market years. In practice, the cut schedule will likely be periodic, rather than annual, for many small woodland areas.

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

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

<table>
<thead>
<tr>
<th>Forest Region</th>
<th>Average MAI (m³/ha) by Site Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good</td>
</tr>
<tr>
<td>Kamloops</td>
<td>3.5</td>
</tr>
<tr>
<td>Nelson</td>
<td>3.8</td>
</tr>
<tr>
<td>Prince George</td>
<td>3.4</td>
</tr>
<tr>
<td>- Peace River</td>
<td>3.2</td>
</tr>
<tr>
<td>Prince Rupert</td>
<td>7.1</td>
</tr>
<tr>
<td>- Bulkley-Northwest</td>
<td>3.8</td>
</tr>
<tr>
<td>Cariboo</td>
<td>3.4</td>
</tr>
<tr>
<td>Vancouver</td>
<td>10.2</td>
</tr>
</tbody>
</table>

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

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

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

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

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

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

Clearcutting

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

Clearcutting is used when:

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

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

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

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

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

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

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

**Selection Cutting**

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

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

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

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

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

**Sample Faller's Selection Guidelines:**

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

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

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

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

- Reserve trees to be evenly distributed throughout area.

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

Falling of selected trees should proceed as follows:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Which Logging Methods?

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

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

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

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

Timber harvesting involves 6 basic steps:

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

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

Felling

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

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

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

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

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

Proper Felling Procedures:

1. Remove brush, debris and snags to clear a working and retreat space (at 45° to the direction of fall, and for a distance of about 6 m).
2. Form an undercut by first making a horizontal cut into 1/4 of the tree diameter. Next make an upward diagonal cut to meet the first cut. The fat end of the wedge created should be about 1/3 of the depth of the horizontal cut. The two cuts should meet but not cross at the inside edge of the cut.
3. The backcut should be level and slightly above the horizontal cut line of the undercut.
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To encourage the full use of the Province’s timber resources, the Ministry of Forests and Lands requires that the felling on Crown lands be carried out to specific standards. These ‘utilization standards’ prescribe the maximum stump height and minimum top diameter to which stands must be logged. The ‘close utilization’ standards currently in effect are to a stump height of 30 cm and a top diameter (inside bark) of 10 cm. Although private landowners are not constrained to these harvesting regulations, it is recommended that they be followed for the advantages of: better utilization of timber resources, decreased waste, reduced fire hazard, and fewer slash disposal problems.

**Bucking**

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

Bucking can actually improve log grade by removing defects or creating special products. With such an influence on log value, it is definitely worthwhile to learn about bucking specifications. Simple things, like square cut ends and accurate measurement to include trim allowances, can mean the difference between a high value and low value log. Each tree is bucked on its own characteristics, and should be carefully assessed before making the first cut. Bucking decisions are based on the tree’s quality, distribution of knots, and a knowledge of current market values. When logs are bucked to length for a particular mill, it is important to know the mill’s trim allowance requirements. Log buyers often have cards printed up with their desired log specifications. Be sure to carry this with you; bucking decisions made in the woods can radically affect the value of the log at the mill.
Yarding And Skidding
Yarding transports the logs from the stump to a ‘landing’, or central area, usually at the roadside, where logs are loaded onto trucks. Yarding on the steeper slopes of the Coastal region is carried out by a number of systems that partially lift, rather than drag the logs to the landing. Mobile, grapple yarders and tractor-mounted ‘spars’ or towers, use highlead systems that pull in logs by tongs or attached by chokers, to a cable suspended in the air. In the Interior, yarding is usually done by skidders or crawler tractors which drag the logs by means of heavy wire cables, called chokers, or by a grapple hook. Skidding is also done with draft animals such as horses and more recently with special winches designed for small-scale operations.

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

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

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

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

For slopes of less than 20%, a branching pattern works well. Spur skid trails branch off main skid trails as illustrated. A parallel pattern is also appropriate for both simple terrain and on sideslopes up to 40%. The main trail should always be downhill. The spacing between skid trails will depend on tree height and size as well as the size of skidder winch. On the medium and steeper slopes it is important to minimize the crossing of creeks, ridges and gullies, since this will disrupt natural drainage patterns and increase site disturbance. Wherever possible, skid trails should be built downhill, from the top to the base of the cutblock. Long, steep, straight grades permit water buildup and should be avoided. Maintenance of skid trails usually involves keeping the surface water drained away with water bars and trenches.
Three main types of equipment are used for ground skidding; the selection of which to use is based on the terrain and size of timber. Rubber-tired skidders are used extensively in the Interior, since they are suited to gentle terrain with slopes up to 30%. Skidders equipped with a winch and chokers are used in conjunction with hand fellers; while skidders with grapple-mounds are used with feller-bunchers. High flotation tires are being used on skidders operating over soft and wet ground to minimize soil compaction.

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

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

**Loading**

Loading operations usually involve either a front-end tracked or wheeled loader with a grapple. The front-end loader is somewhat like a fork lift, that gathers up many logs at a time and lifts them onto a logging truck. Some logging trucks are now equipped with hydraulic hoists or booms to make them self-loading. If you contract the loading and hauling operations on your woodland, it is quite likely that you will come into contact with one of these. Some innovative operators have solved the loading challenge using two trees, cable, blocks, a spreader bar and ..........oats (you figure it out!!)

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**Skid Trail Layout and Construction:**

- follow the terrain as much as possible and avoid sharp curves
- for steep terrain, place trails parallel to contour lines to prevent erosion
- ground skidding is usually confined to slopes under 35%
- cut stumps on skid trails to ground level to prevent hang ups, but leave 1 metre stumps along the outer side of the trail to prevent slide-outs
- avoid wet spots and springs
- where trails must cross water seepages, they should be at right angles and on gravel or rocky locations. Place logs in the seepage area to provide a travel surface for equipment and minimize ground disturbance
- trails should be no wider than necessary for the tractor or skidder
- lay out skid trails for easy entry to landings; avoid sharp curves and junction corners
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Hauling
Hauling is often contracted out as a separate operation from other aspects of harvesting. It is a costly activity that is affected by road surface and design, landing organization and loading efficiency, not to mention the distance to the mill or log dump. Since haul costs are often a large portion of logging costs, and can be reduced by careful planning, it is recommended that you seek some professional advice with respect to road and landing layout before you start building.

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

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

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

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

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

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

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

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

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

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

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

What Are The Environmental Considerations?

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

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

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

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

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

Working With A Logging Contractor

Put your handshake in writing.

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

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

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

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

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

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

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

When Is Scaling Required?

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

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

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

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

How Is It Done?

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

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

\[
V = \left( r_1^2 + r_2^2 \right) \times L \times 0.00016 \\
\text{where:} \\
r_1 = \text{radius of the top in cm} \\
r_2 = \text{radius of the butt in cm} \\
L = \text{length in metres} \\
0.00016 \text{ is a constant}
\]

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

\[
V = (8^2 + 12^2) \times 10 \times 0.00016 \\
= (64 + 144) \times 10 \times 0.00016 \\
= .333 \text{ m}^3
\]

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

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

How Are Logs Graded?

