level. This makes levelling easier and sighting more accurate. Depending on the type of compass, sighting is done either along the main body of the compass and through the notched mid-point above North, or at eye-level through a notch in the hinged lid of the compass.

Before you start using the compass, you should check the declination setting. This is the difference in degrees (°) longitude between magnetic North and true North. The declination is set by turning the tiny screw on the movable dial of the compass face. (Your compass should have a tiny screwdriver on the end of a string that is attached to the bearing plate.) As you turn the screw, you change the angle between the orienting arrow and the meridian lines etched on the glass inside the dial. This action 'sets' your compass for the area in which you are working so that you can use magnetic North as a true North reading. The dec-
lation will vary according to the area of the Province you are in. A chart of declinations is included with compass instructions and declinations are often printed on the left side of contour maps as well. Be sure to check that your compass declination is adjusted for your area or your fieldwork will be plagued with error.

There are two basic ways you will use a compass. One is to take the direction of travel from a map, and is called a map bearing. The other is to take the direction of something in a field in order to locate it on a map; this is called a field bearing.

To follow a map bearing:

1. Read the direction in which you wish to travel from the map (e.g., S30°E).
2. Rotate the movable dial on the compass face until this bearing is at the index marker position on the top centre of the bearing plate.
3. Move the compass (and yourself – remembering how to hold the compass!) to a position where the etched orienting arrow and the floating needle are aligned.
4. Holding the compass at eye level, with the mirrored lid partly closed so as to reflect the compass dial, move to the position where you can see that the magnetic needle and the etched arrow are lined up. Without moving, look up through the sighting notch on the mirrored lid and identify an object (such as a tree or rock bluff) that marks your destination.
5. As you move toward this object, take sightings periodically to check that you are on course (keep the orienting arrow and the floating needle aligned). As you get close to the object (the tree or rock bluff), sight through the compass to another reference point beyond this one, to keep you on track as you travel.

Note: Keep metallic items well away from the compass while doing this!!
Forest Inventory

To take your bearing from a map:
In the example below, you are at the north end of McNeill Lake and want to travel to Cecil Hill.

1. Lay the compass on the map so that the scale (either inch or metric) on the side of the compass is on (or parallel to) the line between McNeill Lake and Cecil Hill, making sure that the top, sighting end of the compass, is pointing in the direction you wish to go. (ie: from McNeill Lake to Cecil Hill, and not the other way around!)

2. Keeping the compass in this position, turn the dial so that the meridian lines which are etched into the centre of the dial become parallel with the North-South line on the map. Make sure that the ‘N’ on the dial is pointing in the direction of North on the map, or the bearing you take will be in the opposite direction from where you want to go.

3. The bearing you must follow can be read at the index marker point (N45°W). Write it down on the map so you remember it, then pick up the compass and following the same steps for sighting as outlined above, pick your sighting ‘target’ and you’re on your way.

Step 3

Pea Lake

Index marker point

Cecil Hill
To plot a specific field location onto a map:

In the example below, you are on your way downhill from Pea Lake, and find some pictographs that you want to return to. To plot their location on your map, you need to take cross Bearings to two locations that are already located on the map. This process, of locating a third point by establishing its relationship with two known points is called 'triangulation'.

1. From the field site you wish to locate on your map, find two distinguishable points already plotted on your map, that you can see clearly from where you are. e.g. Mt. Daniel and Cecil Hill.

2. Choose one of the points (Mt. Daniel), and take a bearing to it from your field location (S74°W). Keep the dial at this setting for steps 3, 4, 5.

3. Place the compass on the map so that one edge of the base plate intersects Mt. Daniel.
4. Keeping the edge of the compass base plate on Mt. Daniel, turn the whole compass (not the dial) on the map until the meridian lines in the glass bottom of the dial are parallel with the meridian (North-South) lines of the map. Make sure that the orienting arrow, is pointing in the North direction on the map.

5. Draw a line on the map, along the edge of the compass base plate that is resting on Mt. Daniel – your position will be somewhere along this line.

6. From your field position, take a second bearing – this time to Cecil Hill (S46°W), and repeat steps 3, 4 and 5. Your field position is where the two lines intersect on the map. (• marks the spot!)
Measuring Distance

Where two people are measuring distance, a 50 or 75 metre nylon, wind-up line (often called a ‘chain’) is used. The first person (compass person) follows a compass bearing while pulling one end of the ‘chain’. At regular intervals the compass person stops, the line is pulled taut and the distance is marked with flagging tape. Distance and bearing can be written on the flagging tape with a felt pen (e.g. 55 m, 30°E). The second person follows the line to this point, tying more flagging tape to trees and bushes (or other markers) to mark the line of travel, and the process of measuring and recording the distance travelled continues.

When you are working in sloping terrain, the distance that you travel on the ground must be converted to a horizontal distance to make it possible to record your path on a map. This conversion is made easier by the use of slope correction tables (Appendix II). The slope correction table lists the slope (measured) distance along the top row in multiples of 2 metres, starting at 10 metres and ending at 52 metres. Down the left side of the table are slope % readings in 2% classes starting at 10% and going to 128%. To use a slope correction table to obtain a horizontal distance, you need to know the slope distance and the slope %. The slope distance is the measured distance described above. The slope % is measured using an instrument called a clinometer (see Measuring Tree Height).

For example, to find the horizontal distance between Plot A and Plot B, you first measure the distance between the two (slope distance) and then the slope difference between the two (the slope %). Turning to the slope correction table, you locate the slope distance, in this case, 28 metres. Next, find your slope reading of 34% on the left column, and travel across that row to the 28 metre column, to obtain the horizontal distance of 26.5 metres. To make things easy for yourself, keep in mind that your slope distance is listed in 2 metre classes, and always try to centre your cruise plots, or choose your distance from the tree whose height you are taking, in multiples of two.)

Boundary Marking

Clearly mark out the boundaries of your woodland property as soon as possible. This will make the area easier to find for contractors or others you may be working with, and save time and confusion on the ground when specific work is to be done. The old adage that good fences make good neighbours is all the more true when you (or your neighbour) may be planning to cut trees, build roads, or otherwise develop the property.

Nail firmly but allow space for tree growth.
Boundaries can be marked with paint, metal tags, blazes or posts. For private woodlands, you will need to locate existing survey posts or markers and mark out the property line boundaries using one of these methods. For Woodlot Licences, boundaries must be accurately surveyed and clearly marked as follows:

- with red or orange flagging tape at 50 metre intervals
- with squared trees bearing metal tags showing cumulative distances and bearings at 200 metre intervals (natural boundaries do not require marking)
- by a squared tree (blazed on 4 sides) and metal tag at property corners.

**Designing A Timber Cruise**

Once you have located your boundaries and determined the level of inventory information needed, you are ready to design the timber cruise. Cruises can either measure every tree in an area, as is the case with small stands of high value, or measure a sample of trees which is then used to project a timber volume for the area. Most cruising is done as a sampling of the total area since timber covers such large land areas in British Columbia that the measurement of every tree is not practical. This is called statistical sampling, and is the same theory used in population surveys or opinion polls. By collecting information from a variety of sample plots in an area, it is possible to make statements about the volume, density and condition of trees in the total area.

There are two basic methods of timber cruising used in British Columbia — the variable area plot method and the fixed area plot method. Both are based on the sampling of a ‘population’, or similar grouping of trees. The variable area plot method is quick and commonly used for industrial timber cruising. However, it is also the most difficult to understand, and requires the use of special equipment such as glass prisms. A discussion of variable plot cruising is beyond the needs of this Handbook. For more information, refer to the Ministry of Forests and Lands’ “Forest and Range Inventory Manual”.

The fixed area plot method is recommended for small-scale woodlands and will be discussed in more detail on the following pages. It is appropriate for sampling the forest at all stages of its development, from regeneration to mature timber. Plots can also be remeasured over the years to chart stand growth and timber yield; though special procedures are required to set up these permanent sample plots.

Since the management, and future, of a forest area is based on the information collected from the cruise, it is extremely important that the plots accurately represent the character of the woodland area. This is ensured by the design of the timber cruise. The cruise design has two components — the number of plots that must be established in the area, and where they are to be located.

*Note: Plots should be equidistant apart and the same size*
The Ministry of Forests and Lands has established guidelines for the design and implementation of timber cruises. Sampling is carried out by stratifying an area (grouping the similar forest types into individual strata) and then determining the number of plots required for each strata. The number of sample plots required varies according to the purpose of the timber cruise and the variability of the woodland area. More plots are required for operational cruising purposes than for inventory purposes because operational decisions require more precise information. More plots are required for variable terrain to ensure that the sample information collected accurately portrays the diverse character of your woodland. For further information, refer to the Ministry of Forests and Lands’ “Cruising Procedures and Cruise Compilation Manual”.

The minimum inventory standards require one plot per hectare, and four plots per forest type for areas less than or equal to ten hectares. For timber sales less than 60 hectares, the number of plots is determined on the following basis: for the first 20 ha, take one plot per 0.5 ha (40 plots); for the next 20 ha, take one plot per hectare (20 more plots), and for the remaining area, up to a total of 60 hectares, take one plot per every 2 ha (10 more plots). Do a test calculation to determine how many plots are recommended for a sale area of 50 hectares. (65)

Generally, plots are laid out at pre-determined intervals along plot lines to ensure that conditions throughout the woodland area are sampled in an unbiased manner. The accuracy with which the sample plots represent the entire area depends on this unbiased selection of plots. Plot lines should cross contour lines so that plots are taken at different elevations. More plots are required in areas that have a variety of growing conditions.

In some instances you may want to know how much wood can be produced by thinning a stand or by clearcutting a small patch or fringe of trees along a road or right-of-way. In these cases you may consider doing a full cruise of the area, measuring all the trees involved. However, unless you do the cruise yourself, this becomes an expensive proposition.

Conducting a formal inventory is a complex undertaking. It is very important that the inventory be designed correctly to meet the standards set by the Ministry of Forests and Lands, especially in cases where it is required to qualify for assistance, a loan, or a cutting permit. The inventory provides the information necessary for most management decisions, so it is a good investment, if a costly one. It is strongly recommended that you obtain professional/technical advice with respect to the level of cruise needed before you commit a lot of time and money to this phase of management.

Measuring Cruise Plots

The cruise is usually done by two people, a cruiser and a compass person. From a surveyed or otherwise easy to identify starting point, the compass person will follow a specified compass bearing, pulling a ‘chain’ to measure the pre-determined distance between plots. Flagging tape is tied at the starting point and at regular intervals along the direction of travel, recording both the distance travelled along the line and the compass bearing being followed. Additional markers are placed at each change in bearing. Distances and directions should be recorded on a map sheet or in a notebook as well.

Each plot centre is marked with flagging tape. Plots may be square, rectangular or circular, though circular is the most common since it reduces the boundary of the plot perimeter and is easy to lay out. In circular, fixed area plots, the plot boundary is defined by making a ‘radial sweep’, as shown on the next page. That is, the cruiser stands at the plot centre holding the zero end of the measuring tape over the plot centre while the compass person walks out the distance equal to the radius of the pre-determined plot size. (Slope corrections must be made for ground in excess of 10%). The plot radius is checked to at least eight points on the circumference to establish the plot boundaries. The illustration following shows the trees which would be counted ‘in’ and ‘out’ of the plot. A tree is counted ‘in’ the plot if more than half of its diameter (dbh) is within the plot boundary, as shown on the next page.
In fixed area plot cruising all trees larger than a specified diameter (measured at 'breast height', 1.3 m above the ground; referred to as dbh) occurring within the plot area are measured. Diameters of 17.5 cm for the Coast, and 12.5 cm for the Interior are the current minimum merchantable harvesting limits. However, the provincial inventory includes everything greater than 7.5 cm dbh. You may want to sample to lower diameters for silvicultural reasons (such as the effect of thinning on residual trees, or the kind and quality of understorey trees), but these do not have to be compiled for volumes. Information on the tree species, diameter and condition of trees (stem quality and presence of insects or disease) is also recorded.

Within each plot, you will measure and record:

- tree species
- tree diameters (above a specified minimum)
- tree age (usually one or two)
- tree heights (of those trees drilled for age)
- optional information:
  - indications of decay or insect pests
  - log grades
  - other resource information (soils, fish and wildlife, etc.)

### Fixed Area Sample Plot Sizes

<table>
<thead>
<tr>
<th>Area of Plot</th>
<th>Radius of Plot</th>
<th>Plot per Hectare Factor*</th>
</tr>
</thead>
<tbody>
<tr>
<td>.002 ha (20 m²)</td>
<td>2.52 m</td>
<td>500</td>
</tr>
<tr>
<td>.005 ha (50 m²)</td>
<td>3.99 m</td>
<td>200</td>
</tr>
<tr>
<td>.01 ha (100 m²)</td>
<td>5.64 m</td>
<td>100</td>
</tr>
<tr>
<td>.02 ha (200 m²)</td>
<td>7.98 m</td>
<td>50</td>
</tr>
<tr>
<td>.03 ha (300 m²)</td>
<td>9.77 m</td>
<td>33.3</td>
</tr>
<tr>
<td>.04 ha (400 m²)</td>
<td>11.28 m</td>
<td>25</td>
</tr>
<tr>
<td>.05 ha (500 m²)</td>
<td>12.62 m</td>
<td>20</td>
</tr>
<tr>
<td>.1 ha (1000 m²)</td>
<td>17.84 m</td>
<td>10</td>
</tr>
<tr>
<td>.2 ha (2000 m²)</td>
<td>25.23 m</td>
<td>5</td>
</tr>
</tbody>
</table>

*The plot per hectare factor is the number used to convert a plot total to a per hectare basis. For example, if there are 6 stems of Douglas-fir in a 2.52 m plot, those 6 represent (6 x 500) 3000 stems of Douglas-fir per hectare.
A sample cruise tally card used by the Ministry of Forests and Lands is shown below. The standardized format is designed for efficient recording of information collected in the plots, and computer compilation of the data.

**Measuring Tree Age**

To obtain a reliable indication of stand age and growth rates, the cruise must take the age of 5 or 6 trees in each stand.

The age of a tree is usually determined either by boring an increment core, or cutting the tree down. Boring is done with an increment borer, a type of auger. When bored into the centre of a tree, it takes a small core sample of the tree’s growth rings that can be removed with an extractor and counted. It is important to bore across all the annual growth rings and reach the centre of the tree in order to correctly establish the tree’s age. The very centre, or pith of the tree is usually a darker colour and different texture than the rest of the wood, so you can tell whether or not it has been reached.

**Measuring Tree Diameter**

The most simple and accurate way to measure tree diameter is to use a diameter tape. This is a metal tape, similar to a carpenter’s tape, with a hook on the end that can be fixed in the tree bark. The tape is wrapped around the circumference of the tree at breast height and the tree diameter (dbh) is read directly off the scale to the nearest tenth of a centimetre. The scale on a diameter tape translates the tree’s circumference into a measure of its diameter. If you were to use a regular tape measure, you could convert the circumference into diameter by dividing the circumference by 3.1416.

Increment cores are usually bored at stump height or dbh on the tree, which means that you must add to the number of rings counted in the core sample, the number of years it took the tree to grow to the height at which the sample was bored. This correction will vary by tree species and site class as well as the height at which the tree is bored. The Ministry of Forests and Lands “Field Pocket Manual” has a set of such tables for use in the Coast and Interior. Core sampling is quite simple once you get the knack of it and is an efficient way of determining the tree’s age and growth history, without harming it.

*(Note: Increment borers are expensive. Treat the tip carefully to protect its sharp edge. Tie a piece of flagging tape to the end of the extractor and wedge it gently into the bark of the tree you are boring so you don’t lose it or step on it. Invest in a reamer to help in removing cores that get stuck—the borer tip is delicate and can be ruined by using the extractor to poke out pieces of wood. When boring trees in below zero temperatures, always remove the tool completely from the tree as soon as drilling is complete. Increment borers have been known to freeze to the tree if left too long....)*
Forest Inventory

The most accurate means of determining the stand age is by felling representative trees. As with the increment core, it is necessary to add three to ten years to the growth ring count on a felled tree to account for the number of years it took the tree to grow to the stump height. Although felling may seem a rather drastic way of obtaining a representative age of the stand, it also makes it possible to check the tree for decay.

**Measuring Tree Height**

Measured heights are needed for at least 30 trees of each major species for each stratum (group of forest types with similar species, age and height classes) in the area being cruised. Heights should be taken of trees that represent the full range of diameter classes and are distributed evenly throughout the stratum.

The most common tool for measuring tree height is the Suunto clinometer. The ‘clino’ works on a pendulum principle and measures the angles to the top and to the base of the tree. When these measurements are combined with a measured distance to the tree, the height of the tree can be calculated.

The Suunto makes it possible for you to estimate tree height based on two quick readings of the slope lines from your eye to the top and bottom of the tree, commonly measured at dbh. To use the Suunto, hold it to your right eye and watch the internal movable scale, while looking at the target tree with your left eye. Tilt the instrument until you can see the top of the tree, and read the right hand side of the scale (in %). Make note of the reading, then tilt the instrument to the ‘base’ of the tree (actually, at dbh) and record the reading. Measure the horizontal distance you are from the tree, then calculate the tree height according to the following formula:

\[
Tree \ height = (TT + TBH) \times HD \times .01 + 1.3 \ m
\]

where

\[
TT = Tree \ top \ reading \ (\%)
\]

\[
TBH = Tree \ reading \ at \ breast \ height \ (\%)*
\]

\[
HD = Horizontal \ distance \ from \ tree ***
\]

* The height at dbh (the point to which you sighted on the tree)

** Tree bottom readings are usually a negative %; ignore the negative sign and add the bottom % measurement to the top % measurement. In cases where you are looking uphill to sight both the top and bottom of the tree, and both % readings are positive, subtract the tree bottom % reading from the tree top % reading.

*** Remember to derive the horizontal distance using slope tables
### Standard Cruising Equipment (1988$)

- Metric diameter tape $50
- 50 m nylon wind-up metric measuring tape $50 - $75
- Hip-chain and rolls of string $115
- Cruise cards (waterproof) $10 per 100
- Field book $6
- Spray paint $24 per 12
- Compass $30
- Suunto clinometer (with % scale) $100
- Increment borer (plus reamer) $150
- Axe $30
- Pocket stereoscope $25
- Hand calculator $15
- Flagging $25 per 12
- Forest cover map *
- Contour map *
- Aerial photos *
* Keep non-waterproof materials in zip-lock bags

**Note:** Consult the Yellow Pages for addresses of Forest Equipment suppliers.

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### Processing The Cruise Data

The timber cruise collects a lot of information about the status of trees from sample plots in an area. This information must be processed, or compiled, into a summary that makes statements about the whole area: what is growing there, the volume of merchantable timber on the area, the quality of the timber, its age and growth characteristics. From this information it becomes possible to determine, among other things, a plan and a schedule for developing the area for harvesting. Present day operational cruises are almost always compiled by computer, though hand compilation is still possible, but time consuming.

The cruise is compiled according to the harvesting or merchantability specifications. For instance, if the area is to be selectively logged, then a minimum cutting diameter limit may be set for each species (e.g. lodgepole pine, 12.5 cm; Douglas-fir and larch, 27.5 cm; all other species, 17.5 cm). The cruise compilation determines the volume of each species with the prescribed minimum measurements by sorting through the data. In this way it becomes possible to explore the effects of different cutting systems on the volume to be logged each period.

The computer printouts are detailed enough to identify the volume by species not cut as well as the volume to be cut. Although the information provided in a cruise compilation is more or less standard, the format of the printout varies with the agency producing it. It is important to have the printout thoroughly explained to you by the compiling agency.

The cruise data is compiled by forest types, or by strata (i.e. groups of types with the same or similar species composition, age and height classes). The plots within each stratum are compiled as a group to produce a volume per hectare for each species. These volumes are multiplied by the area of the stratum to obtain a total volume for the stratum. The basic steps of this compilation include:

- Calculating individual tree volumes
- Calculating per-hectare species volumes for all plots
- Calculating total species volumes for each stratum
- Calculating total species volumes for all strata (i.e. the whole area)

To calculate tree volumes, you will need the height and diameter measurements for all trees in each sample plot. Measure the heights of at least one third of the trees on each plot and estimate the heights of the remaining two-thirds using the measured trees as reference points. Or, you can construct a height/diameter curve, based on the measurements of heights and diameters of a minimum of 30 trees for each species in the stratum. If your woodland is less than 200 hectares in size and is one forest type or stratum, you can make do with one height/diameter curve based on heights taken over the entire area.

A height/diameter curve is shown on the next page. Once you have drawn the curve to ‘fit’ the data you have collected, you can estimate the missing height and diameter classes from the graph line.

With a complete set of heights and diameters, you are ready to calculate the volume of each species in the plot. This is done by consulting a Standard Metric Volume Table produced by the Ministry of Forests and Lands. These volume tables are compiled, by species and region, from a large number of felled trees spanning the complete range in diameter and heights for the particular species of tree. For each height and diameter measurement, the
tables give the gross volume of the standing tree (inside bark), including the stump and top. The Standard Metric Volume Table publication also gives merchantability factors, allowing you to obtain gross merchantable tree volumes, minus stump and top.

After the gross merchantable volumes have been obtained for individual trees (by species) they must be netted down to account for losses from decay, waste and breakage, according to the pathological characteristics noted in the cruise data. This appropriate decay, waste and breakage factor can be obtained from the MOFL District Office. It is multiplied by the gross volume (from the volume tables) to obtain the net volume per tree within each plot.

The plot information is next compiled to create a species and volume summary. As shown in the example for stratum 2A, on the next page, net volumes for each species are listed for the stratum, then multiplied by the correct 'per hectare factor' (PHF) to obtain a net volume per hectare for that species. This number is then multiplied by the total area of that stratum to obtain the total volume by species. The area for the stratum is calculated from the mapped boundaries by a simple dot grid (these are readily available for calculating areas on different map scales). The area for the stratum is then multiplied by the per hectare net volume to arrive at the total volume.
Stratum 2A has eight sample plots in it, 0.02 ha in size. The volumes totalled for all eight samples are:

<table>
<thead>
<tr>
<th>Species</th>
<th>All Plots</th>
<th>Avg. Net</th>
<th>PHF</th>
<th>Net</th>
<th>Stratum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Net Volume</td>
<td>Vol. / plot</td>
<td></td>
<td>Vol. / ha</td>
<td>Area</td>
</tr>
<tr>
<td>F</td>
<td>21.0 m$^3$</td>
<td>2.62 m$^3$</td>
<td>50</td>
<td>131.2 m$^3$</td>
<td>20 ha</td>
</tr>
<tr>
<td>L</td>
<td>10.5 m$^3$</td>
<td>1.31 m$^3$</td>
<td>50</td>
<td>65.6 m$^3$</td>
<td>20 ha</td>
</tr>
<tr>
<td>P</td>
<td>5.9 m$^3$</td>
<td>0.74 m$^3$</td>
<td>50</td>
<td>37.0 m$^3$</td>
<td>20 ha</td>
</tr>
<tr>
<td>S</td>
<td>2.9 m$^3$</td>
<td>0.36 m$^3$</td>
<td>50</td>
<td>18.1 m$^3$</td>
<td>20 ha</td>
</tr>
<tr>
<td>B</td>
<td>1.3 m$^3$</td>
<td>0.16 m$^3$</td>
<td>50</td>
<td>8.1 m$^3$</td>
<td>20 ha</td>
</tr>
</tbody>
</table>

Stratum Total: 20 ha 5,200 m$^3$

(Anyone still wondering why this is normally done by computer?)

An updated forest cover map is created from the cruise information, showing the location of plots, the timber types, and any other information which will help in laying out roads and landings. It may identify environmentally sensitive areas, wildlife habitat ranges or potential recreation sites for protection, or stands requiring silvicultural treatments. This map and associated information, forms the basis for planning the protection, management, and timber harvesting activities for the woodland.

You may choose to do the cruise yourself, or contract it out. Depending on your skill and the time available, it may be to your advantage to contract out the cruising for large land areas or for areas in which government assistance is being sought for subsequent forest management activities. If in doubt, check with the District Office of the Ministry of Forests and Lands. Where a formal inventory is required, such as to obtain a cutting permit for Crown lands, the timber cruise must be designed and carried out according to the Ministry standards. Advice with respect to designing and undertaking operational cruising can be obtained from the District Offices of the Ministry.

In most circumstances you will have the timber inventory done by someone knowledgeable in both the cruise procedure and design requirements of the Ministry of Forests and Lands as set out in the “Cruising Procedures and Cruise Compilation Manual”. However, for establishing initial management goals, you may wish to be able to roughly estimate the volume of timber in a particular stand yourself. For this reason, a quick and easy method of estimating tree volume on your own, using some home-made equipment and a set of merchantable volume tables, is provided in the next section.

**Doing It Yourself**

This informal cruise will not meet Ministry of Forests and Lands’ standards, but it will provide an initial method by which you can roughly estimate the volume of standing timber in your woodland.

This section is for those of you who want to do a quick and informal reconnaissance to get to know your woodland and assess its potential to serve your interests and needs. Plan to put in a minimum of 10 to 15 plots for an area of 20 hectares, and add one plot for each additional 4 hectares up to 60 hectares.

When the property is larger than 60 hectares, and the time required to put plots in takes more than a couple of days, it may be in your best interest to do (or contract) a formal cruise, carried out to Ministry standards, from the very start. If you will eventually need this more precise and complete information to develop your area, there is little sense in duplicating the effort and the expense.

**Measuring Distance**

For informal measurements of distance, you can use your natural pace as a ruler. Distance is estimated by multiply-
To determine your pace length, practice walking a marked distance (say, 100 metres). When you reach the point where it takes the same number of paces to cover that distance each time, you have identified your natural pace length. Divide the number of paces by the distance (100 m) to obtain your normal pace length for that terrain. In normal woods terrain, a person of 1.8 metres will cover approximately 0.8 m with one pace, so 125 paces will cover 100 metres. It is important to practice pacing over a variety of terrain, so that you can learn to adjust your estimate of your pace length for different conditions. For instance, where your normal pace length for flat terrain may be 0.8 metres, for uphill or downhill slopes of less than 20% it may be 0.75 m, above 30% it may be 0.66 m, and so on.

Another way of measuring distance on your own is with a 'hip chain'. This device measures distance by running an anchored filament string around a wheel which revolves as you walk along the ground. The hip chain must be calibrated regularly against a 50 metre nylon measuring tape. Used properly, it can be accurate to within 5%. Remember that distances measured on slopes must be corrected to horizontal distance.

**Measuring Trees**

If you don't have access to a clinometer, described earlier, you can build a hypsometer to estimate tree heights. A hypsometer is simply a straight edge (such as a stick) held upright at arm's length, to form two edges of a triangle that can be compared to the triangle formed by a tree and the ground. The hypsometer uses the relationship between these two triangles to estimate the height of the tree.

The Merritt Hypsometer, for which construction instructions are given at the end of the chapter, is a straight, graduated stick that is held vertically at a pre-determined distance from the eye, commonly 60 cm. To estimate tree heights, the measurer paces to a specific distance from the tree, holds the hypsometer at the specified distance from his eye, aligns the bottom of the hypsometer with the bottom of the tree, then looks up to the top of the tree and reads the point on the scale which coincides with the top of the tree.
Two scales are provided on the hypsometer which you will construct, to enable you to estimate tree heights at a distance of 20 metres or 40 metres from the tree. Where the tree bottom and top can be seen at 20 metres, this is the easier scale to use and will likely provide the more accurate estimate. Obviously, the accuracy of the height estimate depends on the accuracy in pacing the distance from the tree, the accuracy with which the hypsometer is held upright at the prescribed distance from the eye, and the accuracy with which the scale is read.

For measuring trees on a slope, you should measure along the contour, or you will need a clinometer or other, more accurate tool that will enable you to convert the slope distance to a horizontal distance.

A Biltmore stick can be used to obtain quick approximations of tree diameter. It consists of a straight rule, approximately 60 - 80 cm long, that is held at right angles to the tree at breast height. The stick must be carefully positioned so that the zero point on the left edge of the stick is at the point indicated as shown in the figure below. By holding your eye at a position mid-point in the tree’s diameter, and the zero point as shown at the left edge of the tree, the diameter of the tree can be read on the scale at the right edge of the tree, at position B. The accuracy of this measurement depends on three things:

- the accuracy with which the Biltmore stick is held from the eyes (the distance L; 60 cm)
- the ability to keep the eye at breast height level
- the regularity of the tree’s girth (you are estimating a diameter based on the assumption that the tree is round in cross section). In cases where the tree has a major bulge or other deviation, take two diameter measurements and use the average of the two

Instructions for constructing the Biltmore stick out of a piece of lathing are included at the end of this chapter.

Note: The hypsometer and Biltmore stick should be used only to obtain rough estimates of tree heights and diameters for planning management goals. Neither tools are accurate enough to meet Ministry of Forests and Lands’ cruising standards.

As you work your way around the plot, mark each tree as it is measured, to keep track of those trees already tallied and avoid duplication. Spray-painting a number on each tree as you go works well, or you can purchase tree tags which are stapled on the tree at dbh level, facing the plot centre. The diameter of each tree will be measured, and the heights of two trees or more, as time permits. Using the measured heights as reference, the heights of remaining trees can be ‘eye-balled’ to the 5 metre height class required to use the volume tables.

Estimating Timber Volume

Though it is clear that the height and diameter measurements taken with the hypsometer and Biltmore stick will only be rough estimates, they will be good enough to allow you to place trees in broad diameter and height classes. The volume tables provided in Appendix IV have been developed for 5 cm diameter classes up to 100 cm dbh and then 20 cm increments, and 5 metre height classes.

Trees are grouped into the diameter class closest to their actual diameter estimate. Diameter classes are identified by the mid-point diameter in the 5 cm class. For example, the 10 cm diameter class includes trees of diameters be-
between 7.5 cm and 12.4 cm; the 25 cm diameter class includes trees with diameters between 22.5 cm and 27.4 cm. Therefore, a tree with a diameter of 18 cm will belong to the 20 cm diameter class, as will a tree with a diameter of 22 cm, while trees with diameters of 28 cm and 32 cm will both belong to the 30 cm diameter class.

Similarly, trees will belong to the height class closest to their estimated height. So trees with heights of 22 metres and 19 metres will belong to the 20 m height class and trees with heights of 23 and 26 metres will belong to the 25 m height class.

Once the height and diameter classes are known, the individual tree volumes can be read directly from the table. For example, refer to the volume table for Coastal Douglas-fir in Appendix IV. Note that volumes are given for both 10 cm and 15 cm top diameters (inside bark) for trees up to the 40 cm diameter class. Past this diameter, the difference between the volumes at the two utilization standards is very small, so they are combined in one table for diameters up to 200 cm. The choice of which top diameter (and table) to use will depend on the log buyer, so be sure to check with the mill to whom you are selling.

The volume of a tree with a diameter of 32 cm (30 cm diameter class), and height of 25 m, measured to a 15 cm top diameter is 0.52 m³. The volume increases to 0.57 m³ if a 10 cm top diameter is utilized. A tree with a diameter of 46 cm (45 cm diameter class) and height of 30 m has a volume of 1.4 m³, to either top diameters.

You will note that volume estimates are not given for all possible diameter and height class combinations in the table. This is because it is unlikely that a Coastal Douglas-fir tree with a diameter of 85 cm would be found in a height class below 20 metres, or, likewise, that a Coastal Douglas-fir in a height class of 50 m would have a diameter less than 30 cm. Where these situations arise, the volumes can be extrapolated from the existing table, if necessary.

Volume tables have been provided for each of the major commercial tree species in British Columbia. These volumes are based on logging to a stump height of 30 cm. Note that there are generally two tables for each tree species. (One set of tables provides Coastal volumes; the other set provides Interior volumes.) These volume tables have been constructed from provincial information for mature stands of timber.

Appendix IV also explains how tree volumes can be calculated by hand using volume equations. As with the volume tables provided, you will need tree height and diameter measurements.

It should be recognized that deductions for loss due to decay are not included in the volume tables since such losses can vary widely from tree to tree. For industrial cruises, the timber cruiser records the presence of one or more of up to eight indicators of defect (conks, scars, dead tops, etc.) which are used in the compilation to deduct for decay.

The data available for loss factors is contained in the “Metric Diameter Class Decay, Waste and Breakage Factors, 1976, For All Forest Inventory Zones in B.C.” produced by the Ministry of Forests and Lands. However, for your informal cruise purposes, decay loss can simply be estimated as 5%, 10%, or 20%, according to the observed condition of the individual tree. It may also be possible to assign a loss deduction to the plot or even to the stand, depending on the consistency of tree species, age or condition. In general, conifers under 80 years have little decay (2% or less). Consult a forester in your area for some advice on a realistic deduction for decay.

Deductions are also made to tree volume estimates for breakage that occurs during felling and waste wood that is left behind after bucking and yarding. Since most of the small-scale private and Woodlot Licence lands have second growth timber, the waste and breakage deductions will be minimal and can therefore be ignored in the informal estimation of volume.

Using this format, it is an easy matter to obtain a quick estimate of the timber volume on your woodland property. Refer to the first section of this chapter to refresh your memory regarding the steps involved in compiling the cruise data. The individual tree volumes you obtain from the volume tables in Appendix IV are already netted down for utilization standards. You will have to net these down further for decay before you tally them for your individual plot volume.
Do-It-Yourself Cruising - One Step At A Time

1. Determine number, location, and size of plots.
2. Establish plot lines.
3. For each commercial tree species within the plot, measure tree diameters and estimate heights.
4. Determine height and diameter class of each tree and tally individual tree volumes.
5. If necessary, net individual tree volumes for decay.
6. Sum individual tree volumes to obtain plot volumes for each plot.
7. Sum plot volumes and divide by number of plots to obtain average plot volume.
8. Multiply average plot volume by the per hectare factor to obtain average volume per hectare.
9. Multiply average volume per hectare by total hectares to obtain volume for total area.

Recommended References:

**B.C. Ministry of Forests and Lands**
- "Cruising Procedures and Cruise Compilation". Valuation Branch
- "Inventory Manual" and "Field Handbook". Inventory Branch
- "B.C. Coastal Fisheries Forestry Guidelines". 1987. MOFL, DFO, COFI

*Crown Publications Inc., Victoria*
- "Forest Act". 1979
- "Metric Diameter Class Decay, Waste and Breakage Factors, for all Inventory Zones in B.C."

*Canadian Forestry Service*
- "Manual of Forest Inventory Guidelines for Federal and Indian Lands". Federal Lands Forestry Branch

*Dept. of Fisheries and Oceans*
- "Handbook for Fish Habitat Protection on Forest Lands in British Columbia". 1981

*Other Sources:*
- "The Canada Land Inventory". A series of Handbooks of land and soil capability classifications for forestry, wildlife, agriculture and recreation
- Forest Cover Maps: Ministry of Forests and Lands, Technical and Administrative Services Branch, Attn: Map Sales, 1450 Government Street, Victoria. V8W 3E7
- Aerial Photographs and Published Maps: Ministry of Environment and Parks, Surveys and Resource Mapping Branch, 553 Superior Street, Victoria. V8V 1X5
Constructing a Biltmore Stick and Hypsometer

1. Cut a piece of wood lathing or other straight edge, flat on two sides, to a length of 1.3 metres. (This is the height at which tree diameters are measured)

2. Sand both sides to prepare for marking and labelling.

3. Place an easy to see (colour) mark at 60 cm along the lathing. This is the distance at which the measuring stick is held from the eye, regardless of whether you are measuring tree heights or diameters. Practice positioning your arm at this length from your eye, and check periodically when you are taking height and diameter readings.

4. Hypsometer:
   Mark one side of the stick with two vertical scales as illustrated. Use a permanent marking pen. Starting at the left edge, with a zero mark at the bottom of the stick, make a mark every 15 cm as you move up the stick. Label these as follows. The first mark, at 15 cm, should be labelled 5; 30 cm should be labelled 10; 45 cm should be labelled 15, and so on. The labels correspond to tree heights in metres.

   On the right edge of the stick, with a different colour marking pen, mark graduations in the following manner: 8 cm, 15 cm, 23 cm, 30 cm, 38 cm, 45 cm, 53 cm, 60 cm, 68 cm, 75 cm, 83 cm, 90 cm, 98 cm, 105 cm, 113 cm, 120 cm, 128 cm, 135 cm, 143 cm and 150 cm. Label these in the same manner as for the left scale, with the 8 cm mark being labelled 5; 15 cm labelled 10; 23 cm labelled 15; 30 cm labelled 20 and so on up to 150 cm, labelled 100.

   The scale on the left edge of the stick is used for height readings when you are standing 20 metres from the tree, and the scale on the right edge is read when you are standing 40 metres from the tree.

5. Biltmore Stick:
   The other side of the stick will be used for measuring tree diameters. The scale will be marked to be read when the stick is held in a horizontal position, parallel to the ground. Mark this scale starting with a zero line about 25 mm from the left end, and at the following points and label with the corresponding diameter.

<table>
<thead>
<tr>
<th>marking points (cm)</th>
<th>diameter class (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.3</td>
<td>10</td>
</tr>
<tr>
<td>13.4</td>
<td>15</td>
</tr>
<tr>
<td>17.3</td>
<td>20</td>
</tr>
<tr>
<td>21.0</td>
<td>25</td>
</tr>
<tr>
<td>24.5</td>
<td>30</td>
</tr>
<tr>
<td>27.8</td>
<td>35</td>
</tr>
<tr>
<td>31.0</td>
<td>40</td>
</tr>
<tr>
<td>34.0</td>
<td>45</td>
</tr>
<tr>
<td>36.9</td>
<td>50</td>
</tr>
<tr>
<td>39.7</td>
<td>55</td>
</tr>
<tr>
<td>42.4</td>
<td>60</td>
</tr>
<tr>
<td>45.0</td>
<td>65</td>
</tr>
<tr>
<td>47.6</td>
<td>70</td>
</tr>
<tr>
<td>50.0</td>
<td>75</td>
</tr>
<tr>
<td>52.4</td>
<td>80</td>
</tr>
<tr>
<td>54.7</td>
<td>85</td>
</tr>
<tr>
<td>56.9</td>
<td>90</td>
</tr>
<tr>
<td>59.1</td>
<td>95</td>
</tr>
<tr>
<td>61.2</td>
<td>100</td>
</tr>
</tbody>
</table>

---
A Forest Management Plan is a statement about both the woodland and you, the woodland manager. It describes the property, the resources on it, and your goals for managing the area. The Forest Management Plan is a blueprint for the long-term and short-term development activities that will achieve your goals.

This chapter discusses how a Forest Management Plan is developed and includes a sample plan to show you how to put it all together. The remaining chapters will address specific aspects of the Forest Management Plan in more depth, including how to go about the various management activities, step by step.
What Is Planning?

Planning is the process by which you determine the steps required to achieve a particular goal. It includes:

- setting goals
- identifying the alternative means of achieving them
- selecting the preferred option
- developing a set of actions (a plan) to carry out this option
- monitoring the plan to see if the goals are being achieved

Although the planning process results in the production of a ‘plan’, the process of planning does not stop. As time passes, conditions change, new information becomes available, and perhaps new ways of dealing with a situation are developed. These must be reviewed and incorporated into a plan to keep it up-to-date and appropriate to the situation that it is meant to deal with.

Why Is A Management Plan Necessary?

The process of preparing a plan forces you to clarify the benefits or goals you want from your woodland. It helps you to identify the alternative ways these goals might be reached, and to choose the most effective means of achieving them.

Forest management is a long-term process. Timber crops take many years to develop and you need to plan your actions long before you take them. For example, harvesting areas must be selected so that roads can be developed to them, and reforestation needs must be defined so that seedlings can be grown for planting. Timber harvesting, in itself, involves many steps—equipment must be scheduled, contracts arranged, and products delivered. Proper planning helps make these management activities more efficient and helps you to avoid unnecessary costs and delays, and unnecessary steps, as you develop your woodland.

Formal Forest Management Plans (called Management and Working Plans) are required for Woodlot Licences in B.C. They are required to qualify for the Indian and Private Forest Land assistance programs, as well as the B.C. Assessment Authority’s ‘managed forest’ classification for reduced property taxes. In general, a Forest Management Plan is recommended for any woodland property. It is a framework for clear thinking that will help you to organize your resources and your actions to achieve your goals for the property.

What Does A Forest Management Plan Look Like?

A Forest Management Plan is a document of your goals for the woodland and how you plan to achieve them. It consists of a written section and one or more accompanying maps. The written section usually includes:

- a general description of the woodland property
- your personal goals for the property
- your long-term management objectives
- your shorter-term development objectives
- proposed management standards and guidelines
- a description and schedule of proposed short-term development activities (Note: five-year Development Plans are required for Woodlot Licences, and recommended for Indian and private lands)

The map (or maps) should highlight the boundaries of the woodland property, the forest cover and other resources within it, its physical features, past development history, road access, and the proposed development activities for the (five-year) period. The Forest Management Plan should be reviewed and updated at least every five years to incorporate changes in the woodland and any of the proposed activities. A sample Forest Management Plan for a private woodland property is provided at the end of this chapter.

How Do I Develop A Forest Management Plan?

In a sense, the development of a Forest Management Plan is what this Handbook is all about. Though in many cases the formal plan may be developed by someone other than yourself, it is important that it reflects your goals and that you understand how it is developed, where choices exist and on what basis decisions are made.
The following table summarizes the sequence of steps normally followed when preparing a Forest Management Plan for a small woodland. For further information on the decisions to be made in each step, you are referred to other chapters.

<table>
<thead>
<tr>
<th>Planning Step</th>
<th>Purpose</th>
<th>Chapter Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identify Personal Goals</td>
<td>To clarify the benefits you want from managing your woodland and to provide guidance to planning decisions</td>
<td>2,3,4,7</td>
</tr>
<tr>
<td>2. Conduct or Review Resource Inventories</td>
<td>To better understand your woodland so that you can consider all feasible management alternatives and actions</td>
<td>2,3</td>
</tr>
<tr>
<td>3. Identify Long-Term Management Objectives</td>
<td>To establish the overall management emphasis and to guide development actions</td>
<td>2,3,4,6,7,8,9,10,11,12,13</td>
</tr>
<tr>
<td>4. Identify Development Objectives</td>
<td>To provide a framework for on-site development of specific areas that reflects management objectives and personal goals</td>
<td>3,4,5,6,7,8,9,10,11,12,13</td>
</tr>
<tr>
<td>5. Establish Management Standards / Guidelines</td>
<td>To identify some of the standards and rules that management practices must follow</td>
<td>4,5,6,8,9,10</td>
</tr>
<tr>
<td>6. Describe and Schedule Short-Term Development</td>
<td>To develop the detailed management actions that will be taken to achieve the development objectives</td>
<td>3,4,5,6,7,8,9,10,11,12,13</td>
</tr>
<tr>
<td>7. Monitor Results</td>
<td>To determine if the Management Plan is being followed and is achieving the desired results</td>
<td>4,11,12</td>
</tr>
</tbody>
</table>

Chapter References:
- 2. Forestry Basics
- 3. Forest Inventory
- 4. Management Planning
- 5. Forest Access
- 6. Harvesting The Trees
- 7. Forest Products
- 8. Reforesting The Land
- 9. Tending The Stand
- 10. Forest Protection
- 12. Getting Help
- 13. Stumpage And Taxes

Identifying Personal Goals
Your personal goals are those benefits that you want to obtain from the management of your woodland property. Some examples of personal goals include:
- to supplement your income by the sale of forest products
- to learn about forestry through direct involvement
- to improve the property's appearance and increase property values
- to gain personal satisfaction
- to provide an outdoor learning centre for family enjoyment
- to improve opportunities for wildlife viewing or hunting
- to qualify for a lower property tax assessment as "managed forest land"
- to provide employment for family members or others

The selection of your goals deserves careful consideration since they will shape the Forest Management Plan and all activities on the woodland for many years to come.
Conducting or Reviewing Resource Inventories
In order to finalize your personal goals and begin to develop plans for your woodland, you need to know what the woodland is producing now, what it is capable of producing, and what limitations there may be to that production. This will mean either conducting an inventory of the land and its resources, or carefully reviewing already existing information. You will need to consider such things as the current forest cover and its condition, the presence of other resource values, soil sensitivity and the nature of the terrain.

For example, suppose that one of your preliminary goals is to supplement your annual income – starting immediately. However, your inventory reveals that out of 100 hectares of forest land, only 7 hectares contain commercially valuable trees that are, or will be, ready to harvest over the next 15 years. As a result, your ability to supplement your annual income from the harvest of sawlogs will be limited in the near future. Happily, there is usually more than one way to reach a goal. Alternative sources of income could be produced by commercially thinning some of the larger immature stands to produce special high value products, such as cedar poles, or cutting fuelwood for commercial sale.

In some cases you may need to modify your preliminary goals (e.g. by reducing your income expectations) to align more closely with the capabilities of your woodland. For further information on potential product categories, see the chapter “Forest Products”.

Identifying Long-Term Management Objectives
Once you know what your woodland is producing, what it can produce, and what you want it to produce, you can establish some overall objectives for its management.

In the case of Woodlot Licences, the overall management objective is to manage the licence area for the sustained production of commercially valuable timber with annual or periodic (up to 5 years) harvests. Other resource values are considered in the planning and conducting of timber management practices, but the main objective of management is timber production.
Private woodland owners, and Indian Bands managing federal Reserve lands, have more flexibility when choosing their management objectives. The rate and timing of harvest can be varied according to personal goals or market cycles, and the range of products produced is not required to focus on the production of commercially valuable timber. In fact, a private woodland owner may choose to manage primarily for a non-timber resource, such as wildlife or recreation, and secondarily for timber production.

The overall management objectives establish the long-term framework for all your forest management activities. They are the basis on which more detailed short-term development objectives are set out for specific areas within the woodland.

Identifying Area Development Objectives
To assist planning, it can be useful to divide the woodland into areas that are similar in terms of how they are to be managed. Each Management Area is comprised of stands that are similar enough in species, age, stocking and site characteristics (soil, terrain, etc.) that they can be treated as one forest management unit.

Once the Management Areas have been defined, you can identify short-term (e.g., five-year) development objectives for each, such as whether you plan to manage an area as even-aged or uneven-aged, and the products you plan to produce. These objectives will, in turn, set the stage for the scheduling of specific management activities, such as road building, harvesting, planting, and stand tending treatments that you intend to follow.

To help explain this process, let’s consider the following example. Rex and Sylvia Trehan own 140 hectares of woodland in the Interior wet belt of B.C. Their personal goals include:

- to supplement their annual income by approximately $5000 for the next 8-10 years to finance their two children’s education; then provide periodic income for their own retirement
- to qualify for the ‘managed forest land’ classification and obtain a lower property tax assessment
- to increase the value of the property over the long-term
- to provide recreational opportunities for family and community groups

Their overall objective for the woodland is to manage the area for the continuous production of commercially valuable trees that can be harvested to provide the benefits described above. The woodland has been divided into five Management Areas as shown and summarized below.

MA 1: 70 ha. Fir - cedar type, 200 years old, 300 stems/ha, medium site, potential MAI 3.5 m³. Some deer use area for spring range.

MA 2: 40 ha. Fir (minor cedar) type, 60 years old, 1200 stems/ha, medium site, potential MAI 3.5 m³.

MA 3: 15 ha. Brushed-in land that was originally cleared for agriculture but found to be unsuitable. Medium site, potential MAI 3.5 m³.

MA 4: 10 ha. Birch (minor cedar) type, 40 years old, medium site, 800 stems/ha, potential MAI 3 m³. Willow grouse and a variety of fur-bearing mammals (marten, weasel) use the area.

MA 5: 5 ha. Swamp and small pond.
There are three alternative development scenarios that the Trehames are considering in identifying their development objectives.

**Alternative 1:**
- harvest MA 1 in its entirety over the first 10-year period, and reforest immediately
- commercially thin MA 2 periodically after harvesting in MA 1 is complete
- plant Douglas-fir Christmas trees in MA 3 with a 7 to 10-year rotation cycle
- construct a dual-purpose mountain bike and cross-country ski trail from their residence through MA 2 to MA 4 and the swamp;
- enhance MA 4 and 5 for wildlife and recreation values

**Alternative 2:**
- as with Alternative 1, but carry out harvesting in MA 1 and commercial thinning in MA 2 at same time; extend harvest period for MA 1 to 30 years and start commercial thinning in MA 2 immediately

**Alternative 3:**
- as with Alternative 1, but manage MA 3 for timber production rather than Christmas trees. This will require clearing the brush and planting Douglas-fir

After careful consideration of the financial and operational implications of each alternative, the Trehames select Alternative 1 as the development option best meeting their long-term management objectives and personal goals. It provides them with the greatest income in the first 8 years to help finance their children's education and fund the development of a cross-country ski and mountain bike trail to the wildlife area in MA 4. Thereafter, the thinnings from MA 2 and Christmas trees from MA 3 will provide them with periodic income for their retirement.
Establishing Management Standards/Guidelines
There are usually performance standards to be met in order to achieve your personal goals and management objectives. It is important that these be set out clearly at the start to guide you and others who might be involved in carrying out activities on the woodland. Performance guidelines are often prescribed for things such as:

- acceptable regeneration delay to reforest the land
- frequency of regeneration surveys and assessments to determine adequate stocking
- acceptable stocking levels for regeneration
- spacing in juvenile stands
- acceptable slash levels for fire hazard reduction and regeneration
- environmental protection (especially watercourses)

Scheduling Short-Term Development Actions
The long-term management strategy for the woodland is translated into shorter-term development objectives for each Management Area on the woodland. These, in turn, must be converted to a detailed set of actions on the ground. In the case of Woodlot Licences, the development schedule (called the Development Plan) must be planned for a five-year period. For private woodland operations this planning period can be varied, though five years is a good planning target.

