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 G22-81008 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 sheep prefer fireweed over many other species and can reduce seedling mortality caused by snowpress 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 watercourses 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 colour 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) 963-5631

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.
Introduction

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 Manage-

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 contribute a considerable volume of wood to the provincial timber supply. Using an arbitrary average parcel size of 200 hectares for these small forest land holdings, approximately 20,000 people, or 1% of the Province's citizens, could become involved in small-scale woodland management.

Small-scale forestry provides an entry into the science and business of forestry to people with diverse interests and backgrounds. It encourages experimentation with different forest management strategies, methods, and equipment in an environment that can be closely monitored. In this way, the program stimulates diversity within the industry by encouraging new entrepreneurs.

Another of the special opportunities that small-scale forestry offers is a chance for the public to become actively involved in managing public lands. The Woodlot Licence program enables individuals, societies, Indian Bands and corporations to practice forest management on Crown lands, or in conjunction with their own private lands. The federal Private and Indian Forest Land Programs provide landowners with the chance to improve the production and value of their forest lands while learning about forest management.

To the Province then, and the provincial economy, small-scale forestry operations could be a significant source of
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 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 stomata 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

Ponderosa pine

Western white 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)

DECIDUOUS (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>P</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>Bb</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>Other favourites...</td>
<td>Western Yew</td>
<td>Taxus brevifolia</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dogwood</td>
<td>Cornus nutallii</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 circinatum</td>
<td></td>
<td></td>
</tr>
</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.

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 different areas 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 floupy when dry and slightly gritty, almost soapy when wet; while clay is very fine and floupy 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

14
more dense and 'compacted'. Soil compaction reduces

Recognizing the capabilities (and limitations) of the soils

Managing a woodland can be an intense and time-con-

no acceptable excuse for not being prepared. Your per-

The practice of forestry takes place on a large scale—even

Part of safety is protecting yourself, and an effective

There is

your woodland, and organizing forestry operations to

Personal gear is as important as the hardware you use for a

'small-scale' operations. It uses powerful equipment

wardrobe of protective gear is readily available. There is

the first step in being safe is knowing that you are at risk and what

job. Shown below are the basic elements of the safe (and

that can easily harm or kill, and relies heavily on situ-

no in excess surface runoff which may cause instability and soil ero-

you can do to prevent accidents.

long-lived) woodland operator.

ation-specific judgement. The active logging phases are

f you woodland, and organizing forestry operations to

development of your Forest Management Plan. Alternative

as well as seasonal considerations are discussed in the "Harvest-

sion.

minimize problems will be an important task in the devel-

harvesting methods, specific equipment options, as well

ing The Trees" chapter.
the most dangerous activities you will encounter. If you plan to be anywhere near a chainsaw, it is strongly advised that you read the “Fellers’ 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
“Fellers’ 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.P (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.

43 Polygon (stand) no.
C(h) Cedar (>20% and over in volume) (hemlock - less than 20% by volume in the stand)
9 Age class 9 (251 years +)
6 Height class 6 (46.5-55.4 metres)
1 Stocking class 1
m medium site
7 Crown closure class (66-75%)

44 Silviculture opening no.
155 Polygon (stand) no.
NSR Not sufficiently restocked
-m medium site
@L87 Logged 1987
PBB Planted 1988

60(68) * 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.

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*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-
Dilation 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!!
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.
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, S30° 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.

**Metal Signs**

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.
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 mapsheet 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....)
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:

\[
\text{Tree height} = (\text{TT} + \text{TBH}) \times \text{HD} \times 0.01 + 1.3 \text{ m}\]