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

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

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

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

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

What Is A Timber Mark?

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

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

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

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

Special Forest Products

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

Standard forms and procedures have been developed to record scale data. The procedures and forms required for scaling special forest products may vary slightly according to the particular product. Christmas trees are graded by height categories, and recorded as the number of pieces by species. Poles, pilings and building logs are
A list of the special products categories, a brief description of the products and their dimensions is given below. For more detailed information, refer to the Forest Service "Scaling Manual".

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

Recommended References:

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

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

Workers’ Compensation Board of B.C.
“Faller’s and Buckers’ Handbook”
“Yarding and Loading Handbook”

Forest Engineering and Research Institute of Canada (FERIC)
Use of the farm tractor in the forest:
“Evaluation of the Agri-Winch: A Farm Tractor-Mounted Logging Winch”. TR-41
“4WD Articulated Tractors and Skidders for Woodlots”. TN-87
“Hydraulic Grapple Loaders for Farm Tractors”. TN-88
“Logging Winches for Farm Tractors”. TN-90
“Logging Trailers for Farm Tractors”. TN-97
Small, inexpensive equipment for woodlot owners who do not have a farm tractor:
“Evaluation of Wood Caddy and Goliath Mini-Skidders”. TN-86
“Can All-Terrain Vehicles be Used for Forest Work?”
Equipment for fuelwood and energy-chip production:
“Evaluation of the Bruks Mobile Chipper”. TR-91
“High-Capacity Firewood Processing and Marketing”. Handbook #76
Other FERIC
“Handbook for Ground Skidding and Road Building in the Kootenay Area of B.C.”
“Timber Development Planning for the B.C. Interior: The Total Chance Concept”. Handbook No. 4
“Handbook For Logging With Farm Tractor-Mounted Winches”. Handbook No. 2

New Brunswick Department of Natural Resources

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

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

SAMPLE LOGGING CONTRACT

THIS AGREEMENT made the _____ day of ______________, 19__

BETWEEN

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

AND

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

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

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

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

1. AREA

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

2. FIRE REGULATIONS

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

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

4. OWNERSHIP

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

5. SLASH DISPOSAL

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

6. ROADS

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

7. TIMBER MARK

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

8. TIMING

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

9. DELIVERY

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

10. PAYMENT

The Owner agrees to pay the Contractor $________ per tonne for all logs delivered to _________________ (e.g. Acme Sawmills Ltd.) for the said area of District Lot 000. Payments shall be scheduled as follows:

a) within 10 days of receipt of scaling records, an advance of $______ (commonly 60%) per tonne.

b) within 30 days of completion of logging, the remainder of $______ (commonly 40%) per tonne, less any amounts necessary to repair damages to the access roads, and to leave the area in a workmanlike manner in keeping with good standards of logging practice.
Prior to making any payments to the Contractor, the Owner may require the Contractor to furnish receipted payrolls to the Owner in compliance with the Woodworker Lien Act.

11. APPLICABLE LAWS

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

12. LIABILITY

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

13. ARBITRATION

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

14. NOTICE

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

IN WITNESS THEREOF the parties hereto have executed this Agreement.

Date: __________________________

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

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

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

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

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

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

**Choosing Your Products**

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

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

<table>
<thead>
<tr>
<th>Products</th>
<th>Fd</th>
<th>Pl</th>
<th>Ps</th>
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</table>

**Species Key**

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

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

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

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

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

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

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

Market conditions will affect the price you get for your product. Since production costs remain fairly constant, your ability to take advantage of high points in the market cycle will make a large difference in the profit you receive for your goods. Private owners and Indian Bands in particular, have considerable flexibility in terms of when and how much they cut. It is worth your while to follow the ups and downs of the markets in which you are selling, and be ready to act when markets are paying top prices.

To do this, you must have your roads in place and your production process clearly outlined. Define your own role in production as early as possible, and identify potential sub-contractors for felling, skidding or hauling.

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

Selling What You Produce

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

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

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

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

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

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

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

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

Conditions Of Sale

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

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

Basis of Sale

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

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

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

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

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

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

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

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

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

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

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

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

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

Special Products From Your Woodland

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

<table>
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<tr>
<th>Species</th>
<th>Heat / unit</th>
<th>Ignition</th>
<th>Smoking</th>
<th>Sparks</th>
<th>Splitting</th>
<th>Rating</th>
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<td>little</td>
<td>few</td>
<td>medium</td>
<td>excellent</td>
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<td>little</td>
<td>few</td>
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<td>many</td>
<td>med.-hard</td>
<td>best kindling</td>
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<tr>
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<td>medium</td>
<td>little</td>
<td>few</td>
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<td>excellent</td>
</tr>
<tr>
<td>cedar</td>
<td>med.-low</td>
<td>easy</td>
<td>medium</td>
<td>easy</td>
<td>best kindling</td>
<td></td>
</tr>
<tr>
<td>spruce, pine, balsam</td>
<td>low-med.</td>
<td>medium</td>
<td>medium</td>
<td>many</td>
<td>best kindling</td>
<td></td>
</tr>
<tr>
<td>larch, Douglas-fir</td>
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<td>medium</td>
<td>little</td>
<td>medium</td>
<td>easy-med.</td>
<td>good</td>
</tr>
<tr>
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<td>easy</td>
<td>little</td>
<td>many</td>
<td>easy-med.</td>
<td>medium</td>
</tr>
</tbody>
</table>

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

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

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

<table>
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<tr>
<th>dbh (cm)</th>
<th>10</th>
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<th>20</th>
<th>25</th>
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<td>23</td>
<td>10.5</td>
<td>5.8</td>
<td>3.5</td>
<td>2.4</td>
<td>1.7</td>
<td>1.3</td>
<td>1.0</td>
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<td>.67</td>
<td>.54</td>
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Agro-Forestry
In many areas, forestry activities can be carried out successfully in conjunction with the production of farm crops or forage for domestic livestock. Agro-forestry, as this practice is called, may produce the two crops adjacent to one another, as a shelterwood arrangement where the tree crop protects the agriculture crop, or the two may be combined as understorey/overstorey crops, such as the undergrazing of Douglas-fir and pine stands by domestic livestock in the Interior of the Province.

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

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

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

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

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

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

A woodland nursery can be an enjoyable and rewarding project for all ages and interests. The most nimble members in the family can pick the cones and oversee the extraction of seed; the scientists can devise experiments to test seedling response to various soils or fertilizers; and the economist in the family can calculate the costs of renewing the crop that the entrepreneurs are planning to log, while the wildlife biologist devises a cutting plan to enhance deer habitat. Something for everyone. And there’s always the woodpile for working out those day-to-
day frustrations and getting something in return.