This Development Plan sets out the schedule for all operations that will take place on the woodland over the (5-year) period, describing:

- **What will be done**: road construction, harvesting, stand tending, reforestation, etc.
- **Where it will be done**: Management Area
- **When it will be done**: year, season
- **How it will be done**: methods, equipment, treatment, special guidelines
- **Who will do it**: owner, manager, contractor, volunteer group, etc.

It is also a good idea to include an estimate of the cost for each activity, and where the money will come from, to make sure that the money required for the activities planned is available when needed. See the chapter “Getting Help” for sources of funding and other assistance and be sure that your management activities are within your means.

Specific modifications to timber practices to enhance non-timber resources such as wildlife, recreation and aesthetic values are noted (eg. the selection of silviculture systems, harvesting methods, and the amount of timber and area from which it is cut). Where special projects, independent of timber management activities, are undertaken to enhance other resource values (such as the building of a weir or fish-raising pond), they should also be described in the Development Plan. Development Plans are usually summarized in a table form, and accompanied by a map showing proposed roads, cutblocks, treatment areas, etc.

Monitoring the Management Plan
Planning doesn't stop with the production of a Forest Management Plan. You will want to keep track of how well the plan is being followed, and whether or not your management activities are achieving the intended results. As the character of your woodland, and your needs, change, the Plan must be updated to reflect these changes and provide clear direction to operations on the ground. It is a good idea to review your Forest Management Plan annually, and update it as necessary (at least every five years).

It is important that you understand and are comfortable with your Management Plan. It should cover all aspects of what you want from the woodland, and provide a realistic set of activities for achieving these. The Forest Management Plan must work for you.

A sample Forest Management Plan for the Trename property follows. Woodlot Licensees should note that there may be a special format or content requirement for their Management and Working Plans, and are advised to check with the local office of the Ministry of Forests and Lands.
A Sample Forest Management Plan for District Lot 2345:
Owners, Sylvia & Rex Trehané

*Area Description and Map*
D.L. 2345 is located approximately 25 km southwest of Cranmore on the White Lake Road. The area is 140 ha and the White Lake road runs through the parcel. The woodland is adjacent to and east of the Trehané's permanent residence. The resource values on the area are summarized below.

<table>
<thead>
<tr>
<th>Forest Type</th>
<th>Area (ha)</th>
<th>Vol. (m³)</th>
<th>Age Class</th>
<th>Height Class</th>
<th>Stocking Class</th>
<th>Site Class</th>
<th>MAI (m³/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA 1: FC</td>
<td>70</td>
<td>40 000</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>M</td>
<td>3.5</td>
</tr>
<tr>
<td>MA 2: F(C)</td>
<td>40</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>M</td>
<td>3.5</td>
</tr>
<tr>
<td>MA 3: NCBr</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>M</td>
<td>3.5</td>
</tr>
<tr>
<td>MA 4: Ep(C)</td>
<td>10</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>M</td>
<td>3</td>
</tr>
<tr>
<td>MA 5: Swamp</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The area also has a moderate capability for deer, and a variety of fur-bearing animals, songbirds, waterfowl and several families of grouse use Management Areas 4 and 5.
Sample Forest Management Plan (continued)

**Personal Goals**
- to supplement our annual income by approximately $5000 for the next 8 - 10 years to finance our children’s education; then provide periodic income for our retirement
- to increase the value of the property over the long-term
- to provide recreational opportunities for family and community groups
- to qualify for the ‘managed forest land’ classification and obtain a lower tax assessment

**Management Objectives**
To manage the overall area for the continuous production of commercially valuable tree species and to regulate the rate and timing of harvests to achieve personal goals.
- Management Area 1 will be harvested and reforested entirely over a 10-year period, with annual harvests of approximately 4 000 m³. This might be adjusted to take advantage of market conditions. The main products will be sawlogs. Care will be taken to minimize the impact on aesthetic values along White Lake Road.
- Management Area 2 will be improved by commercial thinning, eventually harvested for sawlogs, and reforested.
- Management Area 3 will be developed as a Christmas tree plantation.
- Management Areas 4 and 5 will be developed for recreational and wildlife habitat purposes.

**Development Objectives**
The five-year Development Objectives for each Management Area are summarized as follows:
- Access:
  - construct a road into MA 1, south of White Lake Road to provide logging access
  - construct tractor access into MA 3 for management access to the Christmas tree plantation
- Forestry:
  - harvest all of MA 1 by small clearcuts over 8 - 10 years; plant after logging
  - conduct periodic commercial thinning in MA 2 after MA 1 has been completely harvested
  - plant Douglas-fir seedlings as Christmas tree stock in MA 3; manage with a 7 - 10 year rotation
- Recreation:
  - construct a dual-purpose (cross-country ski and mountain bike) trail from the Trehane residence through MA 2 to MA 4 and MA 5, with a connecting link to the White Lake Road
  - enhance MA 4 and 5 for wildlife and recreational values; construct a waterfowl blind at the pond site for Canada geese and other species

**Management Standards**
- regeneration delay will be a maximum of 5 years following harvesting
- reforestation surveys will be conducted at 2 and 4 years following logging to Ministry of Forests and Lands’ methods and standards
- Ministry of Forests and Lands’ species selection guide and stocking standards will be followed
- survival assessments of plantations will be conducted 1 and 3 years after planting, using Ministry of Forests and Lands’ methods and standards
- no skidding equipment will be used within 30 metres of White Lake Road, and selective cutting within that strip will be carried out to maintain aesthetic values.

**Short-term Development Plan**
The development to be undertaken during the period January 1, 1989 to December 31, 1993, is summarized as follows.
### Five-year Development Plan 1989–1993

<table>
<thead>
<tr>
<th>Activity</th>
<th>Timing</th>
<th>Area</th>
<th>Location</th>
<th>Description</th>
<th>Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Construction</td>
<td>1989 summer</td>
<td>MA 1</td>
<td>spur A</td>
<td>construct spur road 3.5 m wide surface with gravel as needed</td>
<td>contract</td>
</tr>
<tr>
<td></td>
<td>1989 summer</td>
<td>MA 3</td>
<td>spur B</td>
<td>construct tractor access to Christmas tree planting</td>
<td>owner</td>
</tr>
<tr>
<td>Harvest cut</td>
<td>1989 summer</td>
<td>MA 1</td>
<td>Block 1</td>
<td>clearcut 7 ha, hand fell, skid with tractor</td>
<td>owner</td>
</tr>
<tr>
<td></td>
<td>1990 summer</td>
<td>MA 1</td>
<td>Block 2</td>
<td>clearcut 7 ha, hand fell, skid with tractor</td>
<td>owner</td>
</tr>
<tr>
<td></td>
<td>1990 fall</td>
<td>MA 1</td>
<td>Block 1</td>
<td>burn slash</td>
<td>owner</td>
</tr>
<tr>
<td></td>
<td>1991 summer</td>
<td>MA 1</td>
<td>Block 3</td>
<td>clearcut 7 ha, hand fell, skid with tractor</td>
<td>owner</td>
</tr>
<tr>
<td></td>
<td>1991 fall</td>
<td>MA 1</td>
<td>Block 2</td>
<td>burn slash</td>
<td>owner</td>
</tr>
<tr>
<td></td>
<td>1992 spring</td>
<td>MA 1</td>
<td>Block 4</td>
<td>clearcut 7 ha, hand fell, skid with horses</td>
<td>contract</td>
</tr>
<tr>
<td></td>
<td>1992 fall</td>
<td>MA 1</td>
<td>Block 3</td>
<td>burn slash</td>
<td>owner</td>
</tr>
<tr>
<td></td>
<td>1993 summer</td>
<td>MA 1</td>
<td>Block 5</td>
<td>clearcut 7 ha, hand fell, skid with horses</td>
<td>contract</td>
</tr>
<tr>
<td></td>
<td>1993 fall</td>
<td>MA 1</td>
<td>Block 4</td>
<td>burn slash</td>
<td>owner</td>
</tr>
<tr>
<td>Planting</td>
<td>1990 spring</td>
<td>MA 3</td>
<td>Block 6</td>
<td>brush removal with brush blade on tractor; plant 2+1 barefoot D-fir for Christmas tree production</td>
<td>owner</td>
</tr>
<tr>
<td>Stand Improvement</td>
<td>1991 spring</td>
<td>MA 1</td>
<td>Block 1</td>
<td>plant D-fir, cedar, 2+0 plug stock</td>
<td>Jr. Forest</td>
</tr>
<tr>
<td></td>
<td>1992 spring</td>
<td>MA 1</td>
<td>Block 2</td>
<td>plant D-fir, cedar, 2+0 plug stock</td>
<td>Jr. Forest</td>
</tr>
<tr>
<td></td>
<td>1993 spring</td>
<td>MA 1</td>
<td>Block 3</td>
<td>plant D-fir, cedar, 2+0 plug stock</td>
<td>Jr. Forest</td>
</tr>
<tr>
<td>Recreation Trail Dvlp.</td>
<td>1990/91</td>
<td>MA 2, 4,5</td>
<td>see map</td>
<td>construct x-country/bike trail from residence to MA 4 and around swamp/pond</td>
<td>volunteer</td>
</tr>
<tr>
<td></td>
<td>1992 summer</td>
<td>MA 1, 4,5</td>
<td>see map</td>
<td>construct trail from White Lake Road to connect to trail around swamp</td>
<td>volunteer</td>
</tr>
<tr>
<td>Admin.</td>
<td>1992-93</td>
<td>MA 4</td>
<td></td>
<td>Review and update Forest Management Plan and 5-year Development Plan</td>
<td>owner</td>
</tr>
</tbody>
</table>
A woodland road system serves many transportation purposes, including the extraction of timber, access for silviculture treatments, fire control and recreation. Your objective in developing a road network will be to provide for these uses with the minimum disturbance to the landbase and your pocketbook.

This chapter discusses the major considerations in developing your access network, including road layout, construction, maintenance and environmental considerations. Skid trail development is dealt with in the chapter "Harvesting The Trees".
What Are My Access Needs?

Access is vital to a well-managed woodland. You will need to consider a number of different forms of access to your property, including general access via main roads and trails, new logging roads for the removal of timber, branch roads to take you and your equipment to stands requiring spacing, thinning, and pruning, and protection roads to water sources. The building standard will vary with each type of access, depending on the type of vehicle and volume of traffic it will carry, as well as the season of use.

The best approach to road building, environmentally and financially, is to build to the minimum standard required for the projected use. Good planning, engineering and construction are the keys to keeping costs to acceptable levels.

Your road needs will depend on a number of things, including your management objectives, the location and characteristics of your timber, terrain conditions (such as rock, swamp, slope), and the silviculture system and logging methods you plan to use. Part of your initial considerations should include the assessment of existing access roads and trails. One of the benefits of working in second growth stands is the presence of old roadbeds, railway grades and skid trails from when the stand was first cleared. In these areas only minor road upgrading, such as widening or spur road development may be required to complete an access network, and you can often acquire enough knowledge to do it yourself. Where major road location and construction are required to develop a woodland area, an experienced contractor or consultant should be called in to ensure that the most economical and efficient road system is developed.

How Do I Plan A Road Network?

On paper, first.
Your first task in planning your road network will be to sketch out the main routes that provide the best coverage of your woodland and access to particular sites of importance. The purpose of this initial plan is to locate the road network to cover the whole area, while minimizing the total length of road required.

Begin the process of road location at the drawing board, with aerial photos and a good contour map of the area.

Pencil out possible road routes based on the following considerations:

1. Follow contour lines where possible. Try to keep road grades below 10% (no more than 1 metre of vertical rise for every 10 metres horizontal distance).
2. Avoid depressions which may catch and hold water.
3. Steer clear of trouble spots such as swamps, rock outcrops, etc.
4. Minimize the number of stream crossings.
5. Keep a distance from streams and leave a 'green belt' of undisturbed soil and vegetation between roads and waterways to filter runoff and minimize erosion. On flat land, the green belt should be at least 10 metres wide, more on slopes. (Width will vary with topography, stream width, bank stability, fish-bearing quality, etc.)
6. Identify potential sites for landings (flat areas for loading logs onto trucks), such as saddles or benches on ridges.
7. Make use of old road grades or common road systems wherever possible.
8. Road curves should be located on minimum grades. Try to avoid sharp curves, but if unavoidable, provide extra road width in these curves.
9. Avoid unstable soil conditions that could create erosion problems and deposit sediment in fish-bearing streams.
10. Watch for potential sources of gravel to be used for road surfacing and culvert beds.
11. Note requirements for culverts and bridges.

When the road system has been located on the map, the next step is to lay out the roads on the ground. The field location will be based on ‘control points’, or those ‘must do’ items noted in the road planning phase, such as bridge crossings, important timber stands, landing locations, and junctions. Low-use forest roads, such as spur or branch lines, can usually be surveyed using basic hand tools consisting of a compass, clinometer, ‘chain’, slope tables and plastic flagging tape.

Steepness of the road, or gradient, is usually the main concern, and should be limited to about 10% (12% maximum) for long, favourable slopes and 6% for long, adverse slopes. The terms favourable and adverse relate to the conditions facing a loaded logging truck; a grade is favourable when the loaded truck is going downhill, and adverse when the loaded truck is going uphill. For short stretches, favourable grades can be increased to 16-20%, and adverse grades to 10%, if no winter hauling is planned, or if use will be limited to only a few truckloads of logs. Though it is possible to travel grades above this suggested limit, it can be at the expense of your vehicle and road surface.

Road Construction – How Much Can I Do?

Road building usually follows a schedule based on which areas are slated for harvesting or special treatments first. The construction requirements will vary with the drainage, grade, slope, obstacles, stream beds and stream crossing conditions of the site. Before construction actually gets underway, you will have to decide whether to do-it-yourself or hire a contractor. In many cases, you will not have access to the equipment needed for road construction, and if the job is large or complicated you will likely want to hire a competent forest road contractor.

Contracting can be done either as a complete package for a finished roadway at a lump sum price, or for specific portions at hourly rates that include the manpower and equipment. Or you may choose to include road building as part of the harvesting contract for a particular area. Your choice may be influenced by the availability of contractors in your area as well as your ability to supervise the work. At minimum, be prepared to be on-site at the start of any excavation, for construction of stream crossings, and for a final check before the contractor leaves.

A clear construction contract should be drawn up which specifies the extent of the work, method of construction, method of payment, schedule of work, standards of work, holdback requirements and arbitration procedure if work is in dispute. A sample road construction contract is found at the end of this chapter.

Skid trails can be considered an extension of the road network and should be laid out and constructed with appropriate care, depending on the projected level of use. Logging plans should balance skidding distance with road construction costs to ensure the most efficient logging pattern. Skid trail layout and construction are discussed further in the chapter “Harvesting The Trees”.

Equipment

Whether you are planning to do-it-yourself or hire a contractor, you will need to consider the appropriate equipment for the job. Bulldozers, backhoes and front-end loaders are common choices; each has advantages for particular situations.
Bulldozers are favoured for the construction of most forest roads and are recommended for construction except in soft, wet conditions and steep hillsides. They are able to move material horizontally, and offer high productivity and good flexibility at a reasonable cost. The size of the bulldozer required for the job will vary with the total earthmoving requirement as well as the type of soil. These machines come with a variety of front-end blades and rear-mounting attachments like logging winches, rippers, and stump-splitters, which make them versatile for many woodland activities.

Backhoe road construction is suited to uniform sidehills which do not require end movement of excavated material, though this limitation can be overcome by using a truck for end-hauling. The backhoe is well-suited to soft, wet conditions, or situations requiring the breaking of small amounts of isolated or loose rock. Front-end loaders can be fitted with a bucket for loading gravel onto trucks or for transporting material for short distances. For minor road building in favourable conditions, a farm tractor with a bucket and a blade will suffice. Progress, however, may be very slow. The choice of equipment for road construction must trade off efficiency with operating cost.

Construction Steps
Road construction begins with clearing of the right-of-way. All salable wood from right-of-way clearing should be recovered, and tops, branches and stumps should either be buried beneath fill on the low side of the right-of-way, or piled and burned. Construction should be timed for efficient working conditions—avoiding trouble periods such as spring runoff and winter freeze. On poorly drained soils, road construction should be carried out during the dry season.

Road width requirements will vary according to the frequency of use, and the type of products moved. In general, a road with a finished surface of 5 metres is suitable for most forms of small-scale woodland transport. If the road is to be used only infrequently to access a particular area, then a 4 metre surface width, with turnouts, may be sufficient. Similarly, if the projected use of a roadway includes hauling, ongoing stand tending and protection operations, and/or recreational use, then a 6 metre surface width, or greater, may be called for.

The right-of-way should extend approximately 2 to 3 metres beyond the cut and fill, or 5 metres on either side of the main travel surface, whichever is greater. The roadway itself should be higher than the surrounding ground to ensure that it does not become a drainage ditch. Woodland roads of 5 metre widths should have an average ditch depth of at least 0.5 metre and ditch width of 1 metre. These dimensions may vary widely, depending upon the construction material. Extra ditch width is recommended in silt and clay conditions, while shallower ditches are acceptable in rock.

On sidehills, cut bank slopes should not be steeper than 1:1 (1 metre of rise per metre of horizontal distance); and fill bank slopes not steeper than 1:1.5 (1 metre of rise per 1.5 metres of horizontal distance). For steep side slopes
with potential for slumping, consider using local cribbing to hold material in place. Cut and fill banks can be seeded, planted or terraced for soil stability.

The secret to a good roadbed is to keep it well-drained. Proper ditching is one of the keys to road stability, and the size and frequency of culverts is also very important. On flat land, ditches should be placed on both sides of the road. Roadways on slopes only require ditching on the topside, sloped to drain water away from the road. Avoid long grades—they are susceptible to water buildup and require extra culverts. A slight crown in the centre of the road will assist drainage and minimize the formation of potholes.

Culverts should be placed wherever water drains naturally. Their purpose is to drain excess water from roads and ditches and support natural drainage patterns. As a rule of thumb, plan on approximately 5 culverts per kilometre of roadway on average ground. Vary the number according to your specific site conditions.

Culverts can be wooden boxes constructed on-site or metal culverts large enough to handle expected water flows. Wooden culverts should be constructed from cedar to prolong their life. Untreated Douglas-fir or spruce may be an alternative, though these will require replacement more frequently. Though metal or plastic culverts are more expensive items, they may be a cost-effective alternative when compared with the replacement costs for the shorter life-span, non-cedar wooden culverts.

Locating Culverts:

- place at right angles to roadbed to minimize culvert length
- make sure culverts are firmly footed to settle evenly when covered
- where road grades are greater than 6%, culverts should be angled or skewed toward the grade
- provide adequate culvert slope (2-3%) so that water flows freely through the culvert and sediment does not build up at lower end
- culvert must be large enough to anticipate snowmelt and storm water flows
- culverts must be placed at a level to ‘capture’ and channel water flows, but not so low that they capture and accumulate debris
- culvert should be covered with fill to a depth equal to or greater than the culvert diameter (or as recommended by the manufacturer)
- a ditch plug should be installed below the culvert, on the intake side, to prevent water from flowing further down the ditch
Particular care must be taken with installing culverts at stream crossings. Stream bed disturbance should be minimized and the use of broken rock, vegetative cover or other means to reduce soil movement into the stream are advised. Provincial and federal Fisheries officers should be consulted regarding specific procedures and the timing of construction in fish-bearing streams.

**Bridges**

Bridges are recommended when stream flows require steel culverts with diameters above 120 cm, or log deck culverts with a span of over 3 metres. At this point, call in the experts. The cost of professional advice is worth it.

**Surfacing**

Forest roads may require gravelling to provide for all-weather hauling. Surfacing, however, is an expensive proposition, which can in some cases double construction costs. The costs of gravelling are high due to the amount of equipment involved – usually a front-end bucket loader, a truck to haul the gravel and a small bulldozer for spreading the material. These costs rise rapidly with the distance of the gravel source from the road. Gravelling operations should be closely supervised to make sure that the material is used efficiently. Where traffic is light and seasonal, packed dirt roadways, with only the trouble spots gravelled, may suffice.

**How Do I Care For My Roads?**

A well-planned and constructed roadway will minimize potential problems, but a regular maintenance program is needed to ensure the long-term stability of a road system. In most cases you will be able to carry out an effective road maintenance program with hand tools, some gravel, and a truck. Potential trouble areas, such as wet spots, culverts, and steep grades should be noted. Regular inspections should be carried out, with additional checks after heavy rains. New roads and roads with heavy traffic should get special attention. Springtime maintenance is most important – a little shovel work early in the season can prevent potentially larger problems later on.

Maintenance inspections should check all drainage structures, removing debris from ditches and culverts. Watch ditches for flooding or signs of bank erosion which may signal the need for more, or larger, culverts. Check inlets and outlets of culverts for scouring. Road grading should be carried out as needed to maintain road shape and surface, depending on the size of operations and frequency of use. Ruts and potholes should be filled in before spring rains: Cut banks may be vegetated to combat erosion. Side roads not needed all the time, can be put to 'bould' by digging short drainage ditches (water bars) across them to enhance winter and spring runoffs.
What Are The Environmental Considerations?

Road development has a major influence on the efficiency and cost of harvesting operations. It is important that roads are well planned, engineered and constructed from the outset. Road building requires a large commitment of financial resources and often specialized expertise to minimize environmental impacts. Though ‘logging’ is often believed to be the source of erosion and siltation, it is the roads associated with logging that are often the real cause of such damage.

The importance of careful planning and construction cannot be overemphasized. Poorly laid-out or inadequately constructed roads may cause many headaches later on. The dislocation of vegetation and soil, and manipulation of water flows brought about by road building can have harmful effects on the environment. Waterways are the most vulnerable since they pick up the silt and debris that are disrupted during construction. The design and location of culverts is especially important to offset potential problems.

The provincial Fish and Wildlife Branch and the federal Department of Fisheries and Oceans share the responsibility of overseeing the use and care of watercourses in the Province. Stiff penalties are enforced for violations to the Fisheries Act that result in damage to fish-bearing streams, rivers and lakes. Guidelines and regulations are available from both governments and should be consulted during the road construction and logging phases.

In a cooperative effort, the forest industry, provincial Ministries of Forests and Lands and Environment and Parks, and the federal Department of Fisheries and Oceans, have developed guidelines for the management of forestry operations and maintenance of fish habitat in Coastal watersheds. The “Coastal Fisheries Forestry Guidelines” include a field guide for forestry operations, based on the potential impact of a given activity on four ‘stream reach’ classes. The classification ranges from Class I to IV, depending on the abundance of sea-going commercial fish and resident sports fish present, and the stream gradient. Class I has the highest levels of these fish and the lowest stream gradient, and Class IV has no fish present and the highest stream gradient. The importance of Classes III and IV relate to their protection value for the higher Classes; they must be maintained properly in order to minimize downstream effects on Classes I and II.

The Guidelines deal with recommended procedures for the planning and construction of roads and landings, right-of-way felling, clearing and sub-grade construction, locating and installing drainage, and road maintenance. Most of these recommendations are incorporated into earlier sections of this chapter. In addition to these
specific considerations, however, the following overall guidelines are recommended:

- construct roads reasonable distances from Fisheries Sensitive Zones (these are small water bodies such as back channels on main rivers or streams, swamps, or bogs that are important for spawning and rearing)
- avoid construction in areas of high slope instability
- stop construction when soils are extremely wet
- leave streams clear of construction debris
- provide adequate sub-grade drainage
- ensure that drainage is adequate to handle interrupted surface and sub-surface flows
- maintain width and gradient of active stream channels
- leave roads, drainage structures, and watercourses in a condition to minimize erosion, following use

In general, inexperienced people should only attempt road building under favourable conditions (well-drained soils, slopes below 30%, stable terrain, no major stream crossings) and in situations where the road will not be subject to intensive use. In all other circumstances, advice from experienced operators is recommended.

**Steps to Road Building:**

- develop road plan for woodland area
- determine road specifications for each Management Area
- for major, long-term roads seek help
- lay out roads on maps and aerial photos, then locate roads on the ground
- clear right-of-way
- build the sub-grade (the basic roadbed shape)
- install drainage structures
- surface the road where necessary

**Recommended References:**

**B.C. Ministry of Forests and Lands**

- “Ground Skidding Guidelines”. Engineering and Silviculture Branch
- “Protecting Forest Soil”. Silviculture Branch
- “Coastal Fisheries Forestry Guidelines”

**Nova Scotia Department of Lands and Forests**

- “Building Standard Woodland Roads”. 75/109/10
- “Forest Access Roads - Construction Guidelines”.76/12/12

**Oregon State University Extension Service**

- “Planning Woodland Roads”. Extension Circular 1118
- “Road Construction on Woodland Properties”. Extension Circular 1135
- “Designing Woodland Roads”. Extension Circular 1137
- “Maintaining Woodland Roads”. Extension Circular 1139

**Other Sources**

- “Handbook for Ground Skidding and Road Building in the Kootenay Area of B.C.” 1976. FERIC
The following contract is a sample format for your consideration. Note that a contract should be adapted to the particular requirements of each situation. In addition to the items addressed in the following sample contract, you may wish to provide for: Additional Work, Directions to the Contractor, Representations, Curtailment, Special Provisions, Insurance, Assignment and Subcontracting, Default by Contractor, Insolvency of Contractor, and Termination. You are advised to seek legal counsel regarding your contract documents.

SAMPLE ROAD CONSTRUCTION CONTRACT

THIS AGREEMENT made the ______ day of ______________, 19__

BETWEEN

A.B. Cee
(hereinafter called the “Owner”)
OF THE FIRST PART

AND

XYZ Construction Ltd.
(hereinafter called the “Contractor”)
OF THE SECOND PART

WHEREAS the Owner wishes to build an access road of specifications detailed below, within District Lot 000 as shown in red on the map in Schedule “A” attached.

AND WHEREAS the Contractor has agreed to construct the said road in accordance with the terms and conditions set forth in this Agreement.

NOW, THEREFORE, THIS INDENTURE WITNESSETH that the parties hereto agree, each with the other, as follows:

1. LOCATION

The Owner has identified the location of the proposed road on the ground by survey stakes flagged with red ribbon. The Contractor has viewed the location and agrees that the proposed road is 0.75 km in length.

2. ROAD STANDARDS

The road shall be constructed to the standards specified as follows:

a) Surface width ____________________  e) Ditch depth ____________________
b) Right-of-way ____________________  f) Rock excavation ____________________
c) Gravel depth ____________________
d) Culverts: The Contractor will provide all materials as required by the Owner and stated herein.
   materials ____________________
   minimum size ____________________
   frequency ____________________
3. EQUIPMENT

The road will be constructed with the following equipment: ________________________________.

4. GRAVEL

Gravel will be taken from the borrow pit indicated on the map in Schedule “A”. The Contractor
acknowledges having viewed said pit.

5. FIRE REGULATIONS

The Contractor agrees to observe all Provincial Government regulations relating to the safety and security
in respect to fire or other hazard, and that during the fire or dry season, April 15 - October 15, unless otherwise specified
by the Ministry of Forests and Lands, it will take all precautions prescribed by the Forest Act or the regulations
thereunder, or as may be specified by the Owner, and shall cease work if the Owner deems it necessary.

6. PRELOGGING

The Contractor shall, prior to commencing construction of said road, fell, limb and skid all trees and snags
within ___ metres on each side of the flagged centreline to the landing designated on the map in Schedule “A”.

7. OWNERSHIP

All logs produced from the right-of-way belong to the Owner.

8. TIMING

Prelogging of the right-of-way shall commence on __________, 19___, and construction of the road
shall be completed by __________, 19___. It is agreed that time is of the essence hereof.

9. PAYMENT

The Owner has agreed to pay the Contractor $______ for prelogging and construction of the said road.
Payments shall be scheduled as follows:

a) Upon completion of prelogging $_______ (commonly 10-15%); less 10% to be held back pursuant to
Section 10.
b) Upon completion of grade construction, including gravelling and ditching $_______ (commonly 40-
50%); less 10% to be held back pursuant to Section 10.
c) Upon completion of slash disposal, removal of log debris, and final construction in a good workmanlike
manner $_______ (commonly 25-40%); less 10% to be held back pursuant to Section 10.

10. BUILDERS LIENS

The monies held back pursuant to Section 9 shall, subject to the provisions of the Builders Lien Act and
the rights of the Owner thereunder to pay the full amount of the holdback into court, be paid by the Owner to the
Contractor 45 days after completion of the work contemplated by this Agreement, provided that the Owner may retain

9
out of such holdback monies any sums required by law to satisfy any liens against the work or other monetary claims against the Contractor (whether enforceable against the Owner or made by the Owner) and that the Contractor has submitted to the Owner a sworn statement that all accounts for labour, subcontracts and other amounts claimed in connection with the work have been paid. For the purposes of the Agreement, the work shall be deemed to be completed when fully completed to the satisfaction of the owner.

11. APPLICABLE LAWS

The Contractor shall, while performing the work hereunder, observe and perform (and pay and satisfy all assessments or remittances pursuant to) the provisions of the Workers’ Compensation Act, Employment Standards Act, Unemployment Insurance Act (Canada), and the Canadian Pension Plan (Canada), and regulations thereunder, and the hours of work laws and minimum wage laws of British Columbia and all other Governmental regulations, statutes and orders (including obtaining all permits or authorizations) pertaining to or having a bearing upon the Contractor’s work hereunder, and shall indemnify and save harmless the Owner in respect thereof.

12. LIABILITY

The Contractor shall indemnify and hold harmless the Owner and/or any third parties from any and all loss, costs, damages, expenses and claims of every nature whatsoever arising from any fire caused by the negligence of the Contractor or any breach of or failure to observe any Provincial, Federal, and Municipal Government laws, regulations or instructions.

13. ARBITRATION

In the event that any dispute arises between the parties hereto which cannot be reasonably settled, the dispute shall be settled by a single arbitrator appointed pursuant to the Commercial Arbitration Act. Both Owner and Contractor shall be bound by the arbitrator’s ruling, and shall pay equal portions of any expenses incurred.

14. NOTICE

For the purposes of this Agreement, notice shall be deemed to be given to the Owner at __________________________ (Owner’s address), and to the Contractor at __________________________ (Contractor’s Address), or to such other places as shall be from time to time substituted in writing, and such notice shall be deemed to have been received when delivered by hand or forty-eight hours from posting by double registered mail from any post office within the Province of British Columbia.

IN WITNESS THEREOF the parties hereto have executed this Agreement.

Date: ______________________

_________________________  __________________________
Owner                                      Contractor
Harvesting is one of the most important phases in the forest management cycle since it sets the stage for the creation of a new forest. If the harvest is not done properly, the subsequent management steps become focused on cleaning up or correcting damage done, rather than directed towards achieving an overall plan.

This chapter discusses the considerations and decisions related to primary harvesting. You will find information on when and how much to cut, as well as the different systems and logging methods you can use. The development of a logging contract is outlined and a sample contract provided. Also included is a discussion of how forest products are scaled and graded for sale after they are harvested. Intermediate harvesting for stand improvement is discussed in the chapter “Tending The Stand”.
Harvesting the Trees

Harvesting Is More Than Cutting Trees

Harvesting is a focal point in woodland operations, small and large. It is the major revenue-generating phase in forest management and a key development activity in the woodland. Like the changing of the guard, harvesting signals a change in control within the woodland as the emphasis passes from the crop whose shift is up, to the crop that will shape the future.

The decision to harvest is usually based on one or a combination of the following reasons:

- to replace one crop with another
- to cash in some or all of the value of the current crop
- to recover some otherwise natural mortality losses from root rot, blowdown, or mistletoe
- to improve the quality and value of the current crop (see the chapter "Tending The Stand")

But harvesting involves more than just cutting trees. It is part of the overall management strategy by which you plan to achieve your short-term and long-term objectives. The process by which a forest is tended, harvested and replaced is called a 'silviculture system'. Silviculture systems are classified according to the method by which you remove the mature crop and seek to establish the new one. Even-aged stands are maintained by the clearcutting, seed-tree and some shelterwood systems; and uneven-aged stands are maintained by the selection system. Each of these systems represents a strategy for the complete cycle of the stand. The silviculture system you choose will be based on consideration of the forest you have and the forest you wish to create.

Like an iceberg, logging is the most visible part of your Forest Management Plan, and it is easy to forget that it represents more than what you see. Your harvesting program is, in fact, an expression of the following considerations:

- **When to cut: (Rotation)**
  How old is the stand? How much can it be expected to increase in volume and value? How shall I decide whether to cut it now or later? Is natural regeneration planned, and if so, when is the next good seed year expected?

- **How much to cut: (Allowable Annual Cut)**
  What are the harvesting objectives – stand replacement? cash flow? Is the area being salvaged after fire, insect or disease infestation? What are the management objectives for the area regarding other uses? What are the constraints regarding harvest – is the area private or Crown land?

- **Which silviculture system:**
  Are the trees all mature or of varying age classes? Are there particular products ready for harvest? Is the stand healthy or are there pockets of disease or insects? Is the species mix appropriate for my personal goals?

- **Which logging methods:**
  What are the terrain conditions? What is the average slope? What equipment do I have and how could it be converted for logging? How large is the area? What volume of timber will be logged? What access is in place?

- **Which species to regenerate and by which method:**
  What is the current species mix? Which species are appropriate to the site? Which species are favoured? What products are desired? What financial and time resources am I willing to commit? What are the cost implications of natural regeneration versus planting?

*Note: The determination of rotation and allowable annual cut are made in consideration of the entire woodland area. They involve careful consideration of your personal goals and the current inventory of the woodland. The other decisions are made for each Management Area, based on the development objectives you have set, the stand characteristics and terrain in that unit.

The overall planning considerations of when to cut, how much, and according to what system will be discussed first. The 'how to' of logging begins on page 11.
When Do I Harvest?

Choosing when to harvest a stand will depend on a number of factors. The age of the stand, its rate of growth, the financial needs of the operator, or the unplanned interference of insects, disease or fire may all affect the harvest date.

The concept of stand ‘maturity’ is a useful indicator of when to harvest. The biological maturity of a stand is the age at which the stand has reached its maximum rate of production, or when its average annual growth is greatest. To harvest before this point is reached means the loss of significant volume increase and value. To delay harvest beyond this point means that you retain a stand whose annual rate of growth (and incremental value) is slowing down. If you think of a stand as an investment, like a term deposit, this becomes easier to understand.

When you purchase a term deposit, you make an agreement with the bank that you will leave your deposit, untouched, for a specified term. During this time period, the bank agrees to pay you a rate of interest for the use of your money. The end of the term is often referred to as the point at which the investment reaches ‘maturity’. When this term is up you can collect your capital (the original deposit) plus all the accumulated interest, or you may choose to re-invest it for another term.

When you manage a stand of trees, you are making a similar investment. Your deposit is made up of trees, rather than dollars, and the interest you accumulate is the annual growth of those trees. When the trees reach maturity, they can be cut down and the investment can be cashed in, or they can be left to continue growing and increasing in value for another period of time.

The difference between the two cases is that once trees have reached their biological maturity their annual growth starts to slow down, so although the investment continues to grow, it does so at a slower rate. This would be comparable to a drop in interest rates by the time your original term deposit is up. If you invest your money for a second term, you would be doing so at a lower interest rate, and the growth on your investment would therefore be slower than in the first investment period. Pathological maturity, triggered by widespread insect or disease infestation, could be compared to bank failure.

Foresters refer to the point of optimum stand production as the maximum mean annual increment (MAI). The MAI is the average annual rate at which the stand has grown over its lifetime. The figure below depicts the growth of a stand over time, showing the total volume production and also the trend in MAI as the stand grows. The biological maturity is the point at which the MAI is greatest. This is also called the culmination point of MAI. The culmination of MAI is comparable to the point at which a teenager peaks in the rapid growth spurt that often characterizes puberty. Past this point both the teenager and the tree keep growing, though at a slower rate.

![Volume Production in a Stand](image)

The Total Volume line in the figure is known as a ‘volume-over-age-curve’ (VAC). This curve represents the VAC for Coastal Douglas-fir on a good site in the Vancouver Forest Region. VACs are produced by forest cover type, for different sites in Forest Regions throughout the Province and are available from the Inventory Branch of the Ministry of Forests and Lands. By drawing a straight line from the origin (0,0) on the graph, to just touch the edge of the VAC, it is possible to estimate the culmination
Harvesting The Trees

point of the MAI. The age of the stand at this point is the biological maturity of that species on that site. To obtain the actual value of the MAI at this point you would divide the stand volume by the age.

Foresters have traditionally used the biological maturity of trees as the minimum harvesting age for planning harvesting schedules in the Province. The Ministry of Forests and Lands arbitrarily sets 120 years as the harvesting age for most softwood species; and 80 years for lodgepole pine in the Interior.

A stand can be mature in a financial sense also. The financial maturity of a stand is the age at which the stand has reached its maximum rate of financial production and offers the maximum return on investment. Unlike the human analogy, in which the person commonly reaches his financial peak long after he is biologically mature, financial maturity in trees can, and in many cases does, come first. Financial production is defined as the net present value (NPV) of the stand. The NPV represents what the stand is worth, once you have subtracted the costs associated with its production.

The NPV varies with the age of the stand in the same way that the volume does. Ideally, you want to harvest at the point at which the stand gives you the greatest return on investment. This point is difficult to identify since it relates to expected growth rates, markets for wood products and the future value of trees.

In practice, you will likely base the decision of when to harvest on a combination of factors, some biological and some financial (primarily the state of your bank account). It will depend on weighing the costs and benefits of cutting now, against cutting later. Ultimately, it will be influenced by your cash flow situation, and how badly money is needed, since the risks associated with holding onto the trees for a little longer are relatively small. Fire and a change in the market prices for logs and other products are the major risks, since even if the stand blew down or was hit by pests, you could salvage the logs.

Generally speaking, the stand becomes more valuable as it gets older, so you can afford to delay the harvest if it is not costing you money to hold the stand, and you have no financial constraints that make it necessary to harvest immediately. Selective cutting of some commercially valuable trees can be carried out to provide cash flow, while allowing the stand as a whole to continue to grow to greater value.

How Much Do I Cut?

The decision regarding how much to harvest will depend on the management objectives for the area, the age and condition of trees in the stand, and the desired next crop. Special circumstances, such as the need to salvage insect or fire-damaged trees will also influence the material cut. Woodlot Licensees are required to manage their woodlands for sustained yield through regulated harvests more or less equal to the rate at which the trees are growing. Though owners of private land or Indian Reserve land are not regulated in this way, the sustained yield concept is a wise management strategy.

If a tract of land is to be managed to produce a sustained yield, the manager will have to calculate an annual or periodic cut for the woodland. This calculation will provide a rough guide to harvesting, but flexibility is recommended. Economic conditions will prescribe cutting more during high market years and cutting less in low
market years. In practice, the cut schedule will likely be periodic, rather than annual, for many small woodland areas.

As discussed in the chapter “Forestry Basics”, the allowable cut is based on cutting the annual growth of the woodland. To get a rough estimate of the allowable annual cut (AAC) for an area, the mean annual increment (MAI) can be multiplied by the area of the woodland. The following table indicates the average MAIs for all site classes in each of the Forest Regions. Note that these are average figures, and actual MAIs will vary considerably.

Determination of the allowable cut is an essential part of the Forest Management Plan. The potential exists for increasing the allowable cut for an area by carrying out stand tending activities to increase the rate of growth in stands that are not currently achieving their growth potential.

Once the rotation and AAC have been established for the woodland area, you can turn your attention to planning at the Management Area level. This begins with a pre-harvest assessment, called the pre-harvest silviculture prescription, often carried out at the same time as the timber cruise. It collects information on the site (biogeoclimatic classification, soil depth, nutrient and moisture conditions, current conditions of windfall, advance regeneration, shrubs, insects and disease) and the characteristics of the current stand. This information is used to develop a prescription for the area, well in advance of actual harvesting, that indicates the appropriate silviculture system, logging methods, season of operation, site preparation, reforestation method, species selection and follow-up treatment activities. Guidelines and forms for the pre-harvest silviculture prescription have been developed by the Ministry of Forests and Lands – for more information contact your local District Office.

<table>
<thead>
<tr>
<th>Forest Region</th>
<th>Good</th>
<th>Medium</th>
<th>Poor</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kamloops</td>
<td>3.5</td>
<td>2.2</td>
<td>1.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Nelson</td>
<td>3.8</td>
<td>2.3</td>
<td>1.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Prince George</td>
<td>3.4</td>
<td>2.1</td>
<td>1.1</td>
<td>0.4</td>
</tr>
<tr>
<td>- Peace River</td>
<td>3.2</td>
<td>2.4</td>
<td>1.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Prince Rupert</td>
<td>7.1</td>
<td>4.3</td>
<td>2.3</td>
<td>0.5</td>
</tr>
<tr>
<td>- Bulkley-Northwest</td>
<td>3.8</td>
<td>2.7</td>
<td>1.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Cariboo</td>
<td>3.4</td>
<td>2.0</td>
<td>1.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Vancouver</td>
<td>10.2</td>
<td>6.2</td>
<td>2.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

To roughly estimate the amount of wood you can harvest from your land on a sustainable basis, select the appropriate MAI(s) for your region and the site class(es) of your lands, and multiply this number(s) by the number of hectares of land you have in each site class. For example, if you are in the Nelson Region and your woodland has 53 ha of good site and 47 ha of medium site, then your estimated annual growth per hectare would be:

\[
53 \text{ ha} \times 3.8 \text{ m}^3/\text{ha} = 201.4 \text{ m}^3 \\
47 \text{ ha} \times 2.2 \text{ m}^3/\text{ha} = 103.4 \text{ m}^3 \\
\text{Annual growth} = 304.8 \text{ m}^3
\]

If your estimated annual growth is 304.8 m³, and you plan to harvest once every five years, then your estimated periodic cut would be 1 524 m³, or approximately 45 truckloads.
Which Silviculture System?

In managing the forest for timber production, people have tended to copy the clearing and regeneration activities carried out in nature. Clearcutting mimics the clearing and re-establishment process that follows wildfires; natural selection is carried out by disease and insects on individual or small groups of trees in a stand; and shelterwoods have been created historically by small groundfires that cleared the understorey and provided a seedbed.

By harvesting, we maintain this cycle of stand development while capturing the products created in the process. The choice of silviculture system, therefore, is not just a decision to cut, but is part of the whole process of forest renewal, including the preparation of the seedbed and regeneration of the next crop, along with the removal of the current one.

Three silviculture systems are used in British Columbia — clearcutting, selection cutting and, to a lesser extent, shelterwood cutting. The silviculture system you select for an area will depend on the nature of the stand to be harvested, the kind of trees you want for the next crop, and the method of regeneration. The applications and pros and cons of each system are discussed below.

Clearcutting

Clearcutting, or removing all trees from an area in one cut, is the most common form of industrial harvesting in the Province. It is the standard practice in stands of sun-loving species such as Coastal Douglas-fir and lodgepole pine that have trouble regenerating in the shade of a full canopy of trees. It is suited to shallow-rooted species which are vulnerable to blowdown, and is also used as a means of stopping the spread of certain diseases, such as dwarf mistletoe and root rot.

Clearcutting is used when:

- you want to remove the entire stand
- the desired crop species is not represented in the current stand
- you want to regenerate trees that require full sunlight
- you want to produce an even-aged stand
- an area has been attacked by pests, such as bark beetle, and you want to salvage the dead trees and burn beetle-infested residues

The size and shape of clearcuts will be influenced by environmental, economic and social factors, including the management objectives for other resources and land uses. Site characteristics such as soil stability, terrain difficulty and watercourses are major considerations. In general, the more sensitive the area, the smaller the clearcut. Plans for slash disposal and site preparation methods will also affect the size and shape of cutblocks.

After cutting, natural reproduction may be obtained from seeds left on site when trees are felled, or from trees bordering the harvested area. If bordering trees are to be relied on as a seed source, the clearcut should be limited to a maximum width of 60 metres (about 2 tree lengths), and cutting should ideally be completed by the end of August to coincide with the time trees drop their seeds. A variation of clearcutting, called the seed tree method, leaves selected trees standing scattered throughout the area to provide seed sources for natural regeneration. Seed trees should be of good form, of the preferred species, and be windfirm.

Natural regeneration will usually require follow-up management techniques such as fill-in planting, spacing or thinning (see the chapter "Tending The Stand"). The clearcut area may also be restocked by planting seedlings. Planting presents the opportunity to choose the tree species and, by planting stock that is one year or older, to achieve a head start.
on nature in the process of forest renewal (see the chapter "Reforesting The Land").

The major advantage of clearcutting is that harvesting and silvicultural treatments can be carried out over large areas at one time. Equipment and methods of logging can be chosen without concern for damaging ‘leave’ trees. Once the area is cleared, it is more accessible for follow-up tasks such as site preparation, and planting.

Though it may be easier to administer and more efficient in terms of production, there are drawbacks to clearcutting. Without trees to use the groundwater or rainwater, the soil may become wetter and less stable and soil nutrients may be depleted or washed away. Clearcutting can increase the potential for erosion, landslides and the rapid runoff of water until the area regenerates. Risk of this type of damage is the greatest on steep slopes. In addition, a clearcut has a face that only a forester could love. It tends to look naked, next to standing timber, and the even-aged forest that it creates may lack some of the appeal of the more varied, uneven-aged structure.

By the very nature of small-scale woodland operations, it is unlikely that many of the potential drawbacks associated with clearcutting would develop. The reasons for not clearcutting would more likely be based on the personal goals of the operator than on environmental constraints.

**Selection Cutting**

Selection cutting is aimed at the creation or maintenance of uneven-aged stands. The objective of the selection method is to maximize the use of the site and to maintain site stability. Cuttings are made repeatedly, so that regeneration is a continuous process and a permanent forest cover is maintained. Mature timber is removed either as single scattered trees or in small groups. Single-tree selection is usually done in uneven-aged or mixed stands where the trees of marketable age are scattered amongst trees that are not yet marketable.

Many of the Province's small-scale woodland operations are located in second growth timber where the stands are still capable of significant increases in growth and value. Selection harvesting is appropriate to many of these stands because of its ability to serve a number of goals. It is used in the Interior in mixed stands of Douglas-fir/larch/lodgepole pine to remove the pine and favour Douglas-fir and larch as the final crop. It is being used in second growth stands to simulate old growth winter range conditions for black-tailed deer. It is also being used in areas of the Province affected by mountain pine beetle, to remove pines in mixed stands and encourage the regeneration of more vigorous and resistant species. The selection system is the preferred method for harvesting special products such as piling, poles, building logs, and fencing material. The common objective through all selection cuts is to leave a reasonably spaced thrifty stand in good growing condition.
Accessibility is a key requirement of the selection method, and this system will often require a more extensive road network than clearcutting, though much of it will be in branch roads and skid trails rather than mainlines. On the plus side, the road/trail network created provides access for fire protection and silvicultural treatments as well as for recreation and other pursuits carried on throughout the life of the stand. Selection cutting is most successfully carried out on level to rolling terrain and becomes more difficult with increasing slope. The major concern associated with selection cutting is the potential for damage to the soil and the trees or seedlings remaining on site.

Thin or sensitive soils can be severely damaged by heavy or repeated traffic, and can result in erosion and regeneration problems later on. Refer to a discussion of soil characteristics and considerations in the chapters on “Forestry Basics” and “Forest Access”. Wounds to the stems and roots of standing trees can create pathways for the entry of insects and disease. Damage of this type can be minimized by careful, advance planning of harvests and close supervision of contract work during these phases.

In selecting the trees for removal, the goals are to generate revenue, promote regeneration, and enhance the growth of the remaining trees. Therefore, in addition to extracting valuable, mature stems, the low quality or poorly formed and slow-growing trees should also be removed so that the seed source for regeneration is of the preferred crop species. Where the harvesting focuses only on removal of the best, mature stems, then the selection is actually ‘high-grading’, and the stand that is left, as well as the stand that will be regenerated, will be made up of lower quality trees. So long as a tree is healthy and growing it is increasing in value. It makes sense, therefore, to retain some of the larger, higher value stems on site to continue to ‘appreciate’ in value, while removing some of the less thrifty stems to open the area and encourage reproduction. Selection cutting closely resembles thinning since it improves growing conditions and future returns while harvesting some of the mature timber for returns now.