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

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
<table>
<thead>
<tr>
<th>Standard Cruising Equipment</th>
<th>(1988$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-metric diameter tape</td>
<td>$50</td>
</tr>
<tr>
<td>-50 m nylon wind-up metric</td>
<td>$50 - $75</td>
</tr>
<tr>
<td>measuring tape</td>
<td></td>
</tr>
<tr>
<td>-hip-chain and rolls of string</td>
<td>$115</td>
</tr>
<tr>
<td>-crui se cards (waterproof)</td>
<td>$10 per 100</td>
</tr>
<tr>
<td>-field book</td>
<td>$6</td>
</tr>
<tr>
<td>-spray paint</td>
<td>$24 per 12</td>
</tr>
<tr>
<td>-compass</td>
<td>$30</td>
</tr>
<tr>
<td>-Suunto clinometer (with % scale)</td>
<td>$100</td>
</tr>
<tr>
<td>-increment borer (plus reamer)</td>
<td>$150</td>
</tr>
<tr>
<td>-axe</td>
<td>$30</td>
</tr>
<tr>
<td>-pocket stereoscope</td>
<td>$25</td>
</tr>
<tr>
<td>-hand calculator</td>
<td>$15</td>
</tr>
<tr>
<td>-flagging</td>
<td>$25 per 12</td>
</tr>
<tr>
<td>-forest cover map *</td>
<td></td>
</tr>
<tr>
<td>-contour map *</td>
<td></td>
</tr>
<tr>
<td>-aerial photos *</td>
<td></td>
</tr>
<tr>
<td>* keep non-waterproof materials in zip-lock bags</td>
<td></td>
</tr>
</tbody>
</table>

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

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></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>21.0 m³</td>
<td>2.62 m³</td>
<td>50</td>
<td>131.2 m³</td>
<td>20 ha</td>
<td>2.624 m³</td>
</tr>
<tr>
<td>L</td>
<td>10.5 m³</td>
<td>1.31 m³</td>
<td>50</td>
<td>65.6 m³</td>
<td>20 ha</td>
<td>1.312 m³</td>
</tr>
<tr>
<td>P1</td>
<td>5.9 m³</td>
<td>0.74 m³</td>
<td>50</td>
<td>37.0 m³</td>
<td>20 ha</td>
<td>0.74 m³</td>
</tr>
<tr>
<td>S</td>
<td>2.9 m³</td>
<td>0.36 m³</td>
<td>50</td>
<td>18.1 m³</td>
<td>20 ha</td>
<td>0.36 m³</td>
</tr>
<tr>
<td>B</td>
<td>1.3 m³</td>
<td>0.16 m³</td>
<td>50</td>
<td>8.1 m³</td>
<td>20 ha</td>
<td>0.16 m³</td>
</tr>
<tr>
<td></td>
<td><strong>Stratum Total:</strong></td>
<td></td>
<td></td>
<td><strong>20 ha</strong></td>
<td><strong>5 200 m³</strong></td>
<td></td>
</tr>
</tbody>
</table>

(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-
ing the number of paces by your average pace length. One pace is the equivalent of one comfortable walking step, so paces are tallied each time your foot hits the ground.

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 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>
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<td>34.0</td>
<td>45</td>
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<td>36.9</td>
<td>50</td>
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<td>39.7</td>
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<td>56.9</td>
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</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 land' 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</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
11. Business Basics
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 primarily 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 produce trees 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 Treharme 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-raise 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 Treherne 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 Treharne

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 Treharne’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 m$^3$. 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 Treharne 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 plantation</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>owner</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 bare root D-fir for Christmas tree production</td>
<td>owner</td>
</tr>
<tr>
<td></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, Wardens</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, Wardens</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, Wardens</td>
</tr>
<tr>
<td>Stand Improvement</td>
<td>1991-1993</td>
<td>MA 3</td>
<td>Block 6</td>
<td>Christmas tree shearing, protection activities</td>
<td>owner</td>
</tr>
<tr>
<td>Recreation Trail Devlp.</td>
<td>1990/91</td>
<td>MA 2; see map</td>
<td>4, 5</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, see map</td>
<td>4, 5</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.

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.

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.
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 salcable 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 graveling to provide for all-weather hauling. Surfacing, however, is an expensive proposition, which can in some cases double construction costs. The costs of graveling 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. Graveling 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.

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**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

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**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 ________________

b) Right-of-way ________________

c) Gravel depth ________________

d) Culverts: The Contractor will provide all materials as required by the Owner and stated herein.

   materials ________________
   minimum size ________________
   frequency ________________

e) Ditch depth ________________

f) Rock excavation ________________
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
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 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.

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