Ornamental nurseries and some retail stores buy forest products such as seed, cuttings or small plants from species such as wild rose, salal, sword and maidenhair fens, trillium, and Oregon grape. Check with your local nursery or plant store to see what they might be interested in. If you find a reasonable market for a product or plant, consider adding it to your woodland nursery for controlled production.

For the woodworking enthusiast, the forest is a regular storehouse. There are burls to carve (maple, birch, cedar, pine); materials to turn on the lathe (yew, arbutus, birch, yellow cedar); and a variety of special wood grains to explore (yew, arbutus, maple, birch, alder, white pine, yellow cedar). These specialty woods are available in some hardwood and woodworking shops, but once you know what to look for, search them out on your woodland.

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

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

### Why Wood Is Good

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

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

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

“Christmas Tree Culture”. 1988
“Christmas Tree Farming”. Publication B

**B.C. Provincial Museum, Victoria**

“Food Plants of British Columbia Indians - Part I, Coastal Peoples”. Handbook 34
“Food Plants of British Columbia Indians - Part II, Interior Peoples”. Handbook 36

**Canadian Forestry Service**


“An Introduction to Christmas Tree Growing in Canada”. 1982. Publication 1330

“Common Insects and Diseases of Balsam Fir Christmas Trees”. 1981. Publication 1328

**National Museum of Canada, Ottawa**

“Wild Coffee and Tea Substitutes of Canada”. 1978
“Edible Wild Fruits and Nuts of Canada”. 1979
“Edible Wild Greens of Canada”. 1980

**Other Sources**

“The Recognition and Life History of the Major Insects and Mite Pests of Ornamental Shrubs and Shade Trees of B.C.” B.C. Ministry of Agriculture and Fisheries


Prompt and careful reforestation is one of the most significant activities a woodland operator can undertake, since all subsequent management operations build upon the success of this initial act.

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

What Species Shall I Grow?

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

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

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

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

Which Regeneration Method Shall I Use?

There are a number of ways to approach reforestation.

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

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

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

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

Yes – Natural Regeneration *

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

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

No – Artificial Regeneration

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

Preparing The Seedbed

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

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

Drag scarification, a process which scrapes the surface of the site to expose mineral soil, can be achieved by dragging heavy chains or drums behind a tractor or skidder. This technique is commonly used to promote natural pine regeneration in the Interior of B.C. Dragging aligns and crushes slash, exposes mineral soil and brings cones close to the ground where they release their seeds onto the freshly prepared seedbed.
Drag scarification units, whether commercially produced or 'home-built' are somewhat cumbersome and best suited to large, relatively flat areas with low stumps and light slash. More manoeuvrable equipment, such as disc trenchers, can be used to prepare a mineral soil seedbed in partially cut stands. Other machines use blade attachments to move slash and loosen topsoil. This type of scarification is better suited to areas of heavy slash accumulations or large piece sizes.

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

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

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

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

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

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

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Taking What Comes Naturally

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

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

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

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

Doing It Your Way

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

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

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

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

Choosing Your Stock

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

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

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

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

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

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

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

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

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

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

Planting With Care

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

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

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

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

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

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

How Do I Monitor The New Crop?

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

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

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

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

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

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

Recommended References:

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

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

**Other Sources**

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

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

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

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

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

The objectives of stand tending are to:

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

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

What Is Stand Tending?

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

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

When Do I Tend My Stands?

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

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

![Illustration of forest management stages](image)

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

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

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

**Brush Control**

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

ing the seedlings (natural or planted). Competition at this early stage in the tree’s life (2 to 5 years after regeneration) is a very real threat to survival and growth. By reducing the competition at the beginning of the crop cycle and increasing the available light, nutrients and water, you can help your crop trees become firmly established and get off to a productive start. As discussed in the chapter “Reforesting The Land”, brushing is considered part of the process of forest regeneration since a stand can not be classified as established until its trees are free-growing.

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

Sites that are ‘good’ for growing trees are also good for growing brush, and as a result, brush may be a particular problem on your better sites. Many brush species are shade-tolerant, so even silviculture systems such as the shelterwood or selection methods that keep the forest floor partially shaded while regeneration takes place, may not significantly reduce the level of brush competition. A combination of site preparation followed by the planting of large seedling stock is generally recommended for sites where extreme brush problems are anticipated.

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

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

Manual (by hand) brushing is carried out with a variety of hand-held tools that retard the brush species by cutting or girdling their stems. Sandvik brush axes, brush hooks and machetes are effective for weeds and brush with stem diameters less than 3 cm; motorized brush cutters are used for stems less than 5 cm, and are particularly effective with salmonberry and other brush with clumped stems; and power saws are used for stem diameters greater than 5 cm.
Manual brushing is often selected for sensitive sites, such as streamsides or recreation areas, or when brush is a problem only in specific pockets of the woodland. It is usually done during the spring or summer months when the brush species are most sensitive to treatment.

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

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

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

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

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

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

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

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

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

### Brush Control Considerations

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

- **Your treatment objectives:**
  e.g. complete control, to increase light to understory conifers, decrease competition for moisture
- **Your site constraints:**
  slope, accessibility, streamsides
- **What species you want to remove and where they are located:**
  in trouble spots, sensitive areas, or everywhere
- **Cost alternatives:**
  especially labour, if not doing the work yourself
- **Other management considerations:**
  domestic stock, wildlife and fish habitat, recreation and watershed values

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

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**Brush Control Guidelines:**

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

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**Thinning**

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

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

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

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

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

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

The benefits to be achieved by thinning include:

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

**Juvenile Spacing**

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

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

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

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

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

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

The method by which juvenile spacing is carried out will vary with the density of the stand, the diameter of the trees and the percentage of live crown on the trees being removed. Some of the things to be considered in selecting a method are summarized in the following table.
## Juvenile Spacing Considerations