Professional help is recommended when determining which trees to cut and which to leave, since the choice will have such an impact on your future management activities and the final value of your stand. Selection cutting may be carried out by the landowner or contracted to a faller. In either case, it is a good idea to mark the trees of your choice, making clear which are to be cut and which are to stay. Only by doing this can you be assured that your choices will be clearly communicated.
Marking is usually done with paint at two places on the tree – dbh (1.3 m above ground) and stump height (30 cm above ground); most commonly, the marked trees are the ones to be cut.

**Sample Faller’s Selection Guidelines:**

The management objective for this area is to selectively harvest mature trees while preserving the established understorey and regeneration. The selection of which stems to cut or leave will be made by the faller considering the following guidelines:

- In areas containing a heavy understorey (2000+ stems per ha): cut all mature Douglas-fir and larch 30 cm or greater at stump height; cut all other species 20 cm or greater at stump height.

- In areas containing a light understorey (less than 2000 stems per ha): cut 30% (3 out of 10) mature Douglas-fir; cut 80% (8 out of 10) mature larch; cut all other species 20 cm+ at stump height.

- Cut the poorest trees and some of the competing good fir, reserving for crop trees those with the best form, considering: age, thriftiness, tree form and defect (dead tops, scars, forked tops, etc.).

- Reserve trees to be evenly distributed throughout area.

The above is intended as a guide – all areas should contain a healthy stocking of trees when harvesting is completed.

Falling of selected trees should proceed as follows:

- Fall all trees in a herringbone fashion (tops towards trail).

- Leave rub trees (or high stumps) at skid trail turns to prevent trees from sweeping across corners.

- Fall all trees in a manner to minimize damage to regeneration or understorey.

Done properly, the selection method has the potential to improve the forest while reaping its benefits. Many species of wildlife benefit from the environmental conditions existing along the boundaries between young and older trees. Soil is protected from overexposure, and by
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maintaining a more natural system, the forest requires less manipulation (mechanical or chemical) to make it thrive. The term 'selection' implies special attention and care, but with this greater effort comes a better understanding and more complete utilization of the growing site.

The difference between clearcutting and selection cutting is largely a matter of scale and detail. Clearcutting often separates the harvesting phase from the silviculture practices; while selection cutting more clearly integrates the two. The harvesting costs are commonly less for clearcutting than for selection cutting; while the silviculture expenses are often more. Perhaps the most significant difference between the two systems relates to the cash flow. Clearcutting brings a higher immediate return followed by a delay in income as the second crop becomes established and grows. Selection cutting on the other hand, offers smaller but continuous income and natural regeneration proceeds along with harvesting as openings are created.

Shelterwood Cutting
The shelterwood method combines some of the qualities of the clearcutting and selection silviculture systems. The shelterwood method involves the gradual removal of a stand of trees through a sequence of partial cuttings that in some ways resemble thinnings. The first cuttings create vacancies in the stand in which the new crop can become established. Subsequent cuttings remove the 'shelter' of the old crop to make growing room for the new one.

The shelterwood method requires a minimum of two cuttings - the seed cutting to achieve the regeneration of the new crop, and the removal cutting to extract the remainder of the old crop. The removal cutting may be conducted in more than one step where a more gradual removal of trees is desired, either for investment purposes or to meet the regeneration needs of a particular species. If an even-aged crop is desired, the removal cuttings should be conducted over a period of not more than 20% of the rotation.

The shelterwood system can be practiced on a uniform basis, across a Management Area, or in strips or patches. The latter of these is called a group shelterwood, and is commonly practiced by expanding naturally occurring pockets of advanced regeneration through a series of edge cuttings that extend the regeneration 'front' until the harvested areas eventually join. These three variations all produce an even-aged structure. The system can also be practiced as an irregular shelterwood to produce an uneven-aged structure. At this point the shelterwood and selection systems begin to blend; the major difference between the two being that the shelterwood has a final cut that removes all of the oldest stems, while the selection system keeps cutting in a continuous cycle.

Like the selection method, the shelterwood system is particularly attractive to small-scale woodlands since it encourages natural regeneration. Under the canopy of mature trees, both seedlings and the soil are protected from overexposure or severe fluctuations in temperature; shading will act as a deterrent to other vegetation and may reduce the need for brushing.

The shelterwood system is designed for shade-tolerant species which can grow under the canopy of the final crop of trees. It is best applied to those species requiring a large supply of seed and protection for seedlings during their initial stages of development. Shelterwoods have been successful in the management and regeneration of stands of Douglas-fir/lodgepole pine, Douglas-fir/Engelmann spruce, and Douglas-fir/nemlock. Due to the ability to vary the size of opening and exposure, the shelterwood method can be used to regenerate most species, except for the most shade-intolerant.

The shelterwood method may be more costly than clearcutting, largely due to the fact that logging and stand treatments are carried out on smaller areas and in several operations. Similar to the selection system, the shelterwood method will often require a more extensive road network than that required for clearcutting, but with the same advantages of access for other treatment and protection activities. Attention is required to ensure that frequent traffic by machinery minimizes damage to the soil and the remaining trees.

Each of these silviculture systems is similar to naturally occurring disturbances in the forest. Your choice should follow that made by nature - it should be appropriate to the site as well as your end-use goals. This will involve
Three types of cuttings are carried out in the shelterwood method:

1. **Preparatory cutting**: to prepare the stand for reproduction. Openings are created to let in sunlight and rainfall to speed the decomposition of humus, encourage crown development, and start to develop some windfirmness in the trees that will be retained for the final crop. Trees removed are from the lower crown classes. This cutting is important in dense stands and is often accomplished as thinnings.

2. **Seed cutting**: to open enough growing space to establish regeneration of the new crop. The seed cutting is conducted as a single cutting operation (as compared to selection cutting) and is timed for a year when seed of the desired species is abundant. The trees removed are the least desirable intermediate and codominants and all non-desirable species.

3. **Removal cutting**: to make way for the new crop. Removal cutting is usually done within a decade of seed cutting, once the new crop is established and in need of more growing space. Ideally, it is carried out to remove the old crop at the rate at which the new crop fills the site.
trade-offs between the pros and cons of each system for a specific woodland area.

Which Logging Methods?

This section will provide an overview of the steps involved in logging, along with an indication of the level of effort and expertise required. Logging is dangerous work that requires a great deal of skill to do efficiently. Would-be loggers should seek the advice and assistance of others who know what they are doing, and can provide pointers on how to make decisions and how to be safe and effective.

The basic steps in logging are the same regardless of the size of the forest holding. The equipment used, however, will vary a great deal between the industrial and non-industrial woodland operator. Specific pointers are included for those of you interested in doing it yourself along with basic guidelines for those of you who will be shopping for a contractor.

A clear logging plan is essential to both do-it-yourself and contract operations. By coordinating the development activities on the ground, it can save you time and money. It can substantially reduce the extent of compaction, erosion, loss of productive area to unnecessary trails and landings, and damage to the remaining trees. A logging plan summarizes the way in which harvesting is to be carried out on a particular cutblock within a Management Area. It includes how felling and skidding will be done and with what equipment and how wood will flow from stump to landing. The logging plan is usually presented as a map showing cutblock boundaries, main and spur roads, primary and secondary skid trails, and landings.

A cutting permit is required for the harvest of timber on Crown lands in Woodlot Licences. The cutting permit application must include a cruise summary and maps, appraisal data, silviculture prescriptions, and a logging plan. The attachments to the application must be prepared to Ministry of Forests and Lands' standards.

Timber harvesting involves 6 basic steps:

1. Felling, or cutting of the trees
2. Bucking the trees to logs of prescribed lengths
3. Yarding or skidding logs to a central location
4. Loading the logs onto trucks
5. Hauling the logs to the sorting area or mill
6. Slash disposal and site rehabilitation

Each of these steps can be conducted in a number of ways, and use a variety of equipment. The method you choose will depend on the material you are harvesting, the site conditions, and the silviculture system you are following.

Felling

For many woodland operators, felling and bucking will be the only logging phases in which they actively participate. This is understandable since these activities involve a minimum capital outlay for equipment and (unfortunately) are tasks that most of us think we can do with little experience or training. In reality, proper and safe felling is an acquired skill that calls for a knowledge of equipment and trees, common sense, and good judgement.

Though commercial felling is being done more and more by machines such as tree-shears or feller-bunchers, felling will likely be done most often by hand on small-scale woodlands. The first consideration for many landowners wishing to do their own felling is the purchase of a chainsaw. For woodland work, a bar length of between 50 and 60 cm (20 and 24 inches) is recommended. The choice will depend on the size of trees you are working with and the extent of the work being done.

Safety in handling a saw is extremely important. In addition to protective clothing and equipment, knowing how to 'read' tree behaviour and how to protect yourself from common dangers such as limbs breaking, logs rolling, and kickback are critical skills. The felling of trees and bucking of logs are special skills that will only be introduced here. You are strongly advised to obtain a copy of the "Fallers' and Buckers' Handbook" produced by the Workers' Compensation Board (available at cost; see references at the end of the chapter). Be careful. Carry a good first aid kit. And know when to ask for help.
Assessing Tree Behaviour:

- look for tree lean and which side has most branches. Fell within 45° of the direction of the lean
- check for loose or dead limbs or tops that could break off during cutting
- check for signs of rot, such as conks. Remember that species like cedar, hemlock and balsam (grand fir, amabilis fir) are prone to heart rot in the lower trunk
- note any potential for hang up on other trees
- fell snags in the direction of lean; listen and watch for falling branches

Felling sets the stage for the harvesting operations. Careful planning and skill in directing the fall of the tree can reduce potential dangers and delays in hang ups, and breakage of the tree as it lands. Felling should be planned to drop trees into openings, including skid trails, and away from fish-bearing streams and other watercourses, roads or boundary lines. Controlling fall direction can help to align the logs for more efficient (and environmentally sensitive) skidding operations. Correct felling is particularly important in selective logging since it affects the amount of territory the skidder must cover, which in turn affects the amount of soil compaction, potential for hang ups and damage to standing trees.

Proper Felling Procedures:

1. Remove brush, debris and snags to clear a working and retreat space (at 45° to the direction of fall, and for a distance of about 6 m).
2. Form an undercut by first making a horizontal cut into 1/4 of the tree diameter. Next make an upward diagonal cut to meet the first cut. The fat end of the wedge created should be about 1/3 of the depth of the horizontal cut. The two cuts should meet but not cross at the inside edge of the cut.
3. The backcut should be level and slightly above the horizontal cut line of the undercut.
4. There should be enough ‘hinge wood’ to control the direction of fall.
5. Look up to check the tree as you work.
6. Use wedges to lever the tree to fall.
7. Do not turn your back until the tree has completed its fall.

To encourage the full use of the Province’s timber resources, the Ministry of Forests and Lands requires that the felling on Crown lands be carried out to specific standards. These ‘utilization standards’ prescribe the maximum stump height and minimum top diameter to which stands must be logged. The ‘close utilization’ standards currently in effect are to a stump height of 30 cm and a top diameter (inside bark) of 10 cm. Although private landowners are not constrained to these harvesting regulations, it is recommended that they be followed for the advantages of: better utilization of timber resources, decreased waste, reduced fire hazard, and fewer slash disposal problems.

**Bucking**

Bucking is the first step in manufacturing, since it breaks the tree into logs. It is a significant activity that affects the potential value of the tree. Where felling is done by hand, bucking is usually done by the faller as well. As the tree is limbed, it is cut into log lengths of the greatest value. On the Coast, bucking is normally done in the woods. In the Interior, trees are usually skidded full length to the landings where they may be bucked before hauling to the mill.

Bucking can actually improve log grade by removing defects or creating special products. With such an influence on log value, it is definitely worthwhile to learn about bucking specifications. Simple things, like square cut ends and accurate measurement to include trim allowances, can mean the difference between a high value and low value log. Each tree is bucked on its own characteristics, and should be carefully assessed before making the first cut. Bucking decisions are based on the tree’s quality, distribution of knots, and a knowledge of current market values. When logs are bucked to length for a particular mill, it is important to know the mill’s trim allowance requirements. Log buyers often have cards printed up with their desired log specifications. Be sure to carry this with you; bucking decisions made in the woods can radically affect the value of the log at the mill.
Yarding And Skidding

Yarding transports the logs from the stump to a ‘landing’, or central area, usually at the roadside, where logs are loaded onto trucks. Yarding on the steeper slopes of the Coastal region is carried out by a number of systems that partially lift, rather than drag the logs to the landing. Mobile, grapple yarders and tractor-mounted ‘spars’ or towers, use highlead systems that pull in logs by tongs or attached by chokers, to a cable suspended in the air. In the Interior, yarding is usually done by skidders or crawler tractors which drag the logs by means of heavy wire cables, called chokers, or by a grapple hook. Skidding is also done with draft animals such as horses and more recently with special winches designed for small-scale operations.

As with felling and bucking, yarding is most successful when it has been planned in advance. The location of skid trails is the key to an efficient and environmentally sound yarding operation, and they should be laid out with flagging tape to provide direction to construction. Yarding patterns should not cross fish-bearing streams or other watercourses. The area covered by skid trails should be kept to a minimum as heavy machinery compacts soil and can reduce its productivity for growing trees. Excessive disturbance can lead to erosion problems, the loss of soil nutrients and the potential deposit of silt in watercourses.

As a goal, skid trails should be restricted to less than 12 percent of the total logging area. Skid trails should be positioned to remove all accessible timber and provide logical haul patterns to the landings without logs hanging up or sliding into stumps or standing timber. Ideally, they should be laid out and constructed with long-term use in mind, to provide the woodland with a system of access for planting, stand tending operations, recreation and other purposes.

Landings should be located first when planning a ground skidding operation. They should be central to the skidding pattern in areas of heavy timber concentration, and there should be enough landings to keep skidding distances between 250 and 400 metres. Landing size should be kept to a minimum, preferably below one quarter hectare (e.g. 50 m by 50 m). Flat sites with good drainage, such as knolls or benches, are preferred. When clearing
the landing, it is advisable to fell a safety buffer zone of approximately 1 1/2 tree lengths around the landing site.

Skid trails should be located to fit the terrain and minimize soil disturbance. Where drainage is good and slopes are moderate, much of the skidding in the Interior can be done on a random basis, that is, in the absence of properly constructed skid trails. To minimize compaction, wide-tired skidders are recommended, as well as skidding over frozen ground or heavy snowpack conditions where possible. In conditions of greater slope and terrain variability, it is advisable to construct proper skid trails.

For slopes of less than 20%, a branching pattern works well. Spur skid trails branch off main skid trails as illustrated. A parallel pattern is also appropriate for both simple terrain and on sideslopes up to 40%. The main trail should always be downhill. The spacing between skid trails will depend on tree height and size as well as the size of skidder winch. On the medium and steeper slopes it is important to minimize the crossing of creeks, ridges and gullies, since this will disrupt natural drainage patterns and increase site disturbance. Wherever possible, skid trails should be built downhill, from the top to the base of the cutblock. Long, steep, straight grades permit water buildup and should be avoided. Maintenance of skid trails usually involves keeping the surface water drained away with water bars and trenches.
Skid Trail Layout and Construction:

- follow the terrain as much as possible and avoid sharp curves
- for steep terrain, place trails parallel to contour lines to prevent erosion
- ground skidding is usually confined to slopes under 35%
- cut stumps on skid trails to ground level to prevent hang ups, but leave 1 metre stumps along the outer side of the trail to prevent slide-outs
- avoid wet spots and springs
- where trails must cross water seepages, they should be at right angles and on gravel or rocky locations. Place logs in the seepage area to provide a travel surface for equipment and minimize ground disturbance
- trails should be no wider than necessary for the tractor or skidder
- lay out skid trails for easy entry to landings; avoid sharp curves and junction corners

Three main types of equipment are used for ground skidding; the selection of which to use is based on the terrain and size of timber. Rubber-tired skidders are used extensively in the Interior, since they are suited to gentle terrain with slopes up to 30%. Skidders equipped with a winch and chokers are used in conjunction with hand fallers, while skidders with grapple-mounts are used with feller-bunchers. High flotation tires are being used on skidders operating over soft and wet ground to minimize soil compaction.

Small and medium-sized crawler tractors (maximum 150 HP) are suited to skid trail construction and skidding short distances. They are more effective than rubber-tired machines for working on medium steep slopes (up to 40%), soft ground, and in deep snow. The special low ground pressure (L.G.P.) tracked skidder is designed for use on wet, soft ground or deep snow at slopes of up to 50%.

A variety of special equipment, both for ground skidding and cable yarding, designed for the part-time operator is now becoming available in B.C. Refer to the section on Small-Scale Equipment later in this chapter.

Loading

Loading operations usually involve either a front-end tracked or wheeled loader with a grapple. The front-end loader is somewhat like a fork lift, that gathers up many logs at a time and lifts them onto a logging truck. Some logging trucks are now equipped with hydraulic hoists or booms to make them self-loading. If you contract the loading and hauling operations on your woodland, it is quite likely that you will come into contact with one of these. Some innovative operators have solved the loading challenge using two trees, cable, blocks, a spreader bar and ..........oats (you figure it out!!)
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Hauling
Hauling is often contracted out as a separate operation from other aspects of harvesting. It is a costly activity that is affected by road surface and design, landing organization and loading efficiency, not to mention the distance to the mill or log dump. Since haul costs are often a large portion of logging costs, and can be reduced by careful planning, it is recommended that you seek some professional advice with respect to road and landing layout before you start building.

Slash Disposal And Site Rehabilitation
After logging, the slash material (wood residue) left on-site may have to be removed to reduce the fire hazard and/or to prepare the area for reforestation. This may involve spot burning of accumulations on areas such as landings, or broadcast burning where the debris is spread throughout the general area. Or it may involve ‘slashing’ the residue so that it lies flat to the ground. This will accelerate its decomposition and make the area easier to plant. If burning is to be carried out, the construction of firebreaks and other safety measures will be necessary and burning permits will be required. Slash associated with road building should also be disposed of, either by burning or burying. If buried, it should be clear of the road construction area, but not underneath it. Vegetation is not a stable fill base to support a road.

After logging, skid trails and other abandoned roads should be ‘water barred’ to channel water away from the road surface. This can be done by angling small ditches, 10-15 cm deep, at intervals across the road surface to channel water into the side ditches or directly onto the forest floor. Landings should also be treated after logging is finished. Due to the high volume traffic that a landing supports, soil becomes very compacted during the logging operation. Landings may have to be ‘ripped’, or scarified to loosen the soil to improve its drainage and encourage revegetation.
Small-Scale Equipment

With the growing interest in small-scale woodland operations, there is a need for the production of appropriate, small-scale equipment. Some Woodland Associations in the Province act as cooperatives, sharing expenses for contract skidding and other operations, and training in the practice of small woodlands forestry. Individual owners scour the market for small crawlers and skidders, or modify farm tractors for forestry tasks such as yarding and site preparation. The development of the self-loading logging truck has revolutionized small-scale operations by making it economically worthwhile to recover small volumes of material – even one or two truckloads.

Sweden and Finland, longtime practitioners of small-scale forestry, have developed a number of small-scale systems for logging and silvicultural practices. The Swedish “Small Scale Forestry” magazine is full of useful information and equipment ideas applicable to small-scale operations. Also highly recommended are “The Farm Tractor in the Forest” and “The Chainsaw - Use and Maintenance” handbooks produced in Sweden, published and available in Canada through the New Brunswick Department of Natural Resources (see references at the end of the chapter).

If you are thinking of modifying basic farm equipment for forestry work such as skidding or site preparation, keep safety in mind. While it may be possible to ‘make do’ with a tractor for skidding a few truckloads of small logs on flat ground, it can be inefficient and even dangerous on slopes or with larger material. Tractors have a low centre of gravity, become unstable on slopes, and can be pulled over backwards under some circumstances when hauling heavy material.

The Forest Engineering Research Institute of Canada (FERIC) has produced a number of excellent publications on woodlot technology (references at end of chapter). One report compares seven 4-wheel drive tractors and skidders that are currently in use or available for use in small woodlots. Particularly useful for the small operators who manage their woodlands on a part-time basis is the “Handbook For Logging With Farm Tractor-Mounted Winches”. A Canadian-developed tractor-mounting winch, the ‘Agri-Winch’ is reviewed for woodland operations in another study.

For those of you without even a tractor, don’t despair. Small motorized winches that can be attached to a tree to winch-skid cut products from your woodland are also available. The successful use of these light winches depends on careful felling and alignment of cut materials for skidding. They have been used successfully in small clearcut operations but are really making their mark in selective cutting and thinning operations. See “Harvesting Trees From Thinnings Using Small Winches”. There is even a double-drum winch on the market, powered by a chainsaw, that advertises itself as a portable yarde with haulback!

Small tower cable systems and tiny, truck-mounted portable spars and grapple systems have started to fill the special equipment needs of small-scale operators. They are especially useful for logging sensitive areas, wet areas, and for thinning operations. Some equipment dealers are beginning to develop particular expertise in small-scale processing machinery, such as portable sawmills, chippers, and fuelwood processing systems as well.
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Contact your nearest Woodland Association (Appendix III) or local equipment dealers for further sources of information.

Horse logging is growing in popularity as a low-impact means of extracting material from small woodlands and sensitive areas. The method minimizes soil disturbance, compaction and soil erosion as well as damage to the stems and root systems of standing trees. It can, however, be a dangerous activity for the novice, since the operator is physically so close to the logs and cables. Approach it as another equipment decision. The Cariboo Horse Loggers Association should be contacted for further information on the costs and benefits of horse logging.

The choice of equipment to do your job will usually depend on the answers to a few standard questions:

- What is the job I want to do?
- What different ways and with what different equipment can it be done?
- How do each of the alternatives compare in terms of the amount of my time that is needed? The amount of capital cost? The risks involved? The quality of the completed task?

What Are The Environmental Considerations?

Consideration of the environment and other resources must be incorporated into all aspects of timber harvesting operations. Proper planning before harvesting should be followed by close supervision of operations on the ground. Skid trails and yarding patterns on steep ground should be designed to minimize the effect of surface water flows and prevent high traffic areas, such as landings, from turning into mud ponds. Wet sites can be scheduled for logging in winter when the ground is frozen and the impact of machinery is minimized. (See also the discussion in the chapter "Forest Access").

In a recent cooperative effort, the provincial Ministries of Forests and Lands and Environment and Parks, the federal Department of Fisheries and Oceans, and the Council of Forest Industries have developed "Coastal Fisheries Forestry Guidelines" for the protection and maintenance of fish habitat in coastal watersheds where forestry operations are carried out.

The Guidelines deal with recommended procedures for felling and yarding, ground skidding systems, and the treatment of streamside areas to minimize sedimentation and maintain the health and character of stream banks and channels. Many of these recommendations are incorporated into the appropriate sections of this chapter. In addition to these specific considerations, however, the following overall guidelines for harvesting operations are recommended:

- protect Fisheries Sensitive Zones
- evaluate impacts of harvesting operations on downstream values
- evaluate landslide and erosion hazards and use special methods as required
- choose appropriate yarding systems for the site; yard uphill where practical
- assess ground skidding systems carefully for use on slopes greater than 30%
- avoid continual and random stream crossings with skid trails
- maintain stream bank green strips to provide shade and nutrients for fish
- leave some large trees (standing and down) along fish-bearing streams to maintain stream bank stability and the distribution of pools and riffles that are important as hiding cover and protection for fish during periods of extreme stream flow
- prevent introduction of debris into streams; carefully supervise stream cleanup

Along with environmental considerations, harvesting operations should be sensitive to the public environment in which they take place. Skid trails, landings, and cutblocks should be kept free of refuse, fuel containers, or
cables at all times. Woodlot Licensees, in particular, must accommodate public concerns since they are operating on public land. "The Forest Landscape Handbook" published by the Ministry of Forests and Lands is a guide to help people lay out and position harvesting blocks in a manner that is sensitive to the viewer. This is worth considering even for small clearcut blocks. In most cases the costs of going the extra mile in terms of layout and buffer strips, are well worth keeping neighbours and others in your community happy.

**Working With A Logging Contractor**

Put your handshake in writing.

In addition to a logging plan, your best friend in dealing with a logging contractor is a clear and comprehensive logging contract. The contract should clarify such things as:

- the basis on which payment is to be determined (i.e. flat fee or $ per cubic metre)
- logging methods, season, and period
- standards and guidelines to be followed (e.g. close utilization, bucking specifications, streamside protection)
- cleanup responsibilities, site preparation or regeneration responsibilities, road construction or maintenance
- how performance will be assessed and whether there will be a holdback on payment, pending suitable performance

You may contract out one or more parts of the logging operation or as phase packages, such as road development and harvesting, site preparation, and reforestation. Be aggressive in selecting a contractor. It is better to spend the time at the start in making a careful selection than in coping with an unsatisfactory job after the fact. References from previous employers are your best indication of contractor performance.

Be honest and open with the contractor regarding your priorities and concerns. Discuss all contract requirements and preferences with the contractor before you agree to a price. Have a signed contract detailing all agreements before work begins and be on-site for major phase activities as well as random checks on performance. Make it easy for the contractor to reach you with any questions or concerns; if you are not available and he has a deadline to meet, work will proceed without your input.

If you are contracting out operations such as selective harvesting or thinning operations where success depends on good on-site judgement, consider marking all the selected stems at dbh and stump height – a wrong selection can undo the work and investment of many years of effort.

The details of a logging contract will vary for each situation. A sample contract is included at the end of the chapter that will give you a good starting point from which to develop a contract specific to your needs. You are advised to seek legal advice before signing anything – especially the first time around.

Once logging has taken place, the material that has been cut is "scaled" to measure its quality and quantity. Scaling is important since it is often the basis on which you will pay your contractor and the basis on which you will receive payment for your forest products.
Harvesting The Trees

When Is Scaling Required?

Under the Forest Act, all timber that is to be manufactured, sold, or removed from Crown and private lands in the Province must be scaled. Timber cut from federal lands, such as Indian or military reserves, although not under provincial jurisdiction, is also scaled to provincial standards set by the Ministry of Forests and Lands.

Scaling is carried out by independent scaling firms or licenced individuals authorized by the District Manager. The Ministry sets the standards and procedures for scaling, carries out monthly check scaling of all scalers and establishes the conditions under which scaling is done.

Scaling requirements may vary according to special regional or individual circumstances. The District Manager of the Ministry of Forests and Lands is the scaling authority and should be contacted to determine the requirements for individual properties. The District Scaling Officer will work out the basis on which volume will be estimated and the format for reporting. In general, the requirements become less stringent as the volume and value of the wood logged decreases. In some cases, small volumes (less than 3,000 m³) may be exempted from scaling, and instead, the woodland operator may be required to submit a monthly statement to the District Office summarizing the volume cut.

There are two payments related to scaling: the payment to the scaler and the prescribed scaling fee to the Ministry to offset costs of administering the check scaling program. The latter fee may be waived when it is less than ten dollars (approximately ten truckloads, or 330 m³, of wood at the Interior scale rate of $0.03/m³). All woodland operators are required to obtain a registered timber mark (see Timber Mark section) for logs cut from their private or Crown lands to identify the wood for scaling purposes.

How Is It Done?

Piece scaling in British Columbia is carried out according to the B.C. Cubic Metric Scale which measures the firmwood content of the log. This is done by measuring the length of the log, and its top and butt diameters (inside bark). This gross volume can be measured with a carpenter’s rule, and calculated using the following formula.

The formula treats the log as two cylinders and the log volume is based on the averaged volume of the two:

\[
\text{Volume (cubic metres)} = (r_1^2 + r_2^2) \times L \times 0.00016
\]

where:

- \(r_1\): radius of the top in cm
- \(r_2\): radius of the butt in cm
- \(L\): length in metres

0.00016 is a constant

For example, to compute the volume of a log 10 metres long, with a top radius of 8 cm and a butt radius of 12 cm:

\[
V = (8^2 + 12^2) \times 10 \times 0.00016
\]

\[
= (64 + 144) \times 10 \times 0.00016
\]

\[
= .333 \text{ m}^3
\]

Note: All radius measurements are taken to the nearest even number (so 8.5 cm would be recorded as 8 cm; 13.5 cm would be recorded as 14 cm). Lengths are recorded to the nearest 0.2 m, rounded to the nearest, lower even number (a log of 11.5 m would be recorded as 11.4 m). Deductions are made at the time of scaling by reducing the actual radius or length measurements for rot, holes, charred wood or other defects to the log.

Special measuring tools called scaling sticks make scaling an easier and more efficient task. The scaling stick is marked with a number of scales that enable the scaler to calculate log volumes as cylinders, based on measurements of the length and radius of the log. The scaling regulations and procedures for using a scaling stick are set out in the provincial "Forest Service Scaling Manual". This document, as well as a set of tables of volumes of cylinders (which will allow you to calculate your scale volume without using the formula) will most likely be available from the District Office of the Ministry of Forests and Lands.
Most (70%) of the log scaling in the Province is currently done as weight scaling. The remaining 30% is scaled by piece. Piece scaling is done primarily on the Coast where log quality is variable. Weight scaling is a quick and convenient way of measuring wood quantity but is somewhat less accurate than the solid volume scaling method. It is well-suited to the homogeneous logs produced in the Interior of the Province. As a rough guideline, a standard highway logging truck (maximum 2.6 metre bunk) holds approximately 30 cubic metres of wood.

How Are Logs Graded?

Scaling provides you with a measure of the volume of wood logged from a stand, but you (and the government, if it is Crown land) will also be interested in the value of the wood removed. The value of logs is determined through a process called grading, which assigns value according to the species, size, and condition of logs.

On the Coast, all logs are graded when scaled, and are bought or sold by grade category for each species. Most Interior mills grade logs by species and size. Both the Ministry of Forests and Lands and the Council of Forest Industries prepare monthly, quarterly, and yearly summaries of log sales by grade.

A great number of things affect the grade of a log: growth rate, the form or shape of the log, the presence and size of knots, rot or insect damage, and the size of the log. When you realize that a high grade log can be many times the value of a low grade log, it makes sense to buck carefully.
Harvesting The Trees

A set of scaling rules sets out, by species, the characteristics of logs in each of the grade categories. For each category there is a ‘grade rule’ that describes the characteristics of logs, and a specific listing of the log requirements to make the grade.

Whether you plan to buck the logs yourself, or sell the stand to a contractor, be sure to get the best value from your logs.

What Is A Timber Mark?

Timber marks, like cattle brands, are registered symbols that indicate where a log comes from, who holds the mark, whether or not the timber may be exported in log form, and whether the wood is to be charged stumpage or royalty fees. Registered timber marks are required for all timber cut from Crown and private land, and are issued upon application and payment to the Ministry of Forests and Lands. After an application is approved, the operator will receive a timber mark certificate with his assigned timber mark.

Timber marks are hammered into each end of a log. Woodlot Licences are marked as shown, with the letters WLA, followed by three numbers which identify the licensee. The Crown and private land portions of a Woodlot Licence will have different timber marks. The timber marks for wood from private lands have five letters. The first of these will be either an ‘E’ or ‘N’, indicating whether the timber is ‘exportable’ or ‘non-exportable’. The remaining four letters are a unique series that are assigned to the timber producer for that parcel of land. Although there are some exemptions, in general, timber from Crown lands may not be exported. Timber may be exported from private lands in some cases, depending on such things as when the land was Crown-granted. Indian Reserves are federal lands, and timber from these lands is exportable in log form and is free from royalty payments. The timber mark for Indian lands begins with the letters ‘IR’, followed by three numbers designating the Indian Reserve from which the timber comes.

<table>
<thead>
<tr>
<th>WLA</th>
<th>EX</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>288</td>
<td>DHW</td>
<td>176</td>
</tr>
</tbody>
</table>

In special circumstances, operators may be exempted from the hammer mark and assigned a chalk mark for a limited period of time, provided that the material will not be put in the water. Exemption is not available in circumstances where the timber is to be floated or rafted and therefore needs identification in case of escape. To determine your requirements with respect to a timber mark, check with the local District Office of the Ministry of Forests and Lands.

Special Forest Products

Where timber is manufactured into special forest products on-site, it may be scaled as a product. Shingle bolts and pulpwood are measured as stacked cubic metres, or the total amount of wood, bark and airspace contained in a stack of roundwood 1 metre high by 1 metre deep by 1 metre wide. Logs should be cut to uniform lengths and stacked tightly. Deductions should be made for large spaces caused by crooked logs or bolts. Firewood is still commonly scaled as ‘cords’.

Standard forms and procedures have been developed to record scale data. The procedures and forms required for scaling special forest products may vary slightly according to the particular product. Christmas trees are graded by height categories, and recorded as the number of pieces by species. Poles, pilings and building logs are
stick scaled for length and diameter class. Shake bolts are scaled in a stack and multiplied by a special factor to eliminate the volume of bark, airspace and defect in the stack.

A list of the special products categories, a brief description of the products and their dimensions is given below. For more detailed information, refer to the Forest Service “Scaling Manual”.

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Dimensions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>diameter</td>
<td>length</td>
<td></td>
</tr>
<tr>
<td>Building Logs:</td>
<td>Bark removed; shaped into cylinders for house construction</td>
<td>variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car Stakes:</td>
<td>For side supports on railroad flat cars</td>
<td>10-15 cm</td>
<td>3-5 m</td>
<td></td>
</tr>
<tr>
<td>Christmas Trees:</td>
<td>Sold by piece depending on height class</td>
<td>grade 1:</td>
<td>&gt; 5 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>grade 2:</td>
<td>3-5 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>grade 3:</td>
<td>&lt; 3 m</td>
<td></td>
</tr>
<tr>
<td>Cribbing:</td>
<td>Peeled logs; standard length and diameter used in mines, docks or bridges between main supports to hold back rock material</td>
<td>6-20 cm top</td>
<td>1.8-3.0 m</td>
<td></td>
</tr>
<tr>
<td>Fence Posts:</td>
<td>Round and peeled logs; e.g. lodgepole pine, sold by 2 cm diameter classes</td>
<td>6-20 cm top</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Split fence posts from butt logs of cedar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Posts may be 3 or 4 sided, with each side 2 cm length classes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firewood:</td>
<td>Short logs; usually split and bark loosened</td>
<td></td>
<td>0.4 m</td>
<td></td>
</tr>
<tr>
<td>Grape Stakes:</td>
<td>Split or round</td>
<td>7-10 cm</td>
<td>3.5 m</td>
<td></td>
</tr>
<tr>
<td>Hop Poles:</td>
<td>Split or round</td>
<td>7-13 cm</td>
<td>4-6 m</td>
<td></td>
</tr>
<tr>
<td>Mining Timbers:</td>
<td>Round logs, bark removed</td>
<td>10-38 cm top</td>
<td>1.4-2.4 m</td>
<td></td>
</tr>
<tr>
<td>Orchard Props:</td>
<td>Split or round logs</td>
<td>7-13 cm</td>
<td>2.5 m</td>
<td></td>
</tr>
<tr>
<td>Pickets / Palings:</td>
<td>Split cedar; for fence construction</td>
<td>1-2 cm by 7-13 cm</td>
<td>1.2 m</td>
<td></td>
</tr>
<tr>
<td>Filing:</td>
<td>Round peeled logs; for marine structures, foundation support for buildings</td>
<td>max 28 cm top</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poles:</td>
<td>Round, peeled logs to support electric or telephone wires.</td>
<td>max 28 cm top</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulpwood Blocks:</td>
<td>Cottonwood; no bark, no burn, no rot</td>
<td>* 6-14&quot;</td>
<td>22 &quot; ±1&quot;</td>
<td></td>
</tr>
<tr>
<td>Note: dimensions are imperial.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shakes:</td>
<td>Cedar; standard thickness and lengths</td>
<td>9,13, 19 mm</td>
<td>45, 60 cm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A blank is double thickness and sawn into two shakes. Blanks count as two shakes; a double blank counts as four shakes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shake Bolts / Blocks:</td>
<td>Cedar; a bolt is a log or slab from which two 60 cm or three 45 cm blocks may be sawn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shingles:</td>
<td>Cedar; sold in standard sawn lengths</td>
<td></td>
<td>40, 45, 60 cm</td>
<td></td>
</tr>
<tr>
<td>Shingle Bolts:</td>
<td>Cedar; a bolt is a log or slab sawn in lengths from which three 40 cm or 45 cm blocks or two 60 cm blocks may be sawn</td>
<td></td>
<td>1.3, 1.45 m</td>
<td></td>
</tr>
<tr>
<td>Stakes or Sticks:</td>
<td></td>
<td>max 5 cm butt</td>
<td>1-2 m</td>
<td></td>
</tr>
</tbody>
</table>
Harvesting The Trees

Recommended References:

**B.C. Ministry of Forests and Lands**
- B.C. Coastal Fisheries Forestry Guidelines”. 1987. MOFL, DFO, COFI
- “Protecting Forest Soil”. 1987. Silviculture Branch

**Crown Publications Inc., Victoria**
- “Forest Service Scaling Manual”
- “Table of half volume cylinders and cubic decimetres”. Forest Service Publication #546

**Workers’ Compensation Board of B.C.**
- “Fellers’ and Buckers’ Handbook”
- “Yarding and Loading Handbook”

**Forest Engineering and Research Institute of Canada (FERIC)**
- Use of the farm tractor in the forest:
  - “Evaluation of the Agri-Winch: A Farm Tractor-Mounted Logging Winch”. TR-41
  - “4WD Articulated Tractors and Skidders for Woodlots”. TN-87
  - “Hydraulic Grapple Loaders for Farm Tractors”. TN-88
  - “Logging Winches for Farm Tractors”. TN-90
  - “Logging Trailers for Farm Tractors”. TN-97

- Small, inexpensive equipment for woodlot owners who do not have a farm tractor:
  - “Evaluation of Wood Caddy and Goliath Mini-Skidders”. TN-86
  - “Can All-Terrain Vehicles be Used for Forest Work?”

- Equipment for fuelwood and energy-chip production:
  - “Evaluation of the Bruks Mobile Chipper”. TR-91
  - “High-Capacity Firewood Processing and Marketing”. Handbook #76

**Other FERIC**
- “Handbook for Ground Skidding and Road Building in the Kootenay Area of B.C.”
- “Timber Development Planning for the B.C. Interior: The Total Chance Concept”. Handbook No. 4
- “Handbook For Logging With Farm Tractor-Mounted Winches”. Handbook No. 2

**New Brunswick Department of Natural Resources**

**Oregon State University Extension Service**
- “Increasing Values Through Bucking Practices: Manufacturing Logs”. Circular 1184
- “Felling and Bucking Techniques for Woodland Owners”. Circular 1124

**Other Sources**
- “Small Scale Forestry” newsletter. Dept. of Operational Efficiency, Swedish University of Agricultural Sciences. S-770 73 Garpenberg, Sweden. USS10. Published twice yearly (available in English)
The following contract is a sample format for your consideration. Note that a contract should be adapted to the particular requirements of each situation. In addition to the items addressed in the following sample contract, you may wish to provide for: Additional Work, Directions to the Contractor, Representations, Curtailment, Special Provisions, Insurance, Assignment and Subcontracting, Default by Contractor, Insolvency of Contractor, and Termination. You are advised to seek legal counsel regarding your contract documents.

SAMPLE LOGGING CONTRACT

THIS AGREEMENT made the ______ day of ____________________, 19__

BETWEEN

A.B. Cee
(hereinafter called the “Owner”)
OF THE FIRST PART

AND

XYZ Logging Ltd.
(hereinafter called the “Contractor”)
OF THE SECOND PART

WHEREAS the Owner wishes to log all merchantable trees on the portion of District Lot 000 as described in Schedule “A” attached.

AND WHEREAS the Contractor has agreed to log the said area in accordance with the terms and conditions set forth in this Agreement.

NOW, THEREFORE, THIS INDENTURE WITNESSETH that the parties hereto agree, each with the other, as follows:

1. AREA

The Contractor will confine its logging to the area defined in Schedule “A” attached.

2. FIRE REGULATIONS

The Contractor agrees to observe all Provincial Government regulations relating to the safety and security in respect to fire or other hazard, and that during the fire or dry season, Apr. 15 - Oct. 15, unless otherwise specified by the Ministry of Forests and Lands, it will take all precautions prescribed by the Forest Act or the regulations thereunder, or as may be specified by the Owner, and shall cease work if the Owner deems it necessary.
3. MERCHANTABLE TIMBER

The Contractor will cut and remove all trees and windfalls which will yield merchantable logs, defined as logs containing at least 50% sound wood and of or greater than a minimum top diameter of 10 cm inside bark and a minimum length of 5 metres. The Contractor is also required to fell all snags above 3 metres in height.

4. OWNERSHIP

All logs produced from the said area belong to the Owner.

5. SLASH DISPOSAL

The Contractor agrees that all slash or logging debris resulting from the Contractor’s operations will be disposed of by the Contractor to the satisfaction of the representatives of the Ministry of Forests and Lands and/or the Owner.

6. ROADS

The Contractor shall build at his own expense spur or skid roads necessary for logging, and shall maintain and repair, as necessary, all access roads used by the Contractor.

7. TIMBER MARK

The Contractor will stamp all logs before removal from the area with the Marking Hammer to be provided by the Owner.

8. TIMING

Logging shall commence on ____________, 19__, and shall be completed, including delivery of logs, by ______________, 19__. It is agreed that time is of the essence hereof.

9. DELIVERY

The Contractor will deliver all logs from the area to ____________________________ (e.g. Acme Sawmills Ltd.), where the logs will be scaled by licenced government scalers. Both the Owner and the Contractor will receive a copy of the scale record. The Owner will be responsible for the costs of scaling.

10. PAYMENT

The Owner agrees to pay the Contractor $________ per tonne for all logs delivered to ____________________________ (e.g. Acme Sawmills Ltd.), for the said area of District Lot 000. Payments shall be scheduled as follows:
   a) within 10 days of receipt of scaling records, an advance of $______ (commonly 60%) per tonne.
   b) within 30 days of completion of logging, the remainder of $______ (commonly 40%) per tonne, less any amounts necessary to repair damages to the access roads, and to leave the area in a workmanlike manner in keeping with good standards of logging practice.
Prior to making any payments to the Contractor, the Owner may require the Contractor to furnish receipted payrolls to the Owner in compliance with the Woodworker Lien Act.

11. APPLICABLE LAWS

The Contractor shall, while performing the work hereunder, observe and perform (and pay and satisfy all assessments or remittances pursuant to) the provisions of the Workers’ Compensation Act, Employment Standards Act, Unemployment Insurance Act (Canada), and the Canadian Pension Plan (Canada), and regulations thereunder, and the hours of work laws and minimum wage laws of British Columbia and all other Governmental regulations, statutes and orders (including obtaining all permits or authorizations) pertaining to or having a bearing upon the Contractor’s work hereunder, and shall indemnify and save harmless the Owner in respect thereof.

12. LIABILITY

The Contractor shall indemnify and hold harmless the Owner and/or any third parties from any and all loss, costs, damages, expenses and claims of every nature whatsoever arising from any fire caused by the negligence of the Contractor or any breach of or failure to observe any Provincial, Federal, and Municipal Government laws, regulations or instructions.

13. ARBITRATION

In the event that any dispute arises between the parties hereto which cannot be reasonably settled, the dispute shall be settled by a single arbitrator appointed pursuant to the Commercial Arbitration Act. Both Owner and Contractor shall be bound by the arbitrator’s ruling, and shall pay equal portions of any expenses incurred.

14. NOTICE

For the purposes of this Agreement, notice shall be deemed to be given to the Owner at ________________ (Owner’s address), and to the Contractor at ________________ (Contractor’s Address), or to such other places as shall be from time to time substituted in writing, and such notice shall be deemed to have been received when delivered by hand or forty-eight hours from posting by double registered mail from any post office within the Province of British Columbia.

IN WITNESS THEREOF the parties hereto have executed this Agreement.

Date: ______________________

Owner ____________________________________________ Contractor ____________________________________________
Woodland products range from traditional goods, like sawlogs and plywood peckers, to special products, such as orchard props, Christmas trees and building logs. They can include services such as hiking and fishing, and values such as watershed protection and wildlife enhancement. In some cases, the major ‘products’ of a woodland are fresh air, privacy, and the simple pleasures of a tree environment.

The products you choose to produce will be affected by your short and long-term objectives for the property; the species mix, age and quality of your current forest; and the markets to whom you can sell. This chapter discusses how to select your product mix, identify markets, and design and draw up the conditions of sale.
Forest Products

From Woodland To Marketplace

Producing and selling the forest products from your woodland involves the following steps:

1. Choosing your products
   - consider your personal goals for your woodland
   - check inventory for potential products based on species, age, and condition of stands
   - identify those products that best serve your goals

2. Identifying your markets
   - identify potential markets (local, domestic, export)
   - assign product priorities based on such things as stability of market, highest return, largest market demand, etc.
   - confirm product specifications with buyer
   - choose the point of sale
   - develop contractual agreements

3. Producing your products
   - identify the products to be produced in each Management Area
   - establish appropriate management programs for the production of each product (e.g. pruning for peelers; thinning for sawlogs)
   - set harvesting priorities and logging methods for production of each

Choosing Your Products

Your choice of products will be influenced primarily by your personal goals, management objectives and what you have to work with in your inventory. If you have a mixed, uneven-aged stand, you will have the potential to harvest a variety of products. The following list of products will help you to start thinking of the types of goods you might produce from your current forest.

Note: The specifications for the special products are found in the Scaling section of the chapter “Harvesting The Trees.”

<table>
<thead>
<tr>
<th>Timber Products</th>
<th>Species Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products</td>
<td>Fd</td>
</tr>
<tr>
<td>peeler logs</td>
<td></td>
</tr>
<tr>
<td>sawlogs</td>
<td></td>
</tr>
<tr>
<td>pulp logs</td>
<td></td>
</tr>
<tr>
<td>Special Products</td>
<td></td>
</tr>
<tr>
<td>building logs</td>
<td></td>
</tr>
<tr>
<td>car stakes</td>
<td></td>
</tr>
<tr>
<td>Christmas trees</td>
<td></td>
</tr>
<tr>
<td>cribbing</td>
<td></td>
</tr>
<tr>
<td>fence posts</td>
<td></td>
</tr>
<tr>
<td>firewood</td>
<td></td>
</tr>
<tr>
<td>grape stakes</td>
<td></td>
</tr>
<tr>
<td>hop poles, orchard props</td>
<td></td>
</tr>
<tr>
<td>mining timbers</td>
<td></td>
</tr>
<tr>
<td>pickets, palings</td>
<td></td>
</tr>
<tr>
<td>piling</td>
<td></td>
</tr>
<tr>
<td>poles</td>
<td></td>
</tr>
<tr>
<td>shakes</td>
<td></td>
</tr>
<tr>
<td>shingles</td>
<td></td>
</tr>
</tbody>
</table>

Species Key

Fd Douglas-fir
Pl lodgepole pine
Ps scotch pine
Pw white pine
Py yellow (ponderosa) pine
B balsam
Cw western red cedar
L larch
S spruce
H hemlock
These products obviously have different rotation lengths; some are produced from thinnings, others from mature timber, and still others (such as Christmas trees) from plantations. You may wish to produce a mix of products that can provide you with a continual cash flow, including short rotation crops such as Christmas trees (6-9 years), honey (annual), and firewood (10-20 years, annual thereafter), along with the more traditional timber products of sawlogs and plywood peeler (40-80 years). You may also wish to consider the enhancement and development of aesthetic, recreational, wildlife, watershed and fisheries values as ongoing products of your woodland.

A good way to begin the process of product identification is to make two lists. The first of these will identify your personal goals for the woodland. The second will itemize the potential products from your woodland, based on the species mix, age, size and condition of the trees on the area. Your task will be to determine the best way that you can use your inventory to achieve your goals.

Part of the process of choosing your products will be to consider how the production of different products will affect your short and long-term objectives. Don’t be surprised to find that some of your objectives may conflict. And don’t give up when they do – there may be alternative ways of achieving them.

For instance, the clearing of a 2 hectare stand of Douglas-fir/hemlock sawlogs may be the simplest and quickest way to obtain the short-term cash for your daughter’s forestry tuition, but clearcutting the area will unfaithfully alter the trail system and environment that the whole family currently enjoys for mountain biking and cross-country skiing. As an alternative, there are eight large peeler-quality Douglas-fir trees bordering the property that could pay for half the tuition, and additional revenue could be generated by producing fuelwood from the deciduous/conifer mixed stands on the woodland. Both have benefits, and both have costs to the family – but in many cases, small woodland management is a family business. You must work out the alternatives that best suit you and your family.

It is important to remember that alternatives usually exist, and it is worthwhile to spend time considering them carefully before you confirm your management plans. The ways you use and feel about your forest are as important as other inventory information in planning the development of your woodland. For instance, if aesthetically you value the dominant fir in your stand, then search out market opportunities for the codominant and other species. Don’t compromise your long-term values until you have evaluated alternative ways of solving your short-term cash flow problems.
Identifying Your Markets

Once you have selected the products you are interested in producing from your woodland, the next step is to identify markets for them. For the major timber products, your potential buyers will be readily identifiable – in most cases, the local mills. For special products, such as poles, or Christmas trees, you may have to do a little advertising to interest buyers. You may want to consider getting a log broker to handle the marketing and selling of your forest products, especially if you feel you have valuable products of interest to customers outside your local area.

For local markets, try to obtain a number of bids for your products. Advertise in your local newspaper. Invite potential buyers out to look at your standing timber, and discuss what they are looking for. By cutting to the buyer’s specifications you will obtain the best price for your timber. You can greatly increase the value of your log products by bucking out defects and trimming the ends square (see Bucking in the chapter “Harvesting The Trees”). Find out how much you can get for different products so you can compare their values, costs of production, and the impacts of their production on your woodland.

Market conditions will affect the price you get for your product. Since production costs remain fairly constant, your ability to take advantage of high points in the market cycle will make a large difference in the profit you receive for your goods. Private owners and Indian Bands in particular, have considerable flexibility in terms of when and how much they cut. It is worth your while to follow the ups and downs of the markets in which you are selling, and be ready to act when markets are paying top prices. To do this, you must have your roads in place and your production process clearly outlined. Define your own role in production as early as possible, and identify potential sub-contractors for felling, skidding or hauling.

The Valuation Branch of the Ministry of Forests and Lands produces a monthly statement of average log prices, available free of charge, on request. Lumber prices can be followed in the trade publications, or obtained from your local mill manager.

Selling What You Produce

You have options on ways to sell your products and who to sell them to. Your choice of market will likely consider which option gives you the most control over what happens, and which buyer gives you the best return on your wood. It will also be influenced by the conditions under which you are selling. For instance, you may choose to sell your trees on the stump in cases where you are confident of the accuracy of your inventory, need money quickly, have no capital to invest in harvesting, and are worried about risks to your stand (perhaps from fire or pests). You might choose to sell at the landing if you are unsure of the reliability of your inventory data, and have no means of hauling logs. Or you may choose to sell at the mill in cases where you are able to carry out all logging phases and wish to capture the profit margin at each phase.

<table>
<thead>
<tr>
<th>Options for Sale</th>
<th>Options for Who to Sell to</th>
</tr>
</thead>
<tbody>
<tr>
<td>on the stump, based on the inventory</td>
<td>contractor or log broker</td>
</tr>
<tr>
<td>at the landing or dump, based on the scale</td>
<td>log buyer or mill</td>
</tr>
<tr>
<td>at the mill, based on the scale</td>
<td>mill</td>
</tr>
</tbody>
</table>
The sale of standing timber is classified according to the type of payment received. Unit sales, also known as 'pay-as-you-cut' sales, are tied directly to the volume of timber removed from an area. Payment is based on the material hauled away, at an agreed price per unit of material - cubic metres for logs, cords for firewood, or by the piece with products such as Christmas trees. The unit value is agreed on at the outset, but payment is based on the scaled volume of material at the landing or the mill gate.

Gross sales, or 'lump-sum sales', on the other hand, are made on an area basis where the buyer purchases all timber for a fixed price. Total value is agreed on at the outset, and payment, or a percentage of the total price as a downpayment, is often made before logging begins. The key to successful gross sales is knowing the volume and estimated value of merchantable timber on your woodland so that you are able to judge the offers you receive.

Both systems have advantages and disadvantages. Unit sales enable you to separate out the different products in your woodland, and selectively produce and sell them. This gives you the opportunity to control your production and keep it in line with your other management objectives - by area, species or value. With gross sales you do not have this flexibility since you are basically selling rights to all the timber on a specific area. However, the advantage of a gross sale contract is that you sign over the responsibility and risks associated with the area along with the timber. In the event of unforeseen losses due to such things as fire, weather, poor production, strikes, machine breakdowns, etc., it is the buyer who must absorb the loss. (This is easier to enforce in cases where the total payment for the area is made when the contract is signed, before logging begins.)

With unit sales, you have the option of producing the products yourself; contracting the logging and doing the selling yourself; or selling selected products to the buyer while the trees are still standing and letting the buyer extract them. In both the latter cases it is important for you to negotiate and include in the contract additional terms relating to the logging and site cleanup procedures. Unit sales can result in high-grading of an area unless they are closely controlled.

Since unit sales are based on the material removed, it is extremely important for the seller to keep track of how much is removed. Scaling is commonly carried out at the mill gate, so be sure to ask for all mill receipts to compare the volume removed against the merchantable volumes indicated in the timber cruise. It is also a good idea to request spot scaling checks to make sure that your material is being sorted and sold according to its highest value.

In pricing your products you will have to take into account the quality of the material as well as your costs of production. The cost of production and the sale price you can obtain for your products will depend on:

- species
- quality of wood
- size of trees
- quantity you have to sell
- terrain and access to the site
- distance to the point of sale (e.g. mill)
- market prices for the product

Conditions Of Sale

For both unit and gross sales, the sales contract must clearly state all the understandings between the landowner (or licensee) and the buyer. Harvesting requirements should be spelled out clearly, in writing, at the time the price is set, and should address such things as how the volume will be measured, how the price will be applied (e.g. $/m³ or $/ha), and how and when payments will be made.

For direct sales, the conditions are often negotiated between buyer and seller. Where the sale is put up for tender, the conditions of your sale are drawn up in advance. A list of the things to consider in drawing up your notice of tender or negotiating the terms of sale follows.

Basis of Sale

Unit sales, based on scaled volume, should specify the unit price (e.g. per m³, cord, piece) to be paid for each product as well as the form (tree, log), dimensions and grade specifications for each. The quantity to be delivered in each of the product categories should be clearly
stated, along with any bucking or other processing requirements. Where the harvesting is to be done by the buyer, the sales contract must also include the terms relating to logging standards, methods, and site cleanup.

Gross sales, based on the area of standing timber, where the buyer will carry out the harvesting and removal of timber, should specify all negotiated agreements between the buyer and the landowner/licensee regarding such items as harvesting methods and utilization standards.

**Point of Sale**
For unit sales, indicate where the product becomes the property of the buyer. This will vary with the product as well as the extent to which the owner is involved in the harvesting process. Sales may be at the roadside for products such as Christmas trees or firewood, or at the mill gate for products such as logs or poles.

**Measurement**
For logs, specify whether the products are to be volume scaled or weight scaled, the unit of measurement and the log volume table to be used. Request mill scale receipts and specify the frequency of check scaling. If selling by weight, state the weight-to-volume conversion factor to be used.

**Access**
To protect your woodland, it is a good idea to specify the access road to be used as well as the standards to be followed for the construction of any necessary additional access routes.

**Logging Method and Period**
Where logging is to be carried out by the buyer, the logging methods should be specified for each area, including skidding methods and equipment. Also indicate the period in which logging will take place. This will make it possible for you to control the presence of machinery if a site is sensitive (e.g. winter logging for wet sites), and for you to schedule follow-up activities in the area.

**Removal of Equipment and Cleanup**
Specify the condition in which the site is to be left. This will include logging utilization standards such as stump height, and specifications for the treatment of slash — such as bucking so that it lies flat on the ground or windrowing of slash for burning. Post-logging drainage requirements, such as water-barring of skid trails, and landing ripping, stream cleaning or rehabilitation may also be mentioned.

**Environmental Protection**
Where logging may be close to streams or other sensitive environments, be sure to set out guidelines for safeguards such as stream bank or visual green belts. Reserve areas and any Sensitive Zones (such as for fish) should be clearly mapped and flagged on the ground, and noted in the contract (see “B.C. Coastal Fisheries Forestry Guidelines”). As the landowner or licensee you may be liable under the federal Fisheries Act, for any damage to significant waterways.

**Payment**
The schedule and terms of payment should be clearly set out. In addition, gross sales contracts should specify all special treatments and standards negotiated, including obligations for cleanup, etc. Once an area has been logged, you have little come-back if the job has not been done to your satisfaction. Where the landowner does not receive all the money from the sale until the logging is complete, it is a good idea to require a substantial ‘performance bond’ upon signing. Seek legal advice the first time around.

In cases where you will be contracting the harvesting of a stand, it is possible to negotiate a deal with the contractor where the two of you split the prices received for the products according to a share formula. An arrangement of 50:50, contractor to landowner, is used by some owners. The contractor receives 50% of the price received from the buyer to cover his costs of production; the landowner receives 50% of the price received to cover his ownership (and investment) in the standing timber resource. The details of this type of agreement will vary widely depending on the material being harvested from the area. Refer to the discussion of Working With A Logging Contractor in the chapter “Harvesting The Trees”.

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Forest Products
Producing Your Products

When you have confirmed your mix of products, their specifications, potential buyers, and contractors, the production process can begin. You will need to develop plans for the management and production of specific products in different areas of your woodland. As you plan the harvest of current products, you must also keep in mind the kind of stand and products you wish to create in the future. The silviculture system you choose for the management, harvesting, and reforestation of each Management Area will reflect your long-term product objectives.

For each Management Area you will identify the products to be produced, and the related stand management activities (such as pruning, thinning) required for the production of each product. You will also develop a logging plan that will specify the method of extraction and form in which the product is to be produced, such as log length, etc. These specifications are important to make sure that you maximize the value of each stand and tree.

As with most woodland operations there are a number of ways to ‘skin the cat’. You can do everything yourself or contract it all out. It is often to your advantage to sell your own timber, to make sure that you obtain the highest value for every piece cut and receive payment for every log harvested. Whichever route you take, it is worth your while to remain in control of when and how work is done. The amount of potential damage caused by sloppy harvesting and skidding can cost you greatly in terms of the value of the products you recover from the current crop, the health of the remaining stand, and the necessary post-production cleanup and site rehabilitation.

Special Products From Your Woodland

Christmas Trees

Christmas trees are finding increasing favour as a small woodland crop that the operator can manage almost entirely on his own. They have a short rotation—less than 10 years—and require a minimum cash investment once the site has been prepared and the initial stock has been purchased. Be forewarned, however, that profitable Christmas tree production involves a lot of work, and there is a healthy competition from domestic and U.S. growers, as well as producers of artificial trees.

In British Columbia, Douglas-fir is the species most commonly grown for Christmas tree stock, though pine and amabilis fir are also produced by some growers for specialty markets. When buying Christmas tree stock, as with most seedlings, try to obtain stock grown from seed from your locale, or in a similar area within the species range. Trees adapt to growing conditions in a locale (just as people do!), and some of the traits that make them successful in that environment are passed on, genetically, in their seed. Be sure to discuss species and strain (a subgroup within a species) alternatives with your nurseryman or local forester.

Douglas-fir stock from Duncan, on Vancouver Island, is an acknowledged Coastal favourite with growers because it is a late bud bursting strain. Since many of the pests that plague Christmas trees do their damage at or around the time that new foliage appears in the spring, strains of stock that ‘flush’ (burst their buds) late in the season have distinct advantages. The tree’s new growth emerges after the pest’s eggs have hatched, thus missing the period in which the new larvae are hungriest. Late bud burst also protects the seedlings from foliage damage associated with early frosts.

In Christmas tree production the quality of the stock you choose is extremely important. Since the rotation period
is short, it is essential that the seedlings are strong and healthy and able to establish themselves in the field quickly. Two or three year old stock is recommended; the higher initial cost of older stock is often outweighed by the benefits of a shorter rotation period. Some growers find it worthwhile to grow their own seedlings.

Christmas tree culture is an intensive practice, requiring annual pruning (shearing) to shape the trees and an aggressive protection program. As a cosmetic crop, Christmas trees are especially vulnerable to damage. Insect damage causes discoloration, defoliation, or loss of vigour, and toothed pests such as mice, rabbits, and deer can severely damage stem form and branching patterns. Damage by domestic animals can be controlled by fencing, and the favoured approach to controlling deer damage is to control grass in the Christmas tree plantation. Chemical repellents are sometimes applied directly to the trees, but require constant re-application.

Douglas-fir, the major Christmas tree species grown in British Columbia, is prone to a number of needle diseases. Foremost is the Douglas-fir needle midge, identified by small, brown spots on the underside of the needles. Swiss needle cast is another defoliator of Douglas-fir, and appears in the spring as small, black spots on the underside of needles. Rhabdocline, a fungal disease, is recognized by its red-brown spots on the previous year’s needles. Douglas-fir tussock moth, whose larvae attack new foliage, damages the form and growth of the tree. As with other tree crops, the maintenance of healthy plantations, combined with early identification and prompt removal of infected trees, is often the most effective protection strategy.

Fire and theft are also potential threats to profitable Christmas tree production. Fire guards and fire fighting equipment should be kept in all plantation areas. Plantations should not be in sight of main, public access roads and should be checked regularly, especially prior to the Christmas season. Security measures may be necessary.

Christmas trees can be marketed either on a wholesale or retail basis. Large and remote Christmas tree operations generally sell their trees wholesale. Contracts are signed as early as July or August, and should definitely be completed by the beginning of October. Trees are harvested in late November, and wrapped in twine or mesh bags to align and flatten branches for compact storage and minimum damage during shipping.

Where Christmas tree sales are made on a unit basis, the trees to be harvested should be clearly marked. Wholesale contracts often provide for 50% payment on signing of the contract, and the remainder once all trees have been received by the buyer.

Smaller-scale growers, close to markets, have the advantage of retailing their products for higher prices. Rental of open-air lots should be settled early in the fall, and trees should be displayed by grade. For growers wishing to decrease the capital involved in Christmas tree harvesting and transportation, and reduce the risk of having cut trees still unsold on Christmas Day, there is a ‘choose and cut’
option where people come to the plantation to select and cut their Christmas tree. The success of this marketing alternative depends on widespread, advance advertising since the selling period is so short. An added benefit of this system is that the trees not selected for harvest in one year can be grown and tended for potential sale in the next season. Growers choosing this option often plant a small number of special species such as true fir (grand or subalpine) and Scotch pine.

Along with Christmas trees, there is often a smaller Christmas market for specialty items such as cedar and holly, wreaths, pine cones, and balsam boughs (for aroma). The entrepreneur may also have home-built Christmas tree stands for sale.

Christmas Tree Guidelines:
- choose quality stock appropriate to your site
- plant stock as soon as possible
- plant carefully
- protect your investment from pests

For a more detailed discussion on the tending and shearing of Christmas trees, consult the “Christmas Tree Culture” brochure produced by the Ministry of Forests and Lands (reference at end of the chapter).

Fuelwood
Where markets exist, fuelwood is an excellent dual-benefit woodland crop. It makes use of deciduous and malformed or inferior species that are removed to improve the quality and spacing of your stand, and produces revenue that helps pay for the stand improvement activity. When selecting trees for fuelwood, consider those that are:

- crooked, leaning, windthrown or badly damaged
- diseased, or dying (pest or other damage)
- suppressed trees or suppressing ‘wolf’ trees
- weed trees or inferior species
- don’t overlook cull logs and top ends of trees

Note: In your cleanup, remember the needs of those forest critters (woodpeckers, owls and other cavity nesters, raccoons, rabbits, etc.) that rely on dead or dying trees and logs for breeding, shelter, and food.

Producing fuelwood is an activity that the woodland operator can carry out on his own, or as a family business, with a minimum of heavy equipment. It requires skills in felling and bucking, some basic equipment for yarding, a strong back and a love of the outdoors. Be ready to work for your wood — an Ontario study estimated the production time for a cord of sugar maple firewood, from felling to splitting to woodshed to stove, at 9.5 hours!!

Two pieces of information are key to the production of fuelwood — different species have different heating capabilities, and dry, heavier wood produces better heating per unit volume than wetter or lighter wood. The hardwood, deciduous species are therefore better for fuelwood than the softwood conifers. Other factors, such as the relative ease of lighting and splitting, as well as the amount of smoke and spark produced, are also important marketing considerations when selecting your fuelwood species.

A comparison of major hardwood and softwood species for each of these factors and an overall rating of their value as fuelwood follows.
## Fuelwood Performance

<table>
<thead>
<tr>
<th>Species</th>
<th>Heat / unit</th>
<th>Ignition</th>
<th>Smoking</th>
<th>Sparks</th>
<th>Splitting</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>apple, dogwood</td>
<td>med.-high</td>
<td>difficult</td>
<td>little</td>
<td>few</td>
<td>medium</td>
<td>excellent</td>
</tr>
<tr>
<td>alder, cherry</td>
<td>medium</td>
<td>difficult</td>
<td>little</td>
<td>few</td>
<td>easy</td>
<td>good</td>
</tr>
<tr>
<td>aspen, cottonwood</td>
<td>low</td>
<td>easy</td>
<td>medium</td>
<td>many</td>
<td>med.-hard</td>
<td>best kindling</td>
</tr>
<tr>
<td>maple, oak</td>
<td>high-med.</td>
<td>medium</td>
<td>little</td>
<td>few</td>
<td>easy</td>
<td>excellent</td>
</tr>
<tr>
<td>cedar</td>
<td>med.-low</td>
<td>easy</td>
<td>medium</td>
<td>many</td>
<td>easy</td>
<td>best kindling</td>
</tr>
<tr>
<td>spruce, pine, balsam</td>
<td>low-med.</td>
<td>medium</td>
<td>medium</td>
<td>many</td>
<td>easy</td>
<td>best kindling</td>
</tr>
<tr>
<td>larch, Douglas-fir</td>
<td>med.-high</td>
<td>medium</td>
<td>little</td>
<td>medium</td>
<td>easy-med.</td>
<td>good</td>
</tr>
<tr>
<td>hemlock, birch</td>
<td>med.-low</td>
<td>easy</td>
<td>little</td>
<td>many</td>
<td>easy-med.</td>
<td>medium</td>
</tr>
</tbody>
</table>

Fuelwood is sold in log lengths (1.2 metre and 2.4 metre) to firewood processors as unsplit firewood logs (usually less than 30 cm diameter), or as split firewood for fireplaces and woodstoves. Hardwoods are generally preferred by fireplace customers because they burn longer and throw fewer sparks. Dense, seasoned, hardwoods provide the best heat value per unit of wood.

### Tips For Reducing Drying Time:
- leave the leaves on felled trees for the first month after felling
- leave felled trees to 'hang to dry' (i.e. supported by brush or stumps to keep them above the moist forest floor) in the woods for a year
- place bucked sections on 'cribbing' to keep above ground and facilitate air flows
- pack woodpiles loosely and in separate piles
- keep under shelter (a roof, not a plastic or tarp) and well-aired

Fuelwood is still sold mainly in cord portions, either as a standard cord of 1.2 m x 1.2 m x 2.4 m (based on the old 4’ x 4’ x 8’ imperial measure); a face cord, where the piece length is specified, such as 0.5 m x 1.2 m x 2.4 m; or by weight. The following table, taken from “Handbook on High-Capacity Production and Marketing of Fuelwood” (see reference at end of the chapter) indicates the number of trees required to produce a cord of firewood.

<table>
<thead>
<tr>
<th>dbh (cm)</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>65</th>
<th>70</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td># of trees</td>
<td>67</td>
<td>23</td>
<td>10.5</td>
<td>5.8</td>
<td>3.5</td>
<td>2.4</td>
<td>1.7</td>
<td>1.3</td>
<td>1.0</td>
<td>.82</td>
<td>.67</td>
<td>.54</td>
<td>.46</td>
<td>.40</td>
</tr>
<tr>
<td>per cord</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Agro-Forestry**

In many areas, forestry activities can be carried out successfully in conjunction with the production of farm crops or forage for domestic livestock. Agro-forestry, as this practice is called, may produce the two crops adjacent to one another, as a shelterwood arrangement where the tree crop protects the agriculture crop, or the two may be combined as understorey/overstorey crops, such as the undergrazing of Douglas-fir and pine stands by domestic livestock in the Interior of the Province.

![Image of livestock grazing in forested area](image)

The production of timber and sheep has been achieved with great success in New Zealand, where the sheep actually assist in controlling brush competition in forest plantation areas (once the seedlings have reached sufficient size to be safe from browsing by the sheep of course!). Agro-forestry has been particularly attractive to some developing countries, where trees are used for multiple purposes, including: fuelwood, fodder, shelter, food, and erosion control.

In British Columbia, the joint production of agriculture and forest products has yet to come of age. On a commercial scale it has been most successful in the Interior, where timber is grown in conjunction with the production of beef cattle. Agro-forestry is a practice well-suited to the intensive small-scale woodland operation, where long-rotation timber products (sawlogs) can be produced along with shorter rotation agricultural crops.

**Family Forestry**

In addition to all the things you do to improve your woodland and produce items for sale, there are many opportunities for first-hand learning and plain old fun. These ‘woodland products’ should not be overlooked or undervalued—many of you will be growing a crop of kids along with your trees.

One of the pioneers of small-scale forestry in B.C. cites the annual Christmas tree harvest (and on-site party) by the local Junior Forest Warden club as his most successful woodland activity. Another family makes many of their Christmas gifts from woodland goods—cone ornaments and wreaths, pressed flowers, potpourri sachets, terrariums, and jewelry castings.

A Fraser Valley family has planted Christmas trees as the understorey to an existing timber crop, is growing tree seedlings in a greenhouse and in seedbeds on the woodland, and is harvesting car stakes and cedar poles as commercial thinnings. They even raise chickens for egg sales along with a few pigs on the woodland.

Fish ponds are a natural addition to a family woodland, both for personal and commercial consumption. Trout are being successfully pond-reared on some of the Coastal woodlands, and it seems reasonable to expect success with similar ventures in the Interior. Forests are sources of other food products as well, including: nuts (such as hazelnuts), berries, mushrooms, edible roots, herbs and other plants. Recognizing and collecting these materials can be very satisfying (in more ways than one!). A number of source books for identifying and even preparing forest delicacies are available; some are listed at the end of the chapter.

A woodland nursery can be an enjoyable and rewarding project for all ages and interests. The most nimble members in the family can pick the cones and oversee the extraction of seed; the scientists can devise experiments to test seedling response to various soils or fertilizers; and the economist in the family can calculate the costs of renewing the crop that the entrepreneurs are planning to log, while the wildlife biologist devises a cutting plan to enhance deer habitat. Something for everyone. And there’s always the woodpile for working out those day-to-
For the woodworking enthusiast, the forest is a regular storehouse. There are burls to carve (maple, birch, cedar, pine); materials to turn on the lathe (yew, arbutus, birch, yellow cedar); and a variety of special wood grains to explore (yew, arbutus, maple, birch, alder, white pine, yellow cedar). These specialty woods are available in some hardwood and woodworking shops, but once you know what to look for, search them out on your woodland.

With the rich history of native Indian use of the Province’s forest lands, your woodland offers an excellent study site on which to explore and learn how trees and other plants have been used as sources of traditional food, clothing, tools, medicines, shelter, transportation and social and religious artifacts.

There are many product opportunities on small-scale woodlands in addition to log production. Each property is different, and each is shaped by the desires (and talents) of its operators. Using simple technologies, your creative energies, problem-solving skills, and elbow grease, you can shape your property to a variety of ends.

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**Why Wood Is Good**

Wood is a delightful and fascinating material. It has life, smell, texture and personality. Its advantages as a building material relate largely to its cellular structure and the fact that it is made up of hollow tube-like cells or fibres. Here are some of the reasons why ‘Wood is Good’:

- it is relatively light, strong for its weight, and easily transported
- it is easily fastened nails, screws or glue
- it is a poor conductor of heat, electricity and sound
- it is porous, and holds paint or stain well
- it floats, unless saturated
- it resists rusts, acid and salt water
- where defects exist, they are usually on the surface and can be readily detected
- it absorbs shock and vibration
- it expands little with changes in temperature
- it is pleasing to the eye, touch, nose
- it is easily worked and grows more beautiful with age
- it is multi-purpose: as trees, timber, and forest products
- it is renewable
Recommended References:

**B.C. Ministry of Forests and Lands**
- "Christmas Tree Culture". 1988
- "Christmas Tree Farming". Publication B

**B.C. Provincial Museum, Victoria**
- "Guide to Common Edible Plants of British Columbia". Handbook 20
- "Guide to Common Mushrooms of British Columbia". Handbook 24
- "Food Plants of British Columbia Indians - Part I, Coastal Peoples". Handbook 34
- "Food Plants of British Columbia Indians - Part II, Interior Peoples". Handbook 36

**Canadian Forestry Service**
- "The Feasibility of a Home Heating Fuelwood Industry on Southern Vancouver Island". 1981. ENFOR. BC- X-224
- "An Introduction to Christmas Tree Growing in Canada". 1982. Publication 1330
- "Common Insects and Diseases of Balsam Fir Christmas Trees". 1981. Publication 1328

**National Museum of Canada, Ottawa**
- "Wild Coffee and Tea Substitutes of Canada". 1978
- "Edible Wild Fruits and Nuts of Canada". 1979
- "Edible Wild Greens of Canada". 1980

**Other Sources**
- "The Recognition and Life History of the Major Insects and Mite Pests of Ornamental Shrubs and Shade Trees of B.C." B.C. Ministry of Agriculture and Fisheries
- "Handbook on High-Capacity Production and Marketing of Fuelwood". FERIC Handbook 6
Prompt and careful reforestation is one of the most significant activities a woodland operator can undertake, since all subsequent management operations build upon the success of this initial act.

The method of regeneration you choose will be influenced by the size, shape, and other conditions of the site, including the current tree species growing there. It will also depend on the needs of the species you want to grow. This chapter will discuss your regeneration options and the things you should consider when planning the reforestation program for your woodland.
Reforesting The Land

What Species Shall I Grow?

The answer to this question will depend on your personal goals as well as the capability of your site, including what is currently growing there. Reforestation strategies are determined on the basis of a silvicultural assessment of the site (called the pre-harvest silviculture prescription), carried out prior to harvesting. Handbooks that detail the procedures of site diagnosis, species selection, and site preparation have been developed for most of the Forest Regions, and are available for reference at the Regional Offices of the Ministry of Forests and Lands. A discussion with a forester is also strongly recommended prior to harvesting.

The species you grow will also be influenced, in part, by the stage at which you begin to manage your woodland property. Where the woodland is forested, you may decide to regenerate the area naturally, with species of the current crop. Or you may decide to replace the crop, by planting with a species more suited to your personal goals.

Where you have inherited an area that is ‘tree-free’, as pasture or as cleared land after harvesting or fire, the selection of tree species will be based on a number of factors, including the characteristics of the planting site, such as exposure, soil type, elevation, and slope. A quick survey of any stumps on-site, as well as the mature forest in neighbouring stands, will give you an idea of the species that have been nature’s choice for the area. Keep in mind, however, that the forces that cleared this site may have effectively pushed it to an earlier successional stage than that of neighbouring stands. For example, if the woodland is in the Prince Rupert Region, and the site you wish to reforest was recently harvested and burned, it may be advisable to plant lodgepole pine or spruce (pioneer species) rather than the cedar/hemlock evident in the adjacent stands.

Once the species suited to the area have been identified, you must consider your intermediate and end-product goals. Are the trees being produced for wildlife habitat? Soil stability and conservation? Streambank improvement? Windbreaks? Fuelwood? Sawlogs? Christmas trees? Is a mixture of species desired, such as hardwoods for annual firewood harvest and softwoods for long-term investment? When these questions have been answered and the ideal species have been selected, the next decision is how to introduce them to the site.

Which Regeneration Method Shall I Use?

There are a number of ways to approach reforestation.

1. You can let nature handle it. (natural regeneration)
2. You can assist nature. (seed tree selection, site preparation)
3. You can shortcut nature. (artificial regeneration)
4. You can carry out a combination of the above methods.

The method you choose will depend on a number of things, including:

- your management goals
- the availability of seed source
- the site capability and characteristics
- your ability to finance reforestation
- the time period in which you want to establish a new crop

Where a seed source exists, you may choose either to regenerate an area naturally, or to plant it. The choice of reforestation method and the silviculture system of which it is a part, follows the type of decision process shown.
Do I Want To Choose My Species From The Current Stand?

Yes – Natural Regeneration *

- Which species do I wish to regenerate? (all or some of the current crop)
- What cutting pattern will give this species priority as a seed source? (seed tree, selective, shelterwood, clearcut)
- When is the next good seed year anticipated for the desired species? (to schedule harvest and site preparation)
- What site preparation will enhance the regeneration success of this species? (scarification, burning, slashing)

No – Artificial Regeneration

- What species are appropriate for this type of site?
- Of these, which best meets my end-product goals?
- Is the chosen species shade-tolerant?
  Yes
  (selective or shelterwood with planted understory)
  No
  (clearcut and plant)
- What site preparation will facilitate planting and enhance seedling establishment? (slashing, scarification, burning)

* Planted stock may be used to supplement natural regeneration where the desired species has limited seed.

Preparing The Seedbed

Site preparation is carried out to ready the soil to receive seed or seedlings, reduce fire hazard, and control pests. This may involve clearing, burning, or breaking up slash or windfall which create obstacles to planting, removing competing vegetation, or exposing mineral soil to create a favourable seedbed.

Sites are usually mechanically prepared by piling slash, mixing, mounding or scalping the forest floor. The choice of treatment depends on the needs of the species you wish to regenerate as well as site, climate, and cost considerations. These activities are carried out manually with hand tools, mechanically with heavy equipment, or by the use of chemicals or prescribed burning. Specialized equipment has been developed for site preparation on large timber production areas. For the small-scale woodland owner, it is also possible to move slash and expose mineral soil by fitting special blades or chains to tractors or skidders.

Drag scarification, a process which scrapes the surface of the site to expose mineral soil, can be achieved by dragging heavy chains or drums behind a tractor or skidder. This technique is commonly used to promote natural pine regeneration in the Interior of B.C. Dragging aligns and crushes slash, exposes mineral soil and brings cones close to the ground where they release their seeds onto the freshly prepared seedbed.
Reforesting The Land

Drag scarification units, whether commercially produced or ‘home-built’ are somewhat cumbersome and best suited to large, relatively flat areas with low stumps and light slash. More manoeuvrable equipment, such as disc trenchers, can be used to prepare a mineral soil seedbed in partially cut stands. Other machines use blade attachments to move slash and loosen topsoil. This type of scarification is better suited to areas of heavy slash accumulations or large piece sizes.

Factors such as soil type, slope, stumps, the volume and size of slash and the amount of brush on site must be considered when selecting site preparation equipment. Brush rakes or V-plows should not be used on sites where stumps are large and more closely spaced than the width of the attached blade. Dry sites with slopes below 20% are the favoured conditions for mechanical site preparation. On steeper slopes, equipment productivity falls while site preparation costs go up. In some cases the action of skidders during the harvesting process can provide sufficient scarification to produce an adequate seedbed, however, heavy traffic can compact the soil and impair seedling establishment. Where scrub growth occurs on small areas or heavy equipment cannot be used, brush and weed trees can be cut manually with brush hooks, brush saws or powersaws. Wet sites which will not support heavier equipment may also require hand clearing.

Chemical sprays and burning are effective means of disposing of competing vegetation and logging slash prior to planting. Prescribed burning is usually the easiest and least expensive method of site preparation, though on small areas it can be difficult to control. Applied properly, it can accomplish a number of objectives, including the removal of debris, reduction of fire hazard, removal of pests and competing vegetation, and the exposure of mineral soil.

A combination of windrowing or piling of slash and burning is advisable on sites with unevenly spread slash, or where other site values must be protected. This form of site preparation is commonly and successfully applied to small woodland holdings.
Broadcast burning is used effectively on steep slopes, not easily accessed by machines, and on deep soils with a thick litter or humus layer. Since a hot burn (one that burns at high temperatures and consumes everything) can damage the physical and chemical properties of thin or sensitive soils, burning is not recommended on such sites. The need for fire guards and other precautionary measures, in addition to the high risk of escape, make broadcast burning an unlikely means of site preparation on small-scale woodlands.

The District Office of the Ministry of Forests and Lands should be consulted when any burning is being considered for an area. Burning permits are required for provincial lands (Crown and private), and recommended, though not required, for lands which come under federal jurisdiction, such as Indian Reserves.

The decision as to the appropriate site preparation method depends on the site conditions, silviculture system, and management objectives for the area. The costs of site preparation must be weighed against the potential delay in regeneration if no preparation is done. Where natural regeneration is being relied upon, seeding-in may be spotty and seed germination may be poor on sites without advance seedbed preparation. On areas scheduled for planting, consideration must be given to the number and distribution of plantable spots, as well as the factors (such as slash) that will affect planting productivity.

The timing and method of site preparation is planned in coordination with the selection of regeneration method. Where natural regeneration is being encouraged, harvesting and site preparation should be done, if possible, to coincide with a good seed year of the favoured species. Planted stock performance can also be enhanced by the removal of competing vegetation. In general, site preparation is carried out in the summer or fall of the year before planting.

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**Taking What Comes Naturally**

As openings appear in the forest, they are quickly filled with new growth that seeds in from other plants in the area. This new growth will include a variety of species of small plants, shrubs and trees adapted to the site. Nature’s growth objectives are simple, and she achieves them by utilizing the available seed sources. People, on the other hand, set personal (and often multiple) goals for forest land, and by these goals define what is desirable and undesirable in terms of the species of plants or trees growing in a particular area.

In a managed forest, the openings are created with the next crop in mind. The silviculture system includes a reforestation strategy to prepare the site for the species you select. For instance, you can influence natural regeneration by removing all trees except those of the preferred species, or enhance seedling establishment by preparing a seedbed. All the silviculture systems can be used to obtain natural regeneration; your choice of system will be influenced mainly by the species you wish to regenerate.

Your choice of species will likely be a trade-off between what you can get for ‘free’ as natural regeneration, and how well it will serve your goals, versus the (additional) benefits you would expect from a crop that costs you something to plant. Natural regeneration will likely be the most cost-effective means of reforesting a small-scale woodland property, especially in cases where you are able to undertake any follow-up stand tending yourself.

The success of natural regeneration relies heavily on an abundance of seed, so it is a good idea to monitor the cone crops of your seed sources. When the new crop is unevenly distributed throughout the area, it can be supplemented with the transplanting of wildlings (natural stock from other areas on the woodland) or nursery stock. Once the new crop is established, there are specific stand treatments such as brushing and juvenile spacing, that you can carry out to shape its development. Most tree species will regenerate naturally, depending upon site conditions and seed source. The major consideration is often related to how long you are willing to wait for the next crop.
Reforesting The Land

Doing It Your Way

Where more control over the species, spacing, or timing of regeneration is desired, areas are regenerated artificially. The regeneration process includes species selection, site preparation, and either direct seeding or seedling production and planting. Although you may only be actively involved in the site preparation and seeding or planting stages, an understanding of the whole process will help you to make decisions regarding things such as stock type, seedling age, and the supervision of on-site activities.

In general, direct seeding is not a recommended form of forest regeneration. Although it may at first appear to be a very inexpensive means of reforestation, the toll taken by predators such as rodents, birds, and insects, can drastically affect the regeneration success. Further, the method can often lead to significant follow-up costs for fill-in planting, brushing, and juvenile spacing.

On a special project basis, direct seeding may appeal to woodland owners interested in the process of forestry, who would also like to become involved in cone collection, extraction and the treatment of seed. An instructional unit on seed collection and germination entitled “Forest Nursery Studies” is available from the B.C. Teachers’ Federation (see references at end of chapter). As an experimental or educational method, direct seeding may be appropriate, but for ensuring the regeneration of a forest crop in the minimum time period, planting is the better method.

Planting not only allows you to select the favoured species, but gives it a one to five-year head start on other plants that will sprout from local seed. Planting stock comes in two basic forms. Bareroot stock, as it sounds, is grown in nursery seedbeds from which the seedlings are ‘lifted’ and transplanted to field sites. Plug stock is grown in containers, and removed from the container prior to outplanting in the field. The stock is often grown in large ‘styroblocks’ and when removed from these containers the seedlings retain the nursery soil bound up in their roots. This acts like a packed lunch to help sustain them while they get settled in their new forest land environment.

Choosing Your Stock

The type and size of planting stock you choose will depend on the amount of brush competition, soil characteristics, and potential for browse by domestic livestock or wildlife on the site. The choice of stock should be based on the best performance at the least cost. Where competition from other plants is a problem, larger stock outperforms smaller stock. Where site conditions are severe, plug stock can give the seedling the extra nutrients and protection that may ensure its survival.

Plugs can be planted at a very young age, often one year or less, since their roots are protected and fed by the rich soil in which they were seeded. Bareroot seedlings must be a little larger before planting in the field since their roots are not surrounded by a protective and nutrient-rich layer of nursery soil.

The age of planting stock is identified by a two number code. The first number indicates the number of years the seedling has grown in a container or nursery seedbed; the second number gives the number of years the seedling has grown in a transplant seedbed. Added together these numbers give the age of the seedling.
Plug stock is further coded according to the diameter and depth of the container it is grown in. For instance, in the table below, PSB 211 refers to plugs that are grown in styroblocks with a cavity diameter of 2 cm and a cavity depth of 11 cm; PSB 313 is the code for a cavity diameter of 3 cm and depth of 13 cm.

Where site conditions are favourable, less expensive bare-root or small (1+0 or 2+0) plug stock is recommended. Such stock is also cost-effective when a ‘shotgun’ approach (planting lots of small seedlings) has a higher chance of attaining a desired stocking level than does the planting of fewer, larger seedlings. However, since site conditions are not always ideal, the following table indicates the conditions that affect the choice of stock type.

This table indicates, in broad terms, the stock type most suited to general site conditions. However, the ‘best’ choice of species and stock for your site is not always straightforward. Large transplant stock is often planted on sites that have competing vegetation since the larger size gives it an advantage over the competition. It is strongly recommended that you seek the advice of a Ministry or industry silviculturist when choosing the species and stock type for your reforestation program since it sets the stage for the forest you (and your children) will be working with in the years to come.

<table>
<thead>
<tr>
<th>Site Conditions</th>
<th>Bareroot 2+0 Transplants</th>
<th>Plugs (PSB)</th>
<th>211</th>
<th>313</th>
<th>415</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Limited moisture</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
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<tr>
<td>2. Heavy vegetation competition</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>3. Heavy slash</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
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<tr>
<td>4. Organic layer 15+ cm</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
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<tr>
<td>5. Soils: shallow</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>6. Soils: rocky</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>7. Soils: loose</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>8. Soils: compacted</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>
Reforesting The Land

Planning Ahead
Since seedlings take a year or more to produce, it is necessary to register a sowing request with the nursery from which you will be obtaining stock. The request should be made in advance, usually before harvesting begins, and at minimum, about a year and a half prior to planting. For instance, if you harvest this fall, you may burn the site next fall, and plant the following spring.

Though surplus seedlings may be available once all orders are filled in the spring, in general, it is not worth the risk. Planting is expensive, you only want to do it once, and it is worth the effort of planning for. The stock must be grown from seed suited to the characteristics of your woodland, including climate, elevation, and geographical location.

Seedlings must be purchased by the operator. It is common for nurseries to require a down payment with the sowing request, a progress payment on inventory, and the final payment on lifting. The price of seedlings will vary with the size and type of stock. Contact the District Office of the Ministry of Forests and Lands for information on nurseries in your area.

If your reforestation area is small, you may consider the transplanting of wildings. Some woodland operators have found this a successful and relatively inexpensive way of redistributing seedlings in an area, especially helpful in situations where natural regeneration has come in unevenly. You may even consider setting up a 'bush nursery' on your woodland to grow your own stock for special purposes or fill-in planting.

Planting With Care
Planting is carried out with the best success in the spring, when temperatures are moderate and soil moisture is up. Spring planting should begin soon after snowmelt to maximize the amount of time the seedling has to become established before the summer dry season. The southern and western exposures should be planted first since these are the areas that receive the greatest amount of sun, and usually dry out first.

Seedling care, between the time the stock leaves the nursery and is planted, is extremely important. One of the biggest causes of seedling death is from overheating. In transit, stock should be kept cool and ventilated and protected from direct sunshine and wind. While stock is on-site awaiting planting, it should be stored in a shaded place out of the wind. With plug stock, open the tops of the shipping cartons to prevent overheating, and water lightly if necessary. Roots should be kept moist at all times. Bare-root stock is especially vulnerable to roots drying out, and should be planted as soon as possible after lifting. Where planting stock has been frozen, thaw slowly. Keep boxes sealed and in cool, shady conditions and monitor temperature closely to prevent overheating.
The number of seedlings planted per hectare will reflect the management objectives of the woodland operator. Wide spacing, with 3 metres between seedlings, may be followed where juvenile spacing is not planned. However, where sawlogs are the desired end-product, closer spacing may be desirable to keep branch size down and encourage natural pruning. Spacing must also take account of seedling mortality. If trees are planted at a wide spacing, it may be necessary to carry out subsequent fill-in planting in areas where original stock fails to survive. Recommended stocking levels are set for each of the Forest Regions. Check with the District Office of the Ministry of Forests and Lands.

Though a variety of tools (mattocks, dibbles, and seedling 'guns') have been used to plant trees in the past, most stock is currently planted with a special shovel.

Successful planting depends on starting with good quality, healthy stock suited to the conditions of the site, followed by good stock handling procedures, careful selection and preparation of the planting hole, and proper planting of the seedling.

'Screefing' is carried out at individual planting sites to clear the area surrounding the seedling and reduce competition for moisture and soil nutrients. The planting hole should be large enough to accommodate the full length of the roots; and the tree should be planted firmly and tightly without air pockets that could dry out the roots.

Reforestation costs will vary with the number of trees per hectare, the degree of site preparation needed, and the size and type of planting stock. All these will affect the productivity of the planters, as will slope, access, and ground conditions. Quality means everything in planting. The quality of your reforestation plan from the choice of species and stock, to the selection of individual planting sites will influence the cost-effectiveness and final success of your reforestation program. The condition of the seedling when it goes into the ground, and how well it is planted are the final keys to survival.
How Do I Monitor The New Crop?

Following natural or artificial regeneration, a number of check-ups are carried out on a stand to see how the new crop is progressing. These are known as a silviculture survey, and usually involve collecting information to assess the stocking, plantability, regeneration performance and free-growing status of the site.

In assessing the stocking of a site, both natural and artificial regeneration are considered. This survey determines whether the area is satisfactorily restocked (SR) or not satisfactorily restocked (NSR). A plantability assessment is carried out to identify the number and location of plantable spots still remaining on the site. Such spots can be open, without regeneration, or can be currently stocked with brush or an undesirable tree species. The Regeneration Performance Assessment (RPA) is carried out on young plantations and naturally regenerated stands when seedlings are at least five years old. At this stage they have developed a height growth pattern and have survived most initial establishment problems. The assessment measures height growth of the seedlings as well as tree condition and freedom from competing vegetation.

On the basis of these assessments, follow-up action may be called for, including treatments such as fill-in planting, brushing, or juvenile spacing. As these surveys are complicated and require a thorough knowledge of silviculture to undertake successfully, it is recommended that you seek assistance from the Ministry of Forests and Lands or a forestry consultant.

Reforestation does not end when regeneration has been achieved. That is, reforestation means more than putting trees back in the ground; it means re-establishing a forest. A stand cannot be considered to have successfully re-established until the trees within it reach what is known as the 'free-growing' stage, having survived infant mortality and early competition from other vegetation.

Free-growing status is assigned to stems that are as high as, or higher than, neighbouring brush competition and that have approximately 1 metre of free space surrounding their crowns. This may take from five to ten years depending on the site and the severity of brush competition. At this point, they are firmly established and are part of a system of interrelationships with their neighbours. This system of connections forms a balance and an identity which we define as a stand of trees.
Tree Planting Guidelines:

- choose planting spots carefully, depending on species' needs
- clear immediate area of debris and competing vegetation
- make planting hole deep enough to accommodate roots without bending
- plant tree upright, and to the root collar
- fill soil in and around roots to remove air pockets
- tamp down soil firmly around planted seedling

Recommended References:

B.C. Ministry of Forests and Lands

“Silviculture Manual”. 3 volumes. Silviculture Branch
“Drag Scarification Handbook”. Engineering Branch
“Field Guides for the Identification and Interpretation of Ecosystems”. Regional Offices

Other Sources

“Forest Nursery Studies”. 1976. WEDGE. B.C. Teachers’ Federation Lesson Aids
Like any crop, your trees need to be nurtured in order to produce their best. Stands are tended to improve the growth, quality, and value of the trees on your woodland.

This chapter describes the treatments that are carried out at different phases in the growth cycle of a stand to improve timber production. Brushing, conifer release, juvenile spacing, fertilization, thinning, and pruning are discussed in terms of the conditions under which treatment is desirable, the methods of treatment, and the effect each treatment has on the well-being and productivity of your woodland.
Why Cultivate Your Forest?

As a woodland manager, you have some choice in the form your forest takes, including the species of trees, their size, distribution, and even the rate at which they grow. The practice of controlling forest establishment, composition and growth is known as silviculture. 'Silvi' is derived from the Latin word 'silva' which means a wood or forest, and 'culture' means cultivation.

The silvicultural process begins before the forest is harvested, when sites are assessed and the new crop is planned. It includes the establishment of the new forest through practices of site preparation, natural or artificial regeneration, and brush control; and the tending of the new forest through specific treatments designed to improve its growth. Cultivating your forest is a way of shaping it to meet your management goals.

seeds carried in by wind or dropped by birds and other animals using the area. Untended, it will grow according to nature’s whim without discriminating between crops. By tending the forest you can select and shape the crops it produces.

The objectives of stand tending are to:

- control the species composition of the stand to obtain the most value and/or fibre from the site
- control the stand density throughout the life of the stand to achieve the greatest productivity
- reduce the losses to insects, disease, and fire
- reduce the loss of merchantable trees that die from competition

Your objectives may also include creating openings for forage production, improving access to your woodland, or improving its aesthetic appeal and property value.

What Is Stand Tending?

Stand tending is the process of modifying your woodland vegetation to improve tree growth and the quality and value of the timber products produced. By improving the vigour and health of stands, stand tending produces a merchantable crop of trees in a shorter time frame than if the stand were left to grow unmanaged.

A forest is like any other garden, and left alone it will grow to the limits of the available light, soil nutrients, and water. It will potentially support a variety of plants, seeding-in from those already on the site as well as from

When Do I Tend My Stands?

Stand tending can take place throughout the forest management cycle, and is not only a means of improving the value of the trees grown, but also of understanding the forces at work in your forest. Stand tending treatments are designed to either speed up, stop, or reverse the natural successional development of your woodland. This enables you to manage for a particular species, create a more valuable product, or achieve your management goals in a shorter time.

Similar to other crops, the quality of a crop of trees depends on the genetic characteristics of the stock, how well the species is suited to the site conditions, how well it is established on the site, and the extent to which you can tend and protect the crop as it grows. The silviculture activities that deal with the establishment of the crop are discussed in the chapter "Reforesting The Land". Those that improve the growth and value of the crop will be discussed here.
Some of the treatments that are commonly carried out to enhance a timber crop include brushing, conifer release, juvenile spacing, thinning, fertilization, and pruning. The stage at which these take place in a stand’s life are shown in the following illustration.

To develop a stand tending program for your woodland you should recognize when different treatments are needed to improve the growth and well-being of your stands. Evidence of stress and stagnation from competition in your stands can be important signposts to tell you when your trees need help.

Once you have identified the need for treatment, you must decide how to go about it. The appropriate timing and methods of individual stand tending activities will depend on the conditions within each stand and the fertility of each site. In general, it is good practice to rank your stand treatments to treat the best sites first, since these are the areas that have the greatest potential to respond. The exception to this rule is the fertilization of stands that are lacking in specific nutrients and whose growth is limited as a result.

In addition to the basic treatment information provided in the following sections, more detailed materials on specific treatments are available from the Ministry of Forests and Lands, Workers’ Compensation Board, and other sources as indicated at the end of the chapter. Video materials on stand tending are available through L. & M. Media Marketing Services (see Appendix III) as well as some equipment suppliers.

**Brush Control**

The first, and in some ways the most important stand treatment you may carry out, is ‘brushing’ to remove unwanted vegetation from the immediate area surround-
Tending The Stand

In addition to your efforts to prevent brush problems before they arise, you should be prepared to carry out brushing if a problem develops. It is very important to treat your stands before brush competition starts to suppress seedling growth. Brushing can be carried out by a number of treatment methods ranging from hand-cutting to the careful application of herbicides. The selection of the best method for your woodland depends on site and stand conditions, as well as environmental factors.

In assessing the situation you must look at both the brush species and crop tree species and consider such things as the rate at which the brush is growing and the maximum height it will reach, versus the rate at which your seedlings are growing and their ability to withstand competition. You should also consider whether there are enough seedlings to meet the stocking standards, or whether you should carry out whole site treatment such as site preparation and start the establishment phase (reforestation) over again.

Manual (by hand) brushing is carried out with a variety of hand-held tools that retard the brush species by cutting or girdling their stems. Sandvik brush axes, brush hooks and machetes are effective for weeds and brush with stem diameters less than 3 cm; motorized brush cutters are used for stems less than 5 cm, and are particularly effective with salmonberry and other brush with clumped stems; and power saws are used for stem diameters greater than 5 cm.

Your brush control strategy begins long before stands are harvested and brush actually appears. Prior to logging, a silviculture assessment (called the ‘pre-harvest silviculture prescription’) is carried out to determine the appropriate silviculture system by which the stand will be harvested, reforested and tended (see the chapter “Har vesting The Trees”). The assessment predicts, among other things, the potential for brush on the area.