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

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

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

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

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

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

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

### Determining Spacing Interval

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

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

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

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

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

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

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

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

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

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

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

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

**Commercial Thinning**

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

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

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

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

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

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

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

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

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

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

## Stand Targets At Time Of Harvest: Managed Stands

<table>
<thead>
<tr>
<th>Species</th>
<th>Intertree Spacing (m)</th>
<th>Stems/ha</th>
<th>dbh (cm)</th>
<th>Height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coast</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>50 - 60</td>
<td>37.5 - 45</td>
</tr>
<tr>
<td>western hemlock</td>
<td>6.3 - 5.6</td>
<td>250 - 315</td>
<td>40 - 50</td>
<td>37.5 - 45</td>
</tr>
<tr>
<td>western red cedar</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>50 - 60</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td><strong>Interior</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Douglas-fir</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>40 - 45</td>
<td>27 - 33</td>
</tr>
<tr>
<td>western hemlock</td>
<td>6.3 - 5.6</td>
<td>250 - 315</td>
<td>35 - 40</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>western red cedar</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>45 - 50</td>
<td>24 - 30</td>
</tr>
<tr>
<td><strong>Province</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitka spruce</td>
<td>7 - 6.3</td>
<td>200 - 250</td>
<td>50 - 60</td>
<td>37.5 - 45</td>
</tr>
<tr>
<td>white/Engelmann spruce</td>
<td>6.3 - 5.6</td>
<td>250 - 315</td>
<td>40 - 45</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>balsam (grand/amabilis fir)</td>
<td>6.3 - 5.6</td>
<td>250 - 315</td>
<td>45 - 50</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>(subalpine fir)</td>
<td>5.6 - 5</td>
<td>315 - 375</td>
<td>50 - 70</td>
<td>24 - 30</td>
</tr>
<tr>
<td>larch</td>
<td>5.6 - 5</td>
<td>315 - 375</td>
<td>40 - 45</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>white pine</td>
<td>5.6 - 5</td>
<td>315 - 375</td>
<td>40 - 45</td>
<td>30 - 37.5</td>
</tr>
<tr>
<td>lodgepole pine</td>
<td>4.8 - 4.5</td>
<td>440 - 500</td>
<td>30 - 35</td>
<td>24 - 30</td>
</tr>
<tr>
<td>yellow (ponderosa) pine</td>
<td>9 - 7.3</td>
<td>125 - 190</td>
<td>45 - 50</td>
<td>24 - 30</td>
</tr>
</tbody>
</table>

## Stand Targets At Time Of Harvest: Unmanaged Stands

<table>
<thead>
<tr>
<th>Species</th>
<th>Intertree Spacing (m)</th>
<th>Stems/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir</td>
<td>6.5 - 6</td>
<td>230 - 290</td>
</tr>
<tr>
<td>western hemlock</td>
<td>6 - 5.3</td>
<td>290 - 360</td>
</tr>
<tr>
<td>western red cedar</td>
<td>6.5 - 6</td>
<td>230 - 290</td>
</tr>
<tr>
<td>Sitka spruce</td>
<td>6.5 - 6</td>
<td>230 - 290</td>
</tr>
<tr>
<td>white/Engelmann spruce</td>
<td>6 - 5.3</td>
<td>290 - 360</td>
</tr>
<tr>
<td>balsam (grand/amabilis fir)</td>
<td>6 - 5.3</td>
<td>290 - 360</td>
</tr>
<tr>
<td>(subalpine fir)</td>
<td>5.3 - 5</td>
<td>360 - 415</td>
</tr>
<tr>
<td>larch</td>
<td>5.3 - 5</td>
<td>360 - 415</td>
</tr>
<tr>
<td>white pine</td>
<td>5.3 - 5</td>
<td>360 - 415</td>
</tr>
<tr>
<td>lodgepole pine</td>
<td>4.5 - 4</td>
<td>510 - 630</td>
</tr>
<tr>
<td>yellow (ponderosa) pine</td>
<td>8.3 - 6.7</td>
<td>145 - 220</td>
</tr>
</tbody>
</table>

Local conditions such as snow loads, and the frequency and severity of seasonal storms, will influence the degree to which you thin your stands. In dense stands with shallow-rooted species it is often necessary to do two or three lighter thinnings that allow the trees to slowly develop some windfirmness. In areas of heavy snowfall, individual trees need time to develop thicker trunks that will enable them to withstand bending under heavy snow loads.

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

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

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

Where a stand has pockets of disease, spacing will focus on removing the susceptible species. In stands infected with root rot, wider spacing is carried out to minimize root contact and transmittal of the disease. In stands with a stem or needle disease, you are advised to consult with local pest management foresters regarding the appropriate spacing program. The treatment will vary depending on the particular problem and crop tree species. In some cases extra stems are left on-site as insurance against those that may die; in other cases, where it is possible that site disturbance may spread an infection, diseased stands may not be thinned at all.

One of the real benefits of small-scale woodland management lies in the ability to intensively monitor and manage stands. It is possible, through multiple thinnings over the life of the stand, to maximize the growth potential of your crop trees while reaping continued benefits from trees removed as thinnings. Stands can be kept fully stocked as they grow, with stems being removed only when they begin to interfere with the growth of the crop trees.

To do this, however, you must have good road access and be able to make repeated entries into your stands without damaging crop trees or the soils on your woodland. Further, the stems removed in each thinning must be of sufficient volume to pay for the costs of removal. These requirements will depend on whether you are able to do the thinning yourself, and the presence of markets for small wood products in your area. If no markets exist, it may be necessary to space your stand down to final harvest density in one operation.

In most cases, thinnings can be timed to meet good log markets or your specific timetable. Heavy thinnings can be taken at infrequent intervals or light thinnings can be conducted more frequently in cases where markets for small wood products exist and extraction costs are low. Since you will likely want to minimize the costs of thinning and maximize the value of the material you remove, you will probably carry out fewer, heavier, thinnings than the ideal situation of many, lighter, thinnings. Regardless of how thinning is done, the overriding objective is to maintain good crown cover, avoid high-grading, and achieve a good spacing for the development of the larger crop trees.
Tending The Stand

Guidelines for Thinning:

- choose stands with a good response potential:
  - medium or good sites
  - little damage from disease, insects, wind, snow
  - final harvest date at least 15 to 20 years away
- species priority:
  - what can grow best on your site?
  - what species best meets your goals?
  - what insect and disease problems should you consider?
- crop tree selection:
  - species
  - tree location (especially windfirmness)
  - quality
  - vigour
  - live crown ratio and crown balance
  - form
  - insect/disease resistance
  - adjacent trees and openings (i.e. spacing of crop trees)

Thinning Equipment
As discussed in the chapter “Harvesting The Trees”, a variety of special equipment has been developed for small-scale harvesting and thinning operations. The lightness and maneuverability of this equipment enable multiple entries into a stand over its rotation, with minimal damage to the soil and the crop trees.

Small skylines (e.g. Mini-Alp) with light cable and short towers have been developed especially for the removal of small wood from stands on steep slopes. Small crawler tractors (e.g. D3, John Deere 450) and rubber-tired skidders (e.g. John Deere 440), are being used successfully for small-scale operations on moderate slopes.

In addition, equipment dealers are beginning to provide modifications for farm tractors that will allow the skidding of small wood. The Forest Engineering Research Institute of Canada (FERIC) has produced a number of reports on specialized equipment for small-scale woodland thinning and harvesting. A list of these is included at the end of the chapter. Tractor-mounted winches and small yarding machines such as the Swedish “Iron Horse” or American “Radio Horse”, make it possible for operators to harvest thinnings on their own, without the assistance of large machinery or even four wheels.
Horse logging is also proving to be a viable and inexpensive method of thinning small areas, and is being used in many sensitive environments. It is best suited to stands of gentle slopes, few obstacles, and good access since it may require more landings and trails than other skidding methods. The Cariboo Horse Loggers Association (address in Appendix III) is your best reference for information on horse logging and horse logging contractors in the Province.