Sites that are ‘good’ for growing trees are also good for growing brush, and as a result, brush may be a particular problem on your better sites. Many brush species are shade-tolerant, so even silviculture systems such as the shelterwood or selection methods that keep the forest floor partially shaded while regeneration takes place, may not significantly reduce the level of brush competition. A combination of site preparation followed by the planting of large seedling stock is generally recommended for sites where extreme brush problems are anticipated.
Manual brushing is often selected for sensitive sites, such as streamsides or recreation areas, or when brush is a problem only in specific pockets of the woodland. It is usually done during the spring or summer months when the brush species are most sensitive to treatment.

The drawback to manual brushing is that it is labour-intensive and can be expensive, especially if you have a large area or need to repeat brushing treatments. Remember that brush species are pioneer plants whose successional role is to quickly and extensively occupy sites that have been cleared of vegetation (see the chapter “Forestry Basics”). These plants and shrubs are hardy and though you may kill off one year’s growth or even individual plants, they are capable of sprouting, seedling, and re-establishing themselves on a site within a short period of time. In fact, in species such as willow, which easily regrow many shoots from a single cut stem, manual brushing methods can make a brush problem worse. In such situations, the injection of a herbicide is often the only means of killing the plant in one treatment.

**Mechanical brushing** methods are most commonly used in site preparation to remove brush prior to regeneration. Heavy equipment such as tractors or skidders are mounted with special plows or cutters to clear brush and prepare a seedbed (see the chapter “Reforestation The Land”).

In some areas of the Province, the *grazing* of sheep and cattle has been tested as a means of brush control. However, seedlings themselves can sometimes be vulnerable to browse damage, and trampling can also be a problem. The smaller and weaker the seedling, the more vulnerable it is. For this reason, grazing should be delayed until three or four years after planting, when the seedlings are large enough to be seen (and hopefully avoided) and more able to withstand damage.

Where grazing is practiced in regenerating forest areas, it is usually suspended during bud burst when the new foliage on the seedlings is most appetizing and susceptible to breakage. This type of brush control is slow and may be more expensive than it initially looks when the costs of fencing and other necessary forms of livestock control are considered.

Where brush is widespread or persistent, **herbicides** are often chosen as the most effective control method. Herbicides are commonly applied by air or ground. The ground methods include:

- foliar spraying (back-pack or vehicle-mounted sprayers with hand-held nozzles)
- cut-surface application of herbicide to individual trees by injection (e.g., ‘hack and squirt’), or to the surface of freshly-cut stumps
- soil application of granular or pellet herbicides over the root systems of target brush species
- basal spraying

The use of forest herbicides is strictly regulated by the Pesticide Control Act which sets out provisions for all pesticides in the Province, including insecticides (for insect control) and herbicides (for vegetation control). A
Pesticide Use Permit must be obtained from the provincial Pesticide Control Branch of the Ministry of Environment and Parks, for the use of herbicides on both private and public lands used for forestry. The District Manager of the Ministry of Forests and Lands must also be provided with written notice of the proposed herbicide use. Although Indian Bands are not required to obtain this permit for Reserve lands, it is strongly recommended they follow the same procedures of obtaining a permit and notifying the Ministry of Forests and Lands.

To apply or supervise the application of a forest herbicide on Crown or private forest lands you must hold a valid Forest Pesticide Applicator Certificate, which is obtained after completion of a course administered by the Ministry of Forests and Lands and passing the examination set by the Pesticide Control Branch.

Since herbicides are designed to act in specific ways (on foliage or roots) on specific species of brush, the timing and rate of application is critical to treatment effectiveness. It is very important that careful consideration be given to the choice of herbicide and the method and timing of application. Relatively few herbicides are available for forest use and registration changes from time to time, so you are advised to check with local silviculturists as well as the District Office of the Ministry of Forests and Lands when you are considering herbicide application.

### Brush Control Considerations

<table>
<thead>
<tr>
<th>Method</th>
<th>Application</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual</td>
<td>- sensitive areas</td>
<td>- all terrain</td>
<td>- labour-intensive (costly)</td>
</tr>
<tr>
<td></td>
<td>- spring/summer</td>
<td>- little site disturbance</td>
<td>- potential for worker injuries</td>
</tr>
<tr>
<td></td>
<td>- spot problems</td>
<td></td>
<td>- from tools</td>
</tr>
<tr>
<td>Mechanical</td>
<td>- site preparation</td>
<td>- fast</td>
<td>- roots are not killed; often need to repeat treatment</td>
</tr>
<tr>
<td>Livestock</td>
<td>- before bud burst and after bud set</td>
<td>- integrated use</td>
<td>- not for slopes &gt; 35%</td>
</tr>
<tr>
<td>Hericides</td>
<td>- summer (sprayed on foliage)</td>
<td>- species-specific</td>
<td>- potential damage to conifers by trampling, browsing</td>
</tr>
<tr>
<td></td>
<td>- injection (year-round)</td>
<td>- little site disturbance</td>
<td>- limited effect on other resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- seedling exposure to sunlight is gradual</td>
<td>- fencing costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- inexpensive</td>
<td>- only suitable on sites with forage</td>
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<tr>
<td></td>
<td></td>
<td>- controls resprouting</td>
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<tr>
<td></td>
<td></td>
<td>(as above)</td>
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<tr>
<td></td>
<td></td>
<td>- treatment is species-specific</td>
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<td></td>
<td></td>
<td></td>
<td>- public concern</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- few registered herbicides</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- some species of vegetation are resistant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- weather constraints</td>
</tr>
</tbody>
</table>
In choosing the method of brush control for your stands, you should consider:

- **Your treatment objectives:**
  e.g. complete control, to increase light to understory conifers, decrease competition for moisture

- **Your site constraints:**
  slope, accessibility, streamsides

- **What species you want to remove and where they are located:**
  in trouble spots, sensitive areas, or everywhere

- **Cost alternatives:**
  especially labour, if not doing the work yourself

- **Other management considerations:**
  domestic stock, wildlife and fish habitat, recreation and watershed values

Your decision should be made on an area-specific basis considering the potential for damage to crop trees and the other resource values, including the environment.

**Brush Control Guidelines:**

- anticipate brush problems when planning harvesting and reforestation
- treat the best sites (with highest competition) first
- identify target brush species and their locations
- determine alternative means of control
- choose best method for your site and goals
- use equipment and chemicals safely
- obtain a Pesticide Use Permit if using forest herbicides

**Thinning**

Thinning alters stand density by reducing the number of stems per hectare growing on the woodland. It is carried out to focus the growing potential of the site on the trees most capable of responding (your ‘crop trees’). Where markets for small wood products such as poles, car stakes, or fuelwood exist, thinnings make it possible to recover and use some of the small merchantable material produced by the stand during the rotation. In unmanaged stands this material is ‘lost’ since many of the trees on-site die through competition, as they are squeezed out by the hardier trees in the stand.

Thinning can be done at many stages in the development of a stand. It is a given different names depending on the characteristics of the material it removes. The first thinning is usually called juvenile spacing since it removes very young stems. This treatment is also referred to as pre-commercial thinning since the stems removed have traditionally been too small to be sold as a commercial crop by the large industrial operators. Commercial thinnings are carried out later in the life of the stand, and remove stems large enough to be sold as sawlogs or other commercial products. Each of these treatments will be discussed in more detail in the following sections.

Often included in juvenile spacing activities are sanitation thinning, which involves the removal of overtopping diseased or defective stems (such as those infected with dwarf mistletoe); and improvement cutting, which removes poorly formed, or otherwise undesirable deciduous and coniferous stems.

**Conifer release** is another thinning treatment, that focuses on the removal of deciduous tree species that are overtopping and suppressing the growth of more valuable conifers. In many ways it is similar to brushing since it removes species such as alder, maple and other less desirable deciduous species. Conifer release is often carried out in conjunction with juvenile spacing so that the deciduous species are removed while the young conifers are being thinned. It is commonly carried out by the injection of herbicides, or by stem girdling. Both these methods result in slow release (i.e. gradual exposure of the conifers to sunlight) as the deciduous trees die.

Although each of these thinning treatments has a special thrust, they are all done to improve the growing conditions of the stand and the value of the products eventually produced from it.

The volume of wood capable of being produced in any given stand is fairly constant, based on the capability of the site to produce particular species of trees. When some trees are removed, the resources of the site are channelled
onto the trees that remain. This has two advantages. It enables the crop trees to ‘capture’ the growth potential that would otherwise have been ‘wasted’ on trees that would eventually have died from overcrowding. At the same time, it accelerates the natural process of stand development and enables you to produce your crop trees to a merchantable harvest size in a much shorter time period (in some cases 75% or even less of the time it would take to produce similar-sized trees in an unmanaged stand!).

The benefits to be achieved by thinning include:

- shortening rotation by speeding up growth of crop trees
- increasing merchantable volume by concentrating growth on fewer stems
- producing more favourable end-products by controlling the species and stem form
- reducing losses to windthrow and snowpress by increasing individual stem stability
- improving the overall health of the stand and protecting it from disease and insects by the selective removal of diseased or defective stems
- reducing future logging costs by creating a more uniform and larger piece size
In developing a thinning program for your woodland, you will need to consider a number of factors, including how many trees to remove, which ones, and when. Site and stand conditions, the potential markets for small wood products, the number of thinning treatments, as well as the desired end-product, all affect the choice of the number of stems to retain at each phase. The following sections on juvenile spacing and commercial thinning will provide more detailed information to help you make these decisions for the stands in your woodland.

**Juvenile Spacing**

At the time of regeneration, most planted stands contain 800 to 2,000 seedlings per hectare, and natural stands may range up to 25,000 seedlings. The stocking of young stands is often dense and uneven in the early years of a rotation as seedling-in continues and young trees search for a foothold. By the time the trees are 10 to 20 years old and between 3 and 5 metres in height, their crowns and root systems will usually start to crowd each other.

When the crowns of neighbouring trees touch and start to block the entry of sunlight to the forest floor, this indicates that the trees are filling the available growing space and have begun to encroach on each other’s territory. If left, this situation will result in a slowdown in growth. As light below the main canopy is blocked out, the foliage on lower branches will begin to die, and the live crown will appear to ‘shrink’ and recede up the tree.

Juvenile spacing should be carried out just before the live crowns start to recede. The purpose of juvenile spacing is to organize the growing space in the stand by removing unwanted or excess stems. It creates growing room for those species most capable of productive growth on each ‘microsite’ created by the terrain features on your woodland (such as rock outcrops, moist depressions, etc.).

For instance, although your overall goal may be to grow Douglas-fir sawlogs on your Coastal woodland, there may be some spots in your stand that are more suited to growing hemlock (thick litter layer) or cedar (moist depressions). Often these areas will be easy to identify because they will seed-in naturally with the species best-suited to the site. Recognizing these microsite differences, juvenile spacing is carried out to shape the stand with the appropriate mix of species to best use the area.
Tending The Stand

The selection of stands for juvenile spacing and the timing of treatment will depend on the characteristics of the stand and your management objectives. Some guidelines for the selection of stands include:

- dense stands
- shade-intolerant species
- evidence of receding live crowns
- stands where competition is greatest and dominance has not yet been established
- healthy stands, not susceptible to blowdown
- stands with high response potential (best sites, trees 15-25 years old)

In general, juvenile spacing enhances most management objectives by improving access for both people and wildlife, improving stand vigour and reducing the hazards related to fire and pests over the life of the stand. In the short-term however, be aware that juvenile spacing can present a fire hazard to your stand. The spaced material should be laid flat on the ground (to decompose more rapidly) or pulled to cleared areas, such as roadways, for burning. Particular care should be taken to remove slash from roadways where sparks or unintended cigarettes are a potential danger. As an alternative, you may consider leaving an untreated buffer strip along roads in stands where juvenile spacing is being carried out.

The method by which juvenile spacing is carried out will vary with the density of the stand, the diameter of the trees and the percentage of live crown on the trees being removed. Some of the things to be considered in selecting a method are summarized in the following table.
<table>
<thead>
<tr>
<th>Method</th>
<th>Application (stem dia. @ ground)</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Saw</td>
<td>&gt;4 cm</td>
<td>- tree selection easy to see; spacing interval easy to control</td>
<td>- dangerous work; - machine repairs</td>
</tr>
<tr>
<td>Brush Saw</td>
<td>&lt;10 cm</td>
<td>- tree selection easy to see; spacing interval easy to control</td>
<td>- terrain &lt;40%; - difficult to move in heavy slash; - limited to dia. &lt;10 cm; - operator training takes 6 months</td>
</tr>
<tr>
<td>Pruning Shears</td>
<td>&lt;4 cm</td>
<td>- tree selection easy to see; spacing interval easy to control</td>
<td>- large trees difficult to cut; - shears wear out; - probable ingrowth after treatment; - dominance not yet established (so natural crop trees not identified)</td>
</tr>
<tr>
<td>Hand Pulling</td>
<td>&lt;3 cm</td>
<td>- trees must be able to be pulled with minimum effort</td>
<td>- tree selection easy to see; easy to train; - safe for operator; - no equipment</td>
</tr>
<tr>
<td>Chemical</td>
<td>&gt;6 cm</td>
<td>cheapest method with trained crew; slash minimal; equipment easy to maintain; no terrain limitation; safe for operator</td>
<td>use of chemicals around water/wildlife; operator training takes 6-8 months; cannot see spacing interval so poor; quality control; release and response are slower than when trees are physically removed; provides fuel ‘ladder’ into crowns of crop trees</td>
</tr>
<tr>
<td>Mechanical</td>
<td>- where no tree selection is required; - applied as ‘kill’ and ‘leave’ strips; - single species, even-aged, healthy stands; - minimal slash conditions; - stumps &lt;30 cm; slopes &lt;65%</td>
<td>- high productivity; - slash is compacted and broken; - low fire hazard</td>
<td>machine costs high; - no tree selection; - potential for damage to trees in ‘leave strips’; - potential for trees in ‘kill strips’ to be badly damaged but not killed</td>
</tr>
</tbody>
</table>

*Note:* Axes and brush hooks are difficult and dangerous to use for juvenile spacing.
Where juvenile spacing is carried out by power saws or brush saws, stems should be cut according to the following guidelines:

- trees should be cut as close to the ground as possible; stumps less than 30 cm
- cuts should be made below the lowest live branches; where this is not possible due to slash or terrain, all live branches should be cut off the stump to prevent them from becoming replacement main stems
- cut angles should be parallel to the ground
- all stems cut cleanly, i.e. no ‘hinges’
- all damaged (accidentally or otherwise) trees must be cut
- trees should be felled to avoid damage to crop trees
- cut material should be laid flat to the ground
- all conifers (other than crop trees) taller than 1 m must be cut
- cut back all woody vegetation within 1 m of crop trees
- reduce spacing by 50% around natural openings, old skid trails and roads

For more specific details on juvenile spacing you are referred to the “Juvenile Spacing” pamphlet produced by the Ministry of Forests and Lands and the “Juvenile Spacing Manual” produced by the Workers’ Compensation Board (addresses in Appendix III).

Selecting Your Crop Trees

The most important decision you will make in juvenile spacing is the selection of crop trees, since it is on these trees that all your future treatments will be focused and your returns will depend.

When selecting your crop trees, keep in mind that your goal is to concentrate the growth potential of your site on those stems throughout the rotation period. Crop trees should be of the species best-suited to the growing environments in your stand. They should be dominant or codominant trees of good form, free from physical defects, insects or disease. They should have straight trunks without fork or crook and balanced, full crowns of good colour with vigorous leader growth. Branches should be horizontal or downsloping to shed snow, and small in diameter (smaller knots mean higher grade wood products). The crop trees must be windfirm. In short, they must be the best trees in your stand.

Once crop trees have been identified, the stand is spaced to provide growing room for these trees. Spacing is carried out according to the desired distance to be left between the crowns of those trees remaining, known as the ‘intertree distance’. This can be measured in two ways: as rectangular spacing, where the trees are in defined rows and at regular intervals (such as in plantations), or as triangular spacing of direct tree to tree distances (as in regeneration surveys).
The same 3 m x 3 m spacing interval will leave you with 1,100 trees per hectare when carried out as rectangular spacing, but with 1,300 trees per hectare when carried out as triangular spacing — a difference of 15%. Be sure to check which type of spacing is meant in any spacing guidelines you follow. The intertree distances that are referred to in the rest of this chapter will be based on rectangular spacing.

### Determining Spacing Interval

To determine the desired spacing interval for a stand, the following factors are considered:

1. **Crown Width and Length:**
   Leave enough room between trees to maintain approximately 70% live crown until either commercial thinning or final harvest.

2. **Species:**
   The more shade-intolerant the species, the wider the spacing interval.

3. **Site Quality:**
   Higher quality sites will support greater densities of stems without stagnation.

4. **Site Moisture Regime:**
   Drier sites require lower stand densities; root space and moisture become the key limiting factors rather than crown space and light.

5. **Anticipated Future Mortality:**
   Where a certain amount of stem death is anticipated due to forest pests, fire or other causes, you may adopt a more conservative, closer spacing.

6. **Management Objectives:**
   The desired end-products and anticipated future treatments will influence the spacing interval, as will other management objectives, such as forage production.

Some examples of spacing intervals for different management objectives are given below. Forage can be produced in the more open spacing densities, especially in the spacing of lodgepole pine for sawlogs.

<table>
<thead>
<tr>
<th>End-product</th>
<th>Juvenile Spacing</th>
<th>Commercial Thinning</th>
<th>Spacing at Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawlogs (Pl)</td>
<td>5 m x 5 m (400 stems/ha)</td>
<td>none</td>
<td>5 m x 5 m (400 stems/ha)</td>
</tr>
<tr>
<td>(Coast Fd)</td>
<td>5 m x 5 m (400 stems/ha)</td>
<td>6.5 m x 6.5 m (240 stems/ha)</td>
<td>6.5 m x 6.5 m (240 stems/ha)</td>
</tr>
<tr>
<td>Poles (Pl)</td>
<td>3 m x 3 m (1,100 stems/ha)</td>
<td>5 m x 5 m (400 stems/ha)</td>
<td>5 m x 5 m (400 stems/ha)</td>
</tr>
<tr>
<td>(Cw)</td>
<td>4 m x 4 m (625 stems/ha)</td>
<td>6 m x 6 m (280 stems/ha)</td>
<td>6 m x 6 m (280 stems/ha)</td>
</tr>
</tbody>
</table>

**Note:** Crop tree selection takes priority over spacing interval so always leave the best quality, fastest growing trees on-site, and favour the species most suited to the growing conditions.
The following table presents some general provincial ranges for juvenile spacing. The first, smaller number is the suggested spacing interval for stands in which a second pre-commercial or marginally commercial thinning will be carried out, or where substantial kill from insects or disease or other factors is anticipated. The second, larger number is the wider spacing interval suggested in stands which will not be spaced again prior to commercial thinning or early final harvest for small wood products.

<table>
<thead>
<tr>
<th>Species</th>
<th>Intertree Spacing (m)</th>
<th>Stems/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>3 - 5</td>
<td>1,100 - 400</td>
</tr>
<tr>
<td>western hemlock</td>
<td>2.5 - 5</td>
<td>1,600 - 400</td>
</tr>
<tr>
<td>Interior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lodgepole pine</td>
<td>3 - 4</td>
<td>1,100 - 625</td>
</tr>
<tr>
<td>ponderosa pine</td>
<td>3.5 - 5</td>
<td>800 - 400</td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>3 - 4</td>
<td>1,100 - 625</td>
</tr>
<tr>
<td>western larch</td>
<td>3 - 4</td>
<td>1,100 - 625</td>
</tr>
<tr>
<td>spruce</td>
<td>3 - 4</td>
<td>1,100 - 625</td>
</tr>
<tr>
<td>subalpine fir</td>
<td>3 - 4</td>
<td>1,100 - 625</td>
</tr>
</tbody>
</table>

Juvenile spacing prescriptions vary greatly throughout the Province according to stand and site conditions, management philosophy, and forest management objectives. The Ministry of Forests and Lands has developed Regional guidelines to provide more specific direction to spacing intervals for the major commercial species. For more information, check with your District Office.

**Commercial Thinning**

Unless spacing was done very severely, the effects of juvenile spacing do not last forever. Eventually, the root systems and crowns of the young trees on-site will once again begin to compete. As the crowns close together, the number of trees that can occupy the site to best advantage decreases and it is time again to remove some of the less desirable trees to make room for development of the crop trees. Since the objective of thinning is to maintain or improve the rate of growth of crop trees, the time of thinning is determined by when the annual growth rate of these trees begins to slow.

You can check growth rates by taking increment cores from your trees (refer to *Measuring Tree Age* in the chapter "Forest Inventory"). Watch for early signs of reduced annual growth, visible as narrowing in the growth rings closest to the bark. This may indicate the need to reduce competition. Ideally, in an intensively managed stand, stand tending treatments would be carried out in anticipation of competition, so that crop tree growth would never slow down.

At the time of each thinning, the trees of the stand can be separated into three categories. The most important group is, of course, the final crop trees. The second group includes trees that will be removed in later thinnings, but that are kept in the meantime to use the growing space that will eventually be occupied by the final crop. The third category consists of the trees to be removed in the current thinning.

Commercial thinning is carried out when the volume of the excess stems to be removed is sufficient to make the operation profitable. Tree size affects merchantable volume recovery as well as logging costs; as a rule of thumb, average minimum stand diameters for industrial commercial thinnings are 25 cm on the Coast and 20 cm in the Interior. Small-scale operators will likely be able to carry out profitable commercial thinnings at smaller diameters than these, depending on local markets for small wood products and the costs of logging and hauling.

Since many of you will be commercially thinning unmanaged stands, you will need to select your crop trees at this time. Always keep in mind that the purpose of thinning is to create enough growing space in your stand to improve the growth of the trees left behind for the final harvest.
Your crop trees should be:

- of the preferred species and highest potential value
- thick-barked species (e.g. Douglas-fir) versus thin-barked species (e.g. hemlock or true firs) to minimize crop tree damage
- longer-lived species or species with greater response potential (e.g. Douglas-fir or larch versus lodgepole pine)
- species with deep roots versus shallow roots

In mixed stands, such as Interior lodgepole pine/larch, select the most valuable species (larch) as the final crop and remove the lesser value species (pine) as commercial thinnings.

The choice between individual trees is based on: large diameter, dominant or codominant size class, straight trunk, healthy crown, small branches and long distance between branch whors – all of which indicate a healthy, vigorous tree. As with the selection of crop trees at the juvenile spacing stage, the spacing may be varied to allow selection of the best available tree of the preferred species (i.e. it is better to choose the best tree available than to maintain a strict intertree spacing interval).

Commercial thinning determines the final density of the stand at harvest, so the leave stand (of crop trees) should be thinned to the target density appropriate for that species. The Ministry of Forests and Lands has developed stocking guidelines to help you determine how many crop trees of different species you should have at the end of the rotation in order to fully use the growing site. The following tables indicate the target number of crop trees per hectare at the time of final harvest.

Note: The first set of guidelines are for managed stands, which may have had earlier stand treatments (planting, brushing, juvenile spacing, etc). The trees in these stands will generally be larger, more uniform in size and with larger crowns, than trees in unmanaged stands. This means that they will be better able to respond to thinning, and grow more quickly to fill the site. For previously unmanaged stands with smaller trees and a slower response time, 10 to 20% more trees may be left on-site after commercial thinning to grow until harvest.
### Tending The Stand

#### Stand Targets At Time Of Harvest: Managed Stands

<table>
<thead>
<tr>
<th>Species</th>
<th>Spacing (m)</th>
<th>Stems/ha</th>
<th>dbh (cm)</th>
<th>Height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coast</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>50 - 60</td>
<td>37.5 - 45</td>
</tr>
<tr>
<td>western hemlock</td>
<td>6.3 - 5.6</td>
<td>250 - 315</td>
<td>40 - 50</td>
<td>37.5 - 45</td>
</tr>
<tr>
<td>western red cedar</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>50 - 60</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td><strong>Interior</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>40 - 45</td>
<td>27 - 33</td>
</tr>
<tr>
<td>western hemlock</td>
<td>6.3 - 5.6</td>
<td>250 - 315</td>
<td>35 - 40</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>western red cedar</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>45 - 50</td>
<td>24 - 30</td>
</tr>
<tr>
<td><strong>Province</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sitka spruce</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>50 - 60</td>
<td>37.5 - 45</td>
</tr>
<tr>
<td>white/Engelmann spruce</td>
<td>6.3 - 5.6</td>
<td>250 - 315</td>
<td>40 - 45</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>balsam (grand/amabilis fir)</td>
<td>6.3 - 5.6</td>
<td>250 - 315</td>
<td>45 - 50</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>(subalpine fir)</td>
<td>5.6 - 5</td>
<td>315 - 375</td>
<td>35 - 40</td>
<td>24 - 30</td>
</tr>
<tr>
<td>larch</td>
<td>5.6 - 5</td>
<td>315 - 375</td>
<td>40 - 45</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>white pine</td>
<td>5.6 - 5</td>
<td>315 - 375</td>
<td>40 - 45</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>lodgepole pine</td>
<td>4.8 - 4.5</td>
<td>440 - 500</td>
<td>30 - 35</td>
<td>24 - 30</td>
</tr>
<tr>
<td>yellow (ponderosa) pine</td>
<td>9 - 7.3</td>
<td>125 - 190</td>
<td>45 - 50</td>
<td>24 - 30</td>
</tr>
</tbody>
</table>

#### Stand Targets At Time Of Harvest: Unmanaged Stands

<table>
<thead>
<tr>
<th>Species</th>
<th>Spacing (m)</th>
<th>Stems/ha</th>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Species</strong></td>
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<td></td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>6.5 - 6</td>
<td>230 - 290</td>
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<td></td>
</tr>
<tr>
<td>western hemlock</td>
<td>6 - 5.3</td>
<td>290 - 360</td>
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</tr>
<tr>
<td>western red cedar</td>
<td>6.5 - 6</td>
<td>230 - 290</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sitka spruce</td>
<td>6.5 - 6</td>
<td>230 - 290</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>white/Engelmann spruce</td>
<td>6 - 5.3</td>
<td>290 - 360</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>balsam (grand/amabilis fir)</td>
<td>6 - 5.3</td>
<td>290 - 360</td>
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<td></td>
</tr>
<tr>
<td>(subalpine fir)</td>
<td>5.3 - 5</td>
<td>360 - 415</td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>larch</td>
<td>5.3 - 5</td>
<td>360 - 415</td>
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<tr>
<td>white pine</td>
<td>5.3 - 5</td>
<td>360 - 415</td>
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<tr>
<td>lodgepole pine</td>
<td>4.5 - 4</td>
<td>510 - 630</td>
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<tr>
<td>yellow (ponderosa) pine</td>
<td>8.3 - 6.7</td>
<td>145 - 220</td>
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Local conditions such as snow loads, and the frequency and severity of seasonal storms, will influence the degree to which you thin your stands. In dense stands with shallow-rooted species it is often necessary to do two or three lighter thinnings that allow the trees to slowly develop some windfirmness. In areas of heavy snowfall, individual trees need time to develop thicker trunks that will enable them to withstand bending under heavy snow loads.

In Coastal stands, where sunlight is the limiting factor, the timing and degree of 'release' are also important, so as not to expose the crop trees to too much sun, too quickly. Foliage that has developed in lower light levels is not adapted to conditions of direct sunlight, and like a fair skin it is susceptible to 'burning'. Early spacing is

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The route by which you reach these final harvest targets, and the number of thinnings you conduct, will depend on your management objectives, the species you are working with, and the limitations of your site.
therefore recommended, before the trees develop a high proportion of ‘shade needles’.

When spacing has taken place too late, you can often detect a delay in top shoot growth as the tree recovers from this exposure. The degree of ‘thinning shock’ and the resulting delay in growth varies with the amount of exposure and, of course, the species. Species which retain their foliage for many years (such as the true firs) are the hardest hit since they must re-grow a new set of sun-adapted foliage before the tree can return to its previous rate of height and diameter growth. Species such as pine, which replace their foliage every few years, suffer the shock of exposure less.

Where a stand has pockets of disease, spacing will focus on removing the susceptible species. In stands infected with root rot, wider spacing is carried out to minimize root contact and transmittal of the disease. In stands with a stem or needle disease, you are advised to consult with local pest management foresters regarding the appropriate spacing program. The treatment will vary depending on the particular problem and crop tree species. In some cases extra stems are left on-site as insurance against those that may die; in other cases, where it is possible that site disturbance may spread an infection, diseased stands may not be thinned at all.

One of the real benefits of small-scale woodland management lies in the ability to intensively monitor and manage stands. It is possible, through multiple thinnings over the life of the stand, to maximize the growth potential of your crop trees while reaping continued benefits from trees removed as thinnings. Stands can be kept fully stocked as they grow, with stems being removed only when they begin to interfere with the growth of the crop trees.

To do this, however, you must have good road access and be able to make repeated entries into your stands without damaging crop trees or the soils on your woodland. Further, the stems removed in each thinning must be of sufficient volume to pay for the costs of removal. These requirements will depend on whether you are able to do the thinning yourself, and the presence of markets for small wood products in your area. If no markets exist, it may be necessary to space your stand down to final harvest density in one operation.

In most cases, thinnings can be timed to meet good log markets or your specific timetable. Heavy thinnings can be taken at infrequent intervals or light thinnings can be conducted more frequently in cases where markets for small wood products exist and extraction costs are low. Since you will likely want to minimize the costs of thinning and maximize the value of the material you remove, you will probably carry out fewer, heavier, thinnings than the ideal situation of many, lighter, thinnings. Regardless of how thinning is done, the overriding objective is to maintain good crown cover, avoid high-grading, and achieve a good spacing for the development of the larger crop trees.
Guidelines for Thinning:

- choose stands with a good response potential:
  - medium or good sites
  - little damage from disease, insects, wind, snow
  - final harvest date at least 15 to 20 years away
- species priority:
  - what can grow best on your site?
  - what species best meets your goals?
  - what insect and disease problems should you consider?
- crop tree selection:
  - species
  - tree location (especially windfirmness)
  - quality
  - size
  - vigour
  - live crown ratio and crown balance
  - form
  - insect/disease resistance
  - adjacent trees and openings (i.e. spacing of crop trees)

**Thinning Equipment**

As discussed in the chapter “Harvesting The Trees”, a variety of special equipment has been developed for small-scale harvesting and thinning operations. The lightness and maneuverability of this equipment enable multiple entries into a stand over its rotation, with minimal damage to the soil and the crop trees.

Small skylines (e.g. Mini-Alp) with light cable and short towers have been developed especially for the removal of small wood from stands on steep slopes. Small crawler tractors (e.g. D3, John Deere 450) and rubber-tired skidders (e.g. John Deere 440), are being used successfully for small-scale operations on moderate slopes.

In addition, equipment dealers are beginning to provide modifications for farm tractors that will allow the skidding of small wood. The Forest Engineering Research Institute of Canada (FERIC) has produced a number of reports on specialized equipment for small-scale woodland thinning and harvesting. A list of these is included at the end of the chapter. Tractor-mounted winches and small yarding machines such as the Swedish “Iron Horse” or American “Radio Horse”, make it possible for operators to harvest thinnings on their own, without the assistance of large machinery or even four wheels.
Horse logging is also proving to be a viable and inexpensive method of thinning small areas, and is being used in many sensitive environments. It is best suited to stands of gentle slopes, few obstacles, and good access since it may require more landings and trails than other skidding methods. The Cariboo Horse Loggers Association (address in Appendix III) is your best reference for information on horse logging and horse logging contractors in the Province.

Other Treatments

Fertilizing
Just like people, trees require a balanced diet to grow well. While most stand improvement treatments focus on maintaining a continuous and adequate supply of light, water and soil nutrients to the crop trees, there are also instances where trees require additional nutrients to those available on-site. Nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) are the most common elements applied to forest stands. Two common nitrogen fertilizers are urea pellets and ammonium nitrate crystals, both of which can be spread by hand (over small areas) with a garden variety ‘cyclone seeder’.

Another means of increasing the level of nitrogen in the soil is through the presence of alder, lupins, or legumes on the site. These plants have a special relationship with bacteria that live in nodules on their roots, that are able to capture nitrogen from the air. In return for carbohydrates (energy) from the tree, the bacteria feed nitrogen into the plant’s system. When the plant’s leaves fall, this nitrogen is carried back to the soil, enriching the site for all plants growing there. The undersowing of clover, the growing of alder in mixed stands with Douglas-fir, and the sowing of lupins under pine stands in the Interior are being tested experimentally, as a means of increasing the level of available nitrogen on forest sites. A word of caution however: alder may be difficult to control once it becomes established and could create a brush control problem for young conifer stands.

To determine whether or not fertilizer is needed, a chemical analysis is usually carried out on the foliage of trees from the areas in question. Foliar analysis can be done quite inexpensively at a number of laboratories throughout the Province. Check with your District Office of the Ministry of Forests and Lands for advice on where to send your samples, then check with the laboratory to make sure that you can obtain an interpretation of the results along with the analysis.

In preparation for foliage analysis you will need to map out the sites on your woodland according to the forest cover and site class. For each site to be analyzed you will need to collect a different set of samples, so you may wish to only do one site at a time.

Foliage samples should be collected according to the following guidelines and placed in a plastic bag for shipping. It is also a good idea to send along a brief description of the area, the age and species mix of the stand, stocking density, stand history, and any other treatments carried out to date, etc., as background for the analysis.

Avoid sampling trees that:

- have a heavy cone crop (often an indication of stress)
- have insect or disease damage
- are near dirt or gravel roads (dust can contaminate the analysis)

Also, try to handle the samples as little as possible – grease, food, and other materials can ruin the test results.
For each site:

- collect samples from 15 representative trees (all samples in one bag)
- take samples of last year’s needles from two branches on each side of the tree (just a small snip – about 15 cm or 6" from each)
- collect samples during the dormant season (e.g. Sept. 15 – Apr. 1 in the Interior; Oct. – Feb. on the Coast)
- collect samples only from the tallest (dominant and codominant) trees
- collect samples from the upper third of the crown but not from the leader or top two whorls of branches
- if foliage is very wet, air dry it prior to shipping; or ship as quickly as possible after collecting

The needles of the samples are weighed to find out if there has been an increase in growth in response to the fertilizer. The second foliar analysis will show any change in the nutrient status of the trees since the fertilizer was applied. Together, these provide an indication of the amount of fertilizer taken up and the potential response to that fertilizer by the trees on these sites. Although it is not possible to precisely project the amount by which individual stands will respond, this procedure can give you a good idea of which stands will likely respond best. This will help you to determine whether the treatment would be worthwhile, and to rank which stands are most important to fertilize.

The response to fertilization varies from species to species and stand to stand, and appears also to be affected by the age of the tree at the time of treatment. In general, the response to fertilizer is greatest in the first two to four years following application, and lasts from seven to ten years. The effect of fertilization is influenced by the tree’s ability to absorb it from the soil, so factors such as soil moisture, size of tree crown and root system are important variables in fertilizer response. For this reason, fertilization is usually carried out only in spaced or open-grown stands. Likewise, fertilizer is applied in early spring or late autumn when the weather is cool and rain is likely, since the fertilizer needs to be dissolved in order to be taken up by the tree.
In British Columbia, most of the research into forest tree fertilization has focused on the response of Coastal Douglas-fir to nitrogen. Nitrogen is commonly applied as forest grade urea fertilizer which is made up of approximately 46% nitrogen. To meet the treatment level of 200 kg of nitrogen per hectare, the application of 435 kg of fertilizer would be required. Obviously, this would be an unmanageable task by hand, so forest fertilizer is applied most often by helicopter or fixed-wing aircraft.

If you are considering fertilization, it is likely that others in your area are too. It may be worthwhile to organize a cooperative venture through your local Woodland Association. Also contact your District Office of the Ministry of Forests and Lands to see if there is a fertilization program for Crown lands in your area. If the helicopter and fertilizer spreading equipment are already nearby you may be able to reduce the set-up costs of fertilization.

**Pruning**

Pruning refers to the removal of live or dead branches from trees, and is carried out for a variety of management objectives. Most commonly, forest trees are pruned to produce ‘clear’, knot-free timber for high value sawlogs or veneer.

Pruning can be used to control the spread of pests such as the white pine blister rust which enters the tree through the needles of lower branches. It is also done as a fuel management practice to remove branches that act as fuel ladders, which carry ground fires up into the crowns of trees. In British Columbia, pruning has been largely a Coastal stand tending treatment to this point in time, though it is being tried on an experimental basis in some wet belt stands in the Interior.

Knots formed by wood growing around branches and branch stubs reduce the value of the wood when it is milled for lumber or plywood. Pruning is carried out to remove the lower branches of the tree, and promote the formation of clear wood in this area of the trunk as the tree grows.

Ideally, pruning should be started when trees are about 10 cm (dbh) and 4 to 5 metres tall. The first pruning or ‘lift’ should be to a height of 2.5 metres, or the length of one peeler log. It can usually be done with a saw or pruning shears. Further pruning may be done to a height of 6 metres (2 log lengths plus an allowance for stump and trim), preferably in two lifts to minimize the diameter of the knotty core, and will likely require a long-poled saw or shears and a ladder.
The amount of live crown to be retained after pruning varies with the species. As a guideline, two thirds the total height of the tree should be retained in live crown for species such as Douglas-fir, larch, spruce, and hemlock; and one half of the total height for pine species. Remember that the living branches, or crown, of the tree are its food production system. Removing too many of the branches will limit the tree’s ability to produce food and thereby reduce its growth and vigour.

Pruning is best carried out in cold weather, when growth is minimal or the tree is dormant. A small-toothed pruning saw or pruning shears are recommended. For branches larger than 10 cm in diameter it may be necessary to cut in two steps, starting with an undercut, to prevent the bark from ripping below the branch as the second, top cut is made. Branches should be pruned as close as possible to the main stem without causing damage. If a branch stub is left, it will commonly result in a delay in the formation of clear wood as it may take two to five years for the stub to heal over. In general, all dead branches (without needles or leaves) should be removed as they will produce loose knots if left on the tree.

It takes many years to achieve the improvements in wood quality that result from pruning. In general, the potential returns from pruning are related to final tree size. Pruning should be carried out on young trees, early in the rotation, so that a maximum of clear wood can be gained as the trees grow. Pruning is recommended only in conjunction with a thinning program in order to maximize the growth of the pruned trees, and the production of high-value wood. The removal of live crown will slow the growth of pruned trees for a few years, and if unpruned trees are left on-site they have the potential growth advantage over the pruned crop trees. In situations where thinning is not carried out, it is possible that unpruned trees could actually overtop and suppress the crop trees.

Before pruning, it is a good idea to obtain a professional opinion on the potential for increasing tree value that pruning could achieve in a particular stand. For many woodland operators, pruning is an enjoyable activity that produces many benefits in addition to the production of clear wood, including the provision of clearance for horseback, cross-country ski and mountain bike trails.

**Pruning Guidelines:**

- prune only stands of fast-growing, good quality trees of the preferred species (e.g. Douglas-fir on the Coast)
- prune the best dominant and codominant trees (straight stem, unscarred, single top)
- avoid excessively branchy trees
- prune trees early in the rotation (to maximize the amount of clear wood that can be added during the growing cycle)
- prune a minimum log length (6 m) in two or three stages, making sure that 2/3 to 1/2 of the tree remains in live crown, depending on the species
- prune in the dormant season (fall/winter)
- prune close to the bark of the main stem
- wear appropriate eye and head protection

**What Returns Can I Expect?**

Stand tending is an important part of woodland management, providing not only financial rewards but also aesthetic, protection, recreation, and other benefits to the woodland owner. The response to each treatment will vary according to the site, species, and the tree’s age and condition at the time of treatment. In general, the response to stand improvement treatments will be better on your better sites.

By reducing the demand for light and water in a stand, thinning treatments effectively increase the supply of these essential ingredients to the crop trees. As a result, these trees can achieve remarkable increases in growth. Fertilization in specific situations can boost this growth even more.

Through tightly controlled stand tending it is possible to reduce rotation lengths in managed stands by 25% or more of the rotation length of unmanaged stands, resulting in higher values in a shorter time period. In addition to producing crop trees in less time, the trees are often of more uniform piece size which can mean greater harvesting efficiencies and related cost savings. Add to these economic returns the benefits of improved access, aes-
thetic, wildlife and protection values on your woodland, and stand tending becomes a good deal for all woodland operations, large or small.

Treatments should be planned carefully, in consideration of the costs and the potential responses in stand growth and value. Costs of treatment vary tremendously according to the site conditions, method and number of treatments. You are advised to consult foresters in your local area regarding specific treatment costs and applications.

For many of you, stand improvement will be the focus of your woodland activities, and you will be able to cut the costs of treatment considerably by doing the work yourself. There are also a number of financial and employment assistance programs available for stand tending activities (see the chapter “Getting Help”). In addition to improving the value of your forest crop, stand tending will provide you with the opportunity to create the stands on your woodland that work best for you.
Recommended References:

**B.C. Ministry of Forests and Lands**
- "Juvenile Spacing A Guide For Forestry Crews". Pamphlet
- "Silviculture Manual" (chapters 9 and 12). Silviculture Branch
- "A Quick Guide to Pesticides. Use and Regulation in B.C. Forest Management"
- "Forest Pesticide Application Course". Handouts
- "Evaluating Forest Stand Nutrient Status". 1985. Land Management Report No. 20
- "Regional Stand Tending Guidelines"

**B.C. Ministry of Environment and Parks**
- "Handbook for Pesticide Applicators and Pesticide Dispensers". Pesticide Control Branch
- "Guide to Applicants for Pesticide Use Permits and Special Use Permits"

**Canadian Forestry Service, Victoria**
- "Use of Herbicides in Forest Management". CFS Information Report NOR-X-282

**Forest Engineering and Research Institute of Canada (FERIC)**
- Use of the farm tractor in the forest:
  - "Evaluation of the Agri-Winch: A Farm Tractor-Mounted Logging Winch". TR-41
  - "4WD Articulated Tractors and Skidders for Woodlots". TN-87
  - "Hydraulic Grapple Loaders for Farm Tractors". TN-88
  - "Logging Winches for Farm Tractors". TN-90
  - "Logging Trailers for Farm Tractors". TN-97
  - "Evaluation of the G-30 - Vimek Processor Attachment for Farm Tractors". TN-99
  - "Handbook For Logging With Farm Tractor-Mounted Winches". Handbook No. 2
  - Small inexpensive equipment for woodlot owners who do not have a farm tractor:
    - "Evaluation of Wood Caddy and Goliath Mini-Skidders". TN-86
  - "Can All-Terrain Vehicles be Used for Forest Work?"
  - "Pruning Douglas-fir on Coastal British Columbia". Interim Report IR-383-1

**Other Sources**
- "Juvenile Spacing Manual". Workers' Compensation Board
- "Silviculture - The Journal of the New Forest". MacLean Hunter Ltd. 777 Bay St., Toronto, Ont. M5W 1A7
Each year, approximately one million hectares of forest land in British Columbia are damaged or destroyed by the combined actions of fire, insects and disease. The protection of forest land is an ongoing task of prevention, early detection, and control of damaging agents.

This chapter discusses the ways in which you can reduce risk, improve detection, and find assistance for coping with pest problems if and when they occur. Practical information, such as signals and check lists of potential pest problems, fuel management techniques, and other preventative maintenance activities will help you to develop a protection strategy for your woodland.
What Creates A Fire Hazard?

To have a fire you need three things: fuel, oxygen and heat (for ignition). All of these exist in the forest environment. Needles, bark, twigs and wood, provide fuel for ignition and for prolonged burning; forest air is rich with oxygen produced by plants growing on-site; and people and lightning act as sources of ignition. To fight fire, you must remove one or more of these elements. In the case of forest fires, protection efforts are focused on removing or modifying the fuels, regulating the movements and activities of people, and predicting the occurrence of lightning-caused fires.

In developing a fire protection program, it is important to know how fire behaves under different circumstances. The primary factors that influence fire behaviour in a forest are the fuels, weather, and topography (lay of the land). A look at each of these will help you to assess the potential fire risk on your woodland.

Fuel exists in various forms in a forest. Dense, heavy fuels, such as standing timber, fallen trees, and sound stumps are normally difficult to ignite and burn relatively slowly, though with intense heat. Light flash fuels, such as logging slash, brush cuttings, and other residues are easily ignited and burn rapidly. The presence of both types of fuel represent a potential fire hazard to the woodland. Snags are a special concern because they are dead, dry and always ready for ignition.

The volume of fuel affects the amount of heat produced by a fire. The most dangerous fire situations exist where there are both light fuels for ignition, and medium and large materials for prolonged burning. Fuel spacing affects how quickly and to what extent a fire can spread. When fuels are close together, fire spreads faster. As a result, a common fire suppression technique is to separate burning fuels from unburned fuels by creating a ‘fireline’ by hand or machine.

Weather exerts a strong influence on fire behaviour. Temperature affects the drying of fuels and the movements of air, while humidity (the moisture in the air) affects the moisture in the fuel. Dry air, during the day, draws moisture away from fuels, making them more combustible, while moist, night air, can actually dampen and slow down a burn. Wind patterns change during the day, generally blowing upslope during the day as sun-warmed air rises, and downslope during the night as cooler air sinks. Wind also speeds the spread of fire by bringing fresh supplies of oxygen, pre-heating fuels in front of the fire, and igniting spot fires by carrying embers to new fuels.

The terrain, or topography, affects the rate and direction in which fire can spread. Fire tends to spread faster uphill than downhill, and the steeper the slope, the faster the spread. Aspect, the orientation of the land to the North, East, South and West, affects the amount of sunlight that an area receives. South-facing slopes expose fuels to direct sunlight which causes rapid drying. Such slopes are potential ‘hot spots’ and should be watched carefully in the summer months. North-facing slopes, where fuels are more shaded, and often more dense, pose less of a fire risk. Fire behaviour is also affected by terrain because of
its influence on the movement of wind. Landforms such as ridges and rock faces may cause wind turbulence and eddies on their leeward side. When wind is channelled it increases in strength, and in chutes or steep drainages a chimney effect can make fire behaviour extremely dangerous.

What Is My Role In Fire Protection?

The only factors in the fire formula that you can influence are your actions (as a potential source of ignition) and, to a lesser extent, the fuel. Your role in fire protection is to prepare for it, try to prevent it, watch for high hazard situations, and be ready to act quickly if and when it strikes.

Fire protection is part of your overall Forest Management Plan, and your protection strategy will usually have four parts: prevention, preparedness, detection, and suppression. For small-scale woodland operators, the first three will be the major elements, and suppression will likely be limited to taking initial action on forest fires originating on your land.

Fire Prevention

Never was the old saying 'an ounce of prevention is worth a pound of cure' more true than in the case of forest fires, where the values at risk — to timber, range, recreation, wildlife habitat and water — are so high. Prevention usually focuses on two areas: modifying the activities that take place in the forest, according to the degree of fire danger and risk, and modifying the forest fuels to reduce fire hazard.

The Forest Act and associated regulations influence activities taking place on provincial forest lands during the fire season, April 15 – October 15th, by:

- establishing conditions for campfire use
- requiring burning permits
- restricting forest use for industrial operations and recreation, according to the fire danger level
- requiring proper snag and slash disposal
- requiring forestry operations to take special precautions in the cutting, grinding or welding of metals, including the provision of watchmen and sufficient fire fighting equipment in areas where forestry work is being carried out

Forest fuels are the other target of fire prevention activities. Firebreaks (areas of less flammable fuels) and fuelbreaks (areas where fuels have been burned off) can be used to decrease the chance of fire start and spread. Existing fuels can also be modified by practices such as controlled understorey burning, to reduce the potential rate of fire spread. Fuel management strategies include such measures as:

- increased utilization of wood on-site (e.g. removing slash for firewood or small log products)
- clearing fire guards around areas of high risk, such as slash
- cleaning up slash on road rights-of-way
- prescribed burning or mechanical site preparation to reduce fuel hazards
- limiting cutblock size in cases where slash disposal might be difficult
- leaving areas of standing timber as firebreaks
Forest Protection

A fuel management plan is required for Woodlot Licences (and recommended for private lands) as part of the five-year Development Plan. It identifies potential fire problems on the woodland and the fuel management strategies to combat them. The fuel management plan is based on the fire history, weather, and type of fuels in the area, including social considerations such as level of use. Much of this information is available from the District Offices of the Ministry of Forests and Lands.

Fire Preparedness
Since a quick response greatly enhances the chances of early control, being prepared for fire is an important part of the fire protection plan. This includes having the appropriate suppression equipment on hand for the size and type of your woodland operation, and having a plan in place for initial attack if and when a fire occurs.

The objective of the Ministry of Forests and Lands is to contain all wildfires by 10 am of the day following discovery. Since not all forest fires originate on (or limit themselves to) Crown land, the Ministry has entered into various agreements with municipalities, regional districts and others, to enhance forest protection from wildfires. As urban developments encroach on forest land, these agreements are becoming increasingly important. While urban and municipal fire departments are responsible for the prevention and suppression of structural fires, the Ministry of Forests and Lands remains the lead agency in dealing with wildfires.

Part of being prepared is knowing when the risk of fire is highest, so the Ministry of Forests and Lands maintains a fire danger rating system to measure the susceptibility of forest lands to fire. The system uses weather variables of temperature, relative humidity, wind speed and rainfall to model the condition of forest fuels and develop an index of fire danger. The fire danger rating is used in making decisions regarding the regulation of forest land activities including the need for early shifts (so forestry and logging crews finish work and leave the forest before temperatures and fire danger peak), temporary shutdowns of logging operations, or forest closures.

Another aspect of preparedness includes having fire fighting equipment on hand to stop fires as they develop. The "Forest Fire Prevention Regulations" require forestry operations of different types to have the following suppression equipment on-site.

<table>
<thead>
<tr>
<th>Type of Operation</th>
<th>Suppression Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Equipment</td>
<td>1 shovel, 1 pulaski or mattock, 1 fire extinguisher</td>
</tr>
<tr>
<td>Portable Sawmill</td>
<td>as above plus 1 water tank with 4 500 litres of water, 1 pump unit;</td>
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<tr>
<td></td>
<td>clear area of flammable fuels to 30 m</td>
</tr>
<tr>
<td>Power Saw, Cutting, grinding, or welding</td>
<td>1 fire extinguisher and shovel at refuelling point</td>
</tr>
<tr>
<td></td>
<td>2 shovels, 1 fire extinguisher, 2 (18 l) hand-tank pumps;</td>
</tr>
<tr>
<td></td>
<td>clear area of flammable fuels; watchman during and up to 30 minutes after operations</td>
</tr>
<tr>
<td>Explosives</td>
<td>2 shovels, 2 (18 l) hand-tank pumps</td>
</tr>
</tbody>
</table>
In addition, a specific amount of hand equipment, such as axes, shovels, mattocks and hand-tank pumps must be cached on-site according to the size of an operation. Minimum water supplies are also required. As the "Forest Fire Prevention Regulations" change from time to time, woodland operators are advised to check with their District Office for current requirements.

<table>
<thead>
<tr>
<th># of People</th>
<th>Axes</th>
<th>Shovels</th>
<th>Pulaskis/</th>
<th>Hand-tank Pumps</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - 8</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
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<tr>
<td>9 - 15</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
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<tr>
<td>16 - 25</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>4</td>
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<tr>
<td>26 - 40</td>
<td>4</td>
<td>10</td>
<td>8</td>
<td>6</td>
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</tbody>
</table>

What Are My Fire Responsibilities?

Where fire is concerned, little distinction is made between Crown lands and private lands. Everyone owning or occupying forest land is equally responsible for fire prevention and suppression. You are required to dispose of slash on your lands, including the falling of snags and slash burning, and take other measures to prevent the outbreak of fire. Where fire occurs, you are required (under the Forest Act) to report it and take initial, aggressive action in suppressing it. When a fire moves beyond the operator's suppression capabilities, the Ministry of Forests and Lands may take over, and if required to do so, the operator and his equipment must be at the disposal of the Ministry. If you are responsible for a fire outbreak due to operational negligence, or fail to take initial suppression action, you may be liable for suppression expenses incurred by the Ministry of Forests and Lands, or even prosecution.

Fire Detection

Your fire detection activities will include maintaining an overall fire check routine for your woodland during periods of high fire hazard and after lightning, and in areas where forestry work is being carried out.
For the woodland operator on private or Crown lands, the best approach to fire protection is to reduce the chance of fire. The most effective way to do this is to utilize the wood to its maximum and keep all your harvesting and silvicultural operations as 'clean' as possible. In addition, consistent attention to such things as fuel buildup in areas where equipment is operating, following safety procedures when handling flammable substances, and carrying out ongoing slash disposal, can greatly reduce the risks of fire. Knowledge of one’s land and potential hot spots, the basic steps of fire fighting, and who to call in the event of fire, are additional safety measures. The Ministry periodically sponsors one day mini-courses in suppression training and has other excellent written and video materials on fire protection appropriate for all categories of woodland operators. Check with your District Office or L.M. Media Marketing Services Ltd. (addresses in Appendix III).

Being Prepared For Fire:

1. Develop a fire prevention strategy for the site (especially fuel management)
2. Keep a phone list at home, on-site, in vehicle with:
   - fire report number: Zenith 5555
   - MOFL District Office
   - local fire department/volunteer squad
   - 3 neighbours who have agreed to be on call as fire fighting recruits
   - hospital
3. Have access to the following equipment:
   - pickup truck (4 wheel drive if possible)
   - 4 shovels, pulaskis, backpack pumps
   - 1 truck-mounted water pump
4. Know the fire danger rating in your area
5. Develop a water source on site if necessary (roadside water holes, holding tanks)
6. Map all access routes and possible sources of water on-site; leave with MOFL District Office, friends, at home, and in your vehicle
7. Control public access. Check the area after logging or other operations and lightning

Protecting Your Woodland From Pests

Insect pests and diseases which inhabit our forests cause millions of dollars worth of timber losses each year. Forest pests attack a wide range of tree species and ages, retarding growth, affecting tree form, reducing wood quality, and in some cases, killing trees outright. At a forest level they also leave their mark by delaying regeneration, changing species composition, affecting water quality and recreation values, and damaging wildlife habitat. Worse still, in the wake of this destruction, they often create a fire hazard.

The provincial and federal forest services and the forest industry all share in the task of protecting forests from pests. The federal government carries out overview surveys and research, while the provincial government is responsible for operational surveys, the setting of provincial pest policy, and the administration of control measures. Some forest companies employ pest management foresters to oversee protection programs on company owned and licenced forest lands.

Successful pest management begins with prevention and early detection. Through special management practices, attempts are made to prevent or disrupt conditions favourable to particular pests. These may include such things as planting species that are resistant to local pests, managing stands for a mixture of species and age classes, harvesting stands before they become overmature, maintaining clean logging practices, and practicing sanitation cutting to remove infected trees. In many cases the best prevention and control can be done along with other activities in your woodland, such as regeneration, thinning, or harvesting.
Once a problem has been identified and its potential damage appraised, a suppression plan is designed. Control measures may attempt to directly or indirectly manipulate the pest's life cycle or the forest environment in which it lives. For instance:

- selective felling and burning of individual trees is used to control dwarf mistletoe
- trap trees and logs are used in the control of spruce beetle and mountain pine beetle
- Douglas-fir beetle is controlled by practicing good utilization standards
- bark beetle populations are controlled by quick removal of felled timber (which attracts beetles) from the logging site
- biological agents, such as viruses, bacteria, fungi, mites, birds and mammals are being tested for their effectiveness as parasites or predators on particular pests, including defoliating insects
- pesticides are used under stringent regulations prescribed by the Pesticide Control Act of B.C.

How Do I Recognize A Pest Problem?

Pest infestations are sometimes hard to identify, especially in the early stages of attack or infection. Insect and disease pests often cause similar symptoms in the affected trees. To begin the process of detection and appraisal you can do three things:

1. Become familiar with the general warning signs of pest problems (a chart of basic symptoms follows).

2. Find out which major forest pests are currently active in your region. Since the problem species can change radically from year to year, consult with your District Office of the Ministry of Forests and Lands or with the Forest Insect and Disease Survey Unit of the Canadian Forestry Service.

3. Based on the tree species in your inventory, identify which pests are most likely to be in your woodland, then find out the specific symptoms of each. (Insect and disease charts are included in the following sections to help you).

Armed with these clues, do a check on your woodlands. If you find evidence of damage that you suspect may be caused by a forest pest, remove a portion of the affected trunk, branch, foliage, bark or cone. The District Office of your Ministry of Forests and Lands may be able to help you identify the offender and offer suggestions on means of control, or you can mail the sample, along with any related description or supporting information, to the Canadian Forestry Service in Victoria (address in Appendix III) for assistance in identification. You are advised to take every available opportunity to check your woodland for signs and symptoms of pest attack - during casual walks, silvicultural assessments, and road layouts, as well as during specific pest management cruises.

A general check list of symptoms of pest damage and the potential causes follows. More information on the damage done by particular pests is provided in following sections.
Symptoms of Pest Damage

<table>
<thead>
<tr>
<th>General Symptom</th>
<th>Potential Pest</th>
<th>Other Signs</th>
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</thead>
<tbody>
<tr>
<td>Thinning of foliage and discoloration</td>
<td>- defoliating insect</td>
<td>- chewed needles, buds</td>
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<tr>
<td></td>
<td>- root rot</td>
<td>- yellowish needles</td>
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<tr>
<td></td>
<td>- foliage disease</td>
<td>- both normal and discoloured needles, spots</td>
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<tr>
<td>Dead crowns</td>
<td>- bark beetle</td>
<td>- pitch tubes, galleries under bark 'sawdust' on bark</td>
</tr>
<tr>
<td></td>
<td>- root rot</td>
<td>- resin or white 'mycelium' (thread-like strands) at root collar</td>
</tr>
<tr>
<td>Witches broom</td>
<td>- mistletoe</td>
<td>- attacks Interior Douglas-fir, larch, Coastal hemlock, lodgepole pine</td>
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<tr>
<td></td>
<td>- rusts/needle cast</td>
<td>- attacks balsam, spruce, ponderosa pine</td>
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<tr>
<td>Broken tops, conks, cankers</td>
<td>- decay fungi</td>
<td>- scars, mushrooms at base of tree</td>
</tr>
<tr>
<td>Windthrown trees</td>
<td>- root rots</td>
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</table>

Forest Insect Pests

Many thousands of insect species are at work in the forests of B.C., attacking trees from above and below, eating foliage, boring into bark, attacking cones and seeds and damaging wood. Most of the damage is done by a few major players, including the bark beetles, the defoliators, and the cone and seed insects. The following check list can help you determine which types of insects to watch out for in your woodland. Keep in mind that both insects and diseases appear in different phases of their life cycles at different times of the year, and that it may be easier to see the particular pest at a certain point in its cycle. For instance, budworms may be seen most readily as larvae and moths, and rusts will be most visible when they are orange and fruiting in early spring.

Types of Pests and the Trees They Attack

<table>
<thead>
<tr>
<th>Tree of Attack</th>
<th>Foliage Feeders</th>
<th>Bark Beetles</th>
<th>Branch/Stem Feeders</th>
<th>Cone &amp; Seed</th>
<th>Terminal Shoot</th>
<th>Wood Damage</th>
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<tr>
<td>Conifers</td>
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<td>Douglas-fir</td>
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<td>balsam (true firs)</td>
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<td>lodgepole pine</td>
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<td>ponderosa pine</td>
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<td>alder</td>
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</table>
Types of Insect Damage

Bark beetles are among the toughest forest enemies. They bore through the bark of the tree and chew out ‘galleries’ in which to lay their eggs. Within a few weeks the eggs hatch, but the beetle larvae remain in the tree until the following year, extending the network of galleries and eventually eating their way out. They emerge as beetles who then fly on to attack new trees. The galleries created by their chewing disrupts the flow of water and nutrients within the tree, causing a slowdown of growth, and in the worst cases, resulting in death. The adults of most species of beetles carry with them a fungus that penetrates the sapwood of the tree, further cutting off water flow and creating a blue stain that degrades the appearance and value of the wood.

Insects that feed on the leaves or needles of trees are known as defoliators. They include budworms, loopers, and other caterpillars. These larvae feed on the developing buds and new foliage of trees, causing height loss, deformity, and reduced growth. After attack, the foliage is reduced, remaining damaged needles turn brown, and wood growth slows down. Defoliation can weaken trees, making them susceptible to attack by other pests, and successive years of defoliation can kill trees outright.

Insect pests also attack tree cones, destroying the seeds of the next generation of forests. These insects are particularly feared in the seed orchards of the Province where large amounts of genetically superior stock are being developed for extensive reforestation programs. They also affect wild cone collections which can, in turn, reduce the level of natural regeneration success.

Even felled timber is susceptible to insect attack. Ambrosia beetles attack logs left on dry land and the upper portions of logs in booms. As they bore into the wood they introduce a black-staining fungus that reduces its value. All commercial tree species are susceptible to attack. Interior spruce and pine logs exposed during the summer months are subject to similar damage from sawyer beetles.
The insects responsible for much of the damage to B.C. forests, the tree species they attack, and some external indicators of their presence are summarized below:

<table>
<thead>
<tr>
<th>Insect</th>
<th>Tree of Attack</th>
<th>Visual Clues</th>
</tr>
</thead>
<tbody>
<tr>
<td>mountain pine beetle</td>
<td>(mature) lodgepole pine</td>
<td>reddish white pitch nodules on trunk; egg galleries under bark; one-year old infested trees have red foliage</td>
</tr>
<tr>
<td>ponderosa pine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>spruce beetle</td>
<td>(mature) Engelmann spruce white spruce Sitka spruce</td>
<td>bore holes in bark and evidence of sawdust; egg galleries under bark</td>
</tr>
<tr>
<td>Douglas-fir bark beetle</td>
<td>(mature) Douglas-fir</td>
<td>sawdust on bark, egg galleries under bark; wood-coloured ‘frass’ or sawdust on logs</td>
</tr>
<tr>
<td>ambrosia beetle</td>
<td>all conifers (felled and bucked material)</td>
<td></td>
</tr>
<tr>
<td>western spruce budworm</td>
<td>Interior Douglas-fir</td>
<td>larvae feeding on developing buds and new needles</td>
</tr>
<tr>
<td>fir-spruce budworm</td>
<td>alpine fir Interior spruces</td>
<td>larvae feeding on developing buds and new needles</td>
</tr>
<tr>
<td>western blackheaded budworm</td>
<td>western hemlock</td>
<td>larvae feeding on developing buds and new needles</td>
</tr>
<tr>
<td>Douglas-fir tussock moth</td>
<td>(dry belt) Douglas-fir</td>
<td>larvae feeding on new and older foliage</td>
</tr>
</tbody>
</table>

Mature trees are not the only targets of attack. You should also be aware of the pests that can damage your plantations. Black army cutworm is a potential problem on burned sites in the Interior dry belt. It is a single-season pest whose larvae prefer deciduous foliage, so it is often ‘treated’ by postponing planting until the second or third season after burning, when deciduous species such as fireweed may be on-site (to attract the attention of any hungry cutworms) yet not large enough to cause severe competition to new seedlings. Budworms can be a potential problem, so check for signs of these insects in adjacent stands. Weevils may be responsible for any signs of terminal (top shoot) or root collar damage.

They disrupt the normal growth functions of the tree causing specific injury, poor quality wood, reduced tree growth and sometimes death. Specific diseases can be encountered at almost all stages of a tree’s development.

Tree diseases, like human ones, come in a number of forms. These include rots, rusts, cankers and decay. Most decay fungi are microscopic organisms that reproduce by spores. At certain stages in their life cycle, some fungi produce large spore-producing ‘fruiting bodies’ which we recognize as mushrooms or conks. Diseased plants exhibit symptoms in reaction to the presence of the fungus. Trees infected with root rot develop yellowish needles. Those affected by rusts display red or brown spotting on their needles, and those with heart rot have internally decayed wood.

Forest Tree Diseases

Disease organisms are responsible for more damage to B.C. forests than insects and fire combined. Diseases are usually restricted to specific parts of the tree, and like insect pests, are named by the part of the tree they attack, such as root rots, heart rots, leaf spots, and stem cankers.
For further information on disease identification, consult "Common Tree Diseases of B.C." or "Forest Disease Management Notes", available for reference in most District Offices of the Ministry of Forests and Lands. Both these publications have excellent colour photography to help you identify the suspected tree diseases. Another good reference is the "Forest Pest Leaflet" series published by the Canadian Forestry Service.

**Types of Disease Damage**

Wood decay accounts for about half of all the forest losses to disease. It is a slow killer, working from the inner heartwood out toward the sapwood, that damages the tree’s stability and leaves it vulnerable to blowdown. Decay is caused by various fungi that enter trees through scars and wounds. Though it is currently more of a problem in old growth stands than in second growth ones, it is nevertheless a potential threat to second growth forests. Some Interior second growth spruce forests have particularly high levels of decay.

### Types of Diseases and the Trees They Attack

<table>
<thead>
<tr>
<th>Tree of Attack</th>
<th>Root Rot</th>
<th>Heart Rot</th>
<th>Sap Rot</th>
<th>Dwarf Mistletoe</th>
<th>Cankers</th>
<th>Foliage Disease</th>
<th>Rusts</th>
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<tr>
<td><strong>Conifers</strong></td>
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<td>maple</td>
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<td>arbutus</td>
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Root rots are diseases caused by fungi that spread from infected root systems to those of healthy trees. The potential for damage is great because of the difficulty of detection and the ease of spread. The worst of the rots can live in stumps for up to a century and survive even forest fires if the infected roots are insulated from the heat by the soil. In some cases the spread of root rot may be done without actual contact between the infected and the healthy root system — when fungi are spread by means of small, thread-like structures (mycelium) that stretch out through the soil from the infected roots.

Root diseases retard tree growth and can lead to susceptibility to blowdown. Young, second growth forests, are particularly vulnerable to root disease, and should be monitored carefully for signs of pockets of dead or dying trees. Most Coastal Douglas-fir forests have laminated root rot (Phellinus weirii) occurring within them. Root disease can also kill seedlings and pole-sized trees.

Stem diseases such as rusts and cankers weaken the tree, damage wood, and reduce growth. Rusts tend to attack young trees and are often identified by the presence of cankers on the branches and trunks of infected trees and dead or dying tops. The rust fungus enters through the tree's needles, and travels through the bark (often creating branch cankers) to the main stem where it forms cankers that girdle the tree. Young plantations are especially vulnerable, and rusts pose a potential threat to the extensive Lodgepole pine forests in the Interior of the Province. Rusts generally require two hosts to complete their life cycle, such as white pine blister rust whose alternate hosts are currants and gooseberries.

Dwarf mistletoes are parasitic flowering plants that attack four of the Province's most valued tree species: Interior Douglas-fir, Lodgepole pine, coastal western hemlock and western larch. Not to be confused with the leafy mistletoe we use for celebrations at Christmas time, dwarf mistletoe causes severe damage to our provincial forests. Mistletoe spreads through a stand by ejecting its seeds at high speeds, and covering distances of up to fifteen metres. The mistletoe attaches itself as a sticky seed to the tree, then sends roots through the bark and into the tree to tap water and nutrients.

The infection is recognizable by large swellings on tree stems or branches and by 'witches broom', a dense tangle of branches. While it rarely kills the host tree (other than larch), it drastically reduces growth and leaves the tree vulnerable to attack by other disease or insects. In old growth stands it can substantially decrease the value of
the tree, while in second growth, the effect is mainly a reduced rate of growth.

Foliage on young trees, and cones on older trees, are also disease targets. While foliar disease results mainly in cosmetic damage and is a problem for ornamental species and Christmas trees, cone diseases can drastically reduce regeneration success. Spruce cone rust, which leads to malformation and premature opening of cones has had a serious effect on cone collection programs in the northern Interior. The impact of cone and seed diseases will increase with the move to second growth forests and extensive regeneration programs.

How Do I Protect My Woodland?

As part of your Forest Management Plan you are encouraged to develop an insect and disease map of your woodland. This will help you to become familiar with the pests that are present, and to make it possible for you to monitor their activities over the years. Contact your District Office of the Ministry of Forests and Lands for information on how to conduct a pest survey to detect the presence and extent of insect pest and disease threats on your woodland.

Similar to bacteria in our bodies, pests can be present in a forest without causing undue harm. Pests become problems when some event in the woodland triggers a population outbreak or causes particular trees to become more vulnerable to attack. In most cases, pests will follow a cycle, and may only present real problems two or three times in a rotation period. In general, pest outbreaks are easier to prevent than control, so forest management techniques that keep your trees healthy and strong are an important part of your protection plan.

Management techniques, such as the creation of a mosaic of age classes (either as even-aged or uneven-aged stands) can help break up your woodland and prevent the development of simultaneous outbreaks over large areas. Silvicultural treatments, such as pruning and thinning can be effective in dealing with specific pest-to-host relationships such as white pine blister rust. Juvenile spacing and thinning are important protection activities for second-growth stands. Infected stems should be removed as early after detection as possible. Genetic research into disease-resistant strains of trees offer a ray of hope, but one that is still a long way off. An alternative involves planting or encouraging the natural regeneration of species that are not affected by pests that are well-established in the region.

### Preventing Insects and Disease:

- remove low vigour or cankered trees that could be susceptible to insects
- maintain vigour by thinning, and avoid damage to remaining stems
- clean areas of fresh windfall, logging slash
- carefully match regenerated species to the growing site
- inspect stands for signs of disease or insect damage
- watch stored wood for signs of insect infestation (such as ambrosia beetle)

Pest control is often difficult for the small-scale woodland owner since lands adjacent to his woodland are likely to be infected as well. Where you identify a pest problem, seek the support of a coordinated control effort with the Ministry of Forests and Lands and other woodland operators in your area, perhaps through your local Woodland Association. Chemical control is an issue you should discuss with the specialists at your District Office of the Ministry of Forests and Lands. Strict regulations apply to the use of pesticides in British Columbia's forests.
**Controlling Insect Pests**
The Canadian Forestry Service monitors pest outbreaks across Canada, and annually produces a report of “Forest Insect and Disease Conditions in British Columbia and the Yukon”. They have recently compiled statistics on insect outbreaks in B.C. from 1972-1987. The charts below show the trends for budworms and beetles during this period. One of the first things to note is that the budworms take the lead in the area of forest land affected by insects, in a dramatic upswing that started in 1984. Also of interest is the year to year fluctuation in the area affected by the three budworm species.

The second graph, of beetle outbreak, has a far more consistent cycle. The areas affected by mountain pine beetle and spruce beetle appear to rise and fall in a similar manner. Looking at the trend, one might guess that the next high cycle for beetles could be around the end of the 1990s. Unfortunately, pest behaviour is not so easily pinned down. While past trends may be helpful, they are of limited use in predicting future pest occurrences.
Population growth is affected by many factors. For instance, the mountain pine beetle outbreak in the 1980s was a result of the legacy of mature and overmature lodgepole pine that was not logged commercially in the early part of the century, combined with favourable weather conditions which enabled the beetle populations to build up. The outbreak of spruce beetle, on the other hand, is influenced mainly by the amount of susceptible material such as windthrow. So don’t draw any conclusions about the pests on your woodland until you have talked with the experts.

The best approach to protection is preventative stand management. For example:

- mountain pine beetle attack is related to tree vigour and maturity, and stands potentially at risk from this pest should be scheduled for harvest no later than about 80 years of age.
- mountain pine beetle occurs more frequently in pure pine stands than in mixed stands, so another preventative management strategy involves the cultivation of stands with a mixture of species.
- spruce beetle and Douglas-fir beetle thrive in blowdown, and prompt attention to windfall and clean logging practices will reduce the likelihood of beetle buildup.
- good slash disposal and the practice of logging to close utilization standards (30 cm stump height; 10 cm top diameter) has helped reduce the occurrence of Douglas-fir bark beetle.
- often, bark beetles attack trees already weakened by other agents such as root rots or defoliating insects (e.g. Douglas-fir beetle often attacks mature Douglas-fir weakened by successive years of severe defoliation by Douglas-fir tussock moth). Be on the lookout for potential problems.

More specific control measures, such as trap trees and logs are used to control spruce beetle and mountain pine beetle. Since spruce beetle are naturally attracted to windthrown timber, trees are sometimes felled into the shade and bucked into logs to attract these pests. For mountain pine beetle, live, standing trees are baited with attractants. Once the pests have become established in a trap log or trap tree it is destroyed.

Managing the defoliating insects is likewise keyed to early detection and appraisal of the problem. Common prevention measures include thinning to control stand density, and managing stands for a diversity of species and age classes. Defoliators are also vulnerable to parasites, diseases and extreme temperatures. In addition, chemical and biological insecticides can be used to control and kill defoliators. Other methods of control, such as growth regulators which interfere with the insect’s life cycle, or sex attractants that interfere with breeding, are currently being researched.

**Controlling Tree Diseases**

Most attempts to control disease problems involve intensive forest management practices. Decay and rot are being fought by juvenile spacing and thinning which maintain the vigour of stands. Pruning the lower branches of young trees infected with white pine blister rust is carried out to intercept the rust’s movement into the main stem from the branches. Mistletoe is treated by the selective removal of infected trees, or post-logging prescribed burning of the site to destroy any remaining infection spots in advanced regeneration or seedlings.

Root disease is tackled most often by crop replacement. When the *Phellinus* root disease has been detected, the stand is usually harvested and planted with a rot-resistant species, such as cedar or pine. Since root disease may appear in pockets, rather than throughout a stand, it is often possible to stratify your planting, to plant less susceptible species in any identified disease pockets, and plant the desired species in the uninfected areas. After one rotation the area can often be replanted with the desired species. Alternatively, root disease can be treated by ‘stumping’ the area after harvest. This involves removing stumps with an excavator before planting the desired species. Regional guidelines for detecting and treating infected areas are available from the District Offices of the Ministry of Forests and Lands.

**What Else Can Damage My Forests?**

In addition to the damage caused by fire, insects and disease, the health and productivity of woodlands can be affected by animals and machines. Porcupines, bears, squirrels, hares, and a host of other unnamed (and not well-loved) creatures are also pests that plague a tree's
well-being. In recent years, damage caused by agents such as acid rain and other forms of pollution have presented a new problem to forests throughout the world. In British Columbia, however, storms, winter kill, frost, snow press and drought are more immediate causes of stand damage.

Animal-caused damage is most common to trees in the seedling stage, especially nursery-grown stock which resembles candy to wild and domestic grazing animals. The Coastal areas of British Columbia, particularly the Gulf Islands, are plagued by deer browsing on newly planted seedlings. Porcupines are a current complaint on the North Coast. In the Interior, grazing and trampling by domestic livestock including cattle, sheep and horses, can be headaches to the woodland owner, and the Cariboo Region currently has problems with rabbits. Many innovative, but expensive techniques for discouraging wild grazing animals have been tried, including the use of repellents (such as wolf urine!), enclosing individual seedlings in mesh protectors, encouraging hunting, and erecting scarecrows and electric fences. As a general rule, livestock movement should be controlled by the distribution of salt licks, or fencing, to keep them out of newly planted areas.

Mechanical damage usually occurs as a result of poor felling, skidding and road construction practices in which the main stems of standing trees are damaged. The bark is most vulnerable, and damage is the greatest, in spring during sap flow. In addition to the mechanical damage to the trees, damage to soil is a problem. Heavy equipment moving over a thin and fragile soil can lead to a breakdown of its internal structure. Soil compaction reduces soil drainage which can result in the puddling of water, and accelerate the erosion of soil in surface runoff. It can further reduce the productivity of the site by preventing revegetation, especially in heavy traffic areas such as landings. Damage can be minimized to an extent by careful planning and the layout of proper access roads (see the chapter on “Forest Access”).

As forests become managed intensively for many uses, protection measures will be even more important, both to prevent damage related to increased use (e.g. snowmobiles) and to protect the woodland investment from risks of fire, insects and disease. Due to the personal nature of many small-scale woodlands, protection will be a significant forest management activity. Your efforts will involve protecting your woodland from needless damage by the forces you control, and minimizing the risks to it from the forces you can’t control.
Recommended References:

*B.C. Ministry of Forests and Lands*

"Forest Fire Prevention Regulation". 1979. B.C. Reg. 557/78
"The Forest Fire A Basic Guide to Fire Behaviour and Suppression"
"Forest Protection Handbooks" and "Student Workbooks"
"Forest Diseases and Forest Management". 1985
"Pest Topics". Pest information sheets. Protection Branch
"Pest Management Progress". Biannual newsletter. Protection Branch
"Protection Manual". Protection Branch
"Regional Guidelines for Pest Detection and Control Methods". District Offices

*Crown Publications Inc., Victoria*

"Forest Act". 1979

*Canadian Forestry Service*

"Common Tree Diseases of British Columbia". 1974. Publication No. 1245
"Cone and Seed Insects of British Columbia". BC-X-90
"Forest Pest Leaflet". Available for approximately 70 forest pests.
"Foliar Fungi of Western Trees". 1985. A. Funk. BC-X-265
"Forest Insect and Disease Conditions B.C. and Yukon". Annual Report.

*USDA Forest Service*

"Forest Disease Management Notes". 1983. Pacific Northwest Region
Outline of Fire Protection Pre-Organization Plan for Small Woodlands

A. Area Covered and Objective of Plan
   Identify briefly, making sure all areas are included

B. Occupational Responsibilities
   Persons and equipment required to satisfy occupational responsibilities as under section 121 of Forest Act, including any additional contract document requirements

C. Pre-Planning
   1. Regulations for Forest Fire Prevention (Forest Service)
   2. Closing and locking gates to regulate access to area

D. Prevention
   1. Fuel management strategy (slash disposal)
   2. Equipment for forest fire fighting on-site and awareness of the location of equipment and personpower nearby (neighbours, volunteer fire departments, etc.)
   3. Careful use of equipment on woodland; e.g., power saws, machines, smoking, blasting, road use, welding, rubbish disposal, etc.
   4. Monitoring fire hazard rating system (or tracking readings of district hazard)
   5. Detection systems – lookouts, ground patrols, special hazard areas

E. Suppression
   1. Key Forest Service Personnel: Regional and District
      names, telephone and radio telephone numbers (and duty roster during fire season)
   2. Procedure for reporting of forest fires
   3. Key Personnel nearby (neighbours, volunteer fire departments, institutions, companies, etc.) for initial suppression – names, telephone and radio telephone numbers
   4. Initial attack plan and procedure

F. Map
   Showing access roads, trails, detection points, tool caches, marshalling points, water sources, etc.
Small-scale woodland management is not a 'get-rich-quick' venture in British Columbia. Managing a forest property can be a complex business, and its success depends on the owner's understanding of the financial requirements and potential returns of the tasks he undertakes. With careful planning and decision-making, a small woodland can provide financial and many other benefits to the operator, now and in the future.

This chapter is intended for the family-oriented woodland owner or licensee, who will likely have income from other sources. It provides the basic framework for developing a Business Plan and Accounting System for a small woodland property.
What Kind Of Business Is This?

Forest management is a long-term business which yields modest and intermittent profits. The investments to finance activities such as tree planting, juvenile spacing, road development and protection are tied up for long periods while the trees grow. Only when logs or other forest products are harvested and sold are revenues produced. In the short-term there may not be enough product revenues to cover the early costs of managing the forest. In many cases, the financial resources to support the management activities of the small-scale woodland (and the family that owns it!) will come from another source than the woodland itself.

Many of you will manage your lands as a small business for the production of timber products, while enhancing other resource values such as range management, recreation, or wildlife habitat. A number of assistance and job creation programs are available to help you with these tasks (see the chapter on “Getting Help”). These, combined with careful planning and elbow grease, can provide the necessary resources for a successful woodland operation.

Why Do I Need A Business Plan?

If you’re like most of us, and you don’t have a lot of money to invest in the management of the woodland; if the woodland is ‘just a bunch of trees’ that you want to cut for ‘firewood, a few poles, and maybe some extra cash at Christmas’; or if you have never planned (or perhaps stuck to) a budget, you’re probably asking yourself if you really need a Business Plan for your woodland. The answer is yes. Here are some of the reasons why:

- It encourages you to be realistic in planning activities.
- It helps you to identify markets and customers, and to determine a fair price for your products.
- Putting your plans on paper forces you to look at the decisions you are making and gives you the chance to identify and address problems before or soon after they appear.
- The Business Plan sets out the amount, source and timing of the financing required to carry out the forest management activities proposed in the Forest Management Plan.

The Business Plan makes it easier for outside parties to assess your financing requirements or other requests for assistance. It is a clear statement of the resources required to meet your goals.

What Is A Business Plan?

The purpose of a Business Plan is to help you reconcile your Forest Management Plan (in cubic metres) with your final results (in dollars).

The Forest Management Plan identifies the work to be done to achieve your management goals. It includes the inventory of resources, the type of products to be produced, the volume of timber to cut, road requirements, harvesting methods, reforestation and stand tending commitments.

The Business Plan is really just a financial statement of your Forest Management Plan. It sets out a budget for your operations based on the revenues you anticipate from the products you plan to produce, and the costs you expect to pay in the process of producing them. It also identifies the capital requirements you will need to carry out your forestry operations, when they are needed, and where you plan to get the money from.

In this way, the Forest Management Plan and the Business Plan work together like the handlebars and the foot pedals on a bicycle. The Forest Management Plan is what keeps you on your charted course, and the Business Plan is what moderates the speed with which you travel. Each serves a different function, but both are important in taking you where you want to go.

How Do I Develop A Business Plan?

The first step in developing the Business Plan is to estimate the revenue from the sale of the forest products. This is done by determining the volume of each type of forest product to be produced annually, identifying the potential customers to whom you might sell it, and estimating the unit price you will receive. With this information you are able to prepare an annual revenue forecast.
The next step is to determine the costs of producing and delivering the scheduled quantities of forest products. These costs include the direct costs of production (such as logging), the costs of managing the forest (such as inventories and stand tending), and the costs of doing business (taxes, rent, office equipment). This information provides the basis for an annual cost forecast.

With the revenue and cost forecasts you will develop the annual and five-year budgets for your woodland. At the end of each year the annual budget is compared with the actual expenditures for that year, and a new budget is prepared for the following year. At that time the five-year budget is also re-evaluated, and updated to include another year.

As part of the business planning process, you will need to identify where the money needed to finance your woodland operations will come from. This will involve determining the amount of capital needed, and when, to finance specific operations (e.g. road development in Year 1; juvenile spacing and cone collection in Year 2; logging costs in Year 3; site preparation and commercial thinning in Year 4; planting in Year 5). In addition to the revenue you generate from the woodland, there are other sources of funding on which you can draw, including such things as small business loan programs, and federal and provincial assistance programs (see the chapter "Getting Help").

These are the general concepts involved in developing a Business Plan for your woodland operations. A set of comprehensive guidelines for "Preparing a Business Plan" as well as other general materials on operating a small business are available from the Ministry of Economic Development, your local Chamber of Commerce, or the Bank of Montreal.

What Kind Of Accounting System Do I Need?

A simple one. A system that is straightforward and easy to use, and that indicates clearly all the activities and transactions that take place on your woodland property. It will have two parts: a set of Budget accounts, which projects future revenues and costs; and a set of Actual accounts, which records past revenues and costs.

Some recommendations for developing your Accounting System include:

- Keep it simple. You can always expand as needed.
- Keep it to a calendar year; quarterly or semi-annual statements can be derived as needed.
- Start with a minimum of account headings (called ledgers), perhaps 5 to 10; these can be subdivided later on as necessary.
- Record all revenues and costs to the nearest dollar. Pennies mean a lot of space and arithmetic that is not necessary for this level of accounting.
- Back up all entries with invoice copies or receipts. (If you don’t get a formal receipt for each transaction, be sure to write down a brief description and the amount received or paid, and put it in the appropriate file.)
- Keep your files and ledger up to date. (This is the hardest one!)
- Use a cash system. Leave considerations of depletion, amortization, and depreciation to the experts.
- Include capital costs for machinery, improvements, office equipment, etc.
- Keep track of your own (and your family’s) time on work related to your woodland.

For those of you who have never before needed an operating plan or budget, consider seeking advice from an accountant or bookkeeper to set up a record keeping system for your particular needs. A few dollars invested in setting up a clear and appropriate accounting system will make it much easier for you to control and save dollars in the management of your woodland.
What Supplies Do I Need?

The hardest part of keeping a Business Plan is often the filing and record keeping side of it. You should have a filing cabinet, or filing boxes, at minimum. A four-drawer cabinet is recommended. Although you may fill only one drawer in the first year of your woodland operations, you should have one place to store all the information and records relating to the property. Paper accumulates with amazing speed.

You will need access to a photocopier to duplicate sections of maps, tallies, and layouts, as well as to copy your outgoing correspondence, invoices and other records. Most libraries, schools and government buildings have coin-operated photocopiers, or you may wish to purchase a small counter-top copier of your own.

A desk calculator is essential, and a printing calculator, which can be used to keep record of the details of calculations, is recommended. A typewriter is not necessary, though it is certainly useful for correspondence, management plans, and reports. If you have the funds, and interest, a personal computer can be a useful all-round tool for word processing, data storage and retrieval, forecasting, and calculations. There are even forestry simulation games available for your kids (see references at end of the chapter).

Diaries are important for record keeping. You should make it a habit to record all your time spent on different woodland-related activities, including consultations and meetings, out-of-pocket expenditures for gas, mileage, and other day-to-day items. Because woodland management will keep you on the go, coat-pocket sized diaries are recommended. A wide selection is available at most stationery stores, as well as by mail order.

Your account records can be kept in a 10 or 12 column hard cover account journal, sometimes called a synoptic ledger. These books can be purchased in most department and stationery stores, as well as some drug stores. Finally, you will need a box of file folders (perhaps two dozen to start with) and miscellaneous pads, pencils, staplers, etc. (not to mention the Swiss army knife........).
What Kind Of Records Should I Keep?

In all likelihood you will already have some kind of a general filing and record keeping system. Your Budget and Accounting records should fit into this system with as little duplicating and cross-referencing as possible. A typical filing system for a small woodland operator follows:

Correspondence:
Both incoming and copies of outgoing correspondence are filed in folders, alphabetically, by name of correspondent.

Legal:
Deeds, ownership documents, boundary surveys, grazing and other permits, etc. Copies of related correspondence may be duplicated and cross-filed here.

Inventory and Resource Data:
Tally cards, inventory computer printouts, maps, reports.

Management and Development Plans:
Your Forest Management Plan and Development Plans (for five-year or other periods); these will provide the information for developing the woodland budgets.

Annual Reports, Cutting Permits, Cutting Records:
This file will be annual, and will include your woodland reports, scaling receipts, etc.

Technical Data:
Essentially background and support information, this file can be as complex or as simple as you wish.

Accounting Records:
Your main business file. It provides the basis for budgeting and control as well as the main information for taxes and other reports.

Budget Projections:
This file will be for both the current year and a five-year forecast. It will be based on the five-year (or other period) activities set out in your Development Plan.

Accounting Records

The files in this section contain either invoices or receipts, and are recorded in the accounts journal. Initially, the files should be fairly general. They can be broken down or subdivided in subsequent years as the need arises. The following sample accounting system uses seven files.

1. Revenues:
   • log sales
   • minor product sales
   • other

2. Costs: Direct
   Logging (by phase)
   • felling and bucking
   • yarding or skidding
   • loading
   • hauling
   • scaling
   • landings, skid roads, temporary spur roads
   • slash disposal
   • other

3. Costs: Indirect
   • property taxes (applicable to private land)
   • annual rent
   • office expenses (telephone, supplies, postage, etc.)
   • insurance (vehicle, equipment)
   • legal and accounting
   • association dues (e.g. Woodland Association)
   • travel, board and lodging expenses
   • subscriptions and publications
   • marketing (advertising products)
   • other: recreational development (X-country or riding trails)

4. Costs: Stumpage
   • Stumpage and Royalty accounts (applicable to Crown land)

5. Costs: Forest Management
   • engineering
   • cruising and inventory
   • mapping
   • Forest Management Plan and Development Plans
   • protection
   • site supervision and reconnaissance
   • other
6. Costs: Silviculture
   - site preparation
   - planting
   - silviculture surveys (pre-harvesting assessments, regeneration, survival surveys, etc.)
   - juvenile spacing
   - rehabilitation
   - cone collection, seed extraction
   - seedlings
   - other

   In the same fashion, when money has been received, the invoice is retrieved from the Accounts Receivable file, entered into the synoptic ledger, marked with the entry number, and refilled into the appropriate ledger file folder (e.g. Revenues, 1988).

   A number of items require cash outlay. These are best dealt with by making sure you obtain a receipt for each cash outlay: enter it immediately into your accounts journal (synoptic ledger); number the receipt with the journal entry; and file it in the appropriate ledger file folder. This is extremely important — those bits you spend on gas, chain oil, files, stationery, etc., eventually add up. Keep an envelope in your vehicle and a special place in your wallet to tuck these, then make a habit of pulling them out for entry at the end of each month.

7. Costs: Capital
   - main roads and bridge construction
   - logging equipment
   - forestry equipment
   - office equipment
   - other

   At the end of each year, you return to your synoptic ledger and add up each of the ledger columns to obtain a cash flow statement for the year. A sample synoptic ledger for one year is found at the end of the chapter. Comparing this statement of actual expenditures to one’s budget is a learning experience for most of us, especially the first time around. For your own records (and for the interest of your banker or accountant) you may want to note any differences between the budget and actual for a particular ledger item, and briefly explain the reason.

   Keeping Your Accounts

   In addition to the accounting files listed above, you will need two active files: one for Accounts Receivable, and one for Accounts Payable. When invoices come in, they go into the Accounts Payable file. When they are paid, they are entered into the synoptic ledger. Each entry gets a number (e.g. 1, 2, 3), which is also recorded on the invoice, then the invoice is filed in the appropriate ledger file folder (e.g. Costs: Direct, 1988 is where you would file contract logging invoices). These can be allowed to accumulate loosely in the file folder during the year, and at year end they will be placed in consecutive order and filed with all other files related to that fiscal year. This way, you start the new fiscal year with a clean set of file folders (along with your new resolutions).

   In the budget, you will list your income and all of your expenses. This is where you should itemize all of your projected expenses, such as your monthly rent, utilities, and any other recurring expenses. The budget is your best estimate of the costs and revenues associated with the activities in your Development Plan.

   For example, consider a Woodlot Licensee who has an allowable annual cut of 1000 m³, needs to build one kilometre of access road prior to logging, and anticipates minor revenues from firewood, cedar boughs, and floral material. His first and second year budgets might look like the following:
YEAR 1

Revenues

- 200 m³ of logs from road right-of-way @ $40/m³ $8,000

Costs

1. Direct Logging Costs
   - 200 m³ felled & bucked @ $4/m³ $800
   - 200 m³ skidded off right-of-way @ $10/m³ 2,000
   - 200 m³ loaded and hauled to mill @ $5/m³ 1,000
   - 200 m³ scaled @ $0.50/m³ 100
   - other 100
   - 4,000 4,000

2. Indirect Costs
   - Annual rental @ $0.25/m³ of AAC $250
   - Office expenses (estimate) 200
   - Insurance (half of vehicle, and liability) 600
   - Legal and Accounting 1,000
   - Association Dues (Woodland Association, etc.) 150
   - Travel, Accommodation, Meals (estimate) 300
   - Subscriptions (publications, etc.) 100
   - Other 100
   - 2,700 2,700

3. Stumpage
   - 200 m³ @ $8/m³ 1,600

4. Forest Management
   - Engineering (estimate) $500
   - Cruising and Inventory nil
   - Mapping nil
   - Management and Development Plans nil
   - Protection (estimate) 500
   - Site Supervision (estimate) 1,000
   - 2,000 2,000

5. Silviculture
   - Cone Collection $100
   - Seed Extraction and Storage 100
   - 200 200

6. Capital Costs
   - Roads – 1 km @ $10,000/km $10,000
   - Forestry survey equipment 1,000
   - Office equipment 500
   - 11,500 11,500

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YEAR 1 CASH FLOW ESTIMATE ($14,000)

* prorated and charged for Crown land portion of Woodlot Licence. If the Woodlot Licence has private land included, there would also be an allowance for property taxes (see the chapter “Stumpage And Taxes”).

At the end of Year 1, the Year 2 budget is adjusted and updated with any changes in plans, and also the budgets for the third, fourth and fifth years. At this time another budget year will be added to the Business Plan (on the basis of the new year added to the five-year Development Plan).
## YEAR 2

### Revenues
- 2,000 m³ of logs from Management Area 2 @ $40/m³  
  $80,000
- 20 cords of firewood @ $60/cord (delivered)  
  $1,200
- Cedar boughs and floral material (estimate)  
  $300
  **Total Revenues**  
  $81,500

### Costs

#### 1. Direct Logging Costs
- 2,000 m³ felled & bucked @ $3.50/m³  
  $7,000
- 2,000 m³ skidded to landing @ $8/m³  
  16,000
- 2,000 m³ loaded and hauled to mill @ $7.50/m³  
  15,000
- Landings and Skid Roads (estimate)  
  4,000
- Scaling: 2,000 m³ @ $0.50/m³  
  1,000
- Slash Disposal – 5 ha @ $300/ha  
  1,500
  **Total Direct Logging Costs**  
  $44,500

#### 2. Indirect Costs
- Annual rental @ $0.25/m³ of AAC  
  $250
- Office expenses (estimate)  
  200
- Insurance (half of vehicle, and liability)  
  600
- Legal and Accounting  
  1,000
- Association Dues (Woodland Association, etc.)  
  150
- Travel, Accommodation, Meals (estimate)  
  300
- Subscriptions (publications, etc.)  
  100
- Other  
  100
  **Total Indirect Costs**  
  2,700

#### 3. Stumpage
- 2,000 m³ @ $8/m³  
  16,000
- 20 cords firewood @ $1.50/cord  
  30
  **Total Stumpage**  
  16,030

#### 4. Forest Management
- Engineering  
  nil
- Cruising and Inventory (estimate)  
  1,000
- Mapping (estimate)  
  500
- Management and Development Plans  
  nil
- Protection (estimate)  
  500
- Site Supervision (estimate)  
  2,000
  **Total Forest Management**  
  4,000

#### 5. Silviculture
- Site Preparation - 5 ha @ $200/ha  
  1,000
- Sowing Request (5000 seedlings) advance payment  
  250
- Silvicultural Survey (estimate)  
  500
  **Total Silviculture**  
  1,750

#### 6. Capital Costs
  nil

### YEAR 2 CASH FLOW ESTIMATE

<table>
<thead>
<tr>
<th>Items</th>
<th>Revenues</th>
<th>Direct Costs</th>
<th>Indirect Costs</th>
<th>Stumpage</th>
<th>Management</th>
<th>Silviculture</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>81,500</td>
<td>44,500</td>
<td>2,700</td>
<td>16,030</td>
<td>1,750</td>
<td>nil</td>
<td>12,520</td>
</tr>
</tbody>
</table>

The budgets for the third, fourth, and fifth years will continue in this format, but with less detail.
### YEAR 3

**Revenues**
- 1,000 m$^3$ of sawlogs @ $40/m^3$ $\quad \quad $40,000
- 30 cords of firewood @ $60/cord $\quad \quad $1,800
- Cedar boughs and floral material (estimate) $\quad $200

**Costs**
1. Direct Logging Costs $\quad $20,000
2. Indirect Costs $\quad $3,000
3. Stumpage $\quad $8,000
4. Forest Management $\quad $4,000
5. Silviculture (includes 5 ha plantation @ $800/ha) $\quad $4,000
6. Capital Costs $\quad $1,000

**YEAR 3 CASH FLOW ESTIMATE** $\quad $2,000

### YEAR 4

**Revenues**
- 1,000 m$^3$ of sawlogs @ $40/m^3$ $\quad $40,000
- 30 cords of firewood @ $60/cord $\quad $1,800
- Cedar boughs and floral material (estimate) $\quad $200

**Costs**
1. Direct Logging Costs $\quad $20,000
2. Indirect Costs $\quad $3,000
3. Stumpage $\quad $8,000
4. Forest Management $\quad $2,000
5. Silviculture (includes 2.5 ha plantation @ $1200/ha) $\quad $3,000
6. Capital Costs $\quad $1,000

**YEAR 4 CASH FLOW ESTIMATE** $\quad $5,000

### YEAR 5

**Revenues**
- 1,000 m$^3$ of sawlogs @ $40/m^3$ $\quad $40,000
- 30 cords of firewood @ $60/cord $\quad $1,800
- Cedar boughs and floral material (estimate) $\quad $200

**Costs**
1. Direct Logging Costs $\quad $20,000
2. Indirect Costs $\quad $3,000
3. Stumpage $\quad $8,000
4. Forest Management (includes new Working Plan) $\quad $5,000
5. Silviculture (includes 5 ha plantation @ $400/ha) $\quad $3,000
6. Capital Costs $\quad $1,000

**YEAR 5 CASH FLOW ESTIMATE** $\quad $2,000
How Do I Handle Non-Cash Items?
In most cases you won’t. The calculations of depreciation, depletion, and amortization can be complex, and are best left to an accountant.

Depreciation is the reduction in the value of assets, resulting from their use. Accounting systems allocate the decline in value over the asset’s projected economic life, by ‘writing off’ either equal amounts or a fixed percentage of the declining balance each year. Depreciation is applied to your capital goods such as vehicles, forestry equipment, or office equipment.

Depletion is an income tax allowance reflecting the purchase price paid for merchantable timber, usually on fee simple land. It is realized as trees are harvested.

Amortization is the income tax allowance for capital projects such as the construction of roads, bridges, or buildings. It is realized annually.