Other Treatments

_Fertilizing_
Just like people, trees require a balanced diet to grow well. While most stand improvement treatments focus on maintaining a continuous and adequate supply of light, water and soil nutrients to the crop trees, there are also instances where trees require additional nutrients to those available on-site. Nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) are the most common elements applied to forest stands. Two common nitrogen fertilizers are urea pellets and ammonium nitrate crystals, both of which can be spread by hand (over small areas) with a garden variety ‘cyclone seeder’.

Another means of increasing the level of nitrogen in the soil is through the presence of alder, lupins, or legumes on the site. These plants have a special relationship with bacteria that live in nodules on their roots, that are able to capture nitrogen from the air. In return for carbohydrates (energy) from the tree, the bacteria feed nitrogen into the plant’s system. When the plant’s leaves fall, this nitrogen is carried back to the soil, enriching the site for all plants growing there. The undersowing of clover, the growing of alder in mixed stands with Douglas-fir, and the sowing of lupins under pine stands in the Interior are being tested experimentally, as a means of increasing the level of available nitrogen on forest sites. A word of caution however: alder may be difficult to control once it becomes established and could create a brush control problem for young conifer stands.

To determine whether or not fertilizer is needed, a chemical analysis is usually carried out on the foliage of trees from the areas in question. Foliar analysis can be done quite inexpensively at a number of laboratories throughout the Province. Check with your District Office of the Ministry of Forests and Lands for advice on where to send your samples, then check with the laboratory to make sure that you can obtain an interpretation of the results along with the analysis.

In preparation for foliage analysis you will need to map out the sites on your woodland according to the forest cover and site class. For each site to be analyzed you will need to collect a different set of samples, so you may wish to only do one site at a time.

Foliage samples should be collected according to the following guidelines and placed in a plastic bag for shipping. It is also a good idea to send along a brief description of the area, the age and species mix of the stand, stocking density, stand history, and any other treatments carried out to date, etc., as background for the analysis.

Avoid sampling trees that:

- have a heavy cone crop (often an indication of stress)
- have insect or disease damage
- are near dirt or gravel roads (dust can contaminate the analysis)

Also, try to handle the samples as little as possible – grease, food, and other materials can ruin the test results.
For each site:

- collect samples from 15 representative trees (all samples in one bag)
- take samples of last year’s needles from two branches on each side of the tree (just a small snip – about 15 cm or 6” from each)
- collect samples during the dormant season (e.g. Sept. 15 – Apr. 1 in the Interior; Oct. – Feb. on the Coast)
- collect samples only from the tallest (dominant and codominant) trees
- collect samples from the upper third of the crown but not from the leader or top two whorls of branches
- if foliage is very wet, air dry it prior to shipping; or ship as quickly as possible after collecting.

The first samples are collected in the fall of the first year and are sent for foliar analysis. The recommended fertilizer is applied in the spring of the next year and the second set of foliage samples is taken in the fall.

The needles of the samples are weighed to find out if there has been an increase in growth in response to the fertilizer. The second foliar analysis will show any change in the nutrient status of the trees since the fertilizer was applied. Together, these provide an indication of the amount of fertilizer taken up and the potential response to that fertilizer by the trees on these sites. Although it is not possible to precisely project the amount by which individual stands will respond, this procedure can give you a good idea of which stands will likely respond best. This will help you to determine whether the treatment would be worthwhile, and to rank which stands are most important to fertilize.

The response to fertilization varies from species to species and stand to stand, and appears also to be affected by the age of the tree at the time of treatment. In general, the response to fertilizer is greatest in the first two to four years following application, and lasts from seven to ten years. The effect of fertilization is influenced by the tree’s ability to absorb it from the soil, so factors such as soil moisture, size of tree crown and root system are important variables in fertilizer response. For this reason, fertilization is usually carried out only in spaced or open-grown stands. Likewise, fertilizer is applied in early spring or late autumn when the weather is cool and rain is likely, since the fertilizer needs to be dissolved in order to be taken up by the tree.

The analysis will provide the status of the nutrients in the trees, and indicate whether the stand could be expected to respond to fertilization. If you wish to know the degree of potential response – which is important information to help you determine whether the response will be worth the cost of fertilization – you will need to carry out a ‘screening trial’.

A screening trial will take one year. It is done by establishing a number of sample plots (perhaps five plots of two trees each) on the site type being analyzed. Two foliar samples, collected a year apart, are taken from these plots.
In British Columbia, most of the research into forest tree fertilization has focused on the response of Coastal Douglas-fir to nitrogen. Nitrogen is commonly applied as forest grade urea fertilizer which is made up of approximately 46% nitrogen. To meet the treatment level of 200 kg of nitrogen per hectare, the application of 435 kg of fertilizer would be required. Obviously, this would be an unmanageable task by hand, so forest fertilizer is applied most often by helicopter or fixed-wing aircraft.

If you are considering fertilization, it is likely that others in your area are too. It may be worthwhile to organize a cooperative venture through your local Woodland Association. Also contact your District Office of the Ministry of Forests and Lands to see if there is a fertilization program for Crown lands in your area. If the helicopter and fertilizer spreading equipment are already nearby you may be able to reduce the set-up costs of fertilization.

**Pruning**

Pruning refers to the removal of live or dead branches from trees, and is carried out for a variety of management objectives. Most commonly, forest trees are pruned to produce ‘clear’, knot-free timber for high value sawlogs or veneer.

Pruning can be used to control the spread of pests such as the white pine blister rust which enters the tree through the needles of lower branches. It is also done as a fuel management practice to remove branches that act as fuel ladders, which carry ground fires up into the crowns of trees. In British Columbia, pruning has been largely a Coastal stand tending treatment to this point in time, though it is being tried on an experimental basis in some wet belt stands in the Interior.

Knots formed by wood growing around branches and branch stubs reduce the value of the wood when it is milled for lumber or plywood. Pruning is carried out to remove the lower branches of the tree, and promote the formation of clear wood in this area of the trunk as the tree grows.

Ideally, pruning should be started when trees are about 10 cm (dbh) and 4 to 5 metres tall. The first pruning or ‘lift’ should be to a height of 2.5 metres, or the length of one peeler log. It can usually be done with a saw or pruning shears. Further pruning may be done to a height of 6 metres (2 log lengths plus an allowance for stump and trim), preferably in two lifts to minimize the diameter of the knotty core, and will likely require a long-poled saw or shears and a ladder.
The amount of live crown to be retained after pruning varies with the species. As a guideline, two thirds the total height of the tree should be retained in live crown for species such as Douglas-fir, larch, spruce, and hemlock; and one half of the total height for pine species. Remember that the living branches, or crown, of the tree are its food production system. Removing too many of the branches will limit the tree’s ability to produce food and thereby reduce its growth and vigour.