Some woodland situations where these concepts may be applied to your income tax return include:

1. Purchase of a fee simple property with merchantable timber on it.
   Part of the purchase price may be allocated to the timber, in which case you can claim ‘depletion’ as the timber is removed.

2. Purchase of a Woodlot Licence.
   The purchase may be treated as a ‘timber resource property’ under the Income Tax Act (see the chapter “Stampage And Taxes”). If so, you will be entitled to claim as an annual expense, 15% of the declining balance of the purchase price.

3. Purchase of a fee simple property with roads or bridges.
   You may be able to allocate part of the purchase price to improvements, such as roads and bridges. If so, you will be entitled to claim an annual amortization expense, usually 8% of the declining balance.

4. Purchase of equipment.
   If you purchase logging or office equipment whose useful life is in excess of one year, and which may be used primarily in connection with your woodland or woodlot, depreciation expenses may be claimed. The amount depends on many factors, so call in your accountant regarding capital cost allowances.

Interest Expense
Interest expense is usually segregated for working capital (line-of-credit) loans and for longer-term capital, equipment, or mortgage loans. As the treatment of interest expense will vary according to a person’s other income and cash requirements, it is not included here, although it could be listed under Indirect Costs.

Beyond The Balance Sheet

The Business Plan and the Accounting System provide the tools to make financially successful decisions. First, they will help you define your financial targets and the means by which you will finance and achieve them. Secondly, they will help you keep track of how you are doing, and make the best next decision based on the available resources and expected results.

In planning specific management activities, such as spacing, thinning, or planting, it is helpful to consider the costs and potential returns from each treatment in order to determine the best investments with the funds you have available. Unfortunately, not all the tools exist yet to help you do this easily. The forest industry in British Columbia has been built on old growth forests, and there is still much to learn about the establishment, tending, and protection of second growth stands.

In the introduction to this Handbook, small-scale forestry was described as “something of a new frontier in B.C.” This means that there will be situations where you can’t find all the answers to your questions. Your attitude towards your woodland operation will be an extremely important factor in running it as a business. You must be prepared to learn as you go, and remember that the benefits of small-scale woodland management extend beyond the balance in the bank account at the end of each year.
Recommended References:

_B.C. Ministry of Economic Development_
“Preparing A Business Plan”
“Preparing A Cash Flow”

_Bank of Montreal_
“Small Business Problem Solver Series”

_Oregon State University Extension Service_
“Forestry Financial Analysis II: Worksheets for How-to-Do-It”. Extension Circular 1147
“Forestry Financial Analysis III: How to Compare Two (or More) Investments”/ Extension Circular 1148

_School Services Canada_
Computer Games for Apple Computers:
“Forest Management”
“Dispatcher”
“Integrated Resource Management”
### 1983 Account Records

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A ssistance can mean almost anything from direct funding, to cost-sharing, to information and training, to plain old good advice. In managing your woodland property you may need financial and technical assistance, and possibly training in some areas to learn how to do things yourself. In many cases, you will also need professional help to do such things as design a road, conduct an inventory, or prepare a Forest Management Plan.

This chapter has been organized according to the type of assistance available: financial, technical, or training. The programs identified cover many types of help, including assistance for forestry activities, the development of business plans, and small business equipment purchases.
Getting Help

Where Do I Begin To Look For Help?

Help is available from a number of provincial and federal agencies as well as through local Woodland Associations and consultants. To help you identify where to go for specific types of help, the table below summarizes the agencies and programs offering assistance of interest to small-scale woodland operators in 1988.

As governments and priorities change, the focus and form of assistance programs offered by them often change as well. The specific programs listed here may no longer be offered by the time you read this, but the agencies themselves will still be a good place to start. It is possible that the agencies responsible for these programs may provide similar programs in the future. If the particular program you are interested in no longer exists, ask if there is similar assistance available from another organization.

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<th>Technical</th>
<th>Training</th>
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<td>Indian Reserve</td>
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<td></td>
<td>BCDC</td>
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</tr>
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Key to Agencies and Programs:

- FIT: Forestry JobTrac
- MOFL: Ministry of Forests and Lands
- PFLP: Private Forests Program
- IFLP: Indian Forest Lands Program
- NEDP: Native Economic Development Program
- ARDA: Special Agricultural and Rural Development Agreements
- INAC: Indian and Northern Affairs Canada
- ICHRDS: Indian Community Human Resources Development Strategy
- FBDB: Federal Business Development Bank
- EIC: Employment and Immigration Canada
- MED: Ministry of Economic Development
- BCDC: British Columbia Development Corporation
- DRIE: Department of Regional Industrial Expansion
- CJS: Canadian Jobs Strategy
Financial Assistance

Canada-B.C. Forest Resource Development Agreement (FRDA) 1985-1990
- Private Forest Lands Program (PFLP)
- Indian Forest Lands Program (IFLP)
Both programs are administered by the Canadian Forestry Service.
Eligibility:
- lands to be kept under forest management for a minimum of 15 years
- minimum of 20 contiguous hectares of productive or potentially productive forest land (may be satisfied by a collective of owners with adjoining lands)
- the programs will contribute up to 80% of project costs for conducting forest inventories, developing forest management plans, backlog reforestation and intensive forest management activities as set out in the management plan
- NOTE: participation in this program may affect provincial and federal tax status of applicant’s private lands and personal income

Dept. of Regional Industrial Expansion (DRIE)
(Department of Industry, Science and Technology)
- Native Economic Development Program (NEDP) to March 31, 1989
- direct financial assistance to Indian-owned businesses
- funding is available to individuals ($100,000 limit); partnerships ($200,000 limit); companies and cooperatives
- Special Agricultural and Rural Development Agreements (ARDA)
  - small business development assistance for commercial ventures ($250,000 limit)
- Business Improvement Loans
  - loans arranged through local Chartered Bank or designated Credit Union for purchase of equipment ($100,000 limit)

Indian and Northern Affairs Canada (INAC)
- Indian Business Loan Fund
  - lender for equipment purchases
- Indian Community Human Resources Development Strategy
  - project-specific funding for Band members to create employment on Reserves
  - each application is judged on its own merits; projects must be completed within one fiscal year
  - appropriate for forestry projects e.g. stand tending

Federal Business Development Bank (FBDB)
- financing for equipment purchases (manufacturing and logging) by incorporated businesses

Employment and Immigration Canada (EIC)
- Section 38 of the Unemployment Insurance Act
  - UI top-up program to employ UI recipients for as long as they are receiving UI benefits. Employer is paid an overhead allowance for each participant in the program to cover program expenses such as equipment
  - limited to finite project
  - can be used by woodland operators to hire people for specific tasks, e.g. stand tending
- Business Development Centres
  - Centres throughout B.C.
  - business counselling, technical assistance and loans or loan guarantees to small businesses
- Community Futures Program
  - loans (to $75,000) for equipment purchases
- Canadian Jobs Strategy (CJS)
  - many different programs; some provide wage subsidies for practical work experience (such as silviculture, or tree planting, milling, etc.) for the unemployed and those on social assistance (See section on Training)
  - appropriate for subsidizing forestry crews
Ministry of Economic Development (MED)
- Small Manufacturer’s Incentive Program
  - interest-free loans (to $50,000) to encourage establishment, expansion, or modernization of wood products processing facilities
- Small Business Venture Capital Program
  - funding for purchase of manufacturing and processing equipment (sawmilling, fence post manufacture, etc.). Will consider logging equipment provided a business and marketing plan are submitted

Ministry of Forests and Lands (MOFL)
- Forestry JobTrac (FJT)
  - applicable to Woodlot Licences and private land within a Woodlot Licence
  - employment program for a minimum of 5 social assistance recipients for 4-6 months on silviculture projects. Sponsor receives an overhead allowance for each participant, to cover operating costs
  - labour can be used for brushing and any basic or intensive forestry practice that is not an obligation of the Licensee. Other activities will also be considered
  - this is the only source of funding for Crown lands in Woodlot Licences
- Research
  - application to the Research Branch of the Regional Office for research proposals

B.C. Development Corporation (BCDC)
- Industrial Development Assistance Program
- Low Interest Loan Assistance Program
  - both programs provide funds for the purchase of sawmilling and other processing equipment (e.g. fence post manufacturing equipment)

Technical Assistance

Federal Business Development Bank (FBDB)
- Case Counselling Services
  - retired professionals do a needs analysis and act as advisors at low cost

Indian and Northern Affairs Canada (INAC)
- District Superintendent of Economic Development
  - assistance in preparing a business proposal and business plan

Canada - B. C. Forest Resource Development Agreement (FRDA) 1985-1990
- Private Forest Lands Program (PFLP)
- Indian Forest Lands Program (IFLP)
Both programs are administered by the Canadian Forestry Service.
  - assistance in developing applications and preparing proposals for an inventory and development of a forest management plan is available from a C.F.S. Development Officer
  - assistance available for conducting forest inventories; development of forest management plans; backlog reforestation and intensive forest manage-
agement activities as set out in forest management plan
- **NOTE**: participation in this program may affect provincial and federal tax status of applicant's private lands and personal income

**Canadian Forestry Service (CFS)**
- Information Services
- Insect and Disease identification

**Ministry of Forests and Lands (MOFL)**
- Extension Services
  - provided to Woodlot Licensees
  - assistance in preparation of the Management and Working Plan
- marking of trees for harvest
- information material

**Ministry of Economic Development (MED)**
- Business Information Centre
  - Vancouver: Resource library and video library
  - Free counselling regarding starting or expanding a business

**Other Sources of Technical Assistance**
- Professional technical assistance is provided by private consulting firms. Check with your local Woodland Association, MOFL District Offices, the Yellow Pages, or contact the Consulting Foresters of B.C. (reference at the end of the chapter) for a listing of consultants in your area

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**Training Opportunities**

**Federal Business Development Bank (FBDB)**
- Seminar programs and training in business management

**Employment and Immigration Canada (EIC)**
- Canadian Jobs Strategy (CJS)
  - many different programs that offer a combination of training, retraining and work experience
  - Skill Shortages: assistance to train current and new employees in new skills
  - Skill Investment: retraining of employees to adjust to changes in technologies and markets
  - Job Entry: training to assist students in making transition from high-school to work; retraining for women returning to the labour market after homemaking; summer work experience for students
  - Job Development: training and practical work experience for long-term unemployed and those on social assistance
  - used by Indian Bands to provide training and work experience to unemployed Band members
  - appropriate for woodland operators wanting to set up forestry crews for stand tending, tree planting, and logging activities
Ministry of Economic Development (MED)

- Business Information Centre
  - Vancouver: Resource Library and video library. Free counselling regarding starting or expanding a business.
  - Victoria office open 2 days per week. Elsewhere, operated through local Chamber of Commerce offices. Videos and information packages on starting a business and the preparation of a cash flow sheet and business plan.

Other Sources of Training

A variety of opportunities exists for the small-scale woodland operator to obtain instruction in specific aspects of forest management. Some of the most appropriate instruction for woodland operators is being offered through regionally-established cooperatives or associations of private owners and Woodlot Licensees. Appendix III includes the contact addresses for the existing Woodland Associations.

The British Columbia Institute of Technology in Burnaby and three of the community colleges: College of New Caledonia in Prince George, Malaspina College in Nanaimo, and Selkirk College in Castlegar, provide full-time programs in forest resources technology. They are also the sites for special workshops that may be of specific interest to small-scale woodland operators. The TRAC Program, an open-learning system for trades training, is also offered through the community colleges. Forestry crewperson and tree planting courses have been offered at Cariboo College (Kamloops) and Malaspina College (Nanaimo). Courses for forestry worker skills are offered at community colleges throughout the Province. Community colleges also offer programs at nightschool or on a continuing education basis. With the current interest in small businesses, you will likely find courses on establishing and managing a business, bookkeeping, or marketing.

Apprenticeship programs are offered through a three-party agreement involving an employer, the Ministry of Advanced Education and Job Training, and the apprentice.

The Council of Forest Industries of B.C. sponsors courses in lumber grading and lumber tallying. The lumber grading courses for all species are offered annually (January – April); the cedar grading course is offered September – November. The Interior Lumber Manufacturing Association and Cariboo Lumber Manufacturing Association also run lumber grading courses. The tallying course is conducted by correspondence.

A number of private trade schools also provide forestry courses. Lorax Forestry Ltd. offers courses relating to woodlot management and operating a small forestry business as well as a silviculture field worker certificate program. The Silviculture Institute of B.C. offers advanced courses in silviculture to professional foresters.

Check also at the District Offices of the Ministry of Forests and Lands – special workshops, seminars, and short courses on protection and other special topics are offered from time to time.
<table>
<thead>
<tr>
<th>Institution</th>
<th>Address</th>
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<tbody>
<tr>
<td>B.C. Development Corporation</td>
<td>Business Finance Division 272 Granville Square, Vancouver V6C 1S4</td>
<td>689-8411</td>
</tr>
<tr>
<td>B.C. Institute of Technology</td>
<td>3700 Willingdon Ave., Burnaby V5G 3H2</td>
<td>434-5734</td>
</tr>
<tr>
<td>Malaspina College</td>
<td>900-5th Street, Nanaimo, V9R 5S5</td>
<td>753-3245</td>
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<tr>
<td>Selkirk College</td>
<td>Box 1200, Castlegar, V1N 3J1</td>
<td>365-7292</td>
</tr>
<tr>
<td>College of New Caledonia</td>
<td>3330-22nd Ave., Prince George V2N 1P8</td>
<td>562-2131</td>
</tr>
<tr>
<td>B.C. Ministry of Economic Development</td>
<td>Programs &amp; Business Development Suite 140, Robson Square 800 Hornby St., Vancouver, V6Z 2C5 Business Information Centre P.O. Box 19, 750 Pacific Blvd. South Vancouver, V6B 6E7 or local Chamber of Commerce</td>
<td>660-4084</td>
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<tr>
<td>B.C. Ministry of Forests and Lands</td>
<td>1450 Government Street, Victoria V8W 3E7</td>
<td>387-3255</td>
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<td>- Regional and District Offices</td>
<td>see Appendix III</td>
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</tr>
<tr>
<td>Canadian Forestry Service</td>
<td>Pacific Forestry Centre 506 W. Burnside Road, Victoria V8Z 1M5</td>
<td>388-0600</td>
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<tr>
<td>Consulting Foresters of B.C.</td>
<td>Assn. of B.C. Professional Foresters, 510 - 744 W. Hastings St., Vancouver, V6C 1A5</td>
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<tr>
<td>Council of Forest Industries</td>
<td>1500-1055 W. Georgia St., Vancouver, V6E 2H1</td>
<td>684-0211</td>
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<tr>
<td>Dept. of Regional Industrial Expansion</td>
<td>P.O. Box 49178, Bentall IV 1101-1055 Dunsmuir St., Vancouver, V7X 1K8</td>
<td>661-2204</td>
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<tr>
<td>Employment &amp; Immigration Canada</td>
<td>For program information, see your local Canada Employment Centre</td>
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<tr>
<td>Federal Business Development Bank</td>
<td>5th floor - 900 W. Hastings St., Vancouver, V6C 1E7 and local offices throughout Province</td>
<td>666-7850</td>
</tr>
<tr>
<td>Indian and Northern Affairs Canada</td>
<td>B.C. Region 800 Burrard Street, Vancouver V6Z 2J3</td>
<td>666-5121</td>
</tr>
<tr>
<td>Lorax Forestry Ltd. (private institution)</td>
<td>9800 - 140th Street, Surrey V3T 4M5</td>
<td>581-4416</td>
</tr>
<tr>
<td>Ministry of Advanced Education and Job Training</td>
<td>offices throughout Province 1-800-742-6117</td>
<td></td>
</tr>
<tr>
<td>Silviculture Institute of B.C.</td>
<td>9800 - 140th Street, Surrey V3T 4M5</td>
<td>581-2524</td>
</tr>
<tr>
<td>TRAC</td>
<td>contact local community college</td>
<td></td>
</tr>
<tr>
<td>Woodland Associations</td>
<td>see Appendix III</td>
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</tr>
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</table>
Depending on the type of land on which you operate, you will be required to pay different forms of user fees for your woodland activities. These may include annual rents and taxes on the land, stumpage fees for the timber cut, taxes on the products, and federal and provincial income taxes.

This chapter will help you to sort out your obligations in the various tax categories. Since some of the categories discussed do not have clear regulations concerning woodland properties, and decisions may be based on interpretation, you are advised to obtain a good tax accountant once your woodland plans are clear.
Stumpage And Taxes

What Charges Will I Pay The Government?

Part of managing a woodland business is administration. As a Woodlot Licensee or woodland owner, you will face a variety of taxes and other levies on the products you produce and the revenue you generate from your woodland property.

For Crown lands, you will pay stumpage, the B.C. Logging Tax, and an annual rent based on the amount of timber you are entitled to cut. For private lands, you will be charged property tax (which includes a fee for the land and a fee for the timber cut from it) and the B.C. Logging Tax. In addition to these charges, you must also pay income tax on the revenues you generate from your woodland. Each of these payments is discussed more fully in the following sections.

Stumpage

Stumpage is the price that is paid to the provincial government for timber harvested from Crown land. Very simply, each log removed from the forest will have a value that varies according to its species, size, quality and geographical location. The amount of stumpage that is charged for the timber depends upon the appraised value of the wood.

"Stumpage appraisal" is the process by which the stumpage to be charged for any given stand is calculated. The government sets an annual stumpage target (revenue) for its forested Crown lands. This total "bill" is divided up among the operators in the industry according to the relative value of the stands of timber being logged. In general terms, the Ministry of Forests and Lands estimates the value (selling price) of the products that can be recovered from a stand, and subtracts the harvesting (operating) costs from this to obtain a net value for the stand. This amount is used to determine the stumpage rate that will be charged to the operator. The stumpage rate is revised periodically to reflect changes in relative values.

An operator with high quality stands or a valuable mix of species will pay a higher average stumpage charge than an operator with an area of poor quality timber, or lower value species. Operating conditions affect the amount of stumpage charged as well, so that operators working in tougher, more costly conditions will pay a lower stumpage charge than operators working in easier terrain (all else being equal). The details of the stumpage appraisal process are discussed in the applicable Coast or Interior Appraisal Manuals (references at the end of the chapter).

For special forest products and deciduous species, the stumpage pricing system is somewhat different. A schedule of minimum rates is set by the Ministry of Forests and Lands for these categories. Rates may be adjusted according to regional differences. For a current schedule of rates, consult the current "Coast Log-Based Appraisal Manual" and "Interior End-Product Appraisal Manual", at local District Offices of the Ministry of Forests and Lands.

Royalties

Royalties are not currently applicable to Woodlot Licences, Indian Reserves or private land.

Rent

Woodlot Licences are subject to an annual rent of $0.25 per cubic metre of allowable annual cut (AAC) attributed to Crown land.

Property Taxes

Assessment Act, Sections 1 and 29,
B.C. Reg. 349/87 Forest Land Regulation
B.C. Reg. 438/81 Prescribed Classes of Property Regulation
B.C. Reg. Land and Cut Timber Values Regulation
Taxation (Rural Area) Act

The following discussion is a brief overview of private land assessment in British Columbia. For further details you are advised to contact the B.C. Assessment Authority. The local Assessor, whose address is found on your assessment notice, should be able to help you directly or will redirect you to someone who can. All private land used for forestry purposes is subject to assessment and taxation. The B.C. Assessment Authority is responsible...
for the assessment of private lands in the Province. It classifies private lands into property classes, including: residential, utilities, industrial, business, recreational property, farm, unmanaged and managed forest land.

Under the Assessment Act, before a property can be eligible for classification as “unmanaged” or “managed” forest land it must first qualify as ‘forest land’, by having as its ‘highest and best use’, the growing and harvesting of trees. This is determined by the Area Assessor, based on the capability of the land and the projected economic returns from its potential uses. For instance, if the land parcel is within the boundaries of, or close to, a major population centre, its highest economic use may be determined to be residential, despite the owner’s desire to use it for forestry. In this type of situation the owner may, of course, use the land as he wishes, however, if its classification is deemed to be residential by the Assessor, then it is residential taxes that will be levied on the property. Private land previously held as ‘tree farm land’ under the Assessment Act is now classified as forest land.

Owners of land meeting the ‘forest land’ requirements may apply to have the land classified as ‘managed forest land’. If they do not apply, or are unsuccessful in meeting the standards required, the land will be classified as ‘unmanaged forest land’. Managed forest land has a lower general rate of taxation than unmanaged forest land.

Applications for classification as managed forest land are made by submitting a special form, available from the Assessment Office, accompanied by a Forest Management Plan for the area. Where the land in the application, along with any other of the owner’s land already classified as managed forest land is less than 100 hectares, the application form may be used as a short form Forest Management Plan. Applications must be submitted prior to June 1 of each year where managed forest land status is desired by the following September 30. The application is reviewed by the Assessor with the advice of a registered professional forester on the Assessment Authority’s staff.

Once managed forest land status has been assigned to a parcel of land, the owner is required to meet certain obligations to maintain this classification. These are set out in the “Forest Land Regulation” and include the submission of an annual report summarizing the volume and areas harvested or damaged, by species and grade, and the progress made towards implementing the Forest Management Plan. If these obligations are not fulfilled, the land may lose its managed forest land status and be reclassified as unmanaged forest land.

All forest land not qualifying for managed forest land status is classified as unmanaged forest land. The landowner should be aware of an important distinction between these two classifications. Unmanaged forest land is vulnerable to reclassification if the highest and best use conditions of the parcel change. For instance, if a community’s boundaries grew to include this parcel of land, then its ‘highest and best use’ might change from forest land to residential, and the parcel may be reclassified by the Assessment Authority. Once a parcel of land has been classified as managed forest land, however, this status (and tax advantage) can be maintained so long as the owner continues to meet the obligations set out in the Forest Management Plan and the required annual reports, regardless of any change in its ‘highest and best use’. If either of these obligations are not met, the land will be reclassified as unmanaged forest land.

In addition to the classification of these lands, the B.C. Assessment Authority is also responsible for their valuation. All forest land, that is, both unmanaged and managed, is valued using the same method. The valuation has two parts: the value that the land has for the purpose of growing and harvesting trees, and the value for the timber cut from the land. The land value is based on consideration of its topography, accessibility, soil quality, parcel size and location, according to a yearly schedule of “Land and Cut Timber Values” set by the Assessment Commissioner. The value of the timber cut is based on the species and grades of logs and the area of the Province in which the timber is harvested. The Assessment Authority annually publishes timber values for the Coast and Interior which are used for assessment purposes.

All owners of forest land are required to submit an annual harvesting return. The value of the timber for the calendar year during which it is cut is added to the land value for the next assessment year. For example, the value of cut timber in the calendar year of 1987, is added to the land value for 1988, and appears on the assessment notice for
1989 (issued in September 1988). This assessed value of the property (incorporating both land and cut timber values) can be appealed, prior to the actual tax notice, if the landowner feels it is incorrect.

The property tax notice will then be issued in June 1989. The property tax is calculated by applying a mil rate (i.e. a set charge per $1,000 of land value) to the assessed value of the property. The mil rate varies according to whether the land parcel is in a rural or municipal territory, and whether the land is managed forest land or unmanaged forest land. The rate includes taxes for school, hospital, local improvement, regional district, and other levies.

Buyers Beware
When purchasing private land classified as 'managed forest land', the buyer should check on recent years of harvesting to discover the possible impact on the next property tax notice. (You wouldn't want to be billed for timber cut and sold before you bought the property). Due to the length of time between the earliest possible harvesting and the tax notice based on that harvest, the check should extend back for two years and five months before the next tax notice (June 1st).

Crown land in a Woodlot Licence is exempt from property tax under the Taxation (Rural Area) Act as long as it is being managed for the purpose of growing continuously and harvesting successive forest crops.

B.C. Logging Tax

*Logging Tax Return of Income-Form No. 542*
*T2S-TC Form (Revenue Canada) to calculate the federal logging tax credit*

A Logging Tax of 10% is levied by the Province on the income derived from logging operations (net of harvesting costs and a processing allowance, if applicable) including: the sale of logs and log exports, the sale of standing timber or the rights to cut, or the sale of log products produced from logs acquired by the taxpayer. This logging tax is in addition to the tax on cut timber (assessed by the B.C. Assessment Authority) paid by private landowners.

An outline of the B.C. Logging Tax Act can be obtained from the Commissioner of Income Tax, Ministry of Finance and Corporate Relations, Parliament Buildings, Victoria, V8V 1X4. The outline includes forms on "Calculation of Income Derived From Logging Operations in B.C." and the "Determination of Processing Assets" and explains how to determine the amount of logging tax you must pay. Note that any logging tax you pay is fully deductible from income tax payable under the federal and provincial Income Tax Acts.

Personal Income Tax

*T4 Tax Form: (see section on Self-Employed Earnings)*
*T1 Tax Guide for Income from a Business or Profession*
*IT-373R Farm Woodlots and Tree Farms*
*IT-481 Timber Resource Properties and Timber Limits*

If you own forest land, grow Christmas trees, or have a Woodlot Licence issued by the B.C. Ministry of Forests and Lands, you should be aware of how your forestry activities influence your personal income tax status. Revenue Canada has certain rules concerning how expenses and income are handled on your tax return when they apply to those forestry activities which are carried out with 'a reasonable expectation of profit'. Two Interpretation Bulletins (IT-373R Farm Woodlots and Tree Farms, and IT-481 Timber Resource Properties and Timber Limits) describe the six categories of activities eligible for tax concessions. Addresses of the B.C. Commissioner of Income Tax and Revenue Canada Area Offices are found in Appendix III.

Each of the six categories handles expenses and income differently, so it is important to determine which category your operations come under. The following decision chart will help you to identify where you belong. At tax time, you should check with Revenue Canada to confirm your category of operation and discuss your eligible deductions with an accountant.
On which type of land are your forestry activities being carried out?

<table>
<thead>
<tr>
<th>Private Land</th>
<th>Crown Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is your income from forestry activities secondary to farming? (Category 1)</td>
<td>Is your main activity growing Christmas trees? (Category 3)</td>
</tr>
<tr>
<td>Is your income from forestry activities more than incidental to income from other sources? (Category 2)</td>
<td>Is the area a Woodlot Licence which includes private land? (Category 2)</td>
</tr>
<tr>
<td>Is your main activity growing Christmas trees? (Category 3)</td>
<td>Is the area a Woodlot Licence which contains no private land? (Category 5)</td>
</tr>
<tr>
<td>Is your forestry activity producing no income, but being carried out to produce mature timber in the future? (Category 4)</td>
<td></td>
</tr>
<tr>
<td>Is the land on which you are practicing forestry in a Woodlot Licence? (Category 2)</td>
<td></td>
</tr>
<tr>
<td>Have you purchased the timber or right to cut it, or the title of the land along with the timber? (Category 6)</td>
<td></td>
</tr>
</tbody>
</table>

**Category 1: Farm Land Which Includes a Woodlot**

Woodlots (not a Woodlot Licence) that provide a secondary (lesser) income than from farming activities.

- Proceeds from the sale of logs, lumber, poles, firewood and Christmas trees are considered income from farming.
- Costs of reforestation are deductible in computing farm income.
- Income received from selling standing timber or right to cut is deducted from the total cost of purchasing the property to obtain an adjusted cost base for the property. If the revenue is greater than the cost base, a tax on the capital gains may be levied.

**Category 2: Farmers as Woodlot Operators**

Woodlots (including Woodlot Licences) owned by farmers where income from annual cutting of timber is greater than income from other farming activities.

- The combined operation of logging and farming is considered farming if the business income is handled by the cash method (i.e. income is declared in the year received and expenses are declared in the year paid).
- Proceeds from the sale of logs, lumber, poles, firewood and Christmas trees are considered income from farming.
- Costs of reforestation are deductible by the cash method (as above) in computing farm income.

**Category 3: Plantation Christmas Tree Farms**

The growing of Christmas trees on private and Crown land, carried out with a reasonable expectation of profit.

- Planting, tending, and harvesting of Christmas trees is regarded as a farming business.
- Income should be declared by the cash method (income is declared in the year received, and expenses are declared in the year paid). If other farm income is being earned as well, then Christmas tree accounts should be reported on an accrual basis (income is declared in the year earned, but not received in the form of payment, and expenses are reported in the year incurred, but not paid).
- Costs of purchasing and planting trees are deductible in the year carried out if income is being reported on a cash method. If income is being reported on an accrual basis, then these are added to the value of the stock (otherwise referred to as the inventory).
- If the Christmas Tree Farm is purchased, no part of the purchase price may be deducted as a cost of the
trees unless the trees are valued separately, in which case they would be treated as above.

- Annual expenses, such as pruning, cultivating, and property taxes, are deductible in the year paid or incurred but cannot be added to the inventory.
- Proceeds from the sale of trees are reported as income. Where the land and trees are sold as a unit, and the trees are not listed as a separate price, no part of the proceeds is reported as income.
- Where no sales of trees are reported by the sixth year after planting (depending on local conditions), the operation becomes a form of ‘forest planting’ (Category 4) and reassessments of prior years may be made.

**Category 4: Forest Planting**
Applies to taxpayers not engaged in a lumbering or logging business who undertake reforestation with the objective of producing mature trees in the future (40 or 50 years or longer).

- The reforestation project is undertaken in a systematic and business-like manner according to good forestry procedures, and holds the prospect of profit when the trees mature. This activity is considered to be farming.
- Apart from revenue from thinning, no revenue is anticipated until the trees are mature.
- In the meantime, recurring costs for property taxes, planting, fertilizing, thinning, etc., may be deducted as a business loss up to $2,500 plus 50% of additional losses up to a maximum deduction of $5,000.

*Note:* Contributions from assistance programs such as the FRDA Private Forest Lands Program would be deductible either from expenses (to reduce business losses) or added to personal income. Private lands subject to a Forest Management Plan may also qualify for this category, even though reforestation may not be undertaken in the first few years.

**Category 5: Woodlot Licences Consisting Solely of Crown Land**

- If a Woodlot Licence is sold, the proceeds of the sale are treated as income rather than capital gain.
- Income and expenses are declared by the accrual method.

**Category 6: Timber Limit**
Applies to the purchase of timber, or non-renewable rights to cut, on private land with or without purchasing the title to the land.

- As the timber is harvested, a capital cost allowance can be applied against the cost of acquiring the timber if such a cost is paid ‘up front’. This capital cost allowance does not apply to situations where the owner is being paid for the timber on a stumpage (pay as cut) basis. If the timber, or right to cut timber, is sold, the sale could be taxed as a capital gain.
- Income and expenses are declared by the accrual method.

**How To Handle Funds From Assistance Programs**

You should be aware of how contributions from assistance programs, such as the Private Forest Lands Program are treated in the income tax return. If you use such contributions to pay yourself to carry out silvicultural work, then you must declare them as employment income. On the other hand, if you hire a contractor, the assistance can be deducted from operating expenses.

Income tax returns for sole proprietorships and partnerships require a financial statement which clearly indicates the share held by each member. An example of the required financial statement is given in the “Tax Guide for Income from a Business or Profession”, available from Revenue Canada Taxation Offices. Each member submits a copy of the statement with his personal income form and completes the ‘self-employed’ portion of the return according to his share in the partnership. The financial statement should show income from the Private Forest Lands Program, as well as funds from other sources. A limited company must complete a corporate return, showing income from funding sources such as the Private Forest Lands Program.
Recommended References:

**B.C. Ministry of Forests and Lands**
- "Coast Log-Based Appraisal Manual"
- "Interior End-Product Appraisal Manual"

**B.C. Ministry of Finance and Corporate Relations**
- "British Columbia Logging Tax Act"

**Crown Publications Inc., Victoria**
- "Assessment Act"
- B.C. Reg. 349/87 "Forest Land Regulation"
- B.C. Reg. 438/81 "Prescribed Classes of Property Regulation"
- B.C. Reg. "Land and Cut Timber Values Regulation"
- "Taxation (Rural Area) Act"

**Revenue Canada**
- Personal Income Tax Forms T4 and T1
- Interpretation Bulletin IT-373R "Farm Woodlots and Tree Farms"
- Interpretation Bulletin IT-481 "Timber Resource Properties and Timber Limits"
Appendix I - Glossary

Forestry, like any profession, has special terms (and meanings for some common words, such as 'crown' and 'chain') to describe its practices. Often there are formal definitions and less formal definitions in use, and in some cases, there are many levels of definition to specific terms.

The glossary that follows has tried to define as simply as possible the forestry terms used in this Handbook. The definitions are more explanatory than definitive, and are not always comprehensive. More formal definitions can be found in several of the manuals (Silviculture, Policy, Inventory, Protection) produced by the Ministry of Forests and Lands.

Additional recommended reference glossaries include:

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advanced regeneration: Trees that have become established naturally under a mature forest canopy and are capable of becoming the next crop after the mature crop is removed.
adverse slope: An uphill incline for hauling or skidding of logs or other loads.
aerial photography: Photos taken from the air at regular intervals that are used in photo interpretation to provide much information about forests and landforms.
age class: Any interval into which the age range of trees, forests, stands or forest types is divided for classification and use. Forest inventories commonly group trees into 20-year age class groups.
agro-forestry: The practice of raising trees and agriculture products such as forage and/or livestock on the same area, at the same time.
allowable annual cut (AAC): The average volume of wood which may be harvested annually under sustained yield management. Roughly equal to the amount of new growth produced by the forest each year including a proportion of the mature volume less deductions for losses due to fire, insects and disease.
amortisation: A procedure by which the capital cost of projects, such as roads or bridges, is written off over a longer period as the timber volumes developed by the projects are harvested and extracted.
artificial regeneration: Establishing a new forest by planting seedlings or by direct seeding (as compared to natural regeneration).
azimuth: The horizontal angle or bearing of a point, measured from the true (astronomic) north. Used to refer to a compass on which the movable dial (which is used to read direction) is numbered in 360°. See also bearing.
backlog: A MOFL term applied to forest land areas where silviculture treatments (such as planting/site preparation) are overdue. Planting is considered backlog if more than 5 years have elapsed since a site was cleared (by harvesting or fire) in the Interior and more than 3 years on the Coast.

bareroot seedling: Stock whose roots are exposed at the time of planting (as compared to container or plug seedlings). Seedlings are grown in nursery seedbeds and lifted from the soil in which they were grown to be planted in the field.
basic silviculture: A term used by the MOFL to refer to the silviculture treatments that are carried out to ensure the establishment of a free-growing tree crop. May include: surveying, site preparation, planting, direct seeding, or brushing. Compare with intensive silviculture.
bearing: A direction on the ground or on a map, defined by the angle measured from some reference direction; this may be true (geographic) North, magnetic North, or grid North. Used also to refer to a compass on which the movable dial (used to read direction) is numbered as four 90° quadrants where N=0, S=0, E=90, W=90. See also azimuth.
Biltmore stick: A stick graduated in such a way that the diameter of a standing tree may be estimated when the stick is held across the main axis of the tree, and at a distance from the eye for which the stick is graduated (usually 60 cm).
bioecological classification: The delineation of biotic regions or zones on the basis of vegetation, soils, topography and climate.
biological maturity: In stand management, the age at which trees or stands have peaked in growth rate and are determined to be merchantable. See also rotation age.
blowdown: See windthrown.
broadcast burning: A controlled burn, where the fire is intentionally ignited and allowed to proceed over a designated area within well-defined boundaries, for the reduction of fuel hazard or for site preparation. See also slash burning.
browse: Small bushes, shrubs, trees, and herbs that provide food for wildlife.
brushing: A silviculture treatment to remove brush and weed species which compete with seedlings for sunlight, water, and soil nutrients. See also conifer release.
brush rake: A tool used in mechanical site preparation to penetrate and mix soil and tear roots.
bucking: Cutting a felled tree into specified log lengths.
bud burst: The time at which the buds on trees and other woody plants begin to grow each year. Also known as ‘bud break’ or ‘flushing’.

buffer strip: A strip of land (often including undisturbed vegetation) where disturbance is not allowed or is closely monitored to preserve or enhance aesthetic and other values along or adjacent to roads, trails, watercourses and recreation sites. See also green belt.

Business Plan: A plan identifying markets, customers, expenditures and finances required to carry out the identified ‘business’, based on projected revenues and costs over a specific period of time.

cambium: A single layer of cells between the woody part of the tree and the bark. Division of these cells results in diameter growth of the tree through formation of wood cells (xylem) and inner bark (phloem).

canopy: The forest cover of branches and foliage formed by tree crowns.

chain: A measuring tape, often nylon, 50 or 75 m in length, used to measure distances.

choker: A noose of wire rope used for skidding or yarding logs.

clearcutting: The harvesting of all trees from an area of forest land in a single cut.

climax forest: A forest community that represents the final stage of natural forest succession for its locality, i.e. for its environment. Often identified as those forests that can reproduce indefinitely (i.e. in their own shade).

clinometer: A simple instrument for measuring vertical angles or slopes. In forestry, used to measure distance and tree heights.

close utilization: Maximum stump height of 30 cm; minimum top dib of 10 cm. See also utilization standards.

closed canopy: The description given to a stand when the crowns of the main level of trees forming the canopy are touching and intermingled, and form a barrier to light penetrating the forest floor from above.

codominant: In stands with a closed canopy, those trees whose crowns form the general level of the canopy and receive full light from above, but comparatively little from the sides. In young stands, those trees with above average height growth.

commercial thinning: A silviculture treatment that ‘thins’ out an overstocked stand by removing trees that are large enough to be sold as products such as poles or fence posts. It is carried out to improve the health and growth rate of the remaining crop trees. As compared to juvenile spacing.

coniferous: Cone-bearing trees having needle or scale-like leaves, usually evergreen and producing wood known commercially as ‘softwoods’.

conifer release: To ‘release’ established coniferous trees from a situation in which they have been suppressed, by thinning out undesirable trees and shrubs which have overtopped them. Carried out to improve the growth of the coniferous trees released. See also brushing.

cork: A hard, spore-bearing structure of a wood-destroying fungus, which projects beyond the bark of a tree. See also fruiting body.

contour maps: A topographic map which portrays relief by means of contour lines.

control points: A system of points with established positions or elevations, or both, which are used as fixed references in positioning maps features.

cord: A pile of stacked rough wood, usually 4 ft by 4 ft by 8 ft (1.2 m x 1.2 m x 2.4 m), containing 128 cubic ft. of wood, bark, and air, or approximately 85 cubic ft. of solid wood.

crop tree: A tree in a young stand, selected to be retained until final harvest.

crown: The live branches and foliage of a tree.

Crown land: Land that is owned by the Crown, or Province. Referred to as federal Crown land when it is owned by Canada (e.g. Indian Reserves, Dept. of National Defence Lands).

cruising: The measurement of standing trees on an area to determine the volume and form of wood on that area. Commonly includes the measurement of other resources on the area, such as soil, wildlife, and fisheries.

culvert: A drain or covered channel that crosses under a road to lead the water from the upper to the lower side.

cut bank: The excavated bank from a ditch line to the top of the undisturbed slope of a road.

cutblock: A specific area with defined boundaries, authorized for harvest.

cut period: The interval between major harvesting operations in the same stand.

cutting permit: The document that contains the authority to harvest trees on a Woodlot Licence.

dbh (diameter breast height): The stem diameter of a tree measured at breast height (1.3 metres above the point of germination. On flat terrain, this would be ground level; on sloping terrain, this would be the mid-point of the slope between the upper and lower sides of the tree).

deciduous: Term applied to trees (commonly broadleaf) that usually shed their leaves annually. Also known commercially as ‘hardwoods’.

declination (magnetic): The angle between true (geographic) North and magnetic North (direction of the compass needle). The magnetic declination varies for different places and is ‘set’ on a compass for a particular location to enable magnetic North to be used as a reference point for true North.

defoliator: An insect that damages trees by eating leaves or needles.

depletion: An income tax allowance reflecting the purchase price paid for merchantable timber, usually on fee simple land. Also, a term used to refer to the process of harvesting your growing stock.

depreciation: Reduction in the value of assets, such as equipment and buildings, resulting from their use. Annual income
Appendix I - Glossary

tax allowance for asset depreciation varies with the nature of the asset.

development objectives: The short-term (often 5-year) planning objectives for a specific Management Area.

Development Plan: A specific plan outlining harvesting, road construction, protection and silviculture activities over the short-term (often 5 years) in accordance with the approved Forest Management Plan.

diameter tape: A graduated tape based on the relationship of circumference to diameter, which provides a direct measure of tree diameter when stretched around the outside of the tree, usually at breast height. See also dbh.

dbh (diameter inside bark): The diameter of a tree or log excluding bark thickness.

disc trencher: A machine designed for mechanical site preparation. It provides continuous rows of planting spots rather than intermittent patches of the patch scarifiers. Consists of scarifying steel discs equipped with teeth.

dominant: Trees with crowns extending above the general level of the canopy and receiving full light from above and partly from the side; taller than the average trees in the stand with crowns well developed.

dot grid: A transparent sheet of film (overlay) with systematically arranged dots, each dot representing a number of area units. Used to determine areas on maps, aerial photos, plans, etc.

drag scarification: A method of site preparation that disturbs the forest floor and prepares logged areas for regeneration. Often carried out by dragging chains or drums behind a skidder or tractor.

eye-wood: See springwood.

Environmental Sensitive Areas (ESA): ESAs for forestry include potentially fragile or unstable soils that may deteriorate unacceptably after forest harvesting, and areas of high value to non-timber resources such as fisheries, wildlife, water and recreation.

even-aged: A forest stand or forest type in which relatively small (10-20 year) age differences exist between individual trees. Even-aged stands are often the result of a single regeneration event, such as clearcutting or a seed cutting in the shelterwood method.

extension services: Assistance provided to woodland operators. May include help with the preparation of forest management plans, cutting permits, marking trees for selective cutting and guidance in carrying out slash disposal, site preparation, planting, etc.

favourable slope (or grade): A downhill (i.e. gravity-assisted) incline for hauling or skidding of logs or other loads.

feller-buncher: A harvesting machine that cuts a tree by shears or a saw and then piles it.

felling: The act of cutting down a standing tree.

fertilization: The addition of fertilizer to promote tree growth on sites deficient in one or more soil nutrient elements. Also used to improve the vigour of crop trees following juvenile spacing or commercial thinning.

fill bank: The fill material used to shape a road from the outer edge of the travelled portion to its intersection with the existing ground profile.

fill-in planting: Planting required to supplement poorly stocked natural regeneration or to replace seedlings that have died on previously planted sites.

financial maturity: The age at which a stand of timber offers the maximum return on investment in terms of volume and grade yield.

firebreak: Areas or strips of less flammable fuels that are either natural (such as standing timber or landslides) or are made in advance (such as cat trails or roads), as precautionary measures, separating areas of greater fire hazard.

fire guard: A man-made barrier (often an area cleared of fuels) constructed at the time of a fire to control it and provide a point from which to carry out fire suppression.

Fisheries Sensitive Zones: Aquatic environments important for the life history of fish, including areas which may not be defined as streams. May include: side and flood channels, swamps, seasonally flooded depressions, lake spawning areas or estuaries.

fixed area plot sampling method: A controlled cruise method whereby small plots of a fixed size are used to sample a portion of a forest area to obtain information (such as tree volume) that can be used to describe the whole area.

flagging tape: Coloured plastic tape which comes in rolls and is used to mark (flag) boundaries or identify certain trees or objects.

flushing: See bud burst.

forage: Grasses, small shrubs, and other plant material that can be used as feed for livestock.

forest: A plant community predominantly of trees and other woody vegetation, growing more or less closely together.

forest cover map: A map showing relatively homogeneous forest stands or cover types, produced from the interpretation of aerial photos and information collected in field surveys. Commonly includes information on species, age class, height class, site and stocking level.

forest ecology: The relationships between forest organisms and their environment.

forest inventory: A survey of a forest area to determine such data as area condition, timber volume and species, for specific purposes such as planning, purchases, evaluation, management or harvesting.

forest land (B.C. Assessment Authority): Land having as its highest and best use the growing and harvesting of trees.

forest management cycle: The phases that occur in the management of a forest, including harvesting, site preparation, reforestation, and stand tending.

Forest Management Plan: A general plan for the management of a forest area, usually for a full rotation cycle, including the objectives, prescribed management activities and standards.
to be employed to achieve specified goals. Commonly supported with more detailed Development Plans.

forest renewal: The renewal of a tree crop, whether by natural or artificial means.

forest type: A group of forested areas or stands of similar composition (species, age, height and stocking) which differentiates it from other such groups.

forest type labels: The symbols which are used to code information about forest types on a forest cover map (e.g. site, disturbance, age and height class, species, stocking).

forest type lines: Lines on a map or aerial photo outlining forest types.

free-growing: Young trees that are as high as or higher than competing brush vegetation, with one metre of free-growing space surrounding their leaders.

fruiting body: The reproductive part of a fungus that contains or bears spores. Also known as a conk.

fuelbreak: See firebreak.

fuel management: The activities carried out to modify fuel accumulations (slash) to reduce the chance of ignition and rate of fire spread.

fuelwood: Trees used for the production of firewood logs or other wood fuel.

fungus: A plant that obtains its nourishment through the organic matter of other plants, causing decay.

galleries: Passages carved out under bark or in wood by insects feeding or laying eggs.

girdling: To kill a tree by severing or damaging the cambium layer and interrupting the flow of food between the leaves and the rest of the tree. A method of 'brushing', carried out using a hatchet or special tool to cut through the bark and cambium of the tree.

grading: Classifying timber, lumber or logs according to quality or end-use.

gripple yarder: A machine used in harvesting to bring logs into a landing. The grapple closes like teeth around the log and is controlled by the machine operator.

green belt: A strip of undisturbed soil and vegetation left along waterways or access routes to minimize the environmental impact from development. See also buffer strip.

gross sales: Where the buyer purchases on an area basis, all timber for a fixed price.

gross total volume: Volume of the main stem of the tree, including stump and top. Volume of the stand, including all trees.

habitat: The place where an organism lives and/or the conditions of that environment including the soil, vegetation, water and food.

habitat management: Management of the forest to create environments which provide habitats (food, shelter) to meet the needs of particular species of wildlife, birds, etc.

hack and squirt: A method of conifer release and juvenile spacing where the bark of a tree is cut (hack) and herbicides are injected (squirt) to kill the tree.

harvest cut: The felling of the mature crop of trees, either as a single clearcutting or a series of regeneration cuttings.

harvesting: The cutting and removal of trees from a forested area.

hauling: A general term for the transport of logs from one point to another, usually from a landing to the mill or shipping point.

heartwood: The inner core of a woody stem, composed of nonliving cells and usually differentiated from the outer wood layer (sapwood) by its darker colour.

height class: Any interval into which the range of tree heights is divided for classification and use; commonly 3, 5 or 10 metre classes.

height/diameter curve: A graphic representation of the relationship between individual tree heights and diameters that is used to determine tree volumes for localized areas.

herbicides: Chemicals used to kill vegetation such as brush, weeds, and competing or undesirable trees.

high-grading: The removal from the stand of only the best trees, often resulting in a poor-quality residual stand.

highlead system: Logging system that uses cables rigged to a spar high above the ground so that one end of the logs can be lifted during yarding.

hinge wood: A term used in felling to indicate the portion of the tree that remains uncut, between the backcut and the undercut. Its width and location are used to influence the direction in which the tree falls.

hip chain: A device used to measure distance by running an anchored filament around a wheel which revolves as you walk (handy for measuring distances on your own).

humus: A general term for the more or less decomposed (plant and animal) residues in the upper soil layer.

hypsometer: A simple instrument (often a stick or other straight edge) used to measure the heights of trees on the basis of similar angles.

improvement cutting: The removal of trees of undesirable species, form or condition from the main canopy of the stand to improve the health, composition and value of the stand.

increment borer: A tool used to extract a core of wood from a living tree, for the purpose of studying the annual growth rings of the tree.

incremental silviculture: See intensive silviculture.

increment core: That part of the cross section of a tree extracted by an increment borer. Used to determine tree age and growth pattern.

insecticides: Chemicals used to kill insects.

integrated forest companies: Forest companies that both produce logs and manufacture them into lumber, pulp and other wood products.

integrated resource management: The management of two or more resources in the same general area; commonly includes water, soil, timber, range, fish, wildlife and recreation.

intensive silviculture: A MOFL term that refers to the treatments carried out to maintain or increase the yield and value of forest stands. Includes treatments such as site rehabilita-
Appendix I - Glossary

tion, conifer release, spacing, pruning, and fertilization. Also known as incremental silviculture. Compare with basic
silviculture.

Intermediate trees: Trees shorter than the dominant and co-
dominant trees in a stand, and with crowns below the general
canopy formed by these trees. See also dominant, codomi-
nant, canopy.

Intertree distance: The distance between tree crowns, usually
used in the context of thinning. Recommended guidelines
for intertree distances are established for different thinning
programs depending on the species and age of trees, site
variables and management objectives.

Juvenile spacing: A silvicultural treatment to reduce the num-
ber of trees in young stands, often carried out before the
steams removed are large enough to be used or sold as a forest
product. Prevents stagnation and improves growing condi-
tions for the remaining crop trees so that at final harvest the
end-product quality and value is increased. See also com-
mercial thinning.