Pruning is best carried out in cold weather, when growth is minimal or the tree is dormant. A small-toothed pruning saw or pruning shears are recommended. For branches larger than 10 cm in diameter it may be necessary to cut in two steps, starting with an undercut, to prevent the bark from ripping below the branch as the second, top cut is made. Branches should be pruned as close as possible to the main stem without causing damage. If a branch stub is left, it will commonly result in a delay in the formation of clear wood as it may take two to five years for the stub to heal over. In general, all dead branches (without needles or leaves) should be removed as they will produce loose knots if left on the tree.

It takes many years to achieve the improvements in wood quality that result from pruning. In general, the potential returns from pruning are related to final tree size. Pruning should be carried out on young trees, early in the rotation, so that a maximum of clear wood can be gained as the trees grow. Pruning is recommended only in conjunction with a thinning program in order to maximize the growth of the pruned trees, and the production of high-value wood. The removal of live crown will slow the growth of pruned trees for a few years, and if unpruned trees are left on-site they have the potential growth advantage over the pruned crop trees. In situations where thinning is not carried out, it is possible that unpruned trees could actually overtop and suppress the crop trees.

Before pruning, it is a good idea to obtain a professional opinion on the potential for increasing tree value that pruning could achieve in a particular stand. For many woodland operators, pruning is an enjoyable activity that produces many benefits in addition to the production of clear wood, including the provision of clearance for horseback, cross-country ski and mountain bike trails.

Pruning Guidelines:

- prune only stands of fast-growing, good quality trees of the preferred species (e.g. Douglas-fir on the Coast)
- prune the best dominant and codominant trees (straight stem, unscarred, single top)
- avoid excessively branchy trees
- prune trees early in the rotation (to maximize the amount of clear wood that can be added during the growing cycle)
- prune a minimum log length (6 m) in two or three stages, making sure that 2/3 to 1/2 of the tree remains in live crown, depending on the species
- prune in the dormant season (fall/winter)
- prune close to the bark of the main stem
- wear appropriate eye and head protection

What Returns Can I Expect?

Stand tending is an important part of woodland management, providing not only financial rewards but also aesthetic, protection, recreation, and other benefits to the woodland owner. The response to each treatment will vary according to the site, species, and the tree’s age and condition at the time of treatment. In general, the response to stand improvement treatments will be better on your better sites.

By reducing the demand for light and water in a stand, thinning treatments effectively increase the supply of these essential ingredients to the crop trees. As a result, these trees can achieve remarkable increases in growth. Fertilization in specific situations can boost this growth even more.

Through tightly controlled stand tending it is possible to reduce rotation lengths in managed stands by 25% or more of the rotation length of unmanaged stands, resulting in higher values in a shorter time period. In addition to producing crop trees in less time, the trees are often of more uniform piece size which can mean greater harvesting efficiencies and related cost-savings. Add to these economic returns the benefits of improved access, aes-
thetic, wildlife and protection values on your woodland, and stand tending becomes a good deal for all woodland operations, large or small.

Treatments should be planned carefully, in consideration of the costs and the potential responses in stand growth and value. Costs of treatment vary tremendously according to the site conditions, method and number of treatments. You are advised to consult foresters in your local area regarding specific treatment costs and applications.

For many of you, stand improvement will be the focus of your woodland activities, and you will be able to cut the costs of treatment considerably by doing the work yourself. There are also a number of financial and employment assistance programs available for stand tending activities (see the chapter "Getting Help"). In addition to improving the value of your forest crop, stand tending will provide you with the opportunity to create the stands on your woodland that work best for you.
Recommended References:

**B.C. Ministry of Forests and Lands**
- "Juvenile Spacing A Guide For Forestry Crews". Pamphlet
- "Silviculture Manual" (chapters 9 and 12). Silviculture Branch
- "A Quick Guide to Pesticides. Use and Regulation in B.C. Forest Management"
- "Forest Pesticide Application Course". Handouts
- "Evaluating Forest Stand Nutrient Status". 1985. Land Management Report No. 20
- "Regional Stand Tending Guidelines"

**B.C. Ministry of Environment and Parks**
- "Handbook for Pesticide Applicators and Pesticide Dispensers". Pesticide Control Branch
- "Guide to Applicants for Pesticide Use Permits and Special Use Permits"

**Canadian Forestry Service, Victoria**
- "Use of Herbicides in Forest Management". CFS Information Report NOR-X-282

**Forest Engineering and Research Institute of Canada (FERIC)**

Use of the farm tractor in the forest:
- "Evaluation of the Agri-Winch: A Farm Tractor-Mounted Logging Winch". TR-41
- "4WD Articulated Tractors and Skidders for Woodlots". TN-87
- "Hydraulic Grapple Loaders for Farm Tractors". TN-88
- "Logging Winches for Farm Tractors". TN-90
- "Logging Trailers for Farm Tractors". TN-97
- "Evaluation of the G-30 - Vimek Processor Attachment for Farm Tractors". TN-99
- "Handbook For Logging With Farm Tractor-Mounted Winches". Handbook No. 2

Small inexpensive equipment for woodlot owners who do not have a farm tractor:
- "Evaluation of Wood Caddy and Goliath Mini-Skidders". TN-86
- "Can All-Terrain Vehicles be Used for Forest Work?"
- "Pruning Douglas-fir on Coastal British Columbia". Interim Report IR-383-1

**Other Sources**
- "Juvenile Spacing Manual". Workers’ Compensation Board
- "Silviculture - The Journal of the New Forest". MacLean Hunter Ltd. 777 Bay St., Toronto, Ont. M5W 1A7
Each year, approximately one million hectares of forest land in British Columbia are damaged or destroyed by the combined actions of fire, insects and disease. The protection of forest land is an ongoing task of prevention, early detection, and control of damaging agents.

This chapter discusses the ways in which you can reduce risk, improve detection, and find assistance for coping with pest problems if and when they occur. Practical information, such as signals and check lists of potential pest problems, fuel management techniques, and other preventative maintenance activities will help you to develop a protection strategy for your woodland.
What Creates A Fire Hazard?

To have a fire you need three things: fuel, oxygen and heat (for ignition). All of these exist in the forest environment. Needles, bark, twigs and wood, provide fuel for ignition and for prolonged burning; forest air is rich with oxygen produced by plants growing on-site; and people and lightning act as sources of ignition. To fight fire, you must remove one or more of these elements. In the case of forest fires, protection efforts are focused on removing or modifying the fuels, regulating the movements and activities of people, and predicting the occurrence of lightning-caused fires.

In developing a fire protection program, it is important to know how fire behaves under different circumstances. The primary factors that influence fire behaviour in a forest are the fuels, weather, and topography (lay of the land). A look at each of these will help you to assess the potential fire risk on your woodland.

Fuel exists in various forms in a forest. Dense, heavy fuels, such as standing timber, fallen trees, and sound stumps are normally difficult to ignite and burn relatively slowly, though with intense heat. Light flash fuels, such as logging slash, brush cuttings, and other residues are easily ignited and burn rapidly. The presence of both types of fuel represent a potential fire hazard to the woodland. Snags are a special concern because they are dead, dry and always ready for ignition.

The volume of fuel affects the amount of heat produced by a fire. The most dangerous fire situations exist where there are both light fuels for ignition, and medium and large materials for prolonged burning. Fuel spacing affects how quickly and to what extent a fire can spread. When fuels are close together, fire spreads faster. As a result, a common fire suppression technique is to separate burning fuels from unburned fuels by creating a ‘fireline’ by hand or machine.

Weather exerts a strong influence on fire behaviour. Temperature affects the drying of fuels and the movements of air, while humidity (the moisture in the air) affects the moisture in the fuel. Dry air, during the day, draws moisture away from fuels, making them more combustible, while moist, night air, can actually dampen and slow down a burn. Wind patterns change during the day, generally blowing upslope during the day as sun-warmed air rises, and downslope during the night as cooler air sinks. Wind also speeds the spread of fire by bringing fresh supplies of oxygen, pre-heating fuels in front of the fire, and igniting spot fires by carrying embers to new fuels.

The terrain, or topography, affects the rate and direction in which fire can spread. Fire tends to spread faster uphill than downhill, and the steeper the slope, the faster the spread. Aspect, the orientation of the land to the North, East, South and West, affects the amount of sunlight that an area receives. South-facing slopes expose fuels to direct sunlight which causes rapid drying. Such slopes are potential ‘hot spots’ and should be watched carefully in the summer months. North-facing slopes, where fuels are more shaded, and often more dense, pose less of a fire risk. Fire behaviour is also affected by terrain because of
its influence on the movement of wind. Landforms such as ridges and rock faces may cause wind turbulence and eddies on their leeward side. When wind is channelled it increases in strength, and in chutes or steep drainages a chimney effect can make fire behaviour extremely dangerous.

What Is My Role In Fire Protection?

The only factors in the fire formula that you can influence are your actions (as a potential source of ignition) and, to a lesser extent, the fuel. Your role in fire protection is to prepare for it, try to prevent it, watch for high hazard situations, and be ready to act quickly if and when it strikes.

Fire protection is part of your overall Forest Management Plan, and your protection strategy will usually have four parts: prevention, preparedness, detection, and suppression. For small-scale woodland operators, the first three will be the major elements, and suppression will likely be limited to taking initial action on forest fires originating on your land.

Fire Prevention

Never was the old saying ‘an ounce of prevention is worth a pound of cure’ more true than in the case of forest fires, where the values at risk – to timber, range, recreation, wildlife habitat and water – are so high. Prevention usually focuses on two areas: modifying the activities that take place in the forest, according to the degree of fire danger and risk, and modifying the forest fuels to reduce fire hazard.

The Forest Act and associated regulations influence activities taking place on provincial forest lands during the fire season, April 15 – October 15th, by:

- establishing conditions for campfire use
- requiring burning permits
- restricting forest use for industrial operations and recreation, according to the fire danger level
- requiring proper snag and slash disposal
- requiring forestry operations to take special precautions in the cutting, grinding or welding of metals, including the provision of watchmen and sufficient fire fighting equipment in areas where forestry work is being carried out

Forest fuels are the other target of fire prevention activities. Firebreaks (areas of less flammable fuels) and fuelbreaks (areas where fuels have been burned off) can be used to decrease the chance of fire start and spread. Existing fuels can also be modified by practices such as controlled understorey burning, to reduce the potential rate of fire spread. Fuel management strategies include such measures as:

- increased utilization of wood on-site (e.g. removing slash for firewood or small log products)
- clearing fire guards around areas of high risk, such as slash
- cleaning up slash on road rights-of-way
- prescribed burning or mechanical site preparation to reduce fuel hazards
- limiting cutblock size in cases where slash disposal might be difficult
- leaving areas of standing timber as firebreaks
Forest Protection

A fuel management plan is required for Woodlot Licences (and recommended for private lands) as part of the five-year Development Plan. It identifies potential fire problems on the woodland and the fuel management strategies to combat them. The fuel management plan is based on the fire history, weather, and type of fuels in the area, including social considerations such as level of use. Much of this information is available from the District Offices of the Ministry of Forests and Lands.

Fire Preparedness
Since a quick response greatly enhances the chances of early control, being prepared for fire is an important part of the fire protection plan. This includes having the appropriate suppression equipment on hand for the size and type of your woodland operation, and having a plan in place for initial attack if and when a fire occurs.

The objective of the Ministry of Forests and Lands is to contain all wildfires by 10 am of the day following discovery. Since not all forest fires originate on (or limit themselves to) Crown land, the Ministry has entered into various agreements with municipalities, regional districts and others, to enhance forest protection from wildfires. As urban developments encroach on forest land, these agreements are becoming increasingly important. While urban and municipal fire departments are responsible for the prevention and suppression of structural fires, the Ministry of Forests and Lands remains the lead agency in dealing with wildfires.

Part of being prepared is knowing when the risk of fire is highest, so the Ministry of Forests and Lands maintains a fire danger rating system to measure the susceptibility of forest lands to fire. The system uses weather variables of temperature, relative humidity, wind speed and rainfall to model the condition of forest fuels and develop an index of fire danger. The fire danger rating is used in making decisions regarding the regulation of forest land activities including the need for early shifts (so forestry and logging crews finish work and leave the forest before temperatures and fire danger peak), temporary shutdowns of logging operations, or forest closures.

Another aspect of preparedness includes having fire fighting equipment on hand to stop fires as they develop. The “Forest Fire Prevention Regulations” require forestry operations of different types to have the following suppression equipment on-site.

<table>
<thead>
<tr>
<th>Type of Operation</th>
<th>Suppression Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Equipment</td>
<td>1 shovel, 1 pulaski or mattock, 1 fire extinguisher</td>
</tr>
<tr>
<td>Portable Sawmill</td>
<td>as above plus 1 water tank with 4 500 litres of water, 1 pump unit; clear area of flammable fuels to 30 m</td>
</tr>
<tr>
<td>Power Saw Cutting, grinding, or welding</td>
<td>1 fire extinguisher and shovel at refuelling point</td>
</tr>
<tr>
<td></td>
<td>2 shovels, 1 fire extinguisher, 2 (18 l) hand-tank pumps; clear area of flammable fuels; watchman during and up to 30 minutes after operations</td>
</tr>
<tr>
<td>Explosives</td>
<td>2 shovels, 2 (18 l) hand-tank pumps</td>
</tr>
</tbody>
</table>
In addition, a specific amount of hand equipment, such as axes, shovels, mattocks and hand-tank pumps must be cached on-site according to the size of an operation. Minimum water supplies are also required. As the "Forest Fire Prevention Regulations" change from time to time, woodland operators are advised to check with their District Office for current requirements.

<table>
<thead>
<tr>
<th># of People</th>
<th>Axes</th>
<th>Shovels</th>
<th>Pulaskis/ Mattocks</th>
<th>Hand-tank Pumps</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - 8</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>9 - 15</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>16 - 25</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>26 - 40</td>
<td>4</td>
<td>10</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

Woodlot Licensees, and private owners participating in some assistance programs are required to develop a fire pre-organization plan as part of the Forest Management Plan for their woodlands. The pre-organization plan outlines the fire protection strategy for the area. The plan must be updated annually to keep current with changes to the area. Guidelines for the preparation of a pre-organization plan are provided at the end of the chapter.

**Fire Detection**

Your fire detection activities will include maintaining an overall fire check routine for your woodland during periods of high fire hazard and after lightning, and in areas where forestry work is being carried out.

**What Are My Fire Responsibilities?**

Where fire is concerned, little distinction is made between Crown lands and private lands. Everyone owning or occupying forest land is equally responsible for fire prevention and suppression. You are required to dispose of slash on your lands, including the falling of snags and slash burning, and take other measures to prevent the outbreak of fire. Where fire occurs, you are required (under the Forest Act) to report it and take initial, aggressive action in suppressing it. When a fire moves beyond the operator’s suppression capabilities, the Ministry of Forests and Lands may take over, and if required to do so, the operator and his equipment must be at the disposal of the Ministry. If you are responsible for a fire outbreak due to operational negligence, or fail to take initial suppression action, you may be liable for suppression expenses incurred by the Ministry of Forests and Lands, or even prosecution.

The general policy of the Ministry of Forests and Lands is to make sure that forest fire control action is taken on any land, regardless of ownership or tenure. The federal Department of Indian and Northern Affairs has made arrangements with the Ministry of Forests and Lands to suppress fires on Indian Reserve lands.
For the woodland operator on private or Crown lands, the best approach to fire protection is to reduce the chance of fire. The most effective way to do this is to utilize the wood to its maximum and keep all your harvesting and silvicultural operations as 'clean' as possible. In addition, consistent attention to things such as fuel buildup in areas where equipment is operating, following safety procedures when handling flammable substances, and carrying out ongoing slash disposal, can greatly reduce the risks of fire. Knowledge of one’s land and potential hot spots, the basic steps of fire fighting, and who to call in the event of fire, are additional safety measures. The Ministry periodically sponsors one day mini-courses in suppression training and has other excellent written and video materials on fire protection appropriate for all categories of woodland operators. Check with your District Office or L.M. Media Marketing Services Ltd. (addresses in Appendix III).

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**Being Prepared For Fire:**

1. Develop a fire prevention strategy for the site (especially fuel management)
2. Keep a phone list at home, on-site, in vehicle with:
   - fire report number: Zenith 5555
   - MOFL District Office
   - local fire department/volunteer squad
   - 3 neighbours who have agreed to be on call as fire fighting recruits
   - hospital
3. Have access to the following equipment:
   - pickup truck (4 wheel drive if possible)
   - 4 shovels, pulaskis, backpack pumps
   - 1 truck-mounted water pump
4. Know the fire danger rating in your area
5. Develop a water source on site if necessary (roadside water holes, holding tanks)
6. Map all access routes and possible sources of water on-site; leave with MOFL District Office, friends, at home, and in your vehicle
7. Control public access. Check the area after logging or other operations and lightning

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**Protecting Your Woodland From Pests**

Insect pests and diseases which inhabit our forests cause millions of dollars worth of timber losses each year. Forest pests attack a wide range of tree species and ages, retarding growth, affecting tree form, reducing wood quality, and in some cases, killing trees outright. At a forest level they also leave their mark by delaying regeneration, changing species composition, affecting water quality and recreation values, and damaging wildlife habitat. Worse still, in the wake of this destruction, they often create a fire hazard.

The provincial and federal forest services and the forest industry all share in the task of protecting forests from pests. The federal government carries out overview surveys and research, while the provincial government is responsible for operational surveys, the setting of provincial pest policy, and the administration of control measures. Some forest companies employ pest management foresters to oversee protection programs on company owned and licenced forest lands.

Successful pest management begins with prevention and early detection. Through special management practices, attempts are made to prevent or disrupt conditions favourable to particular pests. These may include such things as planting species that are resistant to local pests, managing stands for a mixture of species and age classes, harvesting stands before they become overmature, maintaining clean logging practices, and practicing sanitation cutting to remove infected trees. In many cases the best prevention and control can be done along with other activities in your woodland, such as regeneration, thinning, or harvesting.
Once a problem has been identified and its potential damage appraised, a suppression plan is designed. Control measures may attempt to directly or indirectly manipulate the pest’s life cycle or the forest environment in which it lives. For instance:

- selective felling and burning of individual trees is used to control dwarf mistletoe
- trap trees and logs are used in the control of spruce beetle and mountain pine beetle
- Douglas-fir beetle is controlled by practicing good utilization standards
- bark beetle populations are controlled by quick removal of felled timber (which attracts beetles) from the logging site
- biological agents, such as viruses, bacteria, fungi, mites, birds and mammals are being tested for their effectiveness as parasites or predators on particular pests, including defoliating insects
- pesticides are used under stringent regulations prescribed by the Pesticide Control Act of B.C.

This chapter discusses the general guidelines for prevention and detection of pest problems on your woodland. Since specific control measures vary throughout the Province, you are advised to contact the District Office of the Ministry of Forests and Lands to refer to the Regional Guidelines that set out the procedures for pest detection and control in your area.

**How Do I Recognize A Pest Problem?**

Pest infestations are sometimes hard to identify, especially in the early stages of attack or infection. Insect and disease pests often cause similar symptoms in the affected trees. To begin the process of detection and appraisal you can do three things:

1. Become familiar with the general warning signs of pest problems (a chart of basic symptoms follows).

2. Find out which major forest pests are currently active in your region. Since the problem species can change radically from year to year, consult with your District Office of the Ministry of Forests and Lands or with the Forest Insect and Disease Survey Unit of the Canadian Forestry Service.

3. Based on the tree species in your inventory, identify which pests are most likely to be in your woodland, then find out the specific symptoms of each. (Insect and disease charts are included in the following sections to help you).

Armed with these clues, do a check on your woodlands. If you find evidence of damage that you suspect may be caused by a forest pest, remove a portion of the affected trunk, branch, foliage, bark or cone. The District Office of your Ministry of Forests and Lands may be able to help you identify the offender and offer suggestions on means of control, or you can mail the sample, along with any related description or supporting information, to the Canadian Forestry Service in Victoria (address in Appendix III) for assistance in identification. You are advised to take every available opportunity to check your woodland for signs and symptoms of pest attack – during casual walks, silvicultural assessments, and road layouts, as well as during specific pest management cruises.

A general check list of symptoms of pest damage and the potential causes follows. More information on the damage done by particular pests is provided in following sections.