Kickback: The sudden and dangerous jump of the butt of a
falling tree as it comes down. Also, the abrupt and dangerous
backward movement of a chainsaw toward the operator,
caused by touching the moving chain at the tip of the
bar to an object when starting to cut.

Landing: The area where logs are collected for loading.

Lateward: See summerwood.

Leave trees: Trees selected to be left on an area following
harvesting or thinning operations for the purpose of contin-
ued growth and/or seed dissemination. See also residual
trees.

Litter layer: The layer of organic debris, mainly bark, twigs and
leaves, on the forest floor.

Logging plan: A schedule of operations for a specific area that
describes in words and on a map how and where harvesting
will take place.

Loss factors: Reductions made to gross volumes to allow for
decay, waste and breakage.

MAI (mean annual increment): The average annual increase
in volume of individual trees or stands up to the specified
point in time. The MAI changes with different growth phases
in a tree's life; being highest in the middle years and then
slowly decreasing with age. The point at which the MAI
peaks is commonly used to identify the biological maturity
of the tree, and its readiness for harvesting.

Managed forest land: Forest land that is being managed under
a forest management plan.

Management Area: Stands or forest types that require similar
management practices and can be grouped for treatment as
a management unit.

Management objectives: The long-term management strate-
gies for a forest area.

map folio: A collection of a series of maps bound together;
often produced as overlays of information, e.g. soils, fish,
water, forest and wildlife.

Merchantable timber: A tree or stand that has attained suffi-
cient size, quality and/or volume to make it suitable for har-
vesting.

Merchantable volume: The amount of sound wood in a single
tree or forest stand that is suitable for marketing under given
economic conditions.

Meridian lines: A north-south reference line often appearing on
maps. Meridian lines are also etched into the bearing plate on
a compass.

Microclimate: Generally, the climate of small areas, especially
insofar as this differs significantly from the general climate
of the region. Stands often create microclimates.

Microsite: A small area which exhibits localized characteristics
different from the surrounding area. For example, the mi-
crosites created by a rock outcrop with thin soils, or the
shaded and cooled areas created on a site by the presence of
slash.

Mil rate: Property assessment based on a set rate per $1,000 of
land value.

Natural regeneration: The renewal of a tree crop by natural (as
compared to human) means, e.g. seed on site, from adjacent
stands, or brought in by wind, birds, animals.

Net present value (NPV): A stand's present worth (before
harvesting) once costs associated with its establishment and
lining have been subtracted.

Net volume: Volume of the main stem, excluding stump and top
as well as defective and decayed wood, of trees or stands.

Non-forest land: Land not primarily intended for growing, or
not supporting forest.

Non-timber resources: Resources other than timber, such as
recreation, aesthetics, wildlife, fish, forage, range, water,
and soils.

NSR (not satisfactorily restocked): Productive forest land
that has been denuded and has failed partially or completely
to regenerate naturally or to be artificially regenerated.

Old growth: A forest of mature or overmature timber that is
beyond its peak growing period.

Operational cruise: An estimate, to a specified degree of
accuracy, of the volume of timber on an area to be harvested.

Overstorey: That portion of the trees, in a forest of more than
one storey, forming the upper or uppermost canopy layer.

Overtopping: Vegetation higher than the favoured species, as in
brush or deciduous species that are shading and suppressing
more desirable coniferous trees.

Per hectare factor: A number used to convert sample plot
information to per hectare information (as in converting the
plot volume to a per hectare volume).

Periodic harvests (periodic cut): The removal of several
years' accumulated AAC in one year or other period.
pest: An organism capable of causing material damage. Forest pests include insects and diseases.
pesticides: A general term for chemicals used to kill either vegetation (herbicides) or insect pests (insecticides).
phloem: A layer of tree tissue, just inside the bark, that conducts food from the leaves to the stem and roots.
pioneer plants: A succession term for plants capable of invading bare sites (e.g., a newly exposed soil surface) and persisting there, i.e., colonizing them, until supplanted by invader or other succession species.
pitch tubes: A tubular mass of resin that forms on the surface of bark at bark-beetle entrance holes.
pith: The central core of a stem and of some roots, representing the first year of growth and consisting mainly of soft tissue.
plot: A carefully measured area laid out for experimentation or measurement.
plug: A seedling grown in a small container, under carefully controlled (nursery) conditions. When seedlings are removed from containers for planting, the nursery soil remains bound up in their roots.
point of sale: The specific area where a product (i.e., tree, log) becomes the property of the buyer.
pre-harvest silviculture assessment (or survey): The survey carried out on a stand prior to logging to collect specific information on the silvicultural conditions such as planting survival, free-growing status, stocking, etc. See also silvicultural survey.
pre-harvest silviculture prescription: A planning system involving the collection of site-specific field data and the development of forest management prescriptions for cutblocks in advance of logging.
prescribed burning: The knowledgeable application of fire to a specified land area to accomplish designated land management objectives.
provincial forest inventory: A description of the quantity and quality of forest trees, non-wood values, and many of the characteristics of the land base, compiled from statistical data for the forest lands of the Province.
pruning: The manual removal of the lower branches of crop trees, to a predetermined height to produce clear, knot-free wood.

railway grade: the roadbed upon which ties and rails were laid.
reamer: A steel tool with a tapered Shank used for freeing 'stuck' increment cores from an increment borer.
reforestation: The natural or artificial restocking (i.e., planting, seeding) of an area with forest trees. Also called forest regeneration.
regeneration delay: The maximum time allowed for initial restocking of a denuded area (from harvesting, fire, etc.) with the minimum number of acceptable trees. The delay is measured in growing seasons from time of denudation.
regeneration performance assessment (RPA): A sampling survey carried out to collect field data on the height growth, competition, and stocking of young stands (5-10 years).
regeneration survey: Carried out to determine the initial restocking of a site. It is used to describe the number of trees on a site that have reached acceptable standards.
registered professional forester: A person registered under the Foresters Act, who performs or directs works, services or undertakings requiring specialized knowledge, training and experience in forestry.
residual trees: Trees remaining in an area following harvesting. Usually non-commercial trees by virtue of species, size or quality. See also leave trees.
right-of-way: The strip of land over which a power line, railway line, road, etc., extends.
rotation age: The age at which a stand is considered mature and ready for harvesting. See also biological maturity.
salvage: To harvest trees that are dead or in poor condition, but that still yield a wood product. Often carried out following fire or insect attack.
sanitation cutting: The removal of damaged or diseased stems to prevent the spread of insects or disease.
sapwood: The light-coloured wood that appears on the outer portion of a cross section of a tree.
scaling: The measuring of lengths and diameters of logs and calculating deductions for defect to determine volume.
scarification: A method of seedbed preparation which consists of exposing patches of mineral soil by mechanical action.
screeding: Removing weeds and small plants together with most of their roots, to clear the area immediately surrounding a planting hole.
second growth: A second forest that develops after harvest of the original mature old growth forest.
seedbed: In natural regeneration, the soil or forest floor on which seed falls; in nursery practice, a prepared area over which seed is sown.
seed orchard: An area of specially planted trees that have been selected for their superior characteristics (i.e., growth, volume, branching, pest resistance, etc.) to breed genetically improved seed.
selection cutting: An uneven-aged silviculture system in which trees are harvested individually or in small groups continuously, at relatively short intervals.
seral stage: The series of changes occurring in the ecological succession of a plant community. (e.g. pioneer stage, or climax stage)
shade-tolerant: The capacity of a tree or plant species to develop and grow in the shade of (and in competition with) other trees or plants.
shearing: In Christmas tree culture, to prune the branches to make dense foliage and give the tree a conical shape.
shelterwood: Any harvest cutting of a more or less regular and mature crop, designed to establish a new crop under the protection of the old.
silviculture: The art and science of growing and tending a forest.
silviculture survey: A sampling procedure to determine
silvicultural conditions such as planting survival, free-growing status, stocking, etc., and leading to management decisions. See also pre-harvest silviculture assessment.

silviculture system: A process, following accepted silvicultural conditions, whereby forests are tended, harvested and replaced (e.g. clearcutting, seed tree, selection cutting, shelterwood cutting).

site class: The measure of the relative productive capacity of a site for a particular crop or stand, based on volume or height at a given age. Forest sites are broadly classed as good, medium, poor, or low.

site preparation: Disturbance of an area's topsoil and ground vegetation to create conditions suitable for regeneration.

site rehabilitation: The conversion of the existing unsatisfactory cover on highly productive forest sites to a cover of commercially valuable species.

skidder: A wheeled or tracked vehicle used for sliding/dragging logs from the stump to a landing.

skidding: The process of sliding/dragging logs from the stump to a landing, usually applied to ground-based operations.

skid trail: A rough-formed, temporary forest trail suitable for use by horses or equipment such as bulldozers or skidders in bringing trees or logs from the actual place of felling to a landing.

skyline: A type of cable logging in which the mainline is stationary and a carriage moves along it carrying logs from the felling site to the landing.

slash: The residue left on the ground after felling, includes unused logs, uprooted stumps, broken tops, etc.

slash burning: The burning of logging slash, often carried out to reduce fire hazard and/or to prepare a site for planting. See also broadcast burning.

slope correction tables: Tables with conversions from slope distance to horizontal distance.

small-scale forestry: In general, non-industrial forestry operations. In B.C., small-scale forestry operations are carried out by Woolplot Licensees, Indian Bands and private landowners.

soil compaction: The compression of soil as a result of heavy equipment traffic.

spacing: The act of removing trees from a stand to decrease the stand density, distribute the crop trees more evenly over the growing site, and create more growing room. See also intertree distance, juvenile spacing, and thinning.

special forest products: As defined under the Forest Act to include: poles; posts; pilings; Christmas trees; building logs; mining timbers; cribbing; firewood and fuel logs; hop poles; orchard props; car stakes; round stakes, sticks and pickets; split stakes, pickets and palings; shake bolts, blocks and blanks; shingle blocks.

springwood: The less dense, larger wood cells of an annual growth ring. Also called earlywood to refer to the fact that it is the wood formed early in the growing season. See also summerwood.

spur road: A branch of a main or secondary road.

stand: A community of trees sufficiently uniform in species, age, arrangement or condition to be distinguishable as a group from the forest or other growth on the area.

stand density: A relative measure of the amount of stocking on a forest area. Often described in terms of stems per hectare.

stand improvement: Any silvicultural treatment that increases the growth, quality or value of trees in a stand.

stand tending: A variety of forest management activities carried out at different stages in the life of a stand. Treatments may include: juvenile spacing; brushing; commercial thinning; fertilization; conifer release; site rehabilitation; mistletoe control; seed tree control; and pruning.

statistical sampling: The selection of sample units from a population and the measurement and/or recording of information on these units, to obtain estimates of population characteristics.

stocking class: A numeric code representing a range of stems per hectare, sometimes estimated by crown closure on aerial photographs, e.g., stocking class 1 is mature with 76+ stems/ha of ≥ 27.5 cm dbh; class 2 is mature with < 76 stems/ha; class 0 is immature.

stomata: Pores in plant leaves that control the respiration of a plant.

strata: Groups of forest types with the same or similar species composition, age and height classes. (plural of stratum).

stratum: A subdivision of a forest area to be inventoried, based on a group of trees with the same or similar species composition, age and height class.

stream gradient: The general slope, or rate of vertical drop per unit of length, of a flowing stream.

stumpage: The price that must be paid to the provincial government for timber harvested from Crown land.

stumpage appraisal: The process by which the stumpage to be charged for harvesting on any given area is estimated.

sub-grade: That part of a road consisting of the material already in place (the road base).

succession: The replacement of one plant community by another in progressive development toward climax vegetation.

summerwood: The denser, later-formed wood of an annual growth ring. Also known as 'latewood' relating to the time in the growing season that these cells are produced. See also springwood.

suppressed: Trees with crowns entirely below the general level of the crown cover receiving little or no direct light from above or from the sides.

survival assessment: A survey that estimates survival, which is the percentage of trees living after a period of growth (often 2-5 years) following planting.

sustained yield: A method of forest management that calls for an approximate balance between net growth and amount harvested.

tenure: The holding, particularly as to manner or term (i.e. period of time), of a property. Land tenure may be broadly categorized into private lands, federal lands and provincial
Crown lands. The Forest Act defines a number of forestry tenures by which the cutting of timber and other use rights to Crown land are assigned.

**thinning:** The process of removing excess and poorer quality trees from a stand for the purpose of improving the growth and value of the remaining crop trees.

**timber cruising:** The collection of field data on forests, commonly by the measurement and recording of information in sample plots. Includes the measurement and estimation of volumes of standing trees.

**timber mark:** A hammer indentation made on cut timber for identification purposes.

**tolerance:** A relative measure of a tree's ability to survive a deficiency of light, water or nutrients, i.e. shade-tolerant trees can grow under the shade of other plants, in conditions of low light.

**Tree Farm Licence:** A form of tenure agreement which allows the long-term practice of sound forest management and harvesting on Crown land or a combination of Crown and private land, by private interests under the supervision of the Forest Service.

**tree-shearer:** A mechanical device used in felling that cuts or shears the standing tree off at the stump.

**trim allowance:** The extra length (usually 20 cm) of a bucked log to allow for trimming waste in the sawmill.

**turnout:** A space adjacent to a road in which vehicles may park or pull into to allow others to pass.

**understorey:** That portion of the trees or other vegetation in a forest stand below the main canopy level.

**uneven-aged:** Stands with a wide range of ages and sizes.

**unit sales:** Sale of timber based on an agreed 'price per unit of material for timber volume' with payment based on scaled volume.

**unmanaged forest land:** Forest land that is not subject to management under a forest management plan.

**utilization standards:** The utilization limits (stump height and top diameter inside bark) which define the trees considered to be commercially saleable by the MOFL, and therefore the dimensions of all trees that must be cut and removed from Crown land harvesting operations. See close utilization.

**variable area plot sampling method:** A method of timber cruising commonly used for industrial timber cruising in which sampling area (plot size) varies with tree diameter.

**Volume Table:** A table showing the estimated average tree or stand volume based on given tree measurements (usually diameter and height).

**V-plow:** A forest plow with a V-shaped blade used to prepare strips for hand planting by removing surface debris and competing vegetation.

**water bar:** A shallow trench cut into the surface of road, or created by an embankment (e.g. log and soil), to collect and channel water off the surface, to avoid erosion.

**watershed:** An area of land that collects and discharges water...
### Appendix II – Conversion Factors

#### Imperial to Metric Conversions

<table>
<thead>
<tr>
<th>Imperial Units</th>
<th>Metric Equivalents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td></td>
</tr>
<tr>
<td>1 chain</td>
<td>20.116 m</td>
</tr>
<tr>
<td>1 foot</td>
<td>0.305 m</td>
</tr>
<tr>
<td>1 inch</td>
<td>2.54 cm</td>
</tr>
<tr>
<td>1 mile</td>
<td>1.609 km</td>
</tr>
<tr>
<td>1 yard</td>
<td>0.914 m</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td></td>
</tr>
<tr>
<td>1 acre</td>
<td>0.405 ha</td>
</tr>
<tr>
<td>1 mil-acre</td>
<td>4.047 m²</td>
</tr>
<tr>
<td>1 square foot</td>
<td>0.093 m²</td>
</tr>
<tr>
<td>1 square inch</td>
<td>6.452 cm²</td>
</tr>
<tr>
<td>1 square mile</td>
<td>2.59 km²</td>
</tr>
<tr>
<td>1 square yard</td>
<td>0.836 m²</td>
</tr>
<tr>
<td><strong>Volume or Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>1 cord</td>
<td>3.625 m³ (stacked)</td>
</tr>
<tr>
<td>1 cubic foot</td>
<td>0.028 m³</td>
</tr>
<tr>
<td>1 cubic yard</td>
<td>0.765 m³</td>
</tr>
<tr>
<td>1 cunit</td>
<td>2.832 m³</td>
</tr>
<tr>
<td>1 gallon</td>
<td>4.546 l</td>
</tr>
<tr>
<td><strong>Mass or Weight</strong></td>
<td></td>
</tr>
<tr>
<td>1 ounce</td>
<td>28.350 g</td>
</tr>
<tr>
<td>1 pound</td>
<td>0.454 kg</td>
</tr>
<tr>
<td>1 ton</td>
<td>0.907 t</td>
</tr>
<tr>
<td><strong>Ratios</strong></td>
<td></td>
</tr>
<tr>
<td>1 cord per acre</td>
<td>8.956 m³ (stacked)/ha</td>
</tr>
<tr>
<td>1 cubic foot per acre</td>
<td>0.070 m³/ha</td>
</tr>
<tr>
<td>1 mile per gallon</td>
<td>0.354 km/l</td>
</tr>
<tr>
<td>1 pound per cubic foot</td>
<td>16.019 kg/m³</td>
</tr>
<tr>
<td>1 square foot per acre</td>
<td>0.230 m³/ha</td>
</tr>
<tr>
<td>1 ton per acre</td>
<td>2.242 t/ha</td>
</tr>
</tbody>
</table>

#### Metric to Imperial Conversions

<table>
<thead>
<tr>
<th>Metric Units</th>
<th>Imperial Equivalents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td></td>
</tr>
<tr>
<td>1 cm (centimetre)</td>
<td>0.394 inch</td>
</tr>
<tr>
<td>1 km (kilometre)</td>
<td>0.621 mile</td>
</tr>
<tr>
<td>1 m (metre)</td>
<td>0.05 chain</td>
</tr>
<tr>
<td>1 m (metre)</td>
<td>3.281 feet</td>
</tr>
<tr>
<td>1 m (metre)</td>
<td>1.094 yards</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td></td>
</tr>
<tr>
<td>1 cm² (square centimetre)</td>
<td>0.155 square inch</td>
</tr>
<tr>
<td>1 ha (hectare)</td>
<td>2.471 acres</td>
</tr>
<tr>
<td>1 km² (square kilometre)</td>
<td>0.386 square mile</td>
</tr>
<tr>
<td>1 m² (square metre)</td>
<td>0.274 mil-acre</td>
</tr>
<tr>
<td>1 m² (square metre)</td>
<td>10.764 square feet</td>
</tr>
<tr>
<td>1 m² (square metre)</td>
<td>1.196 square yards</td>
</tr>
<tr>
<td><strong>Volume or Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>1 l (litre)</td>
<td>0.220 gallon</td>
</tr>
<tr>
<td>1 m³ (cubic metre)</td>
<td>35.315 cubic feet</td>
</tr>
<tr>
<td>1 m³ (cubic metre)</td>
<td>1.308 cubic yards</td>
</tr>
<tr>
<td>1 m³ (cubic metre)</td>
<td>0.353 cunit</td>
</tr>
<tr>
<td>1 m³ (stacked, stacked m³)</td>
<td>0.276 cord</td>
</tr>
<tr>
<td><strong>Mass or Weight</strong></td>
<td></td>
</tr>
<tr>
<td>1 g (gram)</td>
<td>0.035 ounce</td>
</tr>
<tr>
<td>1 kg (kilogram)</td>
<td>2.205 pounds</td>
</tr>
<tr>
<td>1 t (toone)</td>
<td>1.102 tons</td>
</tr>
<tr>
<td><strong>Ratios</strong></td>
<td></td>
</tr>
<tr>
<td>1 kg/m³ (kilogram per m³)</td>
<td>0.062 pound/cu.ft.</td>
</tr>
<tr>
<td>1 km/l (kilolitre)</td>
<td>2.825 miles per gallon</td>
</tr>
<tr>
<td>1 m³/ha (m³ per hectare)</td>
<td>4.356 square ft/acre</td>
</tr>
<tr>
<td>1 m³/ha (m³ per hectare)</td>
<td>14.291 cu.ft/acre</td>
</tr>
<tr>
<td>1 m³ (stacked)/ha</td>
<td>0.112 cord per acre</td>
</tr>
<tr>
<td>1 t/ha (tonne per hectare)</td>
<td>0.446 ton per acre</td>
</tr>
</tbody>
</table>

In case you were wondering......

- chain = 22 yd
- cord = 128 stacked ft³
- cunit = 100 ft³ of solid wood
- ton = 2,000 lb
- tonne = 1,000 kg
### Appendix II – Conversion Factors

#### SLOPE CORRECTION TABLE

<table>
<thead>
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<th>SLOPE DISTANCE IN METRES</th>
<th>HORIZONTAL DISTANCE IN METRES</th>
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<td>11.9</td>
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<td>18</td>
<td>11.9</td>
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#### SLOPE DISTANCE IN METRES

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<td>10</td>
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#### HORIZONTAL DISTANCE IN METRES

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3
## SLOPE CORRECTION TABLE

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<th>HORIZONTAL DISTANCE IN METRES</th>
<th>SLOPE DISTANCE IN METRES</th>
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## Appendix III – Helpful Extras

### B.C. Ministry of Forests and Lands Offices

**Victoria Branches:**
- 1450 Government Street, Victoria, B.C. V8W 3E7
- Audit Services
- Financial Services
- Human Resources
- Industry, Development & Marketing
- Information Systems
- Integrated Resources
- Inventory
- Land Policy
- Legal Services
- Protection
- Public Affairs
- Real Estate Services
- Research
- Silviculture
- Surveyor General
- Technical & Administrative Services
- Timber Policy
- Valuation

**Vancouver Forest Region**
- Regional Office:
  - 4595 Canada Way,
  - Burnaby, B.C., V5G 4L9
- Campbell River Forest District:
  - 370 South Dogwood Street,
  - Campbell River, B.C., V9W 6Y7
- Chilliwack Forest District:
  - 9850 South McGrath Road, Box 159,
  - Rosedale, B.C., V0X 1X0
- Duncan Forest District:
  - 7233 Trans-Canada Highway, Box 689,
  - Duncan, B.C., V9L 3Y1
- Maple Ridge Forest District:
  - 20450 Dewdney Trunk Road,
  - Maple Ridge, B.C., V2X 3E3
- Mid-Coast Forest District:
  - Sawmill Road, Box 190,
  - Hagensborg, B.C., V0T 1H0
- Port Alberni Forest District:
  - 4227 - 6th Avenue,
  - Port Alberni, B.C., V9Y 4N1
- Port McNeill Forest District:
  - 2291 Mine Road Pl., Box 7000,
  - Port McNeill, B.C., VON 2R0
- Powell River Forest District:
  - 7077 Duncan Street,
  - Powell River, B.C., V8A 1W1

**Queen Charlotte Islands Forest District**:
- Corner 2nd St. and 3rd Ave., Box 39,
- Queen Charlotte City, B.C., V0T 1S0

**Sechelt Forest District**:
- 1975 Field Rd., Box 4000,
- Sechelt, B.C., VON 3A0

**Squamish Forest District**:
- 42000 Loggers Lane, Box 1970,
- Squamish, B.C., VON 3G0

**Pemberton Field Office**:
- Box 157,
- Pemberton, B.C., V0N 2L0

**Prince Rupert Forest Region**
- **Regional Office**:
  - 3726 Alfred St., Bag 5000,
  - Smithers, B.C., V0J 2N0
- ** Bulkley Forest District**:
  - 3793 Alfred Ave., Bag Service 6000,
  - Smithers, B.C., V0J 2N0
- **Cassiar Forest District**:
  - Hwy. 37, General Delivery,
  - Dease Lake, B.C., V0C 1L0
- **Atlin Field Office**:
  - Box 45,
  - Atlin, B.C., V0W 1A0
- **Watson Lake Field Office**:
  - (Seasonal, 01 April - 15 Oct.),
  - Box 248, Watson Lake,
  - Yukon Territories, Y0A 1C0
- **Kalum Forest District**:
  - 310 - 4722 Lakelse Ave.,
  - Terrace, B.C., V8G 1R6
- **Stewart Field Office**:
  - Sixth & Brightwell, Box 918,
  - Stewart, B.C., V0T 1W0
- **Kitsox Forest District**:
  - West Hwy. 62, Box 215,
  - Hazelton, B.C., V0J 1Y0
- **Lakes Forest District**:
  - 33 - 3rd Ave., Box 269,
  - Burns Lake, B.C., V0J 1E0
- **Moric Forest District**:
  - 3429 - 10th Street, Bag 2000,
  - Houston, B.C., V0J 120
- **North Coast Forest District**:
  - 125 Market Place,
  - Prince Rupert, B.C., V8J 1B9
Prince George Forest Region
Regional Office:
1011 - 4th Avenue,
Prince George, B.C., V2L 3H9
Dawson Creek Forest District:
9000 - 17th Street,
Dawson Creek, B.C., V1G 4A4
Chetwynd Field Office:
550 North Access, Box 28,
Chetwynd, B.C., V0C 1J0
Fort Nelson Forest District:
R.R. 1, Mile 301, Alaska Hwy.,
Fort Nelson, B.C., V0J 1R0
Fort St. James Forest District:
Stones Bay Road, Box 100,
Fort St. James, B.C., V0J 1P0
Fort St. John Forest District:
10716 - 100th Avenue,
Fort St. John, B.C., V1J 1Z3
McBride Forest District:
300 Robson Square, Box 40,
McBride, B.C., V0J 2E0
Mackenzie Forest District:
120 Mackenzie Blvd., Box 10,
Mackenzie, B.C., V0J 2C0
Prince George East Forest District:
4055 - 15th Avenue,
Prince George, B.C., V2N 1A5
Prince George West Forest District:
1600 - 3rd Avenue,
Prince George, B.C., V2L 3G6
Vanderhoof Forest District:
Spruce Street, Box 190,
Vanderhoof, B.C., V0J 3A0

Princeton Field Office:
151 Vermillion Ave., Box 818,
Princeton, B.C., V0X 1W0
Peninicon Forest District:
102 Industrial Pt.,
Peninicon, B.C., V2A 7C8
Salmon Arm Forest District:
Box 340,
Salmon Arm, B.C., V0E 2T0
Vernon Forest District:
2501 - 14th Avenue,
Vernon, B.C., V1T 8Z1

Nelson Forest Region
Regional Office:
518 Lake Street,
Nelson, B.C., V1L 4C6
Arrow Forest District:
845 Columbia Ave.,
Castlegar, B.C., V1N 1H3
Nakusp Field Office:
109 - 6th Ave. W., Box 219,
Nakusp, B.C., V0G 1R0
Boundary Forest District:
Sagamore Ave., Box 2650,
Grand Forks, B.C., V0H 1H0
Kettle Valley Field Office:
R.R. 2, Hwy. 3,
Rok Creek, B.C., V0H 1Y0
Cranbrook Forest District:
1902 Theatre Rd.,
Cranbrook, B.C., V1C 4H4
Golden Forest District:
Upper Golden-Donald Rd., Box 1380,
Golden, B.C., V0A 1H0
Invermere Forest District:
406 - 7th Avenue, Box 189,
Invermere, B.C., V0A 1K0
Kootenay Lake Forest District:
R.R. 1, Ridgewood Rd.,
Nelson, B.C., V1L 5P4
Creston Field Office:
Alcrest Dr., Box 340,
Creston, B.C., V0B 1G0
Kaslo Field Office:
Government Building, 4th St., Box 370,
Kaslo, B.C., V0G 1M0
Revelstoke Forest District:
1761 Big Eddy Rd., Box 470,
Revelstoke, B.C., V0G 1M0

Kamloops Forest Region
Regional Office:
515 Columbia Street,
Kamloops, B.C., V2C 2T7
Clearwater Forest District:
R.R. 1, Box 6201,
Clearwater, B.C., V0E 1N0
Kamloops Forest District:
1255 Dalhousie Pl.,
Kamloops, B.C., V2C 5Z5
Lillooet Forest District:
Bag Service 700,
Lillooet, B.C., V0K 1V0
Merritt Forest District:
Box 609,
Merritt, B.C., V0K 2B0
Appendix III – Helpful Extras

Cariboo Forest Region
Regional Office:
540 Borland Street,
Williams Lake, B.C., V2G 1R8
Chilcotin Forest District:
Stum Lake Rd.,
Alexis Creek, B.C., V0L 1A0
Horseshy Forest District:
Boswell St., Box 69,
Horseshy, B.C., V0L 1L0
Likely Field Office:
Cedar Creek Rd., Box 7,
Likely, B.C., V0L 1N0
100 Mile House Forest District:
300 South Cariboo Hwy., Box 129,
100 Mile House, B.C., V0K 2E0
Clinton Field Office:
1425 Cariboo Hwy., Box 340,
Clinton, B.C., V0K 1K0
Quesnel Forest District:
322 Johnston Ave.,
Quesnel, B.C., V2J 3M5
Williams Lake Forest District:
385 Barnard St.,
Williams Lake, B.C., V2G 1G2

Kootenay Region:
2373 Cranbrook St. North,
Cranbrook, B.C., V1C 3T3
Northern Interior Region:
#110- 1460 - 6th Avenue,
Prince George, B.C., V2L 3N2
Coast Region:
#1430 - 1100 Melville St.,
Vancouver, B.C., V6E 4A6
Vancouver Island Region:
2892 Drinkwater Rd.,
Duncan, B.C., V9L 3W8

British Columbia Institute of Technology (BCIT)
3700 Willingdon Ave.,
Burnaby, B.C., V5G 3H2
Phone: (604) 434-5734

B.C. Ministry of Agriculture and Fisheries
Parliament Buildings,
Victoria, B.C., V8W 2Z7

B.C. Ministry of Economic Development - Small Business Services
315 Robson Square, 800 Hornby St.,
Vancouver, B.C., V6Z 2C5
Phone: (604) 660-3900

B.C. Ministry of Environment and Parks (MOEP)
Parliament Buildings,
Victoria, B.C., V8V 1X5

B.C. Ministry of Forests and Lands (MOFL)
1450 Government Street,
Victoria, B.C., V8W 3E7

B.C. Ministry of Finance and Corporate Relations
Parliament Buildings,
Victoria, B.C., V8V 1X4

British Columbia Teachers Federation (BCTF)
2235 Burrard Street,
Vancouver, B.C., V6J 3H9
Phone: (604) 731-8121

Canada Land Inventory - Lands Directorate
Environment Canada
#502 - 1001 W. Pender St.,
Vancouver, B.C., V6E 2M9
Phone: (604) 666-5922

Canadian Forestry Service - Pacific Forestry Centre (CFS)
506 West Burnside Road,
Victoria, B.C., V8Z 1M5
Phone: (604) 388-0600

Canadian Forestry Service (CFS)
Place Vincent Massey, 351 Blvd. St. Joseph,
Ottawa, Ontario, K1A 1G5
Phone: (613) 997-1107

HELPFUL CONTACTS

Applied Science Technologists and Technicians of B.C.
200 Discovery Park, 3700 Gilmore Way,
Burnaby, B.C., V5G 4M1
Phone: (604) 433-0548

Association of B.C. Professional Foresters (ABCFF)
#510 - 744 West Hastings Street,
Vancouver, B.C., V6C 1A5
Phone: (604) 687-8027

Bank of Montreal - Commercial Marketing Department
22nd Floor, 1st Bank Tower, 595 Burrard Street,
Vancouver, B.C., V7X 1L5

B.C. Assessment Authority
1537 Hillside Avenue,
Victoria, B.C., V8T 4Y2
Phone: (604) 595-6211

British Columbia Forestry Association (BCFA)
#1430 - 1100 Melville St.,
Vancouver, B.C., V6E 4A6
Phone: (604) 683-7591

Kamloops Region:
2417 Highway 97 North,
Kelowna, B.C., V1X 4J2

3
Canadian Lumber Standards Administrative Board
#1475 - 1055 West Hastings Street,
Vancouver, B.C., V6E 2E9
Phone: (604) 687-2171

Cariboo Horse Loggers Association
P.O. Box 4321,
Quesnel, B.C., V2J 3J3
Phone: (604) 747-3363

Cariboo Lumber Manufacturers Association (CLMA)
#301 - 197 Second Avenue North,
Williams Lake, B.C., V2G 1Z5
Phone: (604) 392-7778

Council of Forest Industries of B.C. (COFI)
#1500 - 1055 West Hastings Street,
Vancouver, B.C., V6E 2H1
Phone: (604) 684-0211

COFI - Northern Interior Lumber Sector (NILS)
#803 - 299 Victoria Street,
Prince George, B.C., V2L 2J5
Phone: (604) 564-5136

Crown Publications Inc., Victoria
546 Yates Street,
Victoria, B.C. V8W 1K8
(604) 386-4636

Department of Fisheries and Oceans (DFO)
Ste. 400, Station D, 555 West Hastings St.,
Vancouver, B.C., V6B 5G3
Phone: (604) 666-8675

Forest Engineering Research Institute of Canada (FERIC)
#201 - 2112 West Broadway,
Vancouver, B.C., V6K 2C8
Phone: (604) 732-3711

Forest Insects and Disease Survey Unit (FIDS)
Canadian Forestry Service, Pacific Forestry Centre
506 West Burnside Road,
Victoria, B.C., V8Z 1M5
Phone: (604) 388-0600

Forest Pest Management Institute - Department of the Environment
P.O. Box 490,
Sault Ste. Marie, Ontario, P6A 5M7
Phone: (705) 949-9461

Interior Lumber Manufacturers Association (ILMA)
#203 - 2350 Hunter Road,
Kelowna, B.C., V1X 6C1
Phone: (604) 860-9663

L.M. Media Marketing Services Ltd.
2168 Willingdon,
Burnaby, B.C., V5C 5Z9
Phone: (604) 294-6231

Maritimes Forest Research Centre
P.O. Box 4000, College Hill, Fredericton,
New Brunswick, E3B 5P7

New Brunswick Department of Natural Resources
R.R. #5, Fredericton,
New Brunswick, E3B 4X6

Northern Silviculture Committee (NSC)
Box 546,
Smithers, B.C., V0J 2N0

Northwest Christmas Tree Growers Association
Box 3366,
Salem, Oregon, USA 97302
Phone: (503) 364-2942

Nova Scotia Department of Lands and Forests
P.O. Box 68,
Truro, Nova Scotia, B2N 5B8

Oregon State University Extension Service:
Corvallis, Oregon, USA 97331

Pacific Lumber Inspection Bureau
#1460 Guinness Tower, 1055 West Hastings Street,
Vancouver, B.C., V6E 2G8

Pacific Northwest Forest and Range Experiment Station - USDA Forest Service
P.O. Box 3890,
Portland, Oregon, USA 97208

Pacific Reforestation Workers Association
Box 65361, Station F,
Vancouver, B.C., V5N 5P3

Queen's Printer, Ottawa
Canadian Government Publishing Centre,
Department of Supply and Services,
Communications Services Directorate
45 Sacre-Coeur Boulevard,
Hull, Quebec, K1A 0S7

Revenue Canada
South-Eastern B.C.:
277 Winnipeg St., Penticton, B.C., V2A 1N6

Vancouver Island:

1415 Vancouver St., Victoria, B.C., V8S 3W4

Other Areas:
Revenue Canada, 1166 W. Pender St.,
Vancouver, B.C., V6E 3H8
Phone: 1-800-663-9033

St. John Ambulance
611 Cambie Street,
Vancouver, B.C., V5Z 3B2
Phone: (604) 321-2651

School Services Canada
66 Portland Street,
Toronto, Ontario, M5V 2M8
Appendix III – Helpful Extras

Shuswap Okanagan Forestry Association (SOFA)
Box 39, Vernon, B.C., V1T 6M1

Southern Interior Silviculture Committee (SISCO)
c/o 518 Lake Street,
Nelson, B.C., V1L 4C6
Phone: (604) 354-6280

Swedish University of Agricultural Sciences
#5 - 770 73, Garpenberg, Sweden

The Truck Loggers’ Association (TLA)
#900 - 837 West Hastings Street,
Vancouver, B.C., V6C 1B6
Phone: (604) 684-4291

University of British Columbia (UBC)
2075 Wesbrook Mall,
Vancouver, B.C., V6T 1W5
Phone: (604) 228-2211

Faculty of Forestry
Phone: (604) 228-2727

U.S. Department of Agriculture (USDA)
Washington, D.C., USA 20250

USDA Forest Service:
Forest Pest Management-State and Private Forestry
Pouch 6606,
Anchorage, Alaska, USA 99502

Northern Area-State and Private Forestry
Broomall, Pennsylvania, USA 19008

Pacific Northwest Forest and Range Experiment Station
P.O. Box 3890, Portland, Oregon, USA 97208

Western Silvicultural Contractors Association
#310 - 1070 West Broadway,
Vancouver, B.C., V6E 1E7
Phone: (604) 736-8660

Workers’ Compensation Board (WCB)
6951 Westminster Highway,
Richmond, B.C., V7C 1C6
Phone: (604) 273-2266

B.C. WOODLAND ASSOCIATIONS

Boundary Woodlot Association
Box 70, Westbridge, B.C., V0H 2B0

Fraser Valley Woodland Owners Association
14294 Marc Road,
Maple Ridge, B.C., V2X 7G7

Gulf Islands Woodlands Association
R.R. 3, Harrison Avenue C-14,
Ganges, B.C., V0S 1E0

Kamloops Woodlot Association
R.R. 5, Site 3, Comp. 133, Kamloops, B.C., V2C 6C2

North Island Woodlot Association
General Delivery,
Merville, B.C., V0P 2M0

Peace River Woodlot Association
Box 6353, Fort St. John, B.C., V1J 4H8

Vanderhoof Woodlot Association
Box 1250, Vanderhoof, B.C., V0J 3A0

ACTS AFFECTING FOREST LAND MANAGEMENT

Fisheries Act, 1979. RS Chap. 137. B.C. Ministry of Environment and Parks
Forest Act, 1979. RS Chap. 140. B.C. Ministry of Forests and Lands
Heritage Conservation Act, 1979. RS Chap. 165. B.C. Ministry of Tourism, Recreation and Culture
Indian Act, 1985. RSC., 1-6. Indian and Northern Affairs Canada (federal)
Taxation (Rural Area) Act, 1979. RS Chap. 400. B.C. Ministry of Finance and Corporate Relations
Calculating Tree Volumes

It is possible to obtain a rough estimate of the gross volume of the trees on your woodland using the “Whole Stem Cubic Metre Volume Equations” that have been developed for each commercial tree species in the Province. The volume equations will allow you to calculate the gross volume in cubic metres for entire tree stems, inside bark, including stump and top, when dbh and height are measured in metric units.

Note: For many species there is more than one volume equation, based on the form that the tree takes as it grows, and influenced by the geographical region in which it grows. The equation to use depends on the age of the tree (mature or immature) and/or the Forest Inventory Zone (F.I.Z.) in which it is growing. There are twelve Forest Inventory Zones in British Columbia.

The full list of volume equations for all species, and the zones in which each is applied, can found in the “Forestry Handbook for British Columbia”. 4th ed., Forestry Undergraduate Society, U.B.C.

The equation to calculate the volume of immature Douglas-fir (up to 120 years), growing in the Coastal Forest Inventory Zones is used as an example here.

The volume is calculated as:

\[
\log V = -4.319071 + 1.813820 \log D + 1.042420 \log H
\]

S.E. = ±10.3%
No. of trees = 393
F.I.Z. = A,B,C

where:
- \( V \) is the gross volume of the tree, including stump and top, in cubic metres
- \( D \) is the dbh of the tree in centimetres
- \( H \) is the total height of the tree in metres
- S.E. is the standard error (i.e. a measure of the amount by which the estimate of the volume may vary from the actual gross volume of the tree)
- No. of trees is the number of trees on which this equation has been based
- F.I.Z. is the Forest Inventory Zone in which this equation is applied

Note: ‘log’ is short for logarithm, a mathematical term for the exponent indicating the power to which a fixed number, the base, must be raised to obtain a given number; ‘antilog’ is the opposite, i.e. the fixed number, or base. Tables of logarithms are available, but you will find it much easier to solve this equation using a calculator with a ‘log’ function key.

**Sample Calculation**

An estimate of the volume (\( V \)) of an 85 year old Douglas-fir on Vancouver Island, with a diameter (\( D \)) of 33.8 cm and a height (\( H \)) of 24.3 m, can be calculated as follows:

\[
\begin{align*}
\log D & = \log 33.8 = 1.528917 \\
\log H & = \log 24.3 = 1.385606
\end{align*}
\]

\[
\begin{align*}
\log V & = -4.319071 + 1.813820 \log D + 1.042420 \log H \\
& = -4.319071 + (1.813820 \times 1.528917) + (1.042420 \times 1.385606) \\
& = -4.319071 + 2.7731802 + 1.4443834 \\
\log V & = -0.101508
\end{align*}
\]

To solve for \( V \), take the antilog of -0.101508, which is \( 10^{-0.101508} \)

\[ V = 0.791576 \text{ m}^3 \]

This calculation gives you the gross volume of the tree; which you should remember, can vary by plus or minus 10.3% (the standard error) of the actual volume. To obtain the merchantable volume you would have to subtract the volume contained in the top and stump of the tree; the equation for these reductions can be found in the Ministry of Forests and Lands’ “Waste and Survey Manual”. To obtain the net merchantable volume, the losses which result from decay, waste and breakage must be applied to the merchantable volume. These losses vary by F.I.Z., species, and age group, and can be found in the Ministry of Forests and Lands’ “Metric Diameter Class Decay, Waste and Breakage Factors, for all Inventory Zones in B.C.”
Appendix IV – Tree Volumes

INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

COAST DOUGLAS-FIR

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Stump Height = 30 cm
Top Diameter = 10 cm

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Top Diameter = 15 cm

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Stump Height = 30 cm
Top Diameter = 10 cm & 15 cm

Combined

## INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

### INTERIOR DOUGLAS-FIR

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**Stump Height = 30 cm**  
**Top Diameter = 10 cm**

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**Stump Height = 30 cm**  
**Top Diameter = 15 cm**

| DBH (cm) | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 120 | 140 | 160 | 180 | 200 |
|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| 45       | .51| .74| .97| 1.2| 1.5| 1.7| 1.9| 2.2| 2.4| 2.7|    |    |    |    |    |    |    |    |    |    |    |    |
| 50       | .63| .91| 1.2| 1.5| 1.8| 2.1| 2.4| 2.7| 3.0| 3.3|    |    |    |    |    |    |    |    |    |    |    |
| 55       | .76| 1.1| 1.3| 1.8| 2.2| 2.6| 3.0| 3.4| 3.8| 4.2| 4.7|    |    |    |    |    |    |    |    |    |
| 60       | .91| 1.3| 1.7| 2.1| 2.6| 3.0| 3.4| 3.8| 4.2| 4.7|    |    |    |    |    |    |    |    |    |
| 65       | 1.1| 1.5| 2.0| 2.5| 3.0| 3.5| 4.0| 4.5| 5.0| 5.5|    |    |    |    |    |    |    |    |
| 70       | 1.8| 2.3| 2.9| 3.5| 4.0| 4.6| 5.2| 5.7| 6.3|    |    |    |    |    |    |    |    |
| 75       | 2.0| 2.7| 3.3| 3.9| 4.6| 5.2| 5.9| 6.5| 7.2| 7.8|    |    |    |    |    |    |    |
| 80       | 2.3| 3.0| 3.7| 4.5| 5.2| 5.9| 6.7| 7.4| 8.1| 8.9|    |    |    |    |    |    |    |
| 85       | 2.6| 3.4| 4.2| 5.0| 5.8| 6.7| 7.5| 8.3| 9.2| 10 |    |    |    |    |    |    |
| 90       | 3.8| 4.7| 5.6| 6.5| 7.4| 8.4| 9.3| 10 | 11 | 12 |    |    |    |    |    |    |
| 95       | 4.2| 5.2| 6.2| 7.2| 8.3| 9.3| 10 | 11 | 12 |    |    |    |    |    |    |    |
| 100      | 4.6| 5.8| 6.9| 8.0| 9.1| 10 | 11 | 13 | 14 |    |    |    |    |    |    |    |
| 120      | 6.6| 8.2| 9.7| 11 | 13 | 15 | 16 | 18 | 19 |    |    |    |    |    |    |    |
| 140      | 11 | 13 | 15 | 17 | 20 | 22 | 24 | 26 |    |    |    |    |    |    |    |
| 160      | 14 | 17 | 20 | 22 | 25 | 28 | 31 | 34 |    |    |    |    |    |    |    |
| 180      | 18 | 21 | 25 | 28 | 31 | 35 | 38 | 42 |    |    |    |    |    |    |    |
| 200      | 22 | 26 | 30 | 34 | 38 | 43 | 47 | 51 |    |    |    |    |    |    |    |

**Stump Height = 30 cm**  
**Top Diameter = 10 cm & 15 cm Combined**

**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Boie System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
## Appendix IV – Tree Volumes

### INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

**COAST WESTERN RED CEDAR**

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Stump Height = 30 cm  
Top Diameter = 10 cm

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Stump Height = 30 cm  
Top Diameter = 10 cm & 15 cm

Combined

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# INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

## INTERIOR WESTERN REDcedar

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Top Diameter = 10 cm

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Stump Height = 30 cm
Top Diameter = 10 cm & 15 cm

Combined

**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Bole System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
### Appendix IV – Tree Volumes

**INDIVIDUAL TREE VOLUME TABLE**

(Gross Merchantable Volume in Cubic Metres)

#### COAST WESTERN HEMLOCK

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#### Stump Height = 30 cm

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#### Stump Height = 30 cm

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**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Boole System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
### INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

#### INTERIOR WESTERN HEMLOCK

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**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Boie System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
## Appendix IV – Tree Volumes

### INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

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| Top Diameter = 10 cm |

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**Stump Height = 30 cm**

| Top Diameter = 10 cm & 15 cm Combined |

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**NOTE:** These volumes have been calculated using equations compiled by Demerschak/Kozak, "The Whole Bole System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

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**Top Diameter =** 10 cm

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**Stump Height =** 30 cm  
**Top Diameter =** 15 cm

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**Stump Height =** 30 cm  
**Top Diameter =** 10 cm & 15 cm

**Combined**

**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Boie System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
Appendix IV – Tree Volumes

INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

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Stump Height = 30 cm
Top Diameter = 10 cm

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# INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

## INTERIOR SPRUCE

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**Stump Height = 30 cm**  
**Top Diameter = 10 cm**

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**Stump Height = 30 cm**  
**Top Diameter = 15 cm**

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**Stump Height = 30 cm**  
**Top Diameter = 10 cm & 15 cm Combined**

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**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Bole System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497

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12
## Appendix IV – Tree Volumes

### INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

#### COAST WESTERN WHITE PINE

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Top Diameter = 10 cm

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Stump Height = 30 cm
Top Diameter = 10 cm & 15 cm

**Combined**

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**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Boles System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
### INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

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**Top Diameter = 10 cm**

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**Stump Height = 30 cm**
**Top Diameter = 15 cm**

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**Stump Height = 30 cm**
**Top Diameter = 10 cm & 15 cm Combined**

## Appendix IV – Tree Volumes

### INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

**WESTERN YELLOW PINE**

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Top Diameter = 10 cm

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Top Diameter = 15 cm

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### INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

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#### TREE HEIGHT (METRES)

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**NOTE:** These volumes have been calculated using equations compiled by Demerschalk/Kozak, "The Whole Bole System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

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Top Diameter = 10 cm

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Top Diameter = 15 cm

Stump Height = 30 cm
Top Diameter = 10 cm & 15 cm
Combined

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**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Boles System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
## INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

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## Appendix IV – Tree Volumes

**INDIVIDUAL TREE VOLUME TABLE**  
(Gross Merchantable Volume in Cubic Metres)

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Top Diameter = 10 cm

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Stump Height = 30 cm  
Top Diameter = 10 cm & 15 cm

**Combined**

### INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

#### ASPEN
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- Top Diameter = 10 cm

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- Top Diameter = 15 cm

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## Appendix IV – Tree Volumes

**INDIVIDUAL TREE VOLUME TABLE**  
(Gross Merchantable Volume in Cubic Metres)

**BIRCH**  
Stump Height = 30 cm  
Top Diameter = 10 cm

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**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Boles System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977, Can. J. For. Res., 7:488-497
INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

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Top Diameter = 10 cm

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Stump Height = 30 cm
Top Diameter = 10 cm & 15 cm Combined

**NOTE:** These volumes have been calculated using equations compiled by Damaerschalk/Kozak, "The Whole Bole System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977, Can. J. For. Res., 7:488-497
## Appendix IV – Tree Volumes

### INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

#### BROADLEAF MAPLE

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Stump Height = 30 cm  
Top Diameter = 10 cm

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Top Diameter = 15 cm

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Stump Height = 30 cm  
Top Diameter = 10 cm & 15 cm Combined

**NOTE:** These volumes have been calculated using equations compiled by Demaerschalk/Kozak, "The Whole Bole System: A Conditioned Dual-Equation System for Precise Prediction of Tree Profiles" 1977. Can. J. For. Res., 7:488-497
## INDIVIDUAL TREE VOLUME TABLE
(Gross Merchantable Volume in Cubic Metres)

### RED ALDER

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**Stump Height = 30 cm**

**Top Diameter = 10 cm**

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**Stump Height = 30 cm**

**Top Diameter = 15 cm**

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**Stump Height = 30 cm**

**Top Diameter = 10 cm & 15 cm Combined**

### NOTE: