provide forage and hunting opportunities for many species. In the winter, these gaps, with surrounding forest that can provide snow interception and cover, are used extensively by ungulates.

6.3.3 Species groups and selected species of management concern

Although all species in the ecosystem are components of biodiversity, some may be more important to managers than others because they:

- are rare or endangered;
- may create habitat for others (e.g., primary cavity nesters);
- require specific habitats that are adversely affected by land use practices;
- are commercially valuable and hence a high population level is desired; or
- are important silvicultural allies or pests.

Table 6.2 presents selected wildlife species found in the PRFR that fit one or more of these criteria.

Many of these species share similar habitat requirements and can thus be grouped into species management groups (see Table 6.1). Management activities that maintain specific habitat components will be potentially beneficial to all species that rely on that component. In cases where the effects of a management prescription on wildlife are being monitored, studying the response of one of the species in the group (known as a management indicator species) will give some indication of how the practices are affecting other species in the group.

6.4 Wildlife Habitat Considerations in Timber Harvesting and Silvicultural Planning

This section is a compilation of guidelines laid out in several draft documents dealing with forestry management for wildlife habitat and biodiversity. Field workers who require more detailed and specific guidelines for landscape and stand structure objectives should consult these papers. Documents available or in preparation include:

- Fish, forestry, and wildlife guidelines for coastal forests (B.C. Coastal Fisheries/Forestry Guidelines Technical Committee 1992) and interior forests (B.C. Interior Fish, Forestry, and Wildlife Guidelines Committee 1993)
- Guidelines to maintain biodiversity in coastal forests (B.C. Ministry of Forests/B.C. Ministry of Environment 1992) and interior forests (Steventon 1993)
- Provincial harvesting guidelines for the management and maintenance of wildlife trees (Wildlife Tree Committee of B.C. 1993)

TABLE 6.2. Habitat features of selected species of management concern

Species	Habitat Features
AMPHIBIANS	
Northwestern Salamander	Associated with mature and old-growth forest. CWD probably important. Feed in the forest near still water; generally at lower elevations. Need permanent water for reproduction. Coastal areas only.
Tailed Frog	Associated with forested (often coniferous old growth) riparian areas along fast-moving streams in the CWHvm and CWHws. A blue-listed species.
BIRDS	
Bald Eagle	High densities near coast. Associated with old growth, particularly with large trees to support heavy nests. Nest in riparian and shoreline forests, near feeding habitats. Scavenge and hunt along shorelines, estuaries, salmon rivers. Blue-listed.
Barrow's Goldeneye	PRFR contains majority of breeding range. Nest in large tree cavities in wetland riparian areas. Overwinter in protected coastal inlets. Secondary cavity nester.
Brown Creeper	Abundant in old-growth forests, which may be optimal habitat. Uses older trees with thick, furrowed bark.
Marbled Murrelet	May depend on coastal old growth for nesting habitat; large, mossy limbs of conifers used. Common along the mainland coast, and a significant portion of the world population probably breeding here.
Northern Goshawk	In many habitats in winter, but otherwise generally in coniferous or mixed forests. Nest in 150 + yr conifer stands, northerly exposures.
Peale's Peregrine Falcon	Coastal. Hunt for birds (e.g., Ancient Murrelets) in marine and wetland habitats. Generally cliff nesters, but some nest in large trees.
Pileated Woodpecker	Region-wide resident of mature coniferous and mixed forests. Use coniferous and deciduous trees for nest cavities. Generally need trees at least 25 cm dbh (preferably > 50 cm dbh) for nesting. Use CWD, snags, live trees for foraging.
Vaux's Swift	Nest and roost in tree cavities or broken tops. Possibly dependent on old-growth forests. Forage over openings, riparian areas, and wetlands.
MAMMALS	
Beaver	Use riparian deciduous forests and willow shrublands. Highest densities in low-gradient streams and sheltered lakes with plenty of deciduous trees <10 cm dbh.
Black Bear	Adequate winter den sites extremely important. On coast, typically den in large cedar trees and CWD. Spring forage in wetlands, estuaries, riparian areas, or at higher elevations on southerly aspects. Summer forage often available in early seral plant communities, including burns, cutblocks, and wetlands. Berry crops and salmon streams highly significant in fall.
Caribou	Potentially sensitive to human disturbance of forested migration routes and over-wintering areas. Summer in alpine and subalpine areas; winter in alpine areas and mature, lower-elevation, dry forests with high ground cover of lichens. A blue-listed species with limited distribution.
Fisher	Secondary cavity nester in large cottonwoods. Summer use of riparian areas, pole-sapling forests, and mixed forest. Intolerant of deep snowpacks; winter activity primarily in mature stands with dense canopy closure. Blue-listed species; in decline in recent years.

TABLE 6.2. (Continued)

Species	Habitat Features
Grizzly Bear	Generally den at mid elevations. Spring forage habitats are estuaries sedge fens, avalanche chutes, and riparian areas/seepage sites. Carrion can also be important. Early seral vegetation provides some forage, particularly berry crops. Use old growth for feeding and bedding in coastal floodplains. Riparian areas along salmon rivers extremely important, especially in fall. A blue-listed species.
Keen's Long-eared Myotis	Probably dependent on coastal old-growth forests with associated cliffs to roost and breed. Forage over ponds, riparian areas, etc.; 90% of the world population believed to be in B.C. A red-listed species.
Lynx	Depend on snowshoe hare. Use CWD in older stands for denning.
Marten	Closely associated with mature forests, particularly more productive stands. Need understory diversity and plenty of snags, brush piles, and CWD to den and to provide prey habitat, foraging cover, and hunting access below snow.
Moose	Closely associated with, and may be dependent in severe winters on, mature deciduous and mixed forests for feeding and shelter. Use wetland/riparian areas with dense deciduous cover in summer, also shrubby avalanche tracks. Require abundant browse; willow and red-osier dogwood important.
Mountain Goat	Habitats generally very rugged. At high elevations in summer, generally above treeline. In winter, closely associated with mature forest canopy interspersed with cliffs and ledges (good escape terrain) for shelter, predator protection, and food. May occur at low elevations along the coast.
Mule/Black-tailed Deer	Use coniferous forests and open areas, burns, cutblocks, etc. In spring, use south aspects, floodplains, wetlands, and young seral stages. In summer, young seral stages are often used. In winter, use older forests with arboreal lichens and understory shrubs; warm aspects preferred.
Northern Flying Squirrel	Secondary cavity nester in mature conifer and mixed habitats. Interior populations primarily conifer seed eaters; coastal populations fungivores. Nests in cavities and witch's brooms. Important prey species for owls.
Porcupine	Inhabit many forest types. Pole-sized conifers provide important winter food; may cause extensive damage in second-growth stands. Den in caves, rock crevices, and hollow trees. Larger-limbed trees are used for resting; brush piles are used for cover. Often in riparian habitats in spring and summer.
Red Squirrel	Spruce trees often preferred. Use secondary cavities in large-diameter trees and witch's brooms for nesting. Populations may fluctuate with cone crops; conifer seeds are main food item. Use CWD for food caches.
Red-backed Vole, Northern and Southern	Very important prey species for most predators in the region. Prefers forested habitats with plenty of decaying logs and moss. Also in brushy habitats or in clearings under brush piles. Require lots of CWD on forest floor for cover.
River Otter	Use coastal and riparian mature and old-growth forest for denning, often under large upturned trees. Also found under large tree roots, rock crevices, and in beaver burrows. Need dense riparian cover. Log jams and riparian CWD provide important prey habitat, foraging cover, and den sites.
Snowshoe Hare	Prefer brushfields or deciduous/mixed forests with willow understory. Populations follow a 7- to 10-year cycle. Important prey species.

- Guidelines for maintaining biodiversity during juvenile spacing (B.C. Ministry of Forests/ Ministry of Environment 1993)
- Guidelines for integrating coastal Grizzly Bear habitat (Hamilton *et al*., in prep.)
- Pre-Harvest Silvicultural Prescriptions to protect and maintain wildlife habitat (Klenner 1991[13])

Full references for these and other wildlife references can be found in Appendix 1.

6.4.1 General guidelines for maintaining wildlife habitat values

Current forest management practices aim to establish viable conifer plantations as quickly as possible to achieve an 80- to 100-year rotation. Emphasis over the rotation is on coniferous pole-sapling and young mature seral stages — stages that are generally of least value to wildlife and have the lowest species diversity. These younger forests lack the structural complexity that supports healthy populations of some wildlife species. The important stand habitat components, as described previously, generally arise from senescing mature stands (old growth) or from complex younger stands that contain a significant component of deciduous tree and shrub species as well as scattered snags and veteran trees. Many of these characteristics are affected by forestry activities (Table 6.3).

In general, the two seral stages of the most value to wildlife are the initial shrub-herb and old-growth stages. Preliminary recommendations for the ratio of early seral to mature stages in the landscape are presented in Table 6.4.

Appropriate harvesting activities at the stand level can maintain some of the structural components typical of older forests. Preliminary guidelines for preservation of structural components on zonal sites are outlined in Table 6.5 and are based on surveys of natural mature forests. These values represent the minimum density of components believed necessary to maintain viable populations of attribute-dependent species in managed stands, and are meant to serve as target objectives across small- to medium-sized areas (10 - 100 ha). Note that the listed densities are what should be present at the time of second-growth maturity. Actual numbers must be higher at harvesting to compensate for loss of attributes over the rotation. Natural stands show a high degree of variability in distribution of snags and dead trees. Therefore, for the greatest wildlife use potential, there is value in clumping retained trees.

The following two sections describe approaches to maintaining or enhancing important habitat components during harvesting and silvicultural operations.

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[13] Ibid., p. 6•2.

TABLE 6.3. Potential impacts of broad management activities on important stand structure attributes[a]

Management Activity	Structural Attribute					
	Snags	Large green trees	Coarse woody debris	Tree species diversity	Under-story	Stand structure
Silvicultural system	* *	* *	*	*	* *	**
Site preparation	*[b]	*[b]	**		**	
Regeneration	*[b]	*[b]		**	*	**
Vegetation management	*			**	**	**
Spacing and thinning	**[b]	*	*	**	**	**
Pruning						*
Pest management	**	**	*	*	*	**

** potentially high impacts * potentially significant impacts.

[a] Adapted from Steventon (1993).

[b] Activity does not necessarily affect attribute; however, safety regulations associated with work site activities often require removal of wildlife trees that pose a potential hazard to workers.

TABLE 6.4. Preliminary seral stage objectives by biogeoclimatic zone (percentages of 10 000- to 90 000-ha management units)[a]

Seral Stage	ESSF/MH	SBS/SBPS/BWBS	CWH/ICH
Early to mid seral	< 30%	5 - 50%	< 30%
Mature[b]	> 50%	> 30%	> 40%
Harvest unit size[c]	0 - 100 ha	0 - 200 ha	0 - 100 ha

[a] Adapted from Steventon (1993).

[b] "Mature" is used here to connote the presence of important structural attributes typical of natural mature forests, such as large trees and snags. Approximate minimum years to achieve "mature" status in *appropriately* managed forests for the above zone groups is 80 - 120 years, 60 - 80 years, and 40 - 80 years respectively. Clearcut stands with no retained snags or green trees will require *at least* double these times to begin to produce mature forest structural attributes.

[c] Generally, there should be a greater frequency of smaller rather than larger units, averaging approximately 40 ha. However, in specific situations a few large blocks may be preferable over many small blocks (e.g., for the management of winter caribou habitat in the SBPS). 0-ha harvest units are uneven-aged managed stands. Larger units may be composed of a "cluster" of smaller blocks.

TABLE 6.5. Preliminary minimum structural objectives to be maintained for mature a second-growth stands on zonal sites[b]

Attribute[c]	SBSmc	SBSdk/ SBPS	ESSF	ICH	CWH	MH[d]
Snags/ha >17.5 cm dbh	9 (99)	6 (67)	10 (121)	5 (53)	5 (23)	5
Snags/ha >27.5 cm dbh	3 (24)	3 (12)	8 (84)	2 (13)	2 (11)	3
Snags/ha >37.5 cm dbh	2 (11)	1 (2)	4 (40)	3 (25)	3 (13)	2
Total snags/ha	14 (134)	10 (81)	22 (245)	10 (91)	10 (47)	10
CWD m^3/ha >10 cm diam.	50 (100)	25	50	50 (100)	50	50
Stems/ha >17.5 cm dbh	400 (798)	400 (805)	400 (887)	400 (689)	300 (337)	400
Large trees/ha >37.5 cm dbh	15 (83)	10 (37)	15 (145)	20 (175)	30 (144)	15

[a] "Mature" as defined in Table 6.4.

[b] Values outside brackets are minimum target densities to be present at second-growth stand maturation; values inside brackets are average attribute densities for natural zonal forests (based on surveys of > 35 stands from each zone).

[c] Snags and CWD should represent a range of decay stages from hard to soft.

[d] No stands sampled.

6.4.2 Harvesting considerations

The following guidelines apply mostly to even-aged silvicultural systems rather than uneven-aged systems. *Uneven-aged silvicultural systems such as single tree or group selection offer some advantages over clearcut systems for meeting wildlife habitat objectives because they maintain within-stand structural diversity. Assuming that all snags and large trees have not been selectively removed, these sites will act very much like "mature" stands within the landscape.* Conversely, clearcutting promotes early seral (pole-sapling) stages and removes mature forest habitat components. Clearcutting may have some similarities to wildfire as a disturbance agent; however, it conspicuously lacks the structural "legacies" (patches of live trees, veteran snags, and CWD) that typically remain after wildfire. Even-aged harvesting practices can be modified to maintain some of these habitat components in the managed forest through green tree/snag

retention and manipulation of block size and shape. An overview of the effects of management activities on important structural attributes is presented in Table 6.3.

Green tree and/or snag retention

Patches of trees and snags within a cutblock provide immediate nesting habitat and cover for some species (e.g., Tree Swallows, flycatchers, and bats). More importantly, they provide a source of large-diameter snags for the future forest. Seed tree or shelterwood systems retain green trees, but some must be left unharvested to provide large-diameter snags during the next rotation (Table 6.5). In clearcuts, retaining patches is usually safer and operationally easier than retaining single trees and snags. Possible sites where groups of trees can be retained are:

- **on areas of difficult or uneconomical harvesting** such as in gullies, on unstable slopes, along intermittent streams, and around rocky outcrops;
- **along the boundary of the cutblock;**
- **on drier upland areas** where such trees can also serve as shelterwood trees;
- **on wet sites** where trees are small or of poor quality, or where logging operations may lead to site degradation. Large hardwoods (aspen, birch, cottonwood) can be retained wherever possible since they grow rapidly and should become usable snags;
- **in riparian areas** where fisheries habitat guidelines restrict cutting practices. Live trees should be retained in addition to the recommended fisheries streamside zone to develop as wide a corridor of forested habitat as is feasible. Use of directional falling, faller selection, and yarding away from the area to create a buffer zone with a gradient of decreasing tree density into the clearcut is the optimal approach; and
- **in uniform cutblocks** where small groups of merchantable trees may have to be considered for retention.

For safety reasons, snags should be maintained in patches (e.g., green tree retention areas, along riparian corridors) and should include both hard (recently dead or dying, little decay) and soft snags (advanced decay of firm trees with extensive heart rot) to maintain viable populations over time. Good candidates for large-diameter live trees that can be retained to become future snags are:

- **trees with deformities, broken tops, or heart rot,** which reduce their economic value;
- **large veteran trees;** and
- **hardwoods** such as trembling aspen, paper birch, black cottonwood, and red alder.

Only windfirm trees that will continue to grow to at least 25 cm dbh should be chosen.

CWT retention

Coarse woody debris is most effective as wildlife habitat when it is well dispersed over the cutblock or grouped in small units; large piles of logs provide minimal habitat. Unmerchantable trees should be left where they fall.

Block size and shape

Small, dispersed harvest blocks (1 - 10 ha) provide a large amount of edge habitat, which benefits many species. At a low level of harvest, small clearcuts do not fragment the landscape. However, at high levels of forest removal, dispersed small clearcuts lead to excessive habitat fragmentation and this is deleterious to species that require uninterrupted areas of early seral or mature forested habitat. Larger clearcuts (> 20 ha) have less edge habitat and, in early seral stages (shrub-herb and pole-sapling), may be favoured by species such as voles and Snowshoe Hare that can do considerable damage to plantations in some areas.

At present, it is unclear what landscape patterns are optimal to maintain healthy populations of all species in different zones across the region. However, it is clear that imposing a “checkerboard” of repetitive cutblocks of similar size and shape is not the best approach for optimizing wildlife habitat. Varying the size, shape, and distribution of clearcuts in the landscape is likely to be the most beneficial approach. Some points to consider are:

- **Long narrow cutblocks** can remove large volumes of timber while maximizing edge. It has also been proposed that long narrow parallel cutblocks should be used in caribou migration areas to reduce impacts.
- **Small clearcuts** of less than 10 ha maximize edge habitat and, in low densities, may act as natural gaps in the landscape. At higher rates of cut, clustered cutblocks are preferable because well-dispersed cutblocks may lead to excessive landscape fragmentation.
- **Clustered cutting patterns** reduce the effects of landscape fragmentation and most closely resemble natural disturbance patterns.
- **Partial cutting** maintains more of the habitat components in harvested areas than does clearcutting. Cutblocks that still have understory cover and patches of trees will provide habitats similar to those found in natural forests.
- **Irregular block boundaries** increase the amount of edge and the diversity of edges in a cutblock.

6.4.3 Stand management considerations

Wildlife habitat management objectives can be incorporated into forest management planning during all phases. In general, the decisions made early on are the most critical for long-term habitat conservation.

Site preparation and reforestation

Site preparation has important consequences for short- and long-term wildlife habitat. Treatments such as prescribed burning or mechanical site preparation achieve desired reforestation goals by shortening the time needed for conifers to become established. However, these treatments often remove, albeit temporarily, competing herb and shrub species and accelerate plant succession toward the pole-sapling stage. These plant species often provide important wildlife habitat.

Site preparation treatments also remove or rearrange both solid logs and decaying material on a site after logging. Large-diameter CWD provides good foraging habitat, decays more slowly, and presents less of a fire hazard than does smaller slash. Therefore, broadcast burning should be prescribed such that only fine debris is removed. A moderate- or high-intensity burn will char and case-harden CWD, reducing its value for wildlife. Low-intensity burns will maintain valuable CWD while removing fine slash and may also increase plant species diversity and wild fruit and forage production.

Mechanical site preparation treatments that remove CWD or aggregate slash excessively should be avoided, since they reduce the habitat available to the CWD users. Site preparation treatments that pile slash create clusters of prime habitat for potential pest species such as voles.

The selection of tree species for reforestation will have a long-term effect on stand structure. Blocks planted with several species will provide diverse habitats compared to a monoculture. Planting should be designed to create a mixture of conifer and hardwood species ecologically suited to the site. Hardwoods should be retained wherever possible to maintain habitat diversity.

Vegetation management

Vegetation management treatments aimed at controlling competing brush should be applied with discretion. Competing brush provides cover and forage for many wildlife species. If brush control is necessary for conifers to attain free growing status, patches of brush should be retained:

- along creeks and streams;
- in areas of low forest productivity (e.g., rock outcrops, wet soils);
- in green tree/snag retention areas;
- where severe brush problems are not anticipated; and
- in areas of high forage use by wildlife.

Prescriptions should be considered that reduce the area requiring brushing, such as treating areas only in the immediate vicinity of crop trees. Cluster planting of about five seedlings per cluster with reduced stocking should be considered so that vegetation management treatments can be intensively applied around the tree clusters, rather than broadcasting treatments over the entire block. On problem sites, fast-growing hardwoods (e.g., black cottonwood) may be better able to compete with brush than conifers. Rather than attempting to control brush in these areas in order to establish conifers, it may be preferable to plant hardwoods. Some brushy areas, such as those dominated by red-osier dogwood, willows, and berry-producing shrubs, provide especially important wildlife foraging habitat and should be noted in silvicultural plans for special management consideration.

Stand tending

Spacing and commercial thinning can be used to increase vertical canopy diversity and the quantity of understory forage in even-aged stands. Thinning treatments that remove groups of trees simulate natural gaps (see Section 6.3.2) and promote shrub and herb development. Tree removal by girdling or hack-and-squirt herbicide application can also increase understory growth and provide snags. On the other hand, low thinning, dominant thinning, and selective removal of deciduous trees diminishes stand structure. Wildlife habitat attributes can be promoted in thinning treatments if the following general guidelines are followed:

- Retain all safe snags and veteran trees, as well as some large, mature green trees.
- Vary stand density within a treatment area by leaving some patches unthinned and increasing the spacing in others.
- Maintain a mixture of tree species within the stand.
- Keep obvious wildlife trails free of slash.

Pest management

Pest management treatments in mature forests (e.g., pine beetle and root rot control) can have a significant impact on stand structure. These pest episodes are natural processes that, in wild forests, create snags and forest gaps. Treatments such as fell-and-burn selectively remove from the forest dead and dying trees that are used extensively by cavity nesters. Indiscriminant application of these treatments should be avoided.

6.5 Summary of Wildlife Habitat Considerations in Pre-Harvest Silvicultural Prescriptions

The approach we have taken in this chapter is to provide forestry field workers with a basic understanding of important wildlife habitats and habitat components so that wildlife concerns can be addressed in day-to-day forestry activities. Integrating wildlife habitat objectives and forest

management at the stand level begins with the PHSP. To summarize the information presented in this chapter, a checklist of habitat values that should be considered during the development of a PHSP is provided. Points are presented for the relevant information fields found on the PHSP final agreement form (FS 711C). Note that familiarity with wildlife habitat objectives of higher-level land use plans in a given area is essential for making prescriptions that are effective at the landscape level.

ECOLOGY:

- Note ecologically sensitive areas of uneconomical or difficult harvesting for possible green tree patch retention (see "Leave Tree" Specs, below) — dry sites, wet, low-productivity sites, and riparian areas.

MANAGEMENT OBJECTIVES:

- Use multiple-use management objectives to incorporate wildlife values, particularly in areas with high recreational use, with high timber extraction, or of particular importance to wildlife.

OTHER RESOURCE VALUES (WILDLIFE):

- Note key wildlife species use in the area, such as Grizzly Bear, Caribou, or nesting raptors.
- Note key habitats, such as riparian areas, wetlands, south aspects, or ungulate winter range.

HARVESTING PLAN:

Silvicultural System:

- Consider partial cutting on very dry sites, in riparian forests, on ungulate winter ranges, or wherever it is technically feasible and ecologically suitable.
- If recommending clearcut systems, leave buffers along streams and patches of live and dead trees within a cutblock (see "Leave Tree" Specs, below).
- For any silvicultural system, specify leaving unmerchantable wood on site.

Special Commitments:

- Fish/Forestry and Wildlife considerations in riparian areas.

Seasonal Comments:

Note seasonal considerations on the following points:

- Avoid logging along Caribou migration routes in the spring and fall, and in important feeding areas during the winter.

- Avoid summer logging or use low-pressure machinery in important Caribou wintering areas to minimize disturbance to lichen communities.
- Avoid activities in riparian areas of salmon-producing streams during the fall salmon run.
- Avoid spring and early summer harvesting in raptor nesting areas.
- Avoid winter harvesting in ungulate wintering areas.

Rationale for Opening Size/Configuration:

- Vary size of blocks in relation to each other for a given watershed.
- Leave strips should be maintained between blocks for as long as possible.
- Consider long, narrow parallel cutblocks in caribou migration areas.

"Leave Tree" Specs:

Leave trees left for wildlife purposes could include:

- hardwoods
- patches around raptor nests
- patches of poor-quality trees with deformities
- veteran trees
- riparian/wetland areas
- patches in areas of difficult or uneconomical harvesting (e.g., dry rocky knobs, gullies, wet depressions)
- patches of merchantable trees in uniform blocks

SILVICULTURAL PLAN:

Site Preparation:

- Prescribe low-intensity burns where necessary to increase forage production and minimize loss or case-hardening of CWD.
- Where mechanical site preparation is recommended, specify a minimum of CWD piling.

Brushing:

- Leave brush along streams, low-productivity microsites, and patch retention areas.
- Maintain important forage species such as willow, red-osier dogwood, or berry-producing shrubs.

- Consider spot treatments rather than broadcast treatments.

Stand Tending:

- Avoid thinning stands during the nesting season (May - July).
- Leave a screen of trees along roads.
- Remove slash from obvious game trails.
- Maintain a mix of native tree species.
- Specify killing, but not falling, larger non-commercial trees to create snags.
- On wet, brushy sites with high wildlife forage values, consider group or cluster planting and intensive management of seedling clusters.

Reforestation Prescription:

- Promote mixed species planting within a cutblock and among cutblocks in the same area.
- Maintain a hardwood component in stands.
- Consider planting ecologically suitable species that have not been well represented in other cutblocks in the area.

7 SILVICULTURAL INTERPRETATIONS

Developing and implementing an effective management prescription for a forest site involves integrating and synthesizing many site and operational factors with the management objectives for the site. The BEC system provides a framework for organizing and communicating our knowledge of ecological site factors. It is an essential tool in helping to develop and refine management prescriptions.

The classification and description of ecosystems presented in this guide, combined with information on relative productivity, site limiting factors, silvics, and silviculture, provide the basis for developing silvicultural interpretations for ecological site units.

The PHSP is the formal process for integrating these interpretations with other resource interpretations, operational considerations, and management objectives. The result should be a sound management prescription that can be monitored over time and assessed against site-specific conditions. Successes and failures can be linked to ecological site units and the results used to modify and refine future interpretations and prescriptions.

This field guide is only one of many references that should be used in developing a prescription. There are several recently published reports and interpretive handbooks available in British Columbia that deal at length with specific issues such as silvicultural systems, vegetation management, prescribed fire, mechanical site preparation, site degradation, slope stability, timber harvesting, pest management, wildlife management, and management for biological diversity. A list of resource materials is provided in Appendix 1.

Lavender *et al.* (1990) is an excellent general reference on the methods and principles of forest regeneration in British Columbia. As that publication illustrates, the amount of information available to forest practitioners is indeed overwhelming. The role of this field guide is to present the ecological framework in which to apply this large body of interpretive information to the diversity of forest sites found within the PRFR.

The interpretations presented in this chapter relate primarily to the maintenance or enhancement of site productivity for timber production. Specific interpretations include site productivity, limiting factors for productivity and regeneration, vegetation potential, tree species selection and stocking standards, reforestation considerations, conifer pests and diseases, and grass/legume seed mixes for silviculture, range, and engineering. Wildlife interpretations, including a discussion of wildlife habitat considerations in harvesting and silviculture planning, are presented in Chapter 6.

To date, most of our silvicultural experience in the PRFR has been with even-aged silvicultural systems, primarily clearcutting. Over the past 3 - 4 years, however, several operational and research trials have been established to examine alternatives to conventional clearcutting, involving

several types and intensities of partial cutting, followed by natural and artificial regeneration. Preliminary recommendations on the application of alternative silvicultural systems in the PRFR will be presented within the BEC framework in a future field guide insert. Several references dealing specifically with silvicultural systems are listed in Appendix 1.

7.1 Forest Productivity and Regeneration: Ecological Principles

In our classification and description of forest ecosystems, we have concentrated on three main components of natural ecosystems: climate, soils, and vegetation. Developing silvicultural interpretations from this classification depends on an understanding of these three broad categories of interacting ecological factors.

This section summarizes some basic concepts of climate, soils, and vegetation needed to understand site productivity and crop tree establishment, survival, and growth. These principles and a careful assessment of site characteristics can help the user identify the limiting factors to regeneration and productivity. From there, management prescriptions can be developed, designed specifically to address the limiting factors of the site.

The information presented here is summarized largely from Stathers *et al*. (1990) and Newton and Comeau (1990). Readers should refer to these for a more detailed treatment of these topics.

7.1.1 Climate

Scales of climate

Climatic components (solar radiation, air and soil temperature, precipitation, humidity, and wind) can be evaluated at three main scales: regional climate, local climate, and microclimate.

Regional climate, or mesoclimate, characterizes large areas (biogeoclimatic zones, subzones, and variants) and is not affected by local topography or vegetation. **Local climates** are modified by topography (e.g., aspect) and characterize smaller areas (sometimes recognized as biogeoclimatic phases). **Microclimates** characterize very small areas such as individual plant communities or smaller microsites (e.g., individual seedlings) within them. Local topography and microtopography are major determinants of microclimate, while soil and vegetation can both determine and reflect microclimate.

Regional and local climate determines the overriding limiting factors for regeneration and productivity within a subzone (length of growing season, rainfall, snowpack, etc.) over which we have limited control. Site treatments can, however, considerably alter seedling microclimates.

Solar radiation

The sun's energy drives biological production. However, only a small percentage (< 5%) of the sun's energy reaching the earth is used in photosynthesis. Most of the sun's radiation contributes to heating the soil and air near the ground surface and thus drives the evaporation of water from soil and vegetative surfaces (evapotranspiration). Biomass production increases as evapotranspiration rates increase.

At the regional climate level, factors such as latitude, elevation, and cloud cover affect the intensity and duration of solar radiation. At the local and microclimatic levels, slope and aspect are most important. For example, at 50 degrees north latitude, a 50% slope on a north aspect receives about 65% of the radiation reaching a flat surface and just over 50% of the amount received on a south aspect of similar slope. Similar relationships hold for north- and south-facing microsites (e.g., mounds).

Air temperature and frost

Temperature near the ground is one of the most important microclimatic factors affecting seedling establishment, survival, and growth. Microsite characteristics have a dramatic influence on air temperature. Large annual and diurnal temperature variations are familiar to most of us, but equally important is the often dramatic range in temperature that occurs at any one time within a few metres of the ground surface. During the day, when solar radiation is being absorbed by the ground surface, temperatures can be 5 - 10° C warmer near the ground than at 2 m above the ground. At night there is a net loss of long-wave radiation from the ground to the atmosphere and temperatures can be 2 - 5° C cooler at ground level that at 2 m above the ground.

Radiation frosts occur when this radiation loss results in surface temperatures dropping to below 0° C. The hazard of radiation frost is highest during the spring and fall because of the long nights (especially in the fall) and lower day-time surface heating during these seasons.

The magnitude of the diurnal and elevational temperature differential close to the ground surface depends on several climatic and site factors. Cloud cover, humid air, and windy conditions tend to reduce the temperature variation near the ground (and thus the frost risk). Air temperature generally decreases with increasing elevation, and high-elevation sites tend to experience greater diurnal and annual temperature fluctuations.

We have already discussed how slope and aspect affect the amount of solar radiation received, which greatly affects air temperature near the ground. Slope angle and position also affect surface air temperatures through their influence on cold air drainage and ponding. When air cools, it flows downslope and accumulates in level and depressional areas. This ponding and continued radiative cooling (at night) of cold air on lower slope, depressional, and flat sites results in these sites having a much higher risk of growing season **advection frosts** than better-drained mid and upper slopes. Cold air ponding can occur both at the local level (valley bottom

versus adjacent slopes) and microsite level (depressions versus mounds). Cold air ponding often occurs at the bottom edge of clearcuts where air flow is blocked by the forest canopy.

Vegetative cover can dramatically affect surrounding temperatures. Daytime heating and night-time cooling at the soil surface are both reduced by the shading of vegetative canopies, especially tree canopies. This can effectively remove the temperature differential that would otherwise occur within 2 m of the soil surface. The net effect on seedling growth may be positive on frost-prone sites, or negative in cold climates, where day-time microsite temperatures are reduced. However, some shading is generally considered beneficial for early establishment of natural regeneration, even in cold climates.

Soil temperature

Soil surface and rooting zone temperatures can dramatically affect regeneration and productivity. In the PRFR, low soil temperature is believed to be a significant growth-limiting factor, especially in interior subzones. Damage to seedlings from high temperatures (e.g., southerly aspects that have been slashburned) is much less of a concern in the PRFR.

Although mean annual soil temperature is a function of regional climate, surface soil (and air) temperatures are dramatically influenced by mineral soil and forest floor characteristics. Dark-coloured (e.g., burned) surfaces absorb more radiation than lighter surfaces do, and thus tend to be warmer. Mineral soils conduct heat into, and out of, the underlying profile better than organic soils. Thus, warmer day-time and colder night-time air temperatures occur immediately above organic surfaces than above mineral surfaces, all other factors being equal. However, both soil and surface air temperatures are strongly affected by soil moisture. Wet soils have a higher heat capacity and thus take longer to warm up. Also, because evapotranspiration consumes a larger proportion of radiation absorbed by a wet soil than by a dry soil, wet soils (and the air above them) are generally cooler than dry soils.

Precipitation

The total amount and form of precipitation are largely determined by regional and local climatic factors such as distance from the ocean or other large water bodies, existence of mountain ranges, aspect, and elevation. Localized variation in precipitation may occur as a result of topography; for example, snow accumulation is greatest in areas of least exposure to scouring winds (ridge tops versus leeward slopes and depressions). At the microclimatic scale, variation can occur due to vegetative canopy characteristics and microtopography/surface characteristics. For example, canopy density affects rain and snow interception and snowmelt, while site features such as surface roughness, occurrence of stumps and logs, and surface darkness affect the accumulation, distribution, melting, and downslope movement (creep) of snow.

Too much precipitation can be as limiting to regeneration and productivity as too little. The PRFR includes both ends of the precipitation spectrum. High rainfall combined with low evapotranspiration rates in the Very Wet, Hypermaritime CWH subzone (CWHvh) on the PRFR's outer coast results in excess soil moisture on many sites and moisture deficits on very few sites. In this subzone, an important component of most management prescriptions should be the maintenance or improvement of soil drainage and aeration. In our Dry, Cool SBS subzone (SBSdk), however, droughts sites are common and the conservation of soil moisture becomes an important issue.

Deep snowpacks are characteristic of high-elevation ESSF and MH subzones and northern ICH subzones (especially the ICHvc). Snow cover is important for moisture recharge and insulation, but can also be a limiting factor to regeneration where seedlings are damaged by snow press and snow creep, or where long-lasting snow shortens the length of the growing season. Risk of snow damage (broken or deformed stems) is greatest where wet, heavy snowpacks undergo considerable settling, or where downslope movement of dense snowpacks occurs (the risk is highest on smooth slopes >35%).

Wind

Wind affects forests in many ways. Together with fire and insects, wind is an important natural disturbance agent throughout the PRFR. From the canopy gaps created by localized windthrow, to extensive blowdown areas of several hundred hectares, wind has helped to shape forest structure and age class distribution in many of the region's subzones.

As outlined earlier, windy conditions help to mix surface air and thus decrease the risk of frost at night and intense surface heating during the day. Exceptions occur when, for example, cold downslope winds generated at high elevations or at the heads of glacial valleys reduce temperatures at lower elevations. Wind can also contribute to desiccation, especially on exposed, droughty sites. In very windy environments, such as the exposed outer coast and in subalpine areas, tree form is shaped by the wind.

Although little can be done to control wind, an understanding of local wind characteristics — such as average velocity and direction, frequency of high winds, and local phenomena such as funnelling in valleys — is valuable in planning forestry operations to minimize the impact of wind. Cutblock shape and orientation with respect to prevailing winds, for example, can affect windthrow along the boundaries. Avoiding fine-textured soils with shallow, root-restricting layers when locating cutblock boundaries will also help to lessen the risk of blowdown.

7.1.2 Soil

Soil includes organic and mineral matter, gas- and water-filled pores, and living organisms that inhabit it. It is not abiotic. On a human time scale, soil is a non-renewable natural resource. There are physical, chemical, and

biological properties associated with all soil, and in combination they describe the **soil ecosystem.** Some examples of these properties include texture, colour, depth, and climate at a soil or its horizons (physical); pH and the amount, concentration, and ratio of nutrients (chemical); and all the plants and animals that inhabit at soil (biological). Changes in any of these properties may induce changes in some or all of the other properties — the effect may be imperceptibly small or quite dramatic. The soil is a dynamic ecosystem continuously changing. The changes may be natural, such as seasonal weather patterns, wildfire, and plant succession. Others are human-caused and include harvesting and site preparation activities. BEC can help to predict what changes might take place in the soil ecosystem because some soil properties are closely associated with certain site series (e.g., high water table), and some site phases are defined to reflect a particular soil property, such as texture.

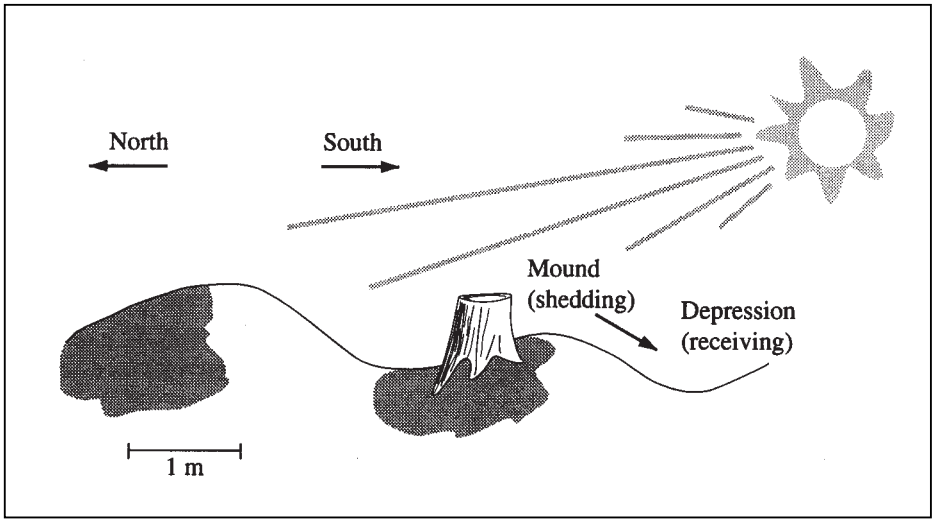
Some practices associated with harvesting and site preparation can deplete site carbon (energy) and nutrient capital, cause structural damage to the soil, or accelerate erosion, reducing productivity to the point that site potential is compromised. To understand the effects that any management activity can have on forest soils, it is necessary to appreciate the nature of the soil ecosystem and its relationship to above-ground components at the forest ecosystem.

Surface soil material includes the upper solum from the ground surface to a depth of 30 - 50 cm, the area in which most biological activity occurs. This includes the forest floor, upper mineral horizons, pore space, and organisms. Within any site, the nature at the surface soil can be greatly influenced by microtopography (Figure 7.1). The following paragraphs briefly explain some of the more important features of surface soil material.

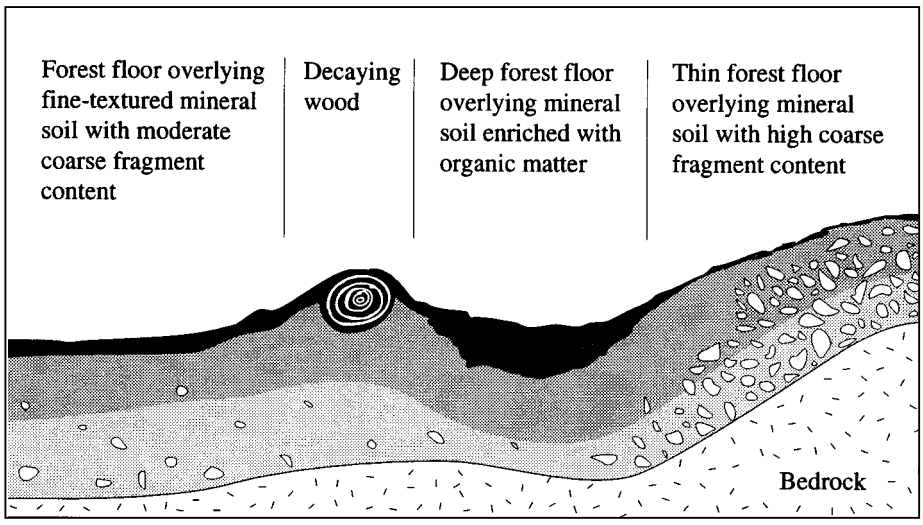
Forest floor and humus form

The forest floor (surface organic layer) is typically more heterogeneous than the underlying mineral layer. In addition to the variation in the depth and coverage of forest floor and decaying wood, variation in the rate of organic matter decomposition also occurs from site to site. This is manifested in the presence of different humus forms (consult Green *et al*. 1993) that indicate differences in nutrient availability. The three humus form orders — Mor, Moder, and Mull — generally indicate an increasing nutrient content and availability, respectively. Therefore, Mor humus forms predominate on nutrient-medium and nutrient-poor sites, while Moder and Mull humus forms predominate on richer sites.

The forest floor insulates the underlying mineral soil from moisture and temperature conditions at the soil surface. The magnitude of this effect is related to forest floor depth: soil temperature and moisture levels beneath deep forest floors fluctuate less throughout the season than beneath thin forest floors. This effect may be undesirable in cold climates where seedling root growth maybe inhibited by low soil temperature during the growing season, but beneficial in warm climates where the presence of the deep forest floor may help to conserve soil moisture.



a) Microtopographic variation in forest soils.



b) Variation in surface substrates associated with forest soils.

FIGURE 7.1 Microtopographic variation in surface soil characteristics and soil climate.

Although poorly decomposed forest floor materials may dry out during the growing season, thus providing unfavourable planting spots, well-decomposed forest floor layers can be acceptable planting spots, especially freely drained mounds on very wet sites. On water-deficient sites, planting close to well-decomposed decaying wood may improve water availability for seedlings.

Mineral Soil

On most forested sites, mineral soil is found beneath the forest floor. There may be an abrupt and clear boundary as in the Mor humus form, or a more gradual one, as in many moder humus forms. In cases where the forest floor is very thin or absent and the first mineral horizon is enriched in organic matter Ah horizon), the humus form is a Mull. Some site preparation techniques disturb or remove the forest floor and the mineral soil may be exposed. Mixing of forest floor materials with the surface mineral horizons, especially nutrient-poor, coarse-textured, or very acidic mineral horizons, will generally improve the quality of planting spots.

Soil texture (see Appendix 11) is one of the most important interpretive mineral soil properties and is easily estimated in the field. Coarse-textured (sandy and/or gravelly) soils typically have a low water- and nutrient-holding capacity, but good water drainage and aeration, and are often associated with nutrient-poor and dry sites. Fine-textured (silty and clayey) soils have high water- and nutrient-holding capacity, but poorer drainage and aeration, and are often associated with more nutrient-rich and wetter sites. In addition, soil compaction and frost heaving of seedlings occur more frequently in finer-textured soils. Loamy soils are generally ideal because they are intermediate in the above properties.

Coarse fragments (particles >2 mm in diameter) reduce the quality of the textural properties by lessening the water- and nutrient-holding capacity. Bedrock close to the surface decreases moisture and nutrient content and restricts rooting. Organic matter in the mineral soil will increase water- and nutrient-holding capacity, improve soil structure, and enhance biological activity. Well-drained and well-structured mineral soil enriched with organic matter is a good indicator of productive microsites and planting spots.

Soil air and water

A medium-textured soil contains about 50% pore space by volume in the mineral portion of the soil. Ideally, about half of the pore space is taken up by air (gases) and the other half by water. The quality of this pore space and the air:water ratio can have marked effects on soil productivity. When water drains from soil, it leaves the large pores first while air replaces it. Water in the intermediate-sized pores mixes with salts and becomes the soil solution that is very important in the transfer of nutrients to plants. Water can be held so tightly to the surface of soil particles in the finest pore spaces that plants will wilt and even die unless additional water is added to the soil. Soils that have a high proportion of small to large pore space are

often poorly aerated and poorly drained. The relative humidity of soil air is usually 100%, and the carbon dioxide and oxygen concentrations are higher and lower, respectively, compared to the above-ground atmosphere. Dinitrogen (N_2) in soil air can be fixed (hydrogen added, resulting in NH_3^+) by numerous free-living or symbiotic soil organisms. This is the primary means of restoring nitrogen to ecosystems through the nitrogen cycle. Compaction of soil is the destruction of pore space (large pores are the first to be affected), and will ultimately reduce soil productivity. Compaction is caused primarily by machinery on medium- and finer-textured soils, when conditions are moist or wet.

Soil organisms

The soil ecosystem contains a diversity of organisms, from vascular plants to rodents and insects, bacteria, and fungi. One cubic centimetre of soil may contain billions of micro-organisms. Nearly all nutrients required for plant growth become available through the various decomposing activities of soil organisms, or through symbiotic relationships that some soil-borne organisms have with plants. Soil fauna generally reduce the particle size of plant and animal detritus, preparing it for smaller organisms to chemically alter. As well, they play an important role in intermixing organic matter with mineral soil. All the organisms, including plant roots, help create favourable soil structure that keeps soils porous. Mycorrhizal fungi can provide nutrients and moisture to plant species by "extending" root systems, and may provide protection from disease organisms. Some soil organisms are responsible for tree diseases such as root rots.

Shifts in species diversity and populations are common occurrences in soils and may be short- or long-lived. These changes can be caused by freezing and drying, or by management activities such as prescribed burning. Because we know little about the long-term effects of forest management on soil biology, we are cautious to make species-specific interpretations. However, the most productive soils are those that are the most biologically active. Therefore, promoting activities that conserve or enhance a diverse population of organisms will ultimately help to maintain productive soils. Conversely, activities that, for example, reduce soil structure or organic matter will reduce favourable conditions for soil organisms and contribute to declining productivity.

Microsite and microtopography

A forest is a mosaic of sites and each site is usually a complex of microsites. A microsite is a portion of a site that is uniform in microtopography and surface soil materials. It can range in size from less than 1 m^2 to occasionally over 5 m^2. Microsites are ever-changing, as a result of aggradation or degradation processes associated with water, wind, mass wasting, blowdown, and wildfire, as well as with forest harvesting, site preparation, and stand tending.

Most sites have several types of microsites, and some of these may be more appropriate for tree establishment than others. While site quality is used as a criterion for tree species selection, microsite quality should be the criterion for the selection of actual planting spots. Furthermore, an understanding of the relationship between microsite and seedling survival and growth on a particular site is essential to the selection of the most appropriate site preparation method.

Mounds and depressions are two principal expressions of microtopography (surface shape) (Figure 7.1). The primary influences on the microclimatic regimes of mounds and depressions are height and frequency, along with slope and aspect.

In general, mounds are drier and warmer than depressions. However, the magnitude of the difference depends on the local climate, relief, and aspect of a site, in addition to the material composition of the mounds and depressions. Because of the accumulation of fine organic and mineral materials, depressions often have greater concentrations of nutrients than do the apices of mounds.

On sites with no major water deficit in the growing season and high precipitation in fall and winter, depressions can have temporary surface ponding or a high water table. In such situations, they are less suitable for seedling establishment and growth than mounds are. On sites in dry and warm climates, where a water deficit is expected early in the growing season, depressions can provide more suitable planting spots than mounds, especially the south exposure of mounds. The latter, however, can be appropriate microsites in cold and snowy climates, while the north exposure of mounds can be suitable in warm climates, particularly on steep, south-facing slopes.

7.1.3 Vegetation

The complex interactions of many soil and climatic factors, together with site disturbance history, are manifested in the vigour and composition of the plant community on a given site. An understanding of vegetation and environment relationships and of the adaptations and behaviour of individual plant species (species autecology) is fundamental to managing the vegetation on a site. The term “vegetation management” is most often used in the context of controlling competing vegetation during reforestation. However, the entire forest management prescription should really be thought of as a vegetation management prescription, because it describes a series of treatments aimed at manipulating a plant community (the forest) for specific purposes. Depending on site characteristics and management objectives (timber versus wildlife, preferred tree species, etc.), manipulations of that plant community may vary considerably.

Vegetation and site diagnosis

Climax vegetation is used as an indicator of site quality, because it is considered to be the best integrator of all site factors. This is fundamental to BEC. The concept of compensating factors is important to understand in this regard. Individual site factors often compensate for one another and thus a plant community may encompass a wide range of soil, site, and climatic parameters. This is apparent in the environmental tables in Chapter 5. For example, a devil's club association in most subzones is typically restricted to lower-slope receiving sites. However, this association extends further up slopes on finer-textured soils, or in wetter, snowier climates, where soils remain moist throughout the growing season. Site diagnosis is more difficult in the absence of climax vegetation, because many individual site parameters have to be assessed and integrated by the surveyor, in the context of the seral plant community. The challenge when interpreting seral communities is separating inherent site factors, such as soil moisture and nutrient regimes, from factors associated with the disturbance, such as increased light and warmth, and mineral soil exposure. This requires experience on the part of the surveyor.

Plant succession

The gradual change in the structure, composition, and functioning of plant communities over time is termed "succession". **Primary succession** occurs on previously non-vegetated surfaces such as rock outcrops, freshly deposited colluvium, or glacial till. Wetland succession resulting from the gradual accumulation of organic matter (peat) on saturated sites is another example of primary succession. In forestry we are concerned mainly with **secondary succession,** the sequence of plant communities that develop after a disturbance such as harvesting or wildfire. Many management practices are aimed at manipulating secondary succession.

In most cases, management objectives call for prompt reforestation, where conifers are established immediately following a disturbance. On sites where initial colonization and biomass production are very rapid, the establishment of desirable crop trees may require large efforts operationally. Often we are attempting to immediately establish species that are naturally adapted to later successional stages, and thus compressing into a few years what under natural conditions may have taken much longer (see Figure 2.2). Pioneer species such as lodgepole pine (on many interior sites) and black cottonwood (on alluvial sites) have thus become more attractive commercial species. These species have initially higher growth rates and require less effort to establish than alternative species (such as spruce and redcedar), which may have more desirable product characteristics but are naturally adapted to later successional stages and are often slower growing.

Rates and patterns of secondary succession are variable, and for many sites not well understood, except in general terms. We know, for example, that initial colonization progresses faster, and biomass production is greatest, on moist to wet, nutrient-rich sites in all subzones. Total plant cover

commonly reaches 100% within 3 - 4 years on these sites, whereas total cover is often less than 50% even after 6 years on slightly dry to fresh sites. There is considerable variation by zone, with the fastest rates of vegetation development occurring in the coastal and transitional CWH and ICH zones, and slowest rates in the AT and northern SWB and BWBS.

Predicting the species composition of seven plant communities is partly possible, but is limited by the considerable chance element that governs the process. Initial species composition is a function of propagules being present on the site and conditions being suitable for germination/ sprouting and growth of these propagules. Propagules originate from three main sources: **1) bud banks** of species present on the site before disturbance; 2) **seed banks** stored on site (in the mineral soil, forest floor, and vegetative canopy); and 3) **seed rain** from adjacent off-site ecosystems.

Bud-banking species can readily resprout from above- and below-ground parts. For example, fireweed and aspen sucker from buds on their roots, thimbleberry and salmonberry sucker from underground rhizomes, and willows resprout from above-ground buds at the base of the stem. Generally, bud-bankers are capable of much more rapid initial growth than plants that have to start from seed. While the component of bud-banking species can be predicted to some extent by their occurrence on a site before harvesting, in some cases bud-banking species may form a very minor component of the mature forest community, but underground roots or rhizomes may expand very rapidly following disturbance (e.g., fireweed). Slashburning or mechanical site preparation may delay the regrowth of some bud-banking species for a year or so (e.g., thimbleberry), but such disturbances, unless very severe, rarely prevent (and may actually encourage) their eventual regrowth. The bud-banking species are the easiest component of the seral community to predict, because they are generally (though often in small amounts) apparent in the mature forest.

The seed bank is much harder to predict. It consists of seeds present at the time of disturbance that are stimulated to germinate. Several disturbance factors may stimulate seed-banking species to germinate, such as surface soil/forest floor mixing, fire, increased surface warming, and light. Although a portion of the seed bank originates from species currently present in the overstory (e.g., lodgepole pine) or understory (e.g., red elderberry), the seed bank often contains species that have long since disappeared from the present plant community. Seed-banking species include thimbleberry, *Ribes* species, red elderberry, red-osier dogwood, and black twinberry that have stored seed in the forest floor or soil for several years. Another seed-banking species is lodgepole pine, which stores seed in the canopy until fire comes along to release it and stimulate germination.

Seed rain is predictable to the extent that the seed dispersal characteristics of those species composing the surrounding vegetation are known. Although millions of seeds typically arrive at a cutblock annually, relatively few of them will land on suitable substrates and germinate. Still, the seed rain component can be a major determinant of secondary

succession, especially on sites that have been severely disturbed. Species that typically colonize via wind-dispersed seed rain include most conifers, red alder, paper birch, and fireweed. Seeds of species such as blueberries and huckleberries, salmonberry, and salal may be transported onto a site by animals. However, these species primarily regenerate in canopy gaps and colonize during secondary succession as bud-bankers.

Vegetation potential and vegetation complexes

From the discussion above, it is apparent that although we can use several clues from pre-harvest and adjacent stand conditions to predict the species composition of post-harvest plant communities, the element of chance hampers precise prediction. We must then generalize about the nature of seral vegetation/environment relationships, based on our experience throughout the region. To this end, we have used a rating system for vegetation potential, combined with the concept of vegetation complexes described by Canard (1984) and Newton and Comeau (1990), to predict and describe initial post-disturbance succession.

Refer to Section 7.2 for a description of vegetation potential classes (Table 7.1) and vegetation complexes (Table 7.2). A rating of vegetation potential, together with the expected vegetation complexes, are presented on a site series basis in the interpretations tables (Section 7.3) for each of the subzones/variants of the PRFR. Comments relevant to vegetation management concerns are also provided in these tables.

Impacts of non-crop vegetation

It is important to assess both the beneficial and detrimental effects of non-crop vegetation development following harvesting or other disturbances. Too often we assume that the net effects on crop tree survival and growth are negative without looking at the entire picture (see Newton and Comeau 1990 for a more detailed discussion of this topic).

Specific **potential benefits** of post-disturbance vegetation development are:

- the capture, storage, and cycling of nutrients on site;
- improvement of soil physical and chemical properties, including nitrogen fixation by species such as alders and legumes;
- prevention of soil erosion, soil puddling, and mass wasting;
- lessened risk of damage to seedlings by certain insects (e.g., spruce weevil impact is often less under a canopy of alder), browsing wildlife, including small mammals, through the provision of alternative food sources (small mammal damage may increase under some circumstances — see below), frost, and intense heat (see Section 7.1.2);

- improvement of forage values for wildlife and domestic livestock (bird diversity is generally higher in stands having a deciduous component);
- enhancement of stream values by providing protective cover and organic debris and stabilizing stream banks; and
- contribution to overall species diversity on the site.

The **detrimental effects** of vegetation development generally centre on impacts on tree seedling establishment, survival, and growth. Specific impacts on seedlings are variable, depending on silvical characteristics such as shade tolerance. Highly suppressed seedlings typically have thin crowns, reduced leaf area, and large height:diameter ratios. These characteristics lead to reduced seedling vigour, growth, strength, and competitive ability.

Specific **potential detrimental effects** include:

- reductions in solar radiation reaching seedlings and the ground. Photosynthetically active radiation (PAR) reaching overtopped seedlings may be reduced by 80% under a vegetative canopy of 50% cover. Under a 100% canopy cover, PAR may be reduced by 95% or more. Reductions in total solar radiation reaching the ground contribute to lower soil and surface air temperatures. Depending on macroclimate, aspect, and other site factors, this may be detrimental (by shortening the effective growing season and delaying bud burst) or beneficial (by protecting seedlings from intense heat and moisture loss).
- reduction in amount of soil water available to tree seedlings. Competition for moisture is not considered to be of major concern on most forested sites within the PRFR, with the exception of some sites in the SBSdk, SBPSmc, and BWBSdk subzones.
- reduction in the initial availability of nutrients to tree seedlings. However, nutrients are not lost from the system, but rather taken up, stored, and recycled by the vegetation. In terms of long-term site productivity, the net effect may be positive.
- physical damage (deformed or broken stems and branches) caused by falling, bending, or wind-whipped vegetation. Shade-intolerant seedlings overtopped by a vegetative canopy are particularly susceptible because of their typically large height:diameter ratios. The risk of physical damage is increased under wet, heavy snowpacks.
- increased risk of small mammal damage, due to the protective cover provided by vegetation, especially grassy swards and aspen thickets.
- increased spread of noxious weeds such as Canada thistle.

Assessment, prevention, and control

Assessment and control of competing vegetation has two components:

1. prediction of vegetation potential (based on pre-disturbance site characteristics and local experience on similar sites) in order to plan and initiate prescriptions that prevent severe competition with crop trees.

2. assessment and control (crop tree release) of present competition levels in harvested areas.

This guide is most applicable to the first component: prediction and prevention. Severe competition problems can often be avoided through the prediction of site-specific vegetation potential and initiation of preventative measures such as:

- use of appropriate silvicultural systems and harvesting techniques, including pre-harvest vegetation control, where applicable;
- use of appropriate site preparation techniques that minimize mineral soil exposure and slow initial vegetation development for 1 - 3 years (prescribed fire as well as mechanical and chemical site preparation methods may be appropriate depending on site conditions);
- prompt planting (the first growing season after harvest);
- use of healthy, vigorous seedlings of the appropriate stock type (large 2-year-old+ stock) and species; and
- on especially problematic sites with very high vegetation potential (see Table 7.1, page 7•18), consider cluster planting of about 5 seedlings per cluster and reduced stocking, so that vegetation management treatments can be intensively applied around the tree clusters, rather than broadcasting treatments over the entire block.

Assessment of existing competition levels (component 2 above) is done during silvicultural surveys. Parameters such as percent cover and height of competitive species in relation to height, diameter, vigour, and physical condition of crop trees are recorded and a subjective assessment made as to whether a problem exists. This subjective assessment is considered to be effective operationally, although some quantitative competition indices designed to refine the process are currently being developed and tested.

Several treatments (either preventative or reactive) are available for controlling competing vegetation. Broad categories of treatments are: chemical, manual, motor-manual, mechanical, and biological (grazing). The choice of treatment will depend on many factors including costs, feasibility, and effectiveness on the specific site conditions, perceived risks to other site resources, and other social concerns (see Newton and Comeau 1990).

Specific information on the autecology and response to management treatments of 35 common British Columbia plants can be found in Coates *et al*. (1990) and Haeussler *et al*. (1990). Other relevant publications are listed in Appendix 1, part 2.

7.2 Interpretations Tables

Interpretations tables are presented for 20 biogeoclimatic units occurring in the PRFR. The purpose of the tables is to summarize, on a site series basis within each subzone or variant, our current knowledge of forest productivity and selected management interpretations. The tables are designed to promote an ecological approach to developing a management prescription, through identifying and addressing the factors that limit productivity and regeneration on each of the site series within a subzone.

The maintenance or enhancement of site productivity for timber production is the major theme of the tables. Specific interpretations are presented under five categories: site productivity, limiting factors for productivity and regeneration, vegetation potential and complexes, tree species selection guidelines, and reforestation considerations. Each of these categories in the tables is explained below.

Note that the tables do not contain "cookbook" prescriptions. In most cases there are many alternative treatments to choose from to address the concerns and recommendations contained in the tables. These tables should be used in combination with the many interpretive handbooks listed in Appendix 1, part 2. The final prescription must consider site-specific conditions, operational constraints, local experience, and management objectives for the site.

7.2.1 Site series

Site series are designated by their number code. The tables are designed to be used in conjunction with the site identification and description information presented for each subzone/variant in Chapter 5.

7.2.2 Productivity

Tree species productivity varies considerably throughout the PRFR. Biogeoclimatic subzone and site series within subzones account for much of this variability, although we have only recently begun to quantify these relationships. The grey bar at the top of the column represents a scale of site index from 0 to 40 m at breast height age 50 yrs (BHA 50). The placement of tree species codes[14] in the grey boxes below indicate mean site index by species for each of the site series. Where information is lacking for a species, or where a species does not generally occur in a site series, it is not included in the site index boxes.

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[14] Tree species codes as in Appendix 3.

This column in the tables portrays our current knowledge of the range in site index (BHA 50) of **natural stands,** within a biogeoclimatic unit. It is thus an indication of relative productivity among the site series making up a subzone/variant.

Ecological site index relationships were derived from several data sources, and data quantity and quality vary considerably by subzone. Height/age data have been collected from more than 1000 ecosystem sample plots throughout the region over the past 15 years. Because these plots were done mostly in mature and old-growth stands, with trees generally over 100 years old and often much older, these data yield the least reliable estimates of site index at age 50. More recently, sampling has been carried out in research by the Forest Service and the University of British Columbia (e.g., Wang *et al.* [1992]) in younger second-growth stands within the region. These data have yielded better site index estimates for some subzones (SBSmc and dk, ICHmc, ESSFmc, CWHvm and vh). Data from Inventory Branch permanent sample plots have also been used. In all cases, the most recent site index (BHA 50) curves were used for the site index calculations (Thrower and Nussbaum 1991; Thrower *et al.* 1991).

For simplicity, statistical confidence is not portrayed for the site index means presented in the tables. Values represent our best estimates from available data and experience within the subzone/variant. In some cases, where little or no data exist, values are either estimated, based on data from ecologically related subzones/variants, or not provided at all for one or more of the species. Sources of data are given in the table footnotes. It is important to note that site index boxes are included to portray general site index ranges and trends within subzones/variants. They should *not* be considered precise estimates. Further sampling is planned to improve the data base for ecological site index relationships, and these tables will be updated in the future.

7.2.3 Limiting factors for productivity and regeneration

This column highlights the site factors most significant in limiting productivity and regeneration for each of the site series. This information forms the basis for prescription development. Possible limiting factors include:

- soil moisture (sites with too little or too much moisture);
- soil nutrients (sites with low total amounts of stored nutrients or sites with low nutrient availability; for example, sites with thick Mor forest floors may have a large nutrient capital, but low availability);
- soil temperature (sites with cold soils due to macroclimatic factors and/or soil characteristics such as excess moisture and thick, insulating forest floors);
- air temperature (sites prone to cold air ponding and frost);
- deep, long-lasting snowpacks;

- root restrictions (sites with compacted horizons, bedrock, or water tables within 30 cm of the soil surface); and
- competing vegetation (sites with high to very high rating for vegetation potential) (see next category).

Basic principles related to these limiting factors are discussed in detail in Section 7.1.

7.2.4 Vegetation potential and complexes

In this column, a rating of vegetation potential and a listing of vegetation complexes are provided for each of the site series.

Vegetation potential describes, in relative terms, the predicted rate of herb and shrub development following disturbance. Four classes are defined and described in Table 7.1. The ranking can be used for both competing vegetation and shrub/herb forage interpretations (the ranking should not be used for berry production or lichen forage interpretations).

Twenty-two major vegetation complexes occurring on harvested sites have been described in British Columbia (Conard 1984; Newton and Comeau 1990). All but one of these complexes occurs in the PRFR.

Vegetation complexes are described in Table 7.2. Each complex consists of a list of species that tend to be associated with one another on ecologically similar sites. The lists have a silvicultural bias and thus emphasize species that may potentially affect crop tree growth (positively or negatively). However, the complexes are also useful for assessing potential wildlife forage values. We have modified the lists somewhat to make them more applicable to the PRFR. Note that not all the species in each complex should always be expected to occur together on a given site. Depending on

TABLE 7.1. Vegetation potential classes

Class	Description
Low	Slow initial rate of herb and shrub development following disturbance. Little or no need for controlling vegetation to ensure adequate regeneration. Competition for moisture may be important on some dry sites.
Medium	Moderate initial rate of herb and shrub development. Generally little need for controlling competing vegetation, although sites should be reforested promptly.
High	Fast initial rate of herb and shrub development. Generally a need to plant promptly following harvest and to plan (in advance of harvest) on controlling vegetation development to ensure successful regeneration.
Very High	Extremely fast initial rate of herb and shrub development. Successful coniferous regeneration will require prompt planting with large, healthy, vigorous stock, and spot or broadcast treatment of competing vegetation. Sites with very high vegetation potential should be considered for hardwood or mixedwood management (e.g., floodplain sites).

TABLE 7.2. Major complexes of competing vegetation in the PRFR (modified from Newton and Comeau 1990)

Complex	Major species	Seral origin[a]	Biogeoclimatic zone	Sites
CW Cottonwood	*Populus balsamifera*	SR/BB	ICH	Floodplains
	Lonicera involucrata	BB/SB	SBS	
	Cornus stolonifera	BB	BWBS	
	Sambucus racemosa	BB/SB		
	Rubus parviflorus	BB/SB		
	Alnus crispa ssp. *sinuata*	BB/SR		
	Alnus tenuifolia	BB/SR		
	Calamagrostis canadensis	BB/SR		
	Cinna latifolia	BB/SB?/SR?		
	Symphoricarpos albus	BB/SB		
CA Cottonwood-alder	*Populus balsamifera*	SR/BB	CWH	Floodplains
	Alnus rubra	SR/SB(BB)		
	Rubus spectabilis	BB/SB		
	Cornus stolonifera	BB/SB		
	Oplopanax horridus	BB		
	Sambucus racemosa	BB/SB		
	Rubus parviflorus	BB/SB		
	Lonicera involucrata	BB/SB		
	Ribes bracteosum	SB(BB)		
MH Mixed hardwood	*Populus tremuloides*	BB	ICH	Various
	Populus balsamifera	SR/BB	SBS	
	Betula papyrifera	SR/BB	BWBS	
	Salix spp.	BB/SR		
	Alnus tenuifolia	BB/SR		
	Alnus crisps ssp. *sinuata*	BB/SR		
AS Aspen	*Populus tremuloides*	BB	ICH SBS BWBS	Various
BP Boreal poplar	*Populus tremuloides*	BB	SBS	Fresh to moist
	Populus balsamifera	SR/BB	BWBS	
RS Red alder - shrub	*Alnus rubra*	SR/SB(BB)	CWH	Fresh to wet
	Rubus parviflorus	BB/SB		
	Rubus spectabilis	BB/SB		
	Sambucus racemosa	BB/SB		
	Oplopanax horridus	BB		
	Ribes spp.	SB(BB)		
	Polystichum munitum	BB(SR?)		
	Athyrium filix-femina	BB(SR?)		
SB Salmonberry	*Rubus spectabilis*	BB/SB	CWH	Fresh to wet
	Rubus parviflorus	BB/SB		
	Ribes spp.	SB(BB)		

[a] BB, SB, and SR refer to bud banker, seed banker, and seed rain, respectively; defined in Section 7.1.3. Sources: Haeussler *et al*. (1990); Stickney (1986); Thomson *et al*. [1993].

TABLE 7.2. (Continued)

Complex	Major species	Seral origin[a]	Biogeoclimatic zone	Sites
SA Salal	*Gaultheria shallon*	BB	CWH	Very dry to wet
MS Mixed shrub	*Rubus parviflorus*	BB/SB	ICH	Fresh to wet
	Rubus idaeus	SB/BB	ESSF	
	Lonicera involucrata	BB/SB	SBS	
	Acer glabrum	SR/BB		
	Alnus crispa ssp. *sinuata*	BB/SR		
	Paxistima myrsinites	BB/SB		
	Sambucus racemosa	BB/SB		
	Oplopanax horridus	BB		
	Salix spp.	BB/SR		
	Cornus stolonifera	BB/SB		
	Epilobium angustifolium	BB/SR/SB		
	Athyrium filix-femina	BB(SR?)		
	Pteridium aquilinum	BB(SR?)		
	Symphoricarpos albus	BB/SB		
ES Ericaceous shrub	*Menziesia ferruginea*	BB/SR	CWH, ICH	Dry to moist
	Vaccinium spp.	SR/BB	ESSF	
	(Rhododendron albiflorum)	BB(SR)	MH	
DA Dry alder	*Alnus crispa*	BB/SR	SBS	Dry to fresh
	Epilobium angustifolium	BB/SR/SB	SBPS	
	(Calamagrostis rubescens)	BB(SR)		
WA Wet alder	*Alnus crispa* ssp. *sinuata*	BB/SR	ICH	Wet
	Alnus tenuifolia	BB/SR	SBS	
	Rubus parviflorus	BB/SB	BWBS	
	Lonicera involucrata	BB/SB	ESSF	
	Calamagrostis canadensis	SR/BB		
	Athyrium filix-femina	BB/SR		
	Dryopteris expansa	BB(SR?)		
DS Dry shrub	*Amelanchier alnifolia*	BB/SB	ICH	Dry to fresh
	Paxistima myrsinites	BB/SB	SBS	
	Shepherdia canadensis	BB/SB	BWBS	
	Symphoricarpos albus	BB/SB	SBPS	
WI Willow	*Salix* spp.	BB/SR	ICH, CWH	Moist to wet
			ESSF	
			SBS	
			BWBS	
			SBPS	
PI Pinegrass	*Calamagrostis rubescens*	BB(SR)	SBS	Dry to fresh
			SBPS	

[a] BB, SB, and SR refer to bud banker, seed banker, and seed rain, respectively; defined in Section 7.1.3. Sources: Haeussler *et al.* (1990); Stickney (1986); Thomson *et al.* [1993].

TABLE 7.2 (Continued)

Complex	Major species	Seral origin[a]	Biogeoclimatic zone	Sites
RG Reedgrass	*Calamagrostis canadensis*	SR	SBS BWBS (ICH) (ESSF)	Moist to wet
FN Fern	*Athyrium filix-femina* *Dryopteris expansa*	BB(SR?) BB(SR?)	ICH, CWH ESSF, MH SBS BWBS	Fresh to wet
BN Bracken	*Pteridium aquilinum*	BB(SR?)	ICH CWH	Dry to wet
FW Fireweed	*Epilobium angustifolium*	BB/SR/SB	CWH ICH ESSF SBS SBPS BWBS	Dry to wet
SH Subalpine herb	*Valerians sitchensis* *Senecio triangularis* *Veratrum viride* *Heracleum lanatum* *Epilobium angustifolium*	BB/SR BB/SR BB BB/SR BB/SR/SB	ESSF	Fresh to wet
IG Introduced grasses	Domestic grasses		ICH ESSF SBS BWBS	Various

[a] BB, SB, and SR refer to bud banker, seed banker, and seed rain, respectively; defined in Section 7.1.3.

Sources: Haeussler *et al.* (1990); Stickney (1986); Thomson *et al.* [1993].

local conditions, species dominance will vary considerably. To help users predict which species are likely to be important, we have included notes on seral origin (bud bank, seed bank, or seed rain) for each of the species in the lists.

For a more complete discussion of the factors to be considered in predicting plant succession following disturbance, refer to Section 7.1.3. The potential beneficial and detrimental effects of non-crop vegetation are also summarized in that section.

7.2.5 Tree species selection guidelines

In this column, tree species selection guidelines are presented for each of the site series. A province-wide correlation of tree species selection and free growing stocking standard guidelines has just been completed (Silviculture Interpretations Working Group 1993). The guidelines presented here are based on this correlation. The stocking standards are presented separately for each subzone in Appendix 17. These guidelines were developed with timber (sawlog) production as a primary management objective, and may require modification on a site-specific basis to meet non-timber resource objectives (through the PHSP process).

The ecological suitability of each tree species for regeneration within a biogeoclimatic unit was evaluated on a site series basis using the following three criteria (Klinka and Feller 1984):

- **Maximum sustainable productivity.** The relative productivity of each tree species was evaluated for each site series.
- **Crop reliability.** The relative susceptibility to natural hazards was evaluated for each tree species to determine which species provided the most reliable choices for a future crop.
- **Silvicultural feasibility.** Ecologically viable tree species were evaluated, based on accumulated silvicultural experience, to determine whether they were able to produce sawlogs in a cost-effective manner on each site series within an acceptable rotation length.

Based on the above evaluation, each tree species was assigned to one of three categories (the tree species codes in Appendix 3 are used to denote the species in the tables):

Primary species are listed first (in alphabetical order) and are unbracketed. These species are ecologically acceptable and have the highest rating for productivity, reliability, and silvicultural feasibility under the average conditions for a site series. Primary species can generally be managed an a major component in a stand.

Secondary species are listed (alphabetically) in square brackets after the primary species. These species are ecologically acceptable, but rank lower than primary species for productivity, reliability, and/or silvicultural feasibility. Depending on the nature and extent of these limitations, secondary species can be managed as either major or minor components in the stand.

Tertiary species are listed last in round brackets. Tertiary species are ecologically acceptable, but rank lower than primary or secondary species for productivity, reliability, and/or silvicultural feasibility. Depending on the nature of their limitations and on local conditions, tertiary species are normally only suitable as a minor component within a stand (20 - 30%), or as a larger component in a few localities, generally on a trial basis.

Restrictions or limitations may apply to primary, secondary, or tertiary species and are indicated either by footnotes (if the restriction applies throughout the subzone), or by comments in the adjacent column entitled *Reforestation Considerations* (see Section 7.2.6 below). Restrictions or limitations may relate to soil and site factors (including microsite), climate (including susceptibility to frost and snow damage), geographic and elevational range, pest hazard, and productivity. It is important that footnotes and comments under *Reforestation Considerations* be checked carefully when the suitability of each of the species is being assessed.

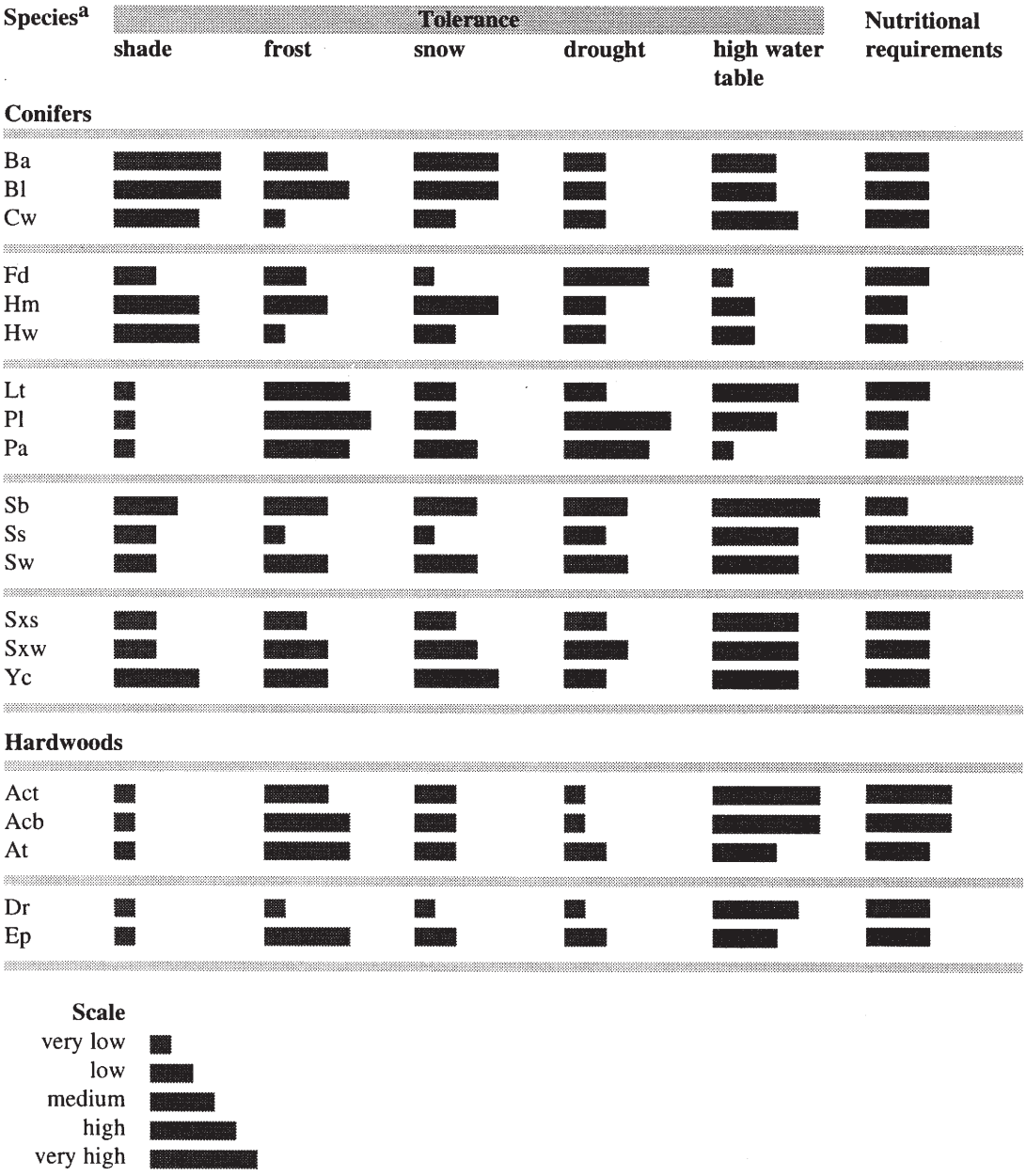
To help users determine species suitability in relation to the site limiting factors and restrictions highlighted in the tables, a ranking of ecological tolerances and nutritional requirements of the major tree species occurring in the PRFR is presented in Figure 7.2. The table can help users choose the species best able to tolerate site-specific limitations such as shade, frost, snow, drought, high water tables, and low nutrient availability. Note that the ranking is an average across all biogeoclimatic units in which the species occurs.

Hardwood species (Hard.) that occur naturally (and reach tree size) on each of the site series are also included in the tables. They are not included in the primary, secondary, and tertiary designations, however, because of the timber- (sawlog-) oriented objective of these guidelines. Hardwood species may not be used to fulfill basic silviculture obligations unless this is specified in the approved Land and Resource Management Plan. On many floodplain sites and some rich, seepage sites, where vegetation potential is very high and/or there is a high risk of flooding and erosion, hardwoods may be considered the best species to regenerate. This will be noted under *Reforestation Considerations*. Note also that there are many potential benefits to maintaining a hardwood component in the stand (see Sections 6.3 and 7.1.3).

Tree species prescription

The tree species selection guidelines in the interpretations tables provide species recommendations that are used with other information to develop the PHSP. Under the Silviculture Regulation, a PHSP must contain both free growing stocking standards (Appendix 17) and a designation of preferred and acceptable species. Preferred and acceptable species are defined as follows:

- **Preferred species.** Preferred species are ecologically suited to the site, and management activities are primarily aimed at establishing these species. The characteristics of these species are consistent with the desired timber and non-timber objectives for the site.
- **Acceptable species.** Acceptable species are ecologically suited to the site, but management activities are not aimed at establishing them.



[a] Tree species codes as in Appendix 3.

FIGURE 7.2 Relative ranking of ecological tolerances and nutritional requirements for major tree species in the PRFR. (Information based on Klinka *et al.* (1990) and ecological field work in the PRFR.)

Preferred and acceptable species may be selected from the primary, secondary, or tertiary categories, provided the species restrictions have been addressed and the species meet the management objectives for the site.

The following procedures should be followed in the development of a tree species prescription:

1. Describe the site and identify the biogeoclimatic unit and site series. Stratification into two or more distinct ecological units may be required.
2. Review the tree species selection guidelines for the site series in question. In transitional areas, review recommendations for neighbouring units. Consider primary, secondary, and tertiary designations, footnotes, and other comments in the interpretations table.
3. Consider management objectives, timber production goals, and integrated resource management goals.
4. Check local site conditions and assess whether species restrictions and limitations apply to the site in question. Assess local performance of recommended species.
5. Estimate the potential (species composition, stocking, vigour) of advance and post-logging natural regeneration.
6. Evaluate the feasibility of establishing and maintaining the recommended species and addressing relevant restrictions and limitations, given existing operational constraints.
7. Determine preferred and acceptable species (or species combination) and their site preparation and regeneration requirements.

Species mixes

Species diversity should be maintained both an the landscape and stand level. It may be impractical (and silviculturally or biologically inappropriate) to maximize diversity an the stand level, but within a landscape unit (e.g., a watershed or planning area) proper planning should ensure that natural levels of tree species diversity are maintained. Such diversity will increase the resilience and resistance of second-growth forests to such hazards as insects, diseases, and changing climates. This diversity will also enhance habitat values for a variety of organisms.

Species mixes are also encouraged at the stand level, but species should be chosen that complement one another in terms of utilization or enhancement of site resources. Potential benefits and some example mixes include:

- enhanced yields through more complete use of available growing space (a less shade-tolerant species could be chosen as the major component and a more shade-tolerant species as the minor component [e.g., Ss/Ba, Ss/Cw, Pl/Hw, Pl/Sxw, Pl/Sxw, Pl/Bl, Sxs/Cw, Sxw/Bl]);
- maintenance or improvement of soil nutrient status (a species having basic, nutrient-rich litter could be combined with a major crop species having more acidic, nutrient-poor litter; such combinations could include a deciduous component — Hw/Cw, Sxs/Cw, Pl/Bl, Pl/At, Sxw/At, Sx/Ep);
- improved stand reliability from pest hazard reduction and enhanced windfirmness (e.g., a Cw component will increase windfirmness; Ba and Cw should be favoured over Ss and Hw in areas of the CWH having high porcupine hazard, and Ba favoured over Ss in areas of high weevil hazard);
- higher wood quality in mixed stands because of increased natural branch pruning; and
- increased overall species and structural diversity of the stand as a result of species mixes. This will enhance the diversity of habitats and other organisms on site.

Additional information on silvical characteristics of tree species can be found in Krajina *et al.* (1982) and Klinka *et al.* (1990).

7.2.6 Reforestation considerations

This column summarizes management considerations relevant to tree species selection and site limiting factors. Species restrictions and limitations specific to a site series or phase (e.g., soil drainage and frost) are presented here. Species restrictions/limitations that apply to the entire subzone or variant (e.g., moose browse on Bl in the SBSmc2) are footnoted at the bottom of the table.

This column highlights management considerations that should be addressed in the PHSP to maintain or improve second-growth productivity for timber production. Comments are geared toward typical or average site conditions for the site series but may, in some cases, be specific to a site phase. These reforestation considerations, together with the wildlife habitat considerations presented in Chapter 6, should set the stage for developing a PHSP; they are not in themselves prescriptions. Prescriptions must be site-specific, considering actual site conditions together with management objectives, including resource values other than timber. In most cases there are several different ways of addressing site limitations and thus several different prescriptions that will address the reforestation considerations presented here. This information should be used in combination with specific interpretation handbooks (Appendix 1) and local experience in developing a prescription.

Slashburning severity guidelines (Trowbridge *et al*. 1989) are presented for each of the site series. These guidelines are based on the amount of fuels consumed and suggest the range of acceptable severity of a fire required to meet management objectives such as vegetation control, creation of plantable spots, ease of planter access, nutrient conservation, and enhancement of soil temperature. A range of acceptable slashburning severity levels (SSL) is given for each site series using the five-class system outlined in Table 7.3.

The **slashburning severity levels** are based on **absolute duff (F and H horizons) consumption** and **percent slash reduction** for size classes <7 cm and >7 cm. These fuel categories can be measured or, with experience, visually estimated, and appear to be reasonably justified parameters for site-specific fire management planning and assessments.

The SSLs that appear in the interpretation tables are suggested for the range of average circumstances encountered. However, some properties such as forest floor depth will vary, and site-specific prescriptions must account for this variation. For example, where the forest floor is thinner than expected for a particular site series, then the SSL should be lowered. Prescribed burning is not recommended on Folisols or shallow mineral soils over bedrock, or in dry, nutrient-poor ecosystems. No SSLs have been suggested for site series where prescribed burning is highly impractical.

TABLE 7.3. Slashburning severity levels and approximate fuel consumption

Severity level (SSL)	Fuel consumption		
	Duff[a]	Slash (%)	
		<7cm	>7cm
0 (no burning)	--	--	--
1	0 cm (moss/litter only)	40	15
2	1-2 cm	50	20
3	2-5 cm	60-70	30
4	5-8 cm	80	40
5	8-15 cm	90	50

[a] "Duff" refers to the F and H horizons and does not include the litter layer.

BWBSdk1 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Pl Sw	Cold soils. Moisture and nutrient deficits on some sites. Root restrictions on compacted tills.	Medium AS, BP, DS, FW, CC
02	Pl Sw	Severe moisture and nutrient deficits. Root restrictions on shallow soils over bedrock.	Low
03	Pl Sw	Moisture and nutrient deficits. Root restrictions on shallow or fine-textured soils.	Low
04	Pl Sw	Very cold soils. Frost/cold air. Moisture and nutrient deficits on most sites.	Low
05	Pl Sw	Moisture deficits on some sites.	Medium AS, BP, DS, FW, MH
06	Pl Sw	Cold soils. Competing vegetation. Frost/cold air.	Medium - High BP, MH, FW
07	Pl Sw	Very cold, wet soils. Nutrient deficits. Frost/cold air. Competing vegetation. Rooting restricted by high water tables.	High WI, MH
08	Pl Sw	Cold, wet, often poorly aerated soils. Frost/cold air. Rooting restricted by high (but fluctuating) water tables and fine textures. Competing vegetation.	Very High CW, WA, WI, RG
09/10/11	Pl Sw	Saturated, very cold soils with poor aeration. Rooting restricted by high water table. Frost and cold air ponding.	Medium WI

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on Lewis (1988) and unpublished Ministry of Forests data. There has been only limited site index sampling in the BWBS zone.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Pl Sw [Bt] (Sb) Hard: At Ep	Pl should be favoured on submesic sites, south aspects, and glaciofluvial landforms. Risk of frost damage on Sw (lower slope, valley bottom sites). Soil temperature and natural regeneration will be enhanced by some reduction or mixing of LFH and mineral soil exposure (this will also encourage hardwood expansion when present in mature stand). Fine-textured morainal soils have higher potential for compaction/windthrow; harvest during dry periods or winter. SSL[e] 1-3 (depending on aspect and moisture regime).
Pl (Sb Sw) Hard: At	Marginal sites for timber production. **Avoid logging.** Conserve thin LFH for moisture and nutrient retention. These sites will be slow to regenerate. SSL 0.
Pl [Sw] Hard: At	Sw should be limited to moister microsites. Natural regeneration of Pl should be encouraged by a light mechanical treatment (drag scarification) provided cones/seeds are present in sufficient quantity. Expect high mortality of planted seedlings (drought). SSL 0-1.
Pl (Sb Sw) Hard: At	Marginally productive, cold, frosty sites; **avoid logging.** These sites will be slow to regenerate. SSL 0-1.
Pl Sw [Bl] (Sb) Hard: At Ep	Similar considerations to 01 (above). 05 appears to be more productive than 01, perhaps reflecting a more recent fire history and thinner feathermoss carpet (warmer soils, greater nutrient availability). Favour Sw on moister examples. SSL 1-2; burning should not be required.
Pl Sw [Bl] (Sb) Hard: Acb At Ep	Risk of frost damage on Sw. Soil temperature and nutrient regimes will be enhanced by reduction/mixing of LFH, but patch scarification preferred in order to minimize aspen competition and soil compaction. Sites should be planted promptly with vigorous stock. SSL 2-3.
Pl Sb Sw Hard: At	These are marginally productive sites that, if disturbed, will be slow to regenerate due to seasonally high water tables and brush competition. Plant promptly on raised microsites (artificial or natural). Risk of frost damage on Sw. SSL 1-3.
Sw [Pl] (Sb) Hard: Acb At Ep	Pl is limited by shade intolerance and saturated soils. Sw may be damaged by frost. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying or mounding to establish seedlings. Elevated microsites are preferred planting spots (drainage, cold soils, frost). Consider cluster planting (see page 7•15) and reduced stocking. Sites often have high risk of compaction and windthrow (finer textures, high water tables) and surface erosion (fluvial sites). SSL 3-4. See Chapter 6 for wildlife habitat considerations in riparian areas.
Pl Sb Sw Hard: Acb At	These sites are very marginal for timber production and **should not be logged.** High risk of frost damage on Sw. Choose elevated microsites for planting.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

BWBSdk2 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Pl, Sw	Cold soils. Moisture and nutrient deficits on some sites. Root restrictions on compacted tills.	Medium AS, BP, DS, FW, MH
02	Pl, Sw	Severe moisture and nutrient deficits. Root restrictions on shallow soils over bedrock.	Low
03	Pl, Sw	Very cold soils. Frost/cold air. Moisture and nutrient deficits on most sites.	Low
04	Pl, Sw, Sb	Very cold, damp soils with thick LFH (Mors) that limit nutrient availability. Frost/cold air.	Low
05	Pl, Sw	Moisture deficits on some sites.	Medium (High) AS, BP, FW, DS, MH
06	Pl, Sw	Cold, wet, often poorly aerated soils. Frost/cold air. Rooting restricted by high (but fluctuating) water tables and fine textures. Competing vegetation.	Very High CW, WA, WI, RG
07/08	Pl, Sw	Saturated, cold soils with poor aeration. Rooting restricted by high water table. Frost and cold air ponding.	Medium WI, RG

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on Lewis (1988) and unpublished Ministry of Forests data. There has been only limited site index sampling in the BWBS zone.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Pl Sw (Sb) Hard: At Ep	Pl should be favoured on submesic sites, south aspects, and glaciofluvial landforms. Risk of frost damage on Sw (lower slope, valley bottom sites). Soil temperature and natural regeneration will be enhanced by some reduction or mixing of LFH and mineral soil exposure (this will also encourage hardwood expansion when present in mature stand). Fine-textured morainal soils have higher potential for compaction/windthrow; harvest during dry periods or winter. SSL[e] 1-3 (depending on aspect and moisture regime).
Pl (Sb Sw) Hard: At	Marginal sites for timber production. **Avoid logging.** Conserve thin LFH for moisture and nutrient retention. These sites will be slow to regenerate. SSL 0.
Pl (Sb Sw) Hard: At	Marginally productive sites on cold, droughty, frosty sites; **avoid logging.** These sites will be slow to regenerate. SSL 0.
Pl Sb Sw [Lt] Hard: At	These are marginally productive sites that, if disturbed, will be slow to regenerate due to seasonally high water tables. Plant promptly on raised microsites (artificial or natural). Risk of frost damage on Sw. SSL 2-3
Pl Sw Hard: At Ep	Similar considerations to 01 (above). 05 often has an At component and lush shrub layers that will expand following disturbance. Favour Sw on moister examples. SSL 1-2. Sites should be planted promptly.
Sw [Pl] (Sb) Hard: Acb At Ep	Pl is limited by shade intolerance and saturated soils. Sw may be damaged by frost. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying or mounding to establish seedlings. Elevated microsites preferred planting spots (drainage, cold soils, frost). Consider cluster planting (see page 7•15) and reduced stocking. Sites often have higher risk of compaction and windthrow (finer textures, high water tables) and surface erosion (fluvial sites). SSL 3-4. See Chapter 6 for wildlife habitat considerations in riparian areas.
Lt Pl Sb Sw	These sites are very marginal for timber production and **should not be logged.** High risk of frost damage on Sw. Choose elevated microsites for planting.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

CWHvh2 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Hw, Cw	Nutrient availability limited by deep Mor humus forms. Excess soil moisture due to hypermaritime climate.	Medium SA, ES, BN
02	Pl, Cw	Severe nutrient deficits and root restrictions on shallow soils. Wind exposure.	Low
03	Hw, Cw	Nutrient deficits and root restrictions on shallow soils over acidic bedrock.	Medium SA
04	Hw, Cw, Ba, Ss	Slope stability. Root restrictions on 04b.	Low ES
05	Hw, Cw, Ba, Ss	Slope stability. Root restrictions on 05b. Competing vegetation.	Medium RS
06	Hw, Cw, Ba, Ss	Slope stability. Competing vegetation. Root restrictions on 06b.	High RS, SB
07	Hw, Cw, Ba, Ss	Slope stability. Competing vegetation. Root restrictions on 07b.	Very High RS, SB

[a] Refer to Section 7.2 for an explanation of each category in the table. Interpretations for active fluvial ecosystems (08, 09, 10) are presented on page 7•46.

[b] Site index estimates are based on unpublished Ministry of Forests data; very limited data for site series 02, 03, and 05.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Cw Hw (Ba Pl Ss Yc) Hard: Dr	Ba and Ss should only be considered on nutrient-medium sites (richer bedrock types). Pl suitable on the poorest sites (acidic bedrock). On the mineral phase (01a), productivity may be enhanced by mounding/mixing of LFH/mineral horizons (some site disturbance will likely be beneficial). There is less opportunity to improve productivity on the lithic (01b) and peaty (01c) phases. Guard against increasing soil moisture by impeding natural drainage patterns. SSL[e] 3-5; burning often not feasible.
Pl [Cw Yc]	Marginal sites for timber production; **avoid logging.** SSL 0.
Cw Hw Pl Hard: Dr	Often marginally merchantable. **Avoid excessive disturbance,** especially on 03b. SSL 0-3.
Ba Hw Ss [Cw] (Yc) Hard: Dr	These sites often occur on steep colluvial slopes where mechanical disturbance should be minimized. There is often abundant advance regeneration (mostly Hw) and natural regeneration of Hw can be expected. Ba and Ss should be favoured on richer bedrock types. Cw may be favoured on unstable/windy slopes (rooting habit offers stability). SSL 1-3.
Ba Cw Ss [Hw] (Yc) Hard: Dr	Similar consideration to 04 above. Hw becomes a secondary species and Cw a primary species to reflect the richer site conditions (base-rich bedrock) associated with this unit. Hw can be favoured where LFH is thick (>20 cm). SSL 1-3.
Ba Cw Ss [Hw] (Yc) Hard: Dr	Hw should only be actively managed for on sites with thick (>20 cm) LFH. 06 and 07 often occur as a complex, with 06 on the more freely drained sites and 07 on the wetter, lower slopes and adjacent to small streams. These productive sites require careful planning to avoid degradation and brush problems. Log during driest season with minimal ground disturbance. Dr will be quick to invade disturbed sites from adjacent stands; control seed sources (girdling, hack and squirt). Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. SSL 3-4; successful burn may be difficult to achieve, especially in 07.
Ba Cw Ss [Hw] (Yc) Hard: Dr	

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

CWHvh2 Interpretations Table[a] (cont.)

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
11	Hw Cw Pl	Saturated, peaty soils restrict rooting, nutrient availability, and productivity.	Medium SA, ES
12	Hw Cw Pl	Saturated, peaty soils severely limit rooting, nutrient availability, and productivity.	Medium SA
13	Hw Cw	Saturated, poorly aerated soils limit rooting and productivity.	Medium SA, SB
14, 15, 16	no information	Extreme exposure to wind and ocean spray. Root restrictions in 14 and 15.	Medium SA
18, 19	no information	Fluctuating, brackish water tables. Wet, poorly aerated soils.	Medium SA, SB

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on unpublished Ministry of Forests data; very limited data for site series 11 to 13.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Cc Hw Yc [Pl]	Bog forests are marginally merchantable. Best productivity occurs where mineral soils underlie relatively shallow (<30 cm) peaty horizons. Such sites may have potential for mounding treatments to improve rooting zone aeration and nutrient regime. All species should be established on elevated (natural or artificial) microsites. Pl often shows best productivity in natural stands. SSL[e] 3-4 (0 on shallow veneers); burning difficult.
Cw Pl Yc,	Generally no potential for timber production. **Avoid disturbance.**
Cw Yc (Hw Ss) Hard: Dr	Similar considerations to 11 above. Because swamp forests have some mineral seepage influence, they are generally more productive than bog forests (11). These sites are still only marginally productive, however, and any treatment must be aimed at maintaining or improving microsite drainage/aeration.
Ss (Cw Hw Pl)	Shoreline forests are generally not merchantable. Such sites are more appropriately managed for wildlife and aesthetic values. **Avoid disturbance.**
Cw Ss Hard: Act Dr	Marginally productive stands bordering estuaries. **Avoid disturbance.** If disturbed, plant on elevated microsites. Such sites are more appropriately managed for wildlife and aesthetic values.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

CWHvm1 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01/06	Ba Cw Hw Ss	Slope stability. Root restrictions on 01b and 06b. Deep LFH (Mors) limit nutrient availability on some sites.	Low ES, FW
02	Cw Hw Pl	Moisture and nutrient deficits. Root restrictions on shallow soils. Wind exposure.	Low
03	Cw Hw Pl	Moisture and nutrient deficits. Root restrictions on shallow soils. Wind exposure.	Medium SA
04	Cw Hw Ba Ss	Slope stability. Root restrictions on shallow veneers. Competing vegetation.	Medium RS
05	Ba Cw Hw Ss	Slope stability. Competing vegetation.	High RS, SB, FW
08	Ba Cw Hw Ss	Slope stability. Competing vegetation.	Very High RS, SB, FW, FN
12	Cw Hw Pl	Saturated, peaty soils restrict rooting, nutrient availability, and productivity.	Medium SA, ES
13	Cw Hw Pl	Saturated, peaty soils severely limit rooting, nutrient availability, and productivity.	Medium SA
14	Cw Hw Ba Ss	Saturated, poorly aerated soils limit rooting and productivity.	Medium SA, SB, FN

[a] Refer to Section 7.2 for an explanation of each category in the table. Interpretations for active fluvial ecosystems (09, 10, 11) are presented on page 7•46 for all CWH subzones.

[b] Site index estimates are based on unpublished Ministry of Forests data; limited data for 04, 12, and 13.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Ba Cw Hw[e] Ss[e]] Hard: Dr	Ba and Ss best suited to nutrient-medium sites that lack salal (i.e., richest examples of 01, often on base-rich bedrock). Cw may be favoured on unstable/windy slopes (rooting habit offers stability). These sites often occur on steep colluvial slopes where mechanical disturbance should be minimized. There is often abundant advance regeneration (mostly Hw) and natural regeneration of Hw can be expected. SSL[g] 1-3 (on 01b)
Pl [Cw Fd[f] Hw]	Marginal sites for timber production; **avoid logging.** SSL 0.
Cw Hw [Fd[f] Pl] Hard: Dr	Often marginally merchantable. **Avoid excessive disturbance,** especially on 03b. SSL 0.
Ba Cw [Hw[e] Ss[e]] Hard: Dr	Risk of weevil damage on Ss. 04 occurs almost exclusively on steep, potentially unstable colluvial slopes over base-rich bedrock. Mechanical disturbance should be minimized. There is often abundant advance and natural Hw regeneration, but because these are nutrient-rich sites, Ba, Cw, (and Ss) should be managed for. Cw may be favoured on unstable slopes (rooting habit offers stability). SSL 1-3 (on stable slopes with deep soils only).
Ba Cw [Hw[e] Ss[e]] Hard: Act Dr	Risk of weevil damage on Ss. 05 often occurs in a complex with 01 on slightly moister and/or richer sites. Competing vegetation is a potential concern and sites should be planted promptly. Minimize mineral soil exposure. SSL 2-4.
Ba Cw [Hw[e] Ss[e]] Hard: Act Dr	Hw should only be actively managed for on sites with thick (>20 cm) LFH. Risk of weevil damage on Ss. These productive sites require careful planning to avoid degradation and brush problems. Log during driest season with minimal ground disturbance. Dr will be quick to invade disturbed sites from adjacent stands; control seed sources (girdling, hack and squirt). Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. SSL 3-4; successful burn may be difficult to achieve.
Cw Hw Yc [Pl] (Hm)	Bog forests are only marginally merchantable. All species must be established on elevated (natural or artificial) microsites. Retain advance regeneration.
Cw Pl Yc	Generally no potential for timber production. **Avoid disturbance.**
Cw (Hw[e] Ss[e])	Highest productivity occurs on 14a where mineral seepage influence is greatest. All species must be established on elevated microsites. Consider cluster planting (see page 7•15) and reduced stocking. Avoid mechanical disturbance and destruction of natural mounds. Preserve natural regeneration of all species.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories.

[e] Risk of Porcupine damage, especially on Hw and Ss in the CWHvm1.

[f] Fd restricted to Gardner Canal/ Kitlope area.

[g] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

CWHvm2 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes
01/06	Ba, Cw, Hw, Ss	Slope stability. Root restrictions on 01b and 06b. Deep LFH (Mors) limit nutrient availability on some sites. Wet, heavy snow.	Low ES, FW
02	Hw	Moisture and nutrient deficits. Root restrictions on shallow soils. Wind exposure.	Low
03	Hw	Moisture and nutrient deficits. Root restrictions on shallow soils. Wind exposure.	Medium SA
05	Ba, Cw, Hw, Ss	Slope stability. Competing vegetation. Wet, heavy snow.	High RS, SB, FW
08	Ba, Cw, Hw, Ss	Slope stability. Competing vegetation. Wet, heavy snow.	Very High RS, SW FW, FN
09	Cw, Hw	Saturated, peaty soils restrict rooting, nutrient availability, and productivity. Wet, heavy snow.	Medium ES
10	Cw, Hw	Saturated, peaty soils severely limit rooting, nutrient availability, and productivity. Wet, heavy snow.	Medium ES
11	Cw, Hw	Saturated, poorly aerated soils limit rooting and productivity. Wet, heavy snow.	Medium SB, FN

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on unpublished Ministry of Forests data collected in the CWHvm1 and adjusted to reflect the lower productivity of the CWHvm2.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Ba [Cw[e]Hw[f] Ss[f] Yc] (Hm)	Ba and Ss best suited to nutrient-medium sites (i.e., richest examples of 01 and 06). Hw best suited to sites with thick (>20 cm) LFH. Cw may be favoured on unstable/windy slopes (rooting habit offers stability). Hm restricted to upper elevations. 01 often occurs on steep colluvial slopes where mechanical disturbance should be minimized. There is often abundant advance regeneration (Hw and Ba) and post-logging natural regeneration of Hw can be expected. Planting will be required to increase component of other species. SSL[g] 1-3 (0 on 01b).
Pl [Cw[e] Hw[f] Yc]	These sites are very rare in the CWHvm2 of the PRFR. Marginal sites for timber production; **avoid logging.**
Cw[e] Hw[f] [Pl Yc]	These sites are very rare in the CWHvm2 of the PRFR. Often marginally merchantable. **Avoid excessive disturbance.**
Ba Cw[e] [Hw[f] Ss[f] Yc] (Hm)	05 often occurs in a complex with 01 on slightly moister and/or richer sites. Hm restricted to upper elevations. Competing vegetation is a potential concern and sites should be planted promptly. Minimize mineral soil exposure. SSL 2-4.
Ba Cw[e] [Hw[f] Ss[f] Yc]	Hw should only be promoted on sites with thick (>20 cm) LFH. Some risk of weevil damage on Ss. These productive sites require careful planning to avoid degradation and brush problems. Log during driest season with minimal ground disturbance. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. SSL 2-3; successful burn may be difficult to achieve.
Cw[e] Hw[f] Yc [Hm] (Pl)	Bog forests are only marginally merchantable. All species must be established on elevated microsites. Retain advance regeneration.
Pl Yc [Hm]	Generally no potential for timber production. **Avoid disturbance.**
Cc Yc (Hm Hw[f] Ss[f])	Marginal sites for timber production. All species must be established on elevated microsites. Hm restricted to upper elevations. Consider cluster planting (see page 7•15) and reduced stocking. Avoid mechanical disturbance and destruction of natural mounds. Retain advance regeneration of all species.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Cw restricted to lower elevations in CWHvm2.

[f] Risk of Porcupine damage, especially on Hw and Ss in the CWHvm2.

[g] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

CWHwm Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Hw, Ss	Slope stability. Root restrictions on 01b. Deep LFH (Mors) limit nutrient availability on some sites.	Medium ES, FW
02	Hw, Ss	Slope stability. Moisture and nutrient deficits. Root restrictions on shallow soils. Wind exposure.	Low ES
03	Hw, Ss	Slope stability. Competing vegetation.	High RS, SB, FW,
04	Hw, Ss	Slope stability. Competing vegetation.	Very High RS, SB, FW, FN
08	Hw, Ss	Saturated, mineral soils and wet, peaty LFH restrict rooting, nutrient availability, and productivity. Cemented horizons also restrict rooting.	Medium ES
09	Hw, Ss	Saturated, poorly aerated soils limit rooting and productivity.	Medium SB, FN
10	Pl	Saturated, peaty soils severely limit rooting, nutrient availability, and productivity.	Medium ES

[a] Refer to Section 7.2 for an explanation of each category in the table. Interpretations for active fluvial ecosystems (05, 06, 07) are presented on page 7•46 for all CWH subzones.

[b] Site index estimates are based on unpublished Ministry of Forests data; very limited data for the CWHwm.

c Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Hw[e] Ss[e] [Ba[f] Cw[f]] (Hm Yc) Hard: Dr	Ba and Ss best suited to moist, nutrient-medium sites (i.e., richest examples of 01). Hw best suited to sites with thick (>20 cm) LFH or where cemented horizons occur. Cw may be favoured on unstable/windy slopes (rooting habit offers stability). Hm and Yc should be considered at upper elevations or on cold air drainage sites. 01 often occurs on steep colluvial slopes where mechanical disturbance should be minimized. There is often abundant advance regeneration of Hw (and Ss) and natural regeneration of Hw can be expected. SSL[g] 1-4 (0 on 01b).
Hw[e] Pl [Cw[f]] (Hm Ss[e]) Hard: Dr	Avoid mechanical disturbance on these steep, upper colluvial/bedrock slopes. Retain advance regeneration of all species. Hw best choice on acidic LFH over rock. SSL 0-1; burning generally unacceptable.
Ss[e] [Ba[f] Cw[f] Hw[e]] (Yc) Hard: Act Dr	03 often occurs in a complex with 01 on slightly moister and/or richer sites where Ss, Ba, (and Cw) should be favoured. Hw will regenerate naturally. Yc can be considered at high elevations. Competing vegetation is a potential concern and sites should be planted promptly. Minimize mineral soil exposure. SSL 2-4.
Ss[e] [Ba[f] Cw[f] Hw[e]] (Yc) Hard: Act Dr	Hw should only be promoted on sites with thick (>20 cm) LFH. These productive sites require careful planning to avoid degradation and brush problems. Log during driest season with minimal ground disturbance. Dr will be quick to invade disturbed sites from adjacent stands; control seed sources (girdling, hack and squirt). Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. SSL 2-4; successful burn may be difficult to achieve.
Pl Yc [Hw[e] Cw[f]] (Hm)	These sites are only marginally merchantable. Avoid soil disturbance and drainage interruption. All species must be established on elevated microsites. Retain advance regeneration of all species. These are cold, wet sites that will be slow to regenerate.
Ss[e] [Hw[e] Cw[f] Yc] Hard: Act Dr	Marginal sites for timber production. All species must be established on elevated microsites. Consider cluster planting (see page 7•15) and reduced stocking. Avoid mechanical disturbance and destruction of natural mounds. Retain advance regeneration of all species.
Pl Yc [Cwf]	Bog woodlands; generally no potential for timber production. **Avoid disturbance.**

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Risk of Porcupine damage, especially on Hw and Ss in the CWHwm.

[f] Ba and Cw do not occur naturally throughout most of the CWHwm; **their use should be restricted to southern portions.**

[g] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

CWHws1 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Hw, Ba	Moisture deficits on some sites (01b). Slope stability (some steep colluvial slopes). Deep LFH (Mors) limit nutrient availability on some sites.	Low ES, FW
02	Hw, Pl	Moisture and nutrient deficits. Root restrictions on shallow soils. Wind exposure.	Low
03	Hw, Ba	Moisture and nutrient deficits. Root restrictions on shallow soils. Wind exposure.	Low
04	Hw, Ba	Slope stability on some steep, colluvial slopes. Competing vegetation. Root restrictions on some shallow soils.	High RS, SB, FW
05	Hw, Ba	Some root restrictions in gleyed soils. Deep LFH (Mors) often limit nutrient availability.	Medium ES, RS, FW
06	Hw, Ba, Cw, Ss	Slope stability. Competing vegetation. Some root restrictions in gleyed soils.	Very High RS, SB, FW, FN
10	Hw, Pl	Saturated, peaty soils severely limit rooting, nutrient availability, and productivity.	Medium ES
11	Hw, Cw	Saturated, poorly aerated soils limit rooting and productivity.	Medium SB, FN

[a] Refer to Section 7.2 for an explanation of each category in the table. Interpretations for active fluvial ecosystems (07, 08, 09) are presented on page 7•46 for all CWH subzones.

[b] site index estimates are based on unpublished Ministry of Forests data.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Ba [Cw[e] Hw[e] Pl Sxs[e]] Hard: Dr	Ba and Sxs best suited to nutrient-medium, fresh to moist sites (i.e., richest examples of 01). Risk of weevil damage on Sxs. Pl suited to 01b (glaciofluvial gravels). There is often abundant advance regeneration of Hw and Ba and this should be protected; natural regeneration of Hw can be expected. Fill plant with Cw, Ba, and Sxs. Mixed stands will lessen the impacts of Porcupine when stands reach pole-sapling stage. SSL[f] 1-3.
Pl [Cw Hw[e]]	Marginal sites for timber production; **avoid logging.** Promote natural regeneration of Pl or plant Pl if seeding-in is inadequate.
Hw Pl [Cw] Hard: Dr	Often marginally merchantable. Avoid excessive disturbance, especially on 03a. LFH horizons important for moisture retention. Light surface disturbance will promote natural Pl regeneration. Plant Pl if necessary. SSL 1-3 on 03a; 0 on 03b.
Ba Cw [Hw[e] Sxs[e]] (Pl) Hard: Act Dr	Risk of weevil damage on Sxs. 04 often occurs in a complex with 01 on slightly moister and/or richer sites. Competing vegetation is a potential concern and sites should be planted promptly. Advance Hw and Ba often present. Minimize mineral soil exposure. Avoid logging during wet season. SSL 2-4.
Ba Cw [Hw[e] Sxs[e]] Hard: Dr	Ba and Sxs best suited to nutrient-medium sites (i.e., richest examples of 05). Risk of weevil damage on Sxs. Favour Hw if LFH layers are thick (>20 cm). There is often abundant advance regeneration of Hw and Ba and this should be protected; natural regeneration of Hw can be expected. Fill plant with Cw, Ba, and Sxs. Mixed stands will lessen the impacts of Porcupine when stands reach pole-sapling stage. Excessive disturbance will promote alder invasion. SSL 2-4.
Ba Cw [Hw[e] Sxs[e]] Hard: Act Dr	Hw should only be promoted on sites with thick (>20 cm) LFH. Risk of weevil damage on Sxs. These productive sites require careful planning to avoid degradation and brush problems. Log during driest season with minimal ground disturbance. Dr will be quick to invade disturbed sites from adjacent stands; control seed sources (girdling, hack and squirt). Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. SSL 2-3; successful burn may be difficult to achieve.
Pl Cw	Bog woodlands; generally no potential for timber production. **Avoid disturbance.**
Cw [Sxs[e]] (Ba Hw[e]) Hard: Act Dr	All species must be established on elevated microsites. Consider cluster planting (see page 7•15) and reduced stocking. Avoid mechanical disturbance and destruction of natural mounds. Retain advance regeneration and promote natural regeneration of all species. Some potential for creating artificial mounds.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Risk of Porcupine damage, especially on Hw and Ss in the CWHws1.

[f] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

CWHws2 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Hw, Ba	Slope stability (some steep colluvial slopes). Deep LFH (Mors) limit nutrient availability on some sites. Wet, heavy snow.	Low ES, FW
02	Hw	Moisture and nutrient deficits. Root restrictions on shallow soils. Wind exposure.	Low
03	Hw	Moisture and nutrient deficits. Root restrictions on shallow soils. Wind exposure.	Low
04	Hw, Ba	Slope stability on some steep, colluvial slopes. Competing vegetation. Root restrictions on some shallow soils. Wet, heavy snow.	High RS, SB, FW
05	Hw, Ba	Some root restrictions in gleyed soils. Deep LFH (Mors) often limit nutrient availability. Wet, heavy snow.	Medium ES, RS, FW
06	Hw, Ba	Slope stability. Competing vegetation. Some root restrictions in gleyed soils. Wet, heavy snow.	Very High RS, SB, FW, FN
10	Hw, Pl	Saturated, peaty soils severely limit rooting, nutrient availability, and productivity.	Medium ES
11	Hw, Cw	Saturated, poorly aerated soils limit rooting and productivity.	Medium SB, FN

[a] Refer to Section 7.2 for an explanation of each category in the table. Interpretations for active fluvial ecosystems (07, 08, 09) are presented on page 7•46 for all CWH subzones.

[b] Site index estimates are based on unpublished Ministry of Forests data collected in the CWHws l and adjusted to reflect the lower productivity of the CWHws2.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Ba[e] [Bl[f] Cw[g] Hw[h] Pl Sxs[h]] (Hm) Hard: Dr	Ba and Sxs best suited to nutrient-medium, fresh to moist sites (i.e., richest examples of 01). Pl suited to driest sites. Hm restricted to upper elevations. There is often abundant advance regeneration of Hw and Ba and this should be protected; natural regeneration of Hw can be expected. Fill plant with Ba, Sxs, and (Cw). Mixed stands will lessen the impacts of Porcupine when stands reach pole-sapling stage. SSL[i] 1-3 (0 on shallow soils over bedrock).
Pl [Cw[g] Hw[h]]	These sites are very rare in the CWHws2 of the PRFR. Marginal sites for timber production; **avoid logging.** Promote natural regeneration of Pl or plant Pl if seeding-in is inadequate. SSL 0.
Hw[h] Pl [Cw[g]] Hard: Dr	These sites are uncommon in the CWHws2 of the PRFR. Often marginally merchantable. **Avoid excessive disturbance.** LFH horizons are important for moisture retention. Light surface disturbance will promote natural Pl regeneration. Plant Pl if necessary. SSL 0.
Ba[e] [Cw[g] Bl[f] Hw[h] Sxs[h]] (Hm) Hard: Act Dr	04 often occurs in a complex with 01 on slightly moister and/or richer sites. Hm restricted to upper elevations. Competing vegetation is a potential concern and sites should be planted promptly. Advance Hw and Ba often present. Minimize mineral soil exposure. Avoid logging during wet season. SSL 2-3.
Ba[e] [Cw[g] Bl[f] Hw[h] Sxs[h]] (Hm) Hard: Dr	Ba and Sxs best suited to nutrient-medium, sites (i.e., richest examples of 05). Favour Hw if LFH layers are thick (>20 cm). Hm restricted to upper elevations. There is often abundant advance regeneration of Hw and Ba and this should be protected; natural regeneration of Hw can be expected. Fill plant with Ba, Sxs, and (Cw). Mixed stands will lessen the impacts of Porcupine when stands reach pole sapling stage. SSL 2-4.
Ba[e] [Bl[f] Cw[g] Hw[h] Sxs[h]] Hard: Act Dr	Hw should only be promoted on sites with thick (>20 cm) LFH. Risk of weevil damage on Ss. These productive sites require careful planning to avoid degradation and brush problems. Log during driest season with minimal ground disturbance. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. SSL 2-4; successful burn may be difficult to achieve.
Pl Cw[g]	Bog woodlands are rare in the CWHws2; generally no potential for timber production. **Avoid disturbance.**
Cw[g] [Sxs[h]] (Ba[e] Hw[h]) Hard: Act Dr	Marginal sites for timber production (and uncommon in the CWHws2 of the PRFR). All species must be established on elevated microsites. Consider cluster planting (see page 7•15) and reduced stocking. Avoid mechanical disturbance and destruction of natural mounds. Retain advance regeneration and promote natural regeneration of all species.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Ba is less vigorous in the easternmost CWHws2.

[f] Bl should be considered on cold air drainage sites.

[g] Cw restricted to lower elevations in western portions of the CWHws2.

[h] Risk of Porcupine damage, especially on Hw and Sxs in the CWHws2.

[i] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

CWH (fluvial) Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
vh2/08	Ss	**High fluvial benches**. Competing vegetation. High (but seasonally fluctuating) water tables may restrict rooting. Moderate flooding/erosion hazard.	Very High RS, SB
vml/09	Ss	High fluvial benches. As above.	Very High CA, RS, SB
wm/05	Ss	High fluvial benches. As above. Frost/ cold air in some upper valleys.	Very High CA, RS, SB
ws1, ws2/07	Sxs	High fluvial benches. As above. Frost/ cold air in some upper valleys (CHWws2).	Very High CA, RS, SB
vh2/09	Ss	Middle fluvial benches. Competing vegetation. High (seasonally fluctuating) water tables restrict rooting. Frequent (annual) flooding, deposition/erosion.	Very High RS
vm1/10	Ss	Middle fluvial benches. As above.	Very High CA
wm/06	Ss	Middle fluvial benches. As above. Frost/cold air in some upper valleys.	Very High CA
ws1 ws2/08	Sxs	Middle fluvial benches. As above. Frost/cold air in some upper valleys (CWHws2).	Very High CA
vh2/10 vm1/11 wm/07 ws1, ws2/09	no information	Low fluvial benches. High water tables restrict rooting. Frequent and prolonged annual flooding, often of high velocity. Annual deposition/ erosion. Competing vegetation.	High CA, WI

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on (very limited) unpublished Ministry of Forests data.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Cw Ss [Ba] (Hw) Hard: Dr Ba Cc [Ss[ef]] (Hw[e]) Hard: Act Dr Ss[e] [Ba[g] Cw[g] Hw[e]] Hard: Act Dr Ba Cw [Bl[h] Sxs[ef]] (Hw[c]) Hard: Act Dr	High fluvial benches represent the most productive forested ecosystems in the CWH zone. Very high vegetation potential, sensitive soils (erosion, compaction), and high wildlife, fisheries, and water values necessitate extremely careful planning and operations on these sites. Refer to Chapter 6 and fisheries, forestry, and wildlife guidelines for riparian ecosystem management. Harvesting should be carried out quickly during the driest season. Mechanical disturbance and mineral soil exposure should be minimized. Fine-textured surface horizons should be protected. Deciduous seed trees should be controlled in advance of harvest if conifer regeneration is the objective. Intensive vegetation control will be required to establish conifers quickly and evenly (herbicides/manual treatments; repeated treatments). Secure stock early and plant immediately with large, sturdy stock on the most raised microsites. Consider cluster planting (see page 7•15) and reduced stocking to facilitate spot treatment around seedlings (fewer, more intensively managed plant ing spots of 3 - 5 seedlings) while maintaining patches of understory for wildlife. Riparian management guidelines favour partial cutting over clearcutting and thus prescribed fire is generally impractical as a vegetation management tool (although it has been shown to be effective on fluvial sites in the CWHvm). Shade-tolerant Cw and Ba are viable alternatives to Ss/Sxs, considering weevil and Porcupine hazard and vegetation competition. Hardwood management should be considered on many sites.
Ss [Ba Cw] (Hw) Hard: Dr [Ba Cw Ss[ef]] Hard: Act Dr [Ba[g] Cw[g] Ss[e]] Hard: Act Dr [Ba Bl[h] Cw Ss[ef]] Hard: Act Dr	Middle fluvial benches are also extremely productive and present many of the same concerns noted above for high fluvial benches. Establishment of coniferous plantations on medium benches, however, is even more problematic due to more frequent surface flooding, and associated sediment erosion /deposition, and extreme competition from deciduous trees and shrubs. Uncertainty about longevity of medium bench sites also makes conifer establishment a questionable investment. Most sites should be managed as pure hardwood (Act/Dr) stands. Middle bench sites are often more appropriately managed for wildlife, watershed, and aesthetic values (see Chapter 6).
Sites not suitable for conifers. Hard: Act[i] Dr	Low bench sites are not suited to conifer establishment (or commercially viable hardwood establishment) due to the frequent and often high-velocity flooding and resultant erosion /sediment deposition. **Do not disturb low bench sites;** they are best managed for wildlife, watershed, and aesthetic values (see Chapter 6).

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Risk of Porcupine damage, especially on Hw, Ss, and Sxs.

[f] Risk of weevil damage on Ss and Sxs.

[g] Ba and Cw do not occur naturally throughout most of the CWHwm. **Their use should be restricted to southern portions.**

[h] Bl should be considered on cold air drainage sites.

[i] Act is rare or absent in the CWHvh2.

ESSFmc Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Bl Sxw	Cold soils. Moderately deep, long-lasting snowpack. Root restrictions on 01b. Frost/cold air.	Low ES, FW
02/03	BI Sxw	Severe moisture and nutrient deficits. Root restrictions on shallow soils.	Low
04	Bl Sxw	Cold soils. Moisture/nutrient deficits. Root restrictions on some shallow soils. Frost/cold air.	Low
05/06	Bl Sxw	Cold soils. Moderately deep, long-lasting snowpack. Competing vegetation. Root restrictions on fine-textured soils. Frost/cold air.	High MS, SH, FW
07	Bl Sxw	Cold soils. Moderately deep, long-lasting snowpack. Root restrictions on fine-textured, wet soils. Competing vegetation. Frost/cold air.	Very High MS, SH, FW, WA
08	Bl	Very cold, wet soils. Deep and long-lasting snowpack. Frost/cold air.	Medium SH
09	Bl Sxw	Saturated, cold soils with poor aeration and low nutrient status. Rooting restricted by high water table. Frost/cold air ponding.	Medium WI
10	Bl Sxw	Saturated, cold soils with poor aeration. Rooting restricted by high water table. Frost/cold air ponding. Competing vegetation.	High WA

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on Kayahara *et al*. (1993). In the ESSF, site index decreases dramatically with increasing elevation. Estimates provided here are relevant to the lower-elevation (operable) ESSF.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Bl Sxw [Pl]	Considering the severe environmental and biological constraints in the ESSFmc, small clearcuts or partial cuts should be considered on all sites; advance regeneration and residual trees of good form should be retained. Risk of snow damage on Pl, especially at higher elevations. Conserve LFH for moisture/nutrient retention, especially on 01a. Soil temperature and natural regeneration can be enhanced by some reduction/mixing of LFH and mineral soil exposure. Risk of soil compaction and windthrow in 01b. SSL[e] 1-2.
Pl (Bl Sxw)	Marginal sites for timber production; **avoid logging.** Conserve thin LFH for moisture/nutrient retention. SSL 0.
Bl Pl Sxw	Conserve LFH for moisture and nutrient retention. Some mechanical disturbance (summer logging) may be beneficial in improving soil temperature/nutrient regime (except on shallow soils over bedrock). Shallow soils and exposed locations susceptible to windthrow. Marginally productive sites. SSL 0-1. See general comment on ESSFmc under 01 above.
Bl Sxw [Pl]S	Pl is susceptible to snow damage and is also limited by shade intolerance on brushy sites. Plant sites promptly after harvest. Assess/treat competing vegetation. Minimize mineral soil exposure. Medium-severity burn generally beneficial in controlling vegetation and improving soil temperature. SSL 2-3. Fine-textured soils have higher risk of compaction and windthrow. See general comment on ESSFmc under 01 above.
Bl Sxw (Pl)	Pl restricted by susceptibility to snow damage and shade intolerance. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying to establish seedlings. Elevated microsites generally preferred planting spots. SSL 2-4; medium-severity burn will generally be beneficial in improving soil temperature. High-severity burn required to (temporarily) control vegetation. Risk of compaction and windthrow. See general comment on ESSFmc under 01 above.
Bl Sxw	These meadow forests are marginal for timber production. Regeneration will be difficult on these high-elevation, snowy sites. Partial cut only to promote natural regeneration. Retain advance regeneration.
Bl Sxw	These sites are very marginal for timber production and **should not be logged.** High risk of frost damage on Sxw. Choose elevated microsites for planting.
Bl Sxw	Sxw and Bl may be damaged by frost. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying or mounding to establish seedlings. Elevated microsites are preferred planting spots (drainage, warmer soils, less frost). Consider cluster planting (see page 7•15) and reduced stocking. Sites often have higher risk of compaction and windthrow (finer textures, high water tables). SSL 4-5. See general comment on ESSFmc under 01.

[d] Species are in alphabetical order within primary, secondary [ ],and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

ESSFmk Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Bl Sxw	Cold soils. Deep, long-lasting snowpack. Root restrictions on 01b. Frost/cold air.	Low ES, FW
02/03	Bl Sxw	Severe moisture and nutrient deficits. Root restrictions on shallow soils over bedrock.	Low
04	Bl Sxw	Cold soils. Long-lasting snowpack. Competing vegetation. Root restrictions on fine-textured soils. Frost/cold air.	High MS, SH
05	Bl Sxw	Cold soils. Deep, long-lasting snowpack. Root restrictions on fine-textured, wet soils. Competing vegetation. Frost/cold air.	Very High MS, SH
06/07	Bl Sxw	Saturated, cold soils with poor aeration. Rooting restricted by high water table. Frost/cold air ponding. Competing vegetation.	High WA

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] There have been no site index data collected in the ESSFmk. Site index estimates are based on Kayahara *et al*. (1993). In the ESSF, site index decreases dramatically with increasing elevation. Estimates provided here are relevant to the lower-elevation (potentially operable) ESSF.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Bl Sxw [Pl] (Ba[f] Hm)	Considering the severe environmental and biological constraints in the ESSFmk, small clearcuts or partial cuts should be considered on all sites; advance regeneration and residual trees of good form should be retained. Risk of snow damage on Pl. Conserve LFH for moisture/nutrient retention, especially on 01a. Soil temperature and natural regeneration can be enhanced by some reduction/mixing of LFH and mineral soil exposure. Risk of soil compaction and windthrow in 01b. SSL[g] 1-2.
Pa Pl (Bl Hm Sxw)	Marginal sites for timber production; **avoid logging.** Long term maintenance of Pa component in these stands is probably dependent on natural fire cycle.
Bl Sxw [Pl] (Ba[f] Hm)	Pl is susceptible to snow damage and is also limited by shade intolerance on brushy sites. Plant sites promptly after harvest. Assess/treat competing vegetation. Minimize mineral soil exposure. Medium-severity burn generally beneficial in controlling vegetation and improving soil temperature. SSL 2-3. Fine-textured soils have higher risk of compaction and windthrow. See general comment on ESSFmk under 01 above.
Bl Sxw (Ba[f] Hm Pl)	Pl restricted by susceptibility to snow damage and shade intolerance. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying to establish seedlings. Elevated microsites generally preferred planting spots. SSL 2-3; medium-severity burn will generally be beneficial in improving soil temperature. High-severity burn required to control vegetation. See general comment on ESSFmk under 01 above.
Bl Sxw	Sxw and Bl may be damaged by frost. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying or mounding to establish seedlings. Elevated microsites are preferred planting spots (drainage, warmer soils, less frost). Consider cluster planting (see page 7•15) and reduced stocking. Sites often have higher risk of compaction and windthrow (finer textures, high water tables). SSL 3-4. See general comment on ESSFmk under 01 above.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Logging has just begun in the ESSFmk. Comments are based on experience in the ESSFmc. The ESSFmk experiences more summer drought than the ESSFmc and has a wetter, deeper snowpack. Pa should be retained wherever it regenerates naturally; leave seed trees standing for wildlife value and diversity.

[f] Ba occurs only in western ESSFmk.

[g] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

ESSFwv Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Bl Sxw	Cold soils. Deep, long-lasting snowpack. Root restrictions on 01b. Frost/cold air.	Low ES, FW
02/03	Bl Sxw	Severe moisture and nutrient deficits. Root restrictions on shallow soils over bedrock.	Low
04	Bl Sxw	Cold soils. Moisture/nutrient deficits. Root restrictions on some shallow soils. Frost/cold air.	Low
05	Bl Sxw	Cold soils. Deep, long-lasting snowpack. Competing vegetation. Root restrictions on fine-textured soils. Frost/ cold air.	High MS, SH, FW
06	Bl Sxw	Cold soils. Deep, long-lasting snowpack. Root restrictions on fine-textured, wet soils. Competing vegetation. Frost/cold air.	Very High MS, SH, FW, WA
07	Bl	Very cold, wet soils. Deep and long-lasting snowpack. Frost/cold air.	Medium SH
08	Bl Sxw	Saturated, cold soils with poor aeration and low nutrient status. Rooting restricted by high water table. Frost/ cold air ponding.	Medium WI
09	Bl Sxw	Saturated, cold soils with poor aeration. Rooting restricted by high water table. Frost/cold air ponding. Competing vegetation.	High WA

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] There have been no site index data collected in the ESSFwv. Site index estimates are based on Kayahara *et al*. (1993). In the ESSF, site index decreases dramatically with increasing elevation. Estimates provided here are relevant to the lower-elevation (operable) ESSF.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Bl Sxw [Pl] (Hm)	Considering the severe environmental and biological constraints in the ESSFwv, small clearcuts or partial cuts should be considered on all sites; advance regeneration and residual trees of good form should be retained. Risk of snow damage on Pl. Conserve LFH for moisture/nutrient retention, especially on 01a. Soil temperature and natural regeneration can be enhanced by some reduction/mixing of LFH and mineral soil exposure. Risk of soil compaction and windthrow in 01b. SSL[e] 1-2.
Pl (Bl Hm Sxw)	Bl is a secondary species (not tertiary) in 03. Marginal sites for timber production; **avoid logging.** Conserve thin LFH for moisture/nutrient retention. SSL 0.
Pl [Bl] (Hm Sxw)	Marginally productive sites. Conserve LFH for moisture and nutrient retention. Some mechanical disturbance (summer logging) may be beneficial in improving soil temperature/nutrient regime (except on shallow soils over bedrock). Shallow soils and exposed locations susceptible to windthrow. Marginally productive sites. See general comment on ESSFwv under 01 above.
Bl Sxw [Pl]	Pl is susceptible to snow damage and is also limited by shade intolerance on brushy sites. Plant sites promptly after harvest. Assess/treat competing vegetation. Minimize mineral soil exposure. Medium-severity burn generally beneficial in controlling vegetation and improving soil temperature. SSL 2-3. Fine-textured soils have higher risk of compaction and windthrow. See general comment on ESSFwv under 01 above.
Bl Sxw (Pl)	Pl severely restricted by susceptibility to snow damage and shade intolerance. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying to establish seedlings. Elevated microsites generally preferred planting spots. SSL 3-4; medium-severity burn will generally be beneficial in improving soil temperature. High-severity burn required to (temporarily) control vegetation. See general comment on ESSFwv under 01 above.
Bl Sxw	These meadow forests are marginal for timber production. Regeneration will be difficult on these high-elevation, snowy sites. Partial cut only to promote natural regeneration. Retain advance regeneration.
Bl Sxw	These sites are very marginal for timber production and **should not be logged.** High risk of frost damage on Sxw. Choose elevated microsites for planting.
Bl Sxw	Sxw and Bl may be damaged by frost. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying or mounding to establish seedlings. Elevated microsites are preferred planting spots (drainage, warmer soils, less frost). Consider cluster planting (see page 7•15) and reduced stocking. Sites often have higher risk of compaction and windthrow (finer textures, high water tables). SSL 4-5. See general comment on ESSFwv under 01 above.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

ICHmc1/1a Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
mc1/ mc1a 01	Pl Sx Hw	Moisture and nutrient deficits on 01b. Competing vegetation where there is a deciduous component in the mature stand.	Medium MH, ES, FW
mc1 02	Pl Hw	Severe moisture and nutrient deficits. Root restrictions on shallow soils over bedrock.	Low
mc1a 02	Pl Sx	Competing vegetation, especially where there is a deciduous component in the mature stand.	High MH, MS, FW
mc1 03	Sx	Competing vegetation, especially where there is a deciduous component in the mature stand.	High MH, MS, FW
mc1a 03	Sx	Competing vegetation. Root restrictions on some fine-textured, gleyed soils. Frost/cold air on some lower slope/ depressions.	Very High MH, MS, FN
mc1 04	Sx	Competing vegetation. Root restrictions on some fine-textured, gleyed soils. Frost/cold air on lower slopes.	Very High MH, MS, FN
mc1 05	Sx	Competing vegetation. High (but seasonally fluctuating) water tables may restrict rooting. Frost/cold air. Risk of flooding/erosion.	Very High CW, MH, MS
mc1 06	Sx	Saturated, cold soils with poor aeration restrict rooting and productivity. Frost/ cold air.	Medium to High WA, (MS)

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on unpublished Ministry of Forests data; very limited data for the ICHmc1/1a.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Hw[e] Pl Sx [Bl[f] Ba] Hard: At Ep	Ba in the ICHmc1a only, on nutrient-medium, moister sites (01a). Natural Hw best suited to unburned 01a with deeper LFH (>10 cm). Pl best choice on 01b. Some mixing of LFH with mineral soil may be beneficial. Avoid excessive mechanical disturbance if At and Ep are present. SSL[h] 2-3 on 01a; SSL 0-2 on 01b. Fire may degrade driest 01b.
PI (Bl[f] Hw) Hard: At	Marginal sites for timber production; **avoid logging.** Conserve thin LFH for moisture and nutrient retention. SSL 0.
Ba Sx [Hw[e] Pl] (Cw [eg]) Hard: Act. At Ep	Risk of spruce weevil; check local conditions and consider alternative species if risk is high. Avoid excessive mechanical disturbance and logging during wetter seasons in order to minimize competing vegetation, especially where At and Ep are present. SSL 2-3; burning may be beneficial in temporarily controlling competing vegetation. Burning may also improve productivity where LFH horizons are thick (>15 cm).
Hw[e] Sx [Bl[f] Pl] Hard: Act At Ep	
Ba Sx [Hw[e] Pl] (Cw[eg]) Hard: Act At Ep	Risk of spruce weevil; check local conditions and consider alternative species if risk is high. Pl is limited by shade intolerance. These productive sites require careful planning to avoid degradation and brush problems. Log during winter or during dry periods. Mechanical disturbance/site treatment should be avoided due to potential for soil compaction, seepage surfacing, and increased vegetation competition. Plant sites promptly with large, sturdy stock. Plant on elevated microsites. Assess/control competing vegetation. SSL 2-4; successful burn may be difficult to achieve on these wet, brushy sites.
Sx [Bl[f] Hw[e] Pl] Hard: Act At Ep	
Sx [Bl[f] Pl] Hard: Act At Ep	Risk of spruce weevil; check local conditions and consider alternative species if risk is high. Pl limited by shade intolerance on these brushy sites. Floodplain sites require careful planning to minimize compaction, erosion, and brush problems. Winter log if possible. Coniferous regeneration will be slow to establish following disturbance due to very high vegetation competition. Vegetation control will be required to establish conifers. Plant large, sturdy stock on elevated microsites. Consider cluster planting (see page 7•15) and reduced stocking. Hardwood management should be considered, especially on low and medium bench floodplains. SSL 3-4; successful burn difficult to achieve. See Chapter 6 for wildlife habitat considerations in riparian areas.
Sx [Bl[f]] (Hw[e]) Hard: Act	All species must be established on elevated microsites. Avoid mechanical disturbance and destruction of natural mounds. Retain advance regeneration of all species and fill plant on mounds (Sx). SSL 4-5 but difficult to achieve and destroys natural regeneration.

[d] Species are in alphabetical order within primary, secondary [ ] and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Risk of frost damage to Hw and Cw throughout the ICHmc 1/1 a.

[f] Moose browse on Bl should be expected throughout the ICHmc1/1a.

[g] Cw is rare in ICHmc1; use on trial basis only.

[h] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

ICHmc2 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Pl, Sx, Hw, Bl	Moisture and nutrient deficits on 01b. Competing vegetation where there is a deciduous component in the mature stand. Frost, especially in 01(2).	Medium MH, FW
02	Pl, Hw, Sx	Severe moisture and nutrient deficits. Root restrictions on shallow soils over bedrock.	Low
03	Pl, Sx, Hw, Ba	Competing vegetation, especially where there is a deciduous component in the mature stand.	High MH, MS, FW
04/54	Pl, Sx, Hw, Bl	Competing vegetation, especially where there is a deciduous component in the mature stand (54). Frost/cold air in 54.	High MH, MS, FW
05	Pl, Sx, Hw, Ba	Competing vegetation. Root restrictions on some fine-textured, gleyed soils. Frost/cold air on some lower slopes/ depressions.	Very High MH, MS, FN
06	Sx	Competing vegetation. High (but seasonally fluctuating) water tables may restrict rooting. Frost/cold air.	Very High CW, MH, MS
07	Sx	Saturated, cold soils with poor aeration restrict rooting and productivity. Frost/ cold air.	High WA, MS
08	Pl, Sx	Saturated, cold soils with poor aeration restrict rooting and productivity. Frost/ cold air.	Medium WI
51	Pl	Moisture and nutrient deficits.	Low
52/53	Pl, Sx	Competing vegetation. Frost/cold air on lower slopes and valley bottoms, especially in the east.	High to Very High MH, AS, MS

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on unpublished Ministry of Forests data. Limited data for site series 02, 03, 06, 07, and 08.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Hw[e] Pl Sx [Bl[f] Cw[e]] Hard: At Ep	Pl (natural or planted) best choice on 01b; Sx on 01a. Cw should be considered on moister examples of 01a. Natural Hw best suited to unburned 01a with deeper LFH (>10 cm). Some mixing of LFH with mineral soil may be beneficial in 01a. Avoid excessive mechanical disturbance if At and Ep are present. Frost may be a concern in 01(2). SSL[h] 2-3 on 01a; SSL 0-2 on 01b. Fire may degrade driest 01b.
Pl [Bl[f] Hw[e]] Hard: At	Marginal sites for timber production; **avoid logging.** Conserve thin LFH for moisture/nutrient retention. SSL 0.
Cw[e] Hw[e] Sx [Bl[f] Pl] (Ba[g]) Hard: Act At Ep	Some risk of spruce weevil. Frost may hamper regeneration on low-lying sites. Avoid mechanical disturbance and logging during wetter seasons in order to minimize competing vegetation and compaction of fine-textured soils. Winter logging preferable, especially in 04. SSL 2-4; burning may be beneficial in temporarily controlling competing vegetation and in improving site productivity where LFH is >15 cm.
Cw[e] Sx [Blf Hw[e] Pl] (Ba[g]) Hard: Act At Ep	
Bl[f] Cw[e] Sx [Hw[e] Pl] (Ba[g]) Hard: Act At Ep	Risk of spruce weevil. Pl is limited by shade intolerance. These productive sites require careful planning to avoid degradation and brush problems. Log during winter or dry periods. Plant sites promptly with large, sturdy stock. Plant on elevated microsites. Assess/control competing vegetation. SSL 3-4 (difficult).
Cw[e], Sx [Bl[f] Pl] (Hw[e]) Hard: Act At Ep	Risk of spruce weevil. Pl limited by shade intolerance. Floodplain sites require careful planning to avoid Compaction, erosion, and brush problems. Winter log if possible. Vegetation control required to establish conifers. Plant large, sturdy stock on elevated microsites. Consider cluster planting (see page 7•15) and reduced stocking. Consider hardwood management. SSL 3-4 (but often impractical). See Chapter 6 for wildlife habitat considerations in riparian areas .
Sx [Bl[f] Cw[e]] (Hw[e] Pl) Hard: Act At Ep	All species must be established on elevated microsites. Avoid mechanical disturbance and destruction of natural mounds. Retain advance regeneration of all species and fill plant on mounds Sx. SSL 4-5 (often impractical).
Pl Sb Sx	Marginal sites for timber production; **avoid logging.** Risk of frost damage on Sx. Choose elevated microsites for planting.
Pl [Bl[f] Sx] (Hw[e])	Bl and Sx should only be considered on moister microsites. Shallow LFH and coarse textures generally preclude burning or mechanical disturbance. Promote natural Pl regeneration. SSL 0-1.
Pl Sx [Bl[f] Cw[e] Hw[e]] Hard: Act At Ep	Depending on coniferous/deciduous component, these seral stands often have limited timber values at present. Conversion to coniferous stands can be very costly due to vigorous hardwood/shrub regeneration following disturbance.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories.

[e] Risk of frost damage on Hw and Cw.

[f] Moose browse on Bl should be expected.

[g] Ba in upper elevations in western ICHmc2 only.

[h] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

ICHvc Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Hw Bl Sx	Heavy and long-lasting snowpack. Competing vegetation. Frost and cold air, specially on 01(2).	High MS, ES, FW
02	Hw Bl	Heavy and long-lasting snowpack. (although less so than in 01). Moisture and nutrient deficits on upper slopes/ ridgecrests. Root restrictions on shallow soils over bedrock. Frost/cold air in 02(2).	Low ES
03	Bl Sx	Heavy and long-lasting snowpack. Competing vegetation. Frost/cold air, especially in 03a. Root restrictions in some gleyed soils (03b).	Very High MS, FW
04	Bl Sx	Competing vegetation. High (but seasonally fluctuating) water tables may restrict rooting. Frost/cold air. Risk of erosion.	Very High CW, MS
05	Bl Sx	Competing vegetation. High (but seasonally fluctuating) water tables may restrict rooting. Frost/cold air. Risk of flooding/erosion.	Very High CW, MS
06	Bl Sx	Saturated, cold soils with poor aeration restrict rooting and productivity. Frost/ cold air.	High WA, WI
51		Very heavy and long-lasting snowpack; snowslides. Competing vegetation. Frost/cold air.	Very High WA, BN
52		Very heavy and long-lasting snowpack. Competing vegetation. Frost/cold air. Rooting restricted by permanently high water table.	Very High WA, WI

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on unpublished Ministry of Forests data; very limited data for the ICHvc.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Bl [Hw[e] Sx[f]] (Hm) Hard: Act At Ep	Hw should only be used in 01(1) where cold air ponding is not a concern. Finer textured, moister soils are associated with 01(2); avoid excessive disturbance to minimize compaction and vegetation competition (consider winter logging). SSL[g] 2-3; fire may be beneficial where LFH >15 cm, but destroys advance Bl and Hw regeneration.
Bl Hw[e] [Pl Sx[f]] (Hm) Hard: At Ep	Pl should only be considered on the driest upper slopes and ridges or coarse outwash; it is rare in the ICHvc; probably limited by the deep snowpack. Hw only on 02(1). 02 includes some sites with shallow soils and thin LFH; avoid disturbance on these sites (fire or mechanical). Otherwise, some mixing of LFH may be beneficial. Advance Bl and Hw regeneration may be acceptable. SSL 0-2.
Bl [Sx[f]] Hard: Act At Ep	These productive sites require careful planning to avoid degradation and brush problems. Log during winter or dry periods. Plant sites promptly with large, sturdy stock. Advanced Bl may be acceptable. Assess/control competing vegetation. SSL 3-4; successful burn may be difficult to achieve.
Bl [Sx[f]] Hard: Act At	Floodplain sites require careful planning to avoid compaction, erosion, and brush problems. Winter log if possible. Vegetation control will be required to establish conifers. Plant large, sturdy stock on elevated microsites especially in 05. Consider cluster planting (see page 7•15) and reduced stocking. Hardwood management should be considered, especially on low and medium bench sites (05). SSL 3-4. Riparian management guidelines favour partial cutting over clearcutting and thus prescribed fire is generally impractical as a vegetation management tool. Refer to Chapter 6 and fisheries, forestry, and wildlife guidelines for riparian ecosystem management.
Bl [Sx[f]] Hard: Act At	
Bl [Sx[f]] Hard: Act At Ep	All species must be established on elevated microsites. Consider cluster planting (see page 7•15) and reduced stocking. Avoid mechanical disturbance and destruction of natural mounds. Retain advance regeneration of all species.
Bl [Sx[f]]	Non-forested and generally not considered for treatment unless included within a cutblock. Mechanical clearing, herbicides, or burning required to establish conifers. Soils are highly productive. Must be planted promptly if cleared.
(Bl Sx[f])	Generally no potential for timber production. **Avoid disturbance.**

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Risk of frost damage on Hw, especially in lower slope/valley bottoms where cold air/frost ponds.

[f] Risk of snow damage and spruce weevil attack on Sx throughout the ICHvc.

[g] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

ICHwc Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Hw, Sx, Bl	Competing vegetation, especially where there is a deciduous component in mature stands [Bob Quinn phase ICHwc(a)]. Frost/cold air at lower elevations [also ICHmc(a)].	Medium MH, ES, FW
02	Pl, Hw	Severe moisture and nutrient deficits. Root restrictions on shallow soils over bedrock.	Low
03	Hw, Sx, Pl, Bl	Moisture and nutrient deficits. Root restrictions on some sites that are shallow to bedrock. Competition from At and Ep in seral stands.	Medium MH, ES
04	Hw, Sx, Bl	Competing vegetation. Frost/cold air on some valley-bottom sites.	High MH, MS, FW
05	Hw, Sx, Bl	Competing vegetation. Frost/cold air on some valley-bottom sites. Root restrictions on some gleyed soils.	Very High MH, MS, FW
06	Sx, Bl	Competing vegetation. High (but seasonally fluctuating) water tables may restrict rooting. Frost/cold air. Risk of flooding/erosion.	Very High CW, MS
07	Hw, Sx, Bl	Cold, saturated soils with low nutrient status. Frost/cold air. Competing vegetation.	High WA, WI
08	Hw, Sx, Bl	Saturated, cold soils with poor aeration restrict rooting and productivity. Frost/cold air.	Very High WA, WI

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on unpublished Ministry of Forests data.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Bl Hw[e] Sx [Pl] Hard: At Ep Act	Hw appears to be limited by frost/cold air in the Bob Quinn phase; Pl and Sx are more prevalent there. There is potential for natural/advance Hw and Bl regeneration on unburned sites. Some mixing of LFH with mineral soil may be beneficial, but avoid excessive disturbance where At or Ep are present in mature stands. SSL[f] 2-3.
Pl (Hw[e]) Hard: At	Marginal sites for timber production; **avoid logging.** Conserve thin LFH for moisture/nutrient retention. SSL 0.
Bl Hw[e] Pl Sx Hard: At Ep	Sx can be favoured on moister microsites. Conserve limited LFH for moisture/nutrient retention. Avoid excessive disturbance in stands with At and Ep component. SSL 0-2.
Bl Sx [Pl Hw[e]] Hard: Act At Ep	Sx uncommon in natural stands. Sites should be planted promptly to avoid need for vegetation control. Minimize mineral soil exposure. Burning may be beneficial in temporarily controlling vegetation (except fireweed). SSL 2-3.
Bl Sx [Hw'] Hard: Act At Ep	These productive sites require careful planning to avoid degradation and brush problems. Log during winter or dry periods. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. SSL 2-3; successful burn may be difficult to achieve.
Bl Sx (Hw[e]) Hard: Act At Ep	Floodplain sites require careful planning to avoid compaction, erosion, and brush problems. Winter log if possible. Vegetation control will be required to establish conifers. Plant large, sturdy stock on elevated microsites; Consider cluster planting (see page 7•15) and reduced stocking. Hardwood management should be considered, especially on low and medium bench sites. SSL 3-4. Riparian management guidelines favour partial cutting over clearcutting and thus prescribed fire is generally impractical as a vegetation management tool. See Chapter 6 for wildlife habitat considerations in riparian areas.
Sx [Pl Bl]	Marginal sites for timber production; **avoid logging.** High risk of frost damage on Sx, Bl, and Hw. Choose elevated microsites for planting. Retain advance regeneration.
Bl Sx (Hw[e]) Hard: Act Ep	All species must be established on elevated microsites. Consider cluster planting (see page 7•15) and reduced stocking. Avoid mechanical disturbance and destruction of natural mounds. Retain advance regeneration of all species.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Risk of frost damage on Hw throughout ICHwc; Hw of limited occurrence in the Bob Quinn phase.

[f] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

MHmm1 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01/04	Hm, Ba, Yc	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Thick, compacted LFH (Mor) limits nutrient availability.	Medium ES
02	Hm, Ba, Yc	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Thick, compacted LFH (Mor) limits nutrient availability. Severe exposure to wind. Root restrictions.	Low ES
03	Hm, Ba, Yc	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Competing vegetation.	High ES, SH
05	Hm, Ba, Yc	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Competing vegetation.	High ES, SH, SB
06	Hm, Ba, Yc	Cold, saturated soils. Heavy and very long-lasting snowpack. Frost/cold air.	Medium SH
07	Hm, Ba, Yc	Cold, saturated soils. Heavy and very long-lasting snowpack. Frost/cold air. Competing vegetation.	High SH
08	Hm, Yc	Cold, saturated, peaty soils. Heavy and very long-lasting snowpack. Frost/cold air.	Medium ES
09	Hm, Yc	Cold saturated mineral soils. Heavy and very long-lasting snowpack. Frost/cold air. Competing vegetation.	High SH, SB

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] No site index sampling has been carried out in the MH zone. Site index estimates are very preliminary, based on Krajina (1969) and adjusted estimates from neighbouring zones.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Ba Hm Yc	To date there has been little or no development in the MH zone of the PRFR and most of the zone is inaccessible due to steep terrain. Our silvicultural knowledge of the MH zone is thus very limited and based mainly on (limited) experience in the Vancouver Forest Region (Klinka *et al*. 1992).
Hm Yc [Ba]	**Any development in this climatically and topographically extreme subalpine zone should be done cautiously and conservatively**, considering the biological and environmental constraints to regeneration and forest productivity. Important reforestation considerations include:
Ba Hm Yc	• Harvesting should only occur on the most productive sites (MHmm1/01, /03 /04, /05) at lower elevations. Harvesting of site series 02 and 06 to 09 should be considered as timber mining.
Ba Yc [Hm]	• Harvesting should be restricted to small clearcuts (patch cuts) or partial cuts in order to promote and protect natural/advance regeneration.
Hm Yc (Ba)	• Advance regeneration of most tree species (Ba, Hm,Yc) is generally present in mature stands, and should be retained in anticipation of release.
Ba Yc [Hm]	• Natural regeneration of all species should be promoted through careful planning of cutblock shape/size and providing for some (but not severe) surface disturbance of LFH horizons.
Hm Yc	• Planting will be required on many sites to supplement natural regeneration and careful attention must be paid to microsite (soil drainage, frost and wind exposure, aspect, protection from snowcreep, disturbed forest floors). Ba and Yc should be promoted in planting programs.
Yc [Hm]	• Slashburning is considered inappropriate on the majority of sites due to the adverse impact on natural regeneration by seed and the destruction of advance regeneration.
	• The most productive sites are moderate to steep colluvial slopes that are influenced by subsurface (flowing) seepage, but are freely drained MHmm1/03 and /05). Productivity declines on imperfectly to poorly drained sites. Disturbance of drainage or subsurface seepage flow will decrease productivity.
	• On most sites it will not be feasible to reach free-to-grow status for 20 or more years and rotations will be very long (150 - 200 years).

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

MHmm2 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01/04	Hm Ba	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Thick, compacted LFH (Mor) limits nutrient availability.	Medium ES
02	Hm Ba	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Thick, compacted LFH (Mor) limits nutrient availability. Severe exposure to wind. Root restrictions.	Low ES
03	Hm Ba	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Competing vegetation.	High ES, SH
05	Hm Ba	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Competing vegetation.	High ES, SH, SB
06	Hm Ba	Cold, saturated soils. Heavy and very long-lasting snowpack. Frost/cold air.	Medium SH
07	Hm Ba	Cold, saturated soils. Heavy and very long-lasting snowpack. Frost/cold air. Competing vegetation.	High SH
08	Hm	Cold, saturated, peaty soils. Heavy and very long-lasting snowpack. Frost/cold air.	Medium ES
09	Hm	Cold saturated mineral soils. Heavy and very long-lasting snowpack. Frost/cold air. Competing vegetation.	High SH, SB

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] No site index sampling has been carried out in the MH zone. Site index estimates are very preliminary, based on Krajina (1969) and adjusted estimates from neighbouring zones.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Ba Hm [Yc[e] Bl[f]]	To date there has been little or no development in the MH zone of the PRFR and most of the zone is inaccessible due to steep terrain. Our silvicultural knowledge of the MH zone is thus very limited and based mainly on (limited) experience in the Vancouver Forest Region (Klinka *et al*. 1992).
Hm [Ba Yc[e] Bl[f]]	**Any development in this climatically and topographically extreme subalpine zone should be done cautiously and conservatively**, considering the biological and environmental constraints to regeneration and forest productivity. Important reforestation considerations include:
Ba Hm [Yc[e] Bl[f]]	• Harvesting should only occur on the most productive sites (MHmm2/01, /03, /04, /05) at lower elevations. Harvesting of site series 02 and 06 to 09 should be considered as timber mining.
Ba [Hm Yc[e] Bl[f]]	• Harvesting should be restricted to small clearcuts (patch cuts) or partial cuts in order to promote and protect natural/advance regeneration.
Hm [Yc[e]] (Ba Bl[f])	• Advance regeneration of most tree species (Ba, Hm) is generally present in mature stands, and should be retained in anticipation of release.
Ba Yc [Hm Yc[e] Bl[f]]	• Natural regeneration of all species should be promoted through careful planning of cutblock shape/size and providing for some (but not severe) surface disturbance of LFH horizons.
Hm [Yc[e]]	• Planting will be required on many sites to supplement natural regeneration and careful attention must be paid to microsite (soil drainage, frost and wind exposure, aspect, protection from snowcreep, disturbed forest floors). Ba and Yc should be promoted in planting programs.
Hm [Yc[e]]	• Slashburning is considered inappropriate on most sites due to the adverse impact on natural regeneration by seed and the destruction of advance regeneration.
	• The most productive sites are moderate to steep colluvial slopes that are influenced by subsurface (flowing) seepage, but are freely drained (MHmm2/03 and /05). Productivity declines on imperfectly to poorly drained sites. Disturbance of drainage or subsurface seepage flow will decrease productivity.
	• On most sites it will not be feasible to reach free-to-grow status for 20 or more years and rotations will be very long (150 - 200 years).

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Yc is restricted to western portion of MHmm2.

f Bl is suitable in eastern portions of the MHmm2.

MHwh1 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Hm Ba Yc	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Thick, compacted LFH (Mor) limits nutrient availability.	Medium ES
02	Hm Ba Yc	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Thick, compacted LFH (Mor) limits nutrient availability. Severe exposure to wind. Root restrictions.	Low ES
04	Hm Ba Yc	Cold soils. Frost/cold air. Heavy, long-lasting snowpack.	Medium ES, SH
05	Hm Ba Yc	Cold soils. Frost/cold air. Heavy, long-lasting snowpack. Competing vegetation.	High ES, SH, SB
06	Hm Ba Yc	Cold, saturated soils. Heavy and very long-lasting snowpack. Frost/cold air.	Medium SH
07	Hm Ba Yc	Cold, saturated soils. Heavy and very long-lasting snowpack. Frost/cold air. Competing vegetation.	High SH
08	Hm Yc	Cold, saturated, peaty soils. Heavy and very long-lasting snowpack. Frost/cold air.	Medium ES
09	Yc Hm	Cold saturated mineral soils. Heavy and very long-lasting snowpack. Frost/cold air. Competing vegetation.	High SH, SB

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] No site index sampling has been carried out in the MH zone. Site index estimates are very preliminary, based on Krajina (1969) and adjusted estimates from neighbouring zones.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Ba Hm Yc [Cw[e] Hw[e] Ss[e]]	To date there has been little or no development in the MH zone of the PRFR and most of the zone is inaccessible due to steep terrain. Our silvicultural knowledge of the MH zone is thus very limited and based mainly on (limited) experience in the Vancouver Forest Region (Klinka *et al*. 1992).
Hm Yc [Cw[e]]	**Any development in this climatically and topographically extreme subalpine zone should be done cautiously** and conservatively, considering the biological and environmental constraints to regeneration and forest productivity.
	Important reforestation considerations include:
Hm Yc [Ba Cw[e] Hw[e]]	• Harvesting should only occur on the most productive sites (MHwh1/01, /04, /05) at lower elevations. Harvesting of site series 02 and 06 to 09 should be considered as timber mining.
Ba Yc [Cw[e] Hm Hw[e] Ss[e]]	• Harvesting should be restricted to small clearcuts (patch cuts) or partial cuts in order to promote and protect natural/advance regeneration.
Hm Yc (Ba)	• Advance regeneration of most tree species (Ba, Hm, Yc) is generally present in mature stands, and should be retained in anticipation of release.
Ba Yc [Cw[e] Hm Ss[e]]	• Natural regeneration of all species should be promoted through careful planning of cutblock shape/size and providing for some (but not severe) surface disturbance of LFH horizons.
Hm Yc	• Planting will be required on many sites to supplement natural regeneration and careful attention must be paid to microsite (soil drainage, frost and wind exposure, aspect, protection from snowcreep, disturbed forest floors). Ba and Yc should be promoted in planting programs.
Yc [Cw[e]] (Hm Ss[e])	• Slashburning is considered inappropriate on the majority of sites due to the adverse impact on natural regeneration by seed and the destruction of advance regeneration.
	• The most productive sites are moderate to steep colluvial slopes that are influenced by subsurface (flowing) seepage, but are freely drained (MHwh1/05). Productivity declines on imperfectly to poorly drained sites. Disturbance of drainage or subsurface seepage flow will decrease productivity.
	• On most sites it will not be feasible to reach free-to-grow status for 20 or more years and rotations will be very long (150 - 200 years).

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] In lower elevations of the MHwh2 only.

SBPSmc Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Pl, Sx	Cold soils. Moisture and nutrient deficits, especially on 01b. Root restrictions on compacted tills.	Low
02	Pl, Sx	Severe moisture and nutrient deficits.	Low
03	Pl, Sx	Cold soils. Moisture and nutrient deficits. Root restrictions on compacted tills.	Low
04	Pl, Sx	Very cold soils with high water tables. Nutrient deficits. Frost/cold air. Rooting restricted by high water tables.	Medium WI
05	Pl, Sx	Very cold soils with seasonally fluctuating water tables. Frost/cold air. Rooting restricted by high water tables. Competing vegetation.	High WA, WI, RG
06	Pl, Sx	Very cold, wet, poorly aerated soils. Frost/cold air. Rooting restricted by high water table. Competing vegetation.	High WA, WI, RG
07	Pl, Sx	Very cold, saturated, poorly aerated soils. Frost/cold air. Tree productivity severely limited.	Medium WI

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on Wang *et al*. [1992], McLennan (1989), and unpublished Ministry of Forests data.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Pl (Sb Sxw) Hard: At	Sxw should only be considered on the mesic phase (01a) Conservation of LFH critical for moisture/nutrient retention; some surface disturbance (summer logging) beneficial for natural Pl regeneration and increasing soil temperature. SSL[e] 0-1; avoid burning, especially on 01b.
Pl (Sb Sxw) Hard: At	Marginal sites for timber production; **avoid logging**. Conserve thin LFH for moisture/nutrient retention. SSL 0.
Pl (Sb Sxw) Hard: At	Marginal sites for timber production. Although moisture deficits occur during summer, soils can be wet and prone to compaction in the spring. Some reduction of LFH horizons (mechanical site preparation [MSP] or fire) will improve soil temperature and promote natural Pl regeneration. SSL 1-3.
Pl Sb Sxw	Marginal sites for timber production. Sxw may be damaged by frost. Harvest during winter or summer dry periods. Sites should be planted with Pl, with some natural Sxw expected. SSL 1-3.
Sxw [Pl] Hard: Act	Sxw may be damaged by frost. Pl limited by shade intolerance and high water tables, especially in 06. Plant sites promptly with large, sturdy stock. Plant on elevated microsites (drainage, warmer soils, less frost). Consider cluster planting (see page 7•15) and reduced stocking. Assess/control competing vegetation. Sites often have a high risk of compaction and windthrow (especially 06; finer textures, high water tables) and surface erosion (especially 05; fluvial sites). Harvest during winter or summer dry periods. SSL 3-5; burning difficult.
Sxw [Pl] Hard: Act	
Pl Sb Sxw	These sites are very marginal for timber production and **should not be logged**. High risk of frost damage on Sxw. Choose elevated microsites for planting.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

SBSdk Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr 0 10 20 30 40	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Pl Sxw	Cold soils. Moisture and nutrient deficits on some sites. Root restrictions on compacted tills 01a.	Medium Ms, AS, FW
02/03	Pl Sxw	Severe moisture and nutrient deficits. Root restrictions on shallow soils over bedrock.	Low
04	Pl	Moisture deficits. Root restrictions on shallow soils over rock.	Low
05	Pl Sxw	Cold soils. Moisture and nutrient deficits. Some root restrictions on finer-textured, compacted tills.	Low
06	Pl Sxw	Cold soils. Root restrictions on fine-textured soils. Competing vegetation.	High AS, FW, MH, MS
07	Pl Sxw	Very cold, wet, poorly aerated soils (especially 07b). Frost/cold air. Rooting restricted by high water table and fine textures (07b). Competing vegetation.	Very High CW, WA
08	Pl Sxw	High (but fluctuating) water tables. Frost/cold air. Competing vegetation.	Very High CW, WA
09/10	Pl Sxw Sb	Saturated, cold soils with poor aeration. Rooting restricted by high water table. Frost and cold air ponding.	Medium WL

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on Wang *et al*. [1992], McLennan (1989), and unpublished Ministry of Forests data.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Pl Sxw [Fd[e]] Hard: At Ep	Fd on south aspects only (trial basis, see footnote). Natural regeneration of Pl will require mineral soil exposure. Mineral soil exposure will also enhance soil temperature, but conserve LFH, especially on 01b. SSL[f] 1-3. 01a has higher risk of soil compaction and windthrow; log during winter or dry periods and choose cutblock boundaries carefully.
Pl (Sxw Sb) Hard: At Ep	Sb minor species on 03 only. Marginal sites for timber production; avoid logging. Conserve thin LFH for moisture/nutrient retention. SSL 0.
Fd[e] Pl (Sxw) Hard: At Ep	Conserve organic matter on these warm, south aspects for moisture/nutrient retention. Mechanical preparation (drag scarification) preferable over burning for promoting natural regeneration. **Avoid excessive disturbance**. Partial cutting (shelterwood, seed tree) appropriate for regeneration of Fd.
Pl Sxw [Fd[e]] Hard: At Ep	Sx restricted to moister microsites. Potential for compaction on fine-textured Luvisols. Mechanical preparation (drag scarification) preferable over burning for promoting natural regeneration while conserving LFH (moisture and nutrients).
Pl Sxw Hard: Act At Ep	Plant sites promptly after harvest. Minimize mineral soil exposure especially where At and Ep are present. Sites should be logged in winter or during dry periods to avoid compaction and excessive disturbance. SSL 2-3; advance regeneration often acceptable and thus burning may not be appropriate.
Sxw [Pl] Hard: Act At Ep	Pl is limited by shade intolerance and saturated soils. Sxw may be damaged by frost. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying (07a) or mounding (07b) to establish seedlings. Elevated microsites preferred planting spots (drainage, cold soils, frost). Consider cluster planting (see page 7•15) and reduced stocking. Sites often have higher risk of compaction and windthrow (finer textures, high water tables) and surface erosion (fluvial sites). SSL 3-4 (3 on 07a).
Sxw [Pl] Hard: Act Ep	Sx may be damaged by frost. Pl limited by shade intolerance and flooding/high water tables. Floodplain sites require careful planning to avoid compaction, erosion, and brush problems. Winter log if possible. Vegetation control will be required to establish conifers. Plant large, sturdy stock on elevated microsites. Consider cluster planting (see page 7•15) and reduced stocking. Consider Act management. SSL 3-4; partial cutting should be considered on riparian sites and thus burning may be impractical. See Chapter 6 for wildlife habitat considerations in riparian areas.
Pl Sb Sxw	Sxw on 10 only. These sites are very marginal for timber production and **should not be logged**. High risk of frost damage on Sxw. Choose elevated microsites for planting.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Fd only occurs in eastern extremity of region.

[f] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

SBSmc2 Interpretations Table[a]

Site series	Productivity[b] Site index - ht (m) at 50 yr (0 10 20 30 40)	Limiting factors for productivity and regeneration	Vegetation potential & complexes[c]
01	Bl, Pl, Sx	Cold soils. Moisture and nutrient deficits especially on (01c). Root restrictions on compacted tills (01a).	Low AS, FW
02	Bl, Pl, Sx, Sb	Severe moisture and nutrient deficits. Root restrictions on shallow soils over bedrock.	Low
03	Bl, Pl, Sx, Sb	Very cold soils (cool aspects). Nutrient and (on some sites) moisture deficits. Root restrictions on fine-textured soils.	Low
05/06	Bl, Pl, Sx	Cold soils (especially 06). Root restrictions on fine-textured soils. Competing vegetation.	High AS, MS, FW
07	Pl, Sx	Very cold, wet soils. Nutrient deficits. Frost/cold air. Root restrictions due to high water table.	Low WI, WA
09	Bl, Pl, Sx	Cold soils. Root restrictions on fine textured soils. Competing vegetation.	Very High MS
10	Bl, Pl, Sx	Very cold, wet, poorly aerated soils (especially 10b). Frost/cold air. Rooting restricted by high water table and fine textures (10b). Competing vegetation.	Very High CW, WA
12	Pl, Sx, Sb	Saturated, cold soils with poor aeration. Rooting restricted by high water table. Frost and cold air ponding.	Medium WI

[a] Refer to Section 7.2 for an explanation of each category in the table.

[b] Site index estimates are based on Wang *et al*. [1992], McLennan (1989), and unpublished Ministry of Forests data; very limited data for Sb and Bl.

[c] Vegetation potential and complexes are described in Section 7.2.4, page 7•18.

Tree species selection guidelines[d]	Reforestation considerations
Pl Sxw [Bl[e]] Hard: At	Pl should generally be favoured over Sxw on 01c. Conserve LFH for moisture/nutrient retention, especially on 01c. Soil temperature and natural regeneration can be enhanced by some reduction of LFH and mineral soil mixing/incorporation. 01a has higher risk of soil compaction and windthrow. SSL[f] 1-3.
Pl (Bl[e] Sxw) Hard: At	Marginal sites for timber production; **avoid logging**. Conserve thin LFH for moisture/nutrient retention. SSL 0.
Pl (Bl[e] Sb Sxw) Hard: At	Reduction of LFH (or mixing with mineral soil) will generally improve soil temperature and productivity. Fine-textured soils have higher risk of compaction and windthrow. SSL 2-3.
Pl Sxw [Bl[e]] Hard: Act At	Plant sites promptly after harvest. Assess/treat competing vegetation. Minimize mineral soil exposure. Medium-severity burn generally beneficial in controlling vegetation and improving soil temperature (SSL 2-4). Fine-textured soils have higher risk of compaction and windthrow.
Pl Sb Sxw Hard: At	Regeneration will be very slow on these marginal sites. Mounding (on finer-textured soils) to improve drainage and increase soil and air temperature may improve productivity. SSL 4-5.
Sx [Bl[e] Pl] Hard: Act At	Pl is limited by shade intolerance. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying to establish seedlings. Elevated microsites generally preferred planting spots. Mounding may be beneficial on finer-textured 09a. SSL 3-5; medium severity burn will generally be beneficial in improving soil temperature. High-severity burn required to control vegetation. 09a has higher risk of compaction and windthrow.
Sx [Bl[e] Pl] Hard: Act At	Pl is limited by shade intolerance and saturated soils. Sxw and Bl may be damaged by frost. Plant sites promptly with large, sturdy stock. Assess/control competing vegetation. Minimize mineral soil exposure by patch scarifying (10a) or mounding (10b) to establish seedlings. Elevated microsites preferred planting spots (drainage, warmer soils, less frost). Consider cluster planting (see page 7•15) and reduced stocking. Sites often have higher risk of compaction and windthrow (finer textures, high water tables) and surface erosion (fluvial sites). SSL 4-5 (2-3 on 10a).
Pl Sb Sxw	These sites are very marginal for timber production and **should not be logged**. High risk of frost damage on Sxw. Choose elevated microsites for planting.

[d] Species are in alphabetical order within primary, secondary [ ], and tertiary ( ) categories. See Section 7.2.5, page 7•22. Tree species codes are described in Appendix 3.

[e] Moose browse on Bl should be expected throughout the SBSmc2.

[f] Slashburning severity levels (SSL) are described in Section 7.2.6, page 7•27.

7.3 Forest Health[15]

Tables 7.4 - 7.9 are provided to guide the user in anticipating and recognizing pests that occur in the most prominent biogeoclimatic zones of the PRFR. The tables do not show every pest that occurs in these zones, but highlight those that are widespread or can cause serious damage to the host. Users should consider these tables as guides for ensuring that future pest problems are considered at an early stage of the prescriptive process.

Hazard and risk

Hazard is defined as the state in which the host is susceptible. Risk is a function of hazard and the presence of a pest. Pest hazard and risk can change over the life of the host.

Some tree species are susceptible to certain pests during only a specific part of their life cycle. When this hazard is high, a "window" exists for the pest to take advantage of this opportunity. A high risk requires a susceptible host (i.e., high hazard), a vigorous pest, and the proper conditions for a successful attack.

An example of this is mountain pine beetle and lodgepole pine. During the early life of the pine, the hazard of attack is very low because the beetle does not favour small-diameter trees. However, once the tree is over 80 years old it is usually of sufficient girth that the hazard to it becomes high. The "window" is now present. The risk of attack is determined by the hazard and the proximity of the nearest beetle-attacked stand. If that attack is 200 km away, the risk is fairly low. If the nearest attack is 2 km away, the risk becomes high.

Using the tables

Only four biogeoclimatic zones are illustrated in the tables. There are two reasons for this. The first is that the recorded history of pests in the PRFR is poor and we do not have information for the remaining zones. The other reason is that, due to the widespread nature of some of these pests, users should be alert for them at all times when working in these zones. Segregation into ecological subzones or variants could lead to a false sense of security when, in reality, it is a lack of data (rather than a lack of pests) that can lead to incorrect assumptions about pest distribution. Only the zones in which the host is a major species component are listed.

The tables are divided into four categories of host damage:

- **Young stand mortality** occurs between the regeneration stage and free growing.[16]

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[15] Contributed by Stefan Zeglen, Forest Pathologist, and Tim Ebata, Forest Entomologist, Prince Rupert Forest Region.

[16] Further details on acceptability of host species in young stands are located in "Free Growing Standards for Northern B.C." (Appendix I, Silviculture Manual Insert A, PRFR).

- **Growth reduction** affects trees that are free growing and in a state of rapid incremental growth (to about culmination age). Pests listed here impede tree vigour and, in many cases, cause mortality before rotation age.
- **Mature stand mortality** afflicts trees that are of sufficient size and maturity to attract and harbour pests that accelerate senescence and usually cause mortality (e.g., bark beetles, decay fungi).
- **Loss of form** occurs at any stage in tree development and is a stem deformity that reduces wood quality (e.g., forks, crooks) and may indirectly cause mortality (e.g., cankers).

Pest species listed under damage categories are noted in two type faces. Bold type indicates pests that present a high risk and are a widespread problem in the zone. Species indicated in plain type face present a lower risk of attack or are limited to specific locations in the zone.

These tables provide specific information on most of the pest problems likely to be encountered in the PRFR and should assist in the preparation of PHSPs. For more information, consult *Pre-Harvest Silvicultural Guidelines for Northern B.C.* (Appendix I, Silviculture Manual Insert I, PRFR), or your local Forest Health specialist.

TABLE 7.4. Major pests of spruce (Sitka, Engelmann, white, and hybrids) in four biogeoclimatic zones of the PRFR

Zone	Young stand mortality	Growth reduction	Mature stand mortality	Loss of form
CWH	**Voles**,[a] Frost	**Porcupine**, Tomentosus root disease, Annosus root disease, Decay[b]	Spruce bark beetle Porcupine, Windthrow[c]	**Spruce leader weevil**,[d] Frost
ESSF	Voles, Frost	**Tomentosus root disease**, Spruce broom rust, Decay [b]	**Spruce bark beetle**, Windthrow[c]	Ungulates, Frost
ICH	Voles, Rhizina root disease, Black army cutworm, Frost	**Tomentosus root disease,** Spruce broom rust, Decay[b]	**Spruce bark beetle**, Windthrow[c]	**Spruce leader** weevil,[d] Frost
SBS	**Voles**, Rhizina root disease, Black army cutworm, Frost	**Tomentosus root disease,** Spruce broom rust, Decay[b]	**Spruce bark beetle,** Windthrow[c]	Ungulates, Frost

[a] **Bold type** indicates a high risk of attack by the pest without proper precautions or a pest that has widespread presence in the zone. Normal type indicates lower risk of attack by the pest, or occurrence only in specific locations within the zone.

[b] Commonly red ring rot (*Phellinus pini*), red belt fungus (*Fomitopsis pinicola*), or Schweinitzii butt rot (*Phaeolus schweinitzii*).

[c] If root system is exposed (i.e., root ball), check for signs of Tomentosus or other root disease. If stem is snapped low on the bole, check for signs of internal decays.

[d] Hazard rating zones based on degree-day accumulation are available from forest district offices.

TABLE 7.5. Major pests of lodgepole pine in four biogeoclimatic zones of the PRFR

Zone	Young stand mortality	Growth reduction	Mature stand mortality	Loss of form
CWH	**Voles**[a]	Tomentosus root disease, Decay,[b] Porcupine	Porcupine, Mountain pine beetle	
ESSF	**Comandra blister rust**, Voles, Western gall rust, Hares	**Tomentosus root disease**, **Pl dwarf mistletoe**, Decay,[b] Porcupine, Squirrel	**Mountain pine beetle**,[c] Porcupine	**Atropellis canker**, **Stalactiform blister rust**
ICH	Voles, Comandra blister rust, Rhizina root disease, Black army cutworm, Warren's root collar weevil	**Tomentosus root disease**, Pl dwarf mistletoe, Decay[b], Porcupine	**Mountain pine beetle**,[c] Porcupine	Atropellis canker, Stalactiform blister rust
SBS	**Comandra blister rust, Voles**, Western gall rust, Rhizina root disease, Black army cutworm, Warren's root collar weevil, Hares	**Tomentosus root disease, Pl dwarf mistletoe**, Decay,[b] Porcupine, Squirrel	**Mountain pine beetle,**[c] Porcupine	**Atropellis canker, Stalactiform blister rust**, Pl terminal weevil

[a] **Bold type** indicates a high risk of attack by the pest without proper precautions or a pest that has widespread presence in the zone. Normal type indicates lower risk of attack by the pest, or occurrence only in specific locations within the zone.

[b] Commonly red ring rot *(Phellinus pini)* or red belt fungus (*Fomitopsis pinicola)*.

[c] Hazard rating zones are available from forest district offices.

TABLE 7.6. Major pests of amabilis fir and subalpine fir in four biogeoclimatic zones of the PRFR

Zone	Young stand mortality	Growth reduction	Mature stand mortality	Loss of form
CWH	**Voles**[a]	Tomentosus root disease, Annosus root disease, Fir broom rust, Blackheaded budworm	Decay[b]	**Ungulates**
ESSF	Voles	Tomentosus root disease, Fir broom rust	**Balsam bark beetle**, Decay[b]	**Ungulates**
ICH	Rhizina root disease, Black army cutworm, Voles	Tomentosus root disease, Fir broom rust, Western blackheaded budworm, Two-year-cycle budworm	**Balsam bark beetle**, Decay[b]	**Ungulates**
SBS	**Voles**, Rhizina root disease, Black army cutworm	Tomentosus root disease, Fir broom rust, Two-year-cycle budworm, Western blackheaded budworm	**Balsam bark beetle,** Decay[b]	**Ungulates**

[a] **Bold type** indicates a high risk of attack by the pest without proper precautions or a pest that has widespread presence in the zone. Normal type indicates lower risk of attack by the pest, or occurrence only in specific locations within the zone

[b] Commonly Indian paint fungus (*Echinodontium tinctorium*) or red belt fungus (*Fomitopsis pinicola*).

TABLE 7.7. Major pests of western hemlock in two biogeoclimatic zones of the PRFR

Zone	Young stand mortality	Growth reduction	Mature stand mortality	Loss of form
CWH	**Voles**,[a] Frost	**Hw dwarf mistletoe, Annosus root disease, Porcupine,** Decay,[b] Western blackheaded budworm	Porcupine	Ungulates, Hemlock fluting, Frost
ICH	Rhizina root disease, Voles, Frost	**Hw dwarf mistletoe,** Annosus root disease, Tomentosus root disease, Decay[b]	Porcupine	Ungulates, Frost

[a] **Bold type** indicates a high risk of attack by the pest without proper precautions or a pest that has widespread presence in the zone. Normal type indicates lower risk of attack by the pest, or occurrence only in specific locations within the zone.

[b] Commonly Indian paint fungus (*Echinodontium tinctorium*), red belt fungus (*Fomitopsis pinicola*), red ring rot (*Phellinus pini*), Schweinitzii butt rot (*Phaeolus schweinitzii*), quinine conk (*Fomitopsis officinalis*). or artist's conk (*Ganoderma applanatum*).

TABLE 7.8. Major pests of western redcedar and yellow-cedar in two biogeoclimatic zones of the PRFR

Zone	Young stand mortality	Growth reduction	Mature stand mortality	Loss of form
CWH	**Voles,**[a] Deer, Frost	**Phellinus root disease**,[b] Annosus root disease	Yellow-cedar decline,[d] Decay[c]	Ungulates, Frost
ICH	Rhizina root disease, Voles, Deer, Frost	**Phellinus root disease**[b]	Decay[c]	Ungulates, Frost

[a] See footnote "a" in Table 7.7 above.

[b] *Phellinus weirii* (cedar strain).

[c] Mainly on Cw, and commonly redcedar pocket rot (*Poria rivulosa*), Indian paint fungus (*Echinodontium tinctorium*), red belt fungus (*Fomitopsis pinicola*), or red ring rot (*Phellinus pini*).

[d] Causal agent uncertain.

TABLE 7.9. Major pests of trembling aspen and black cottonwood in three biogeoclimatic zones of the PRFR

Zone	Young stand mortality	Growth reduction	Mature stand mortality	Loss of Form
CWH	Shepherd's crook disease, Voles	**Cankers**,[ab] Forest tent caterpillar	**Decay**,[c] Poplar and willow borer	
ICH		**Cankers**[b]	**Decay**[c]	
SBS		**Cankers**[b]	**Decay**[c]	

[a] **Bold type** indicates a high risk of attack by the pest without proper precautions or a pest that has widespread presence in the zone. Normal type indicates lower risk of attack by the pest, or occurrence only in specific locations within the zone.

[b] Commonly Cytospora canker (*Valsa sordida*), sooty bark canker (*Encoelia pruinosa*), Hypoxylon canker (*Hypoxylon mammatum*), or *Ceratocystis* spp.

[c] Commonly aspen **trunk rot** (*Phellinus tremulae*), oyster mushroom (*Pleurotus ostreatus*), artist's conk (*Ganoderma applanatum*), or *Pholiota* spp.

7.4 Grass and Legume Seeding[17]

Seeding is a prescriptive practice involving many decisions about the need to seed, species selection, rate of seeding, and method of application. Prescriptions should be made on a site-by-site basis, considering specific site characteristics and the goals or objectives of seeding.

There are numerous research and operational seeding programs that have provided useful information for developing prescriptions. Reports on specific projects are available, as are commonly used handbooks on grass and legume seeding for specific uses, including Carr (1980), Alberta Agriculture (1981), Chatwin *et al*. (1991), and Tingle (1992).

Many resource people are available for providing advice and referrals, including Range, Forest Sciences, Silviculture, Engineering, and Protection personnel with the Ministry of Forests; District Agriculturalists and specialists with the Ministry of Agriculture, Fisheries and Food; and Agriculture Canada researchers in Kamloops, B.C. and Beaverlodge, Alta. Additional information is available from seed companies.

[17] Contributed by Bob Drinkwater, Regional Range Agrologist, Prince Rupert Forest Region.

7.4.1 Developing a seeding prescription

The following seven steps should be taken when developing a seeding prescription:

1. Identify situations where seeding can be done and will have beneficial effects. Forested sites are disturbed by activities such as harvesting, road construction, slashburning, and land clearing, and by events such as wildfire, disease, or insect attack. Seeding can minimize erosion and weed infestation, enhance the nutrient supply on a site through nitrogen additions, and improve soil structure following such disturbances. Seeding can also be effective for vegetation management by reducing undesirable vegetation such as fireweed and thimbleberry, while improving forage production. As well, seeding can have significant benefits when a suitable seedbed is created following a disturbance.

2. Set goals and objectives for the seeding project. Where possible, goals should be measurable.

3. Determine the appropriate seed mix. Commercial seed is available for numerous plant species. The species selected and ratios chosen depend on site conditions such as soil characteristics, climate and species compatibility, persistence of species, availability, and cost. Table 7.10 provides several suggested seed mixes for different uses and site conditions in the PRFR, and Table 7.11 outlines the attributes and tolerances of recommended grass and legume species. Generally, seed should be applied in mixtures of two to five species in various ratios. More than five species in a mix suggests that the prescription is not specific enough.

Commercially available species are usually available in numerous varieties. Varieties will have the general attributes of the species, along with specific characteristics such as winter hardiness, yield, height, and the absence of toxins. Specific varieties should be used if these characteristics are important to attaining goals.

4. Determine the rate of seeding. The rate of seed unit is given in number of seeds per unit area (e.g., seeds/m^2), or weight of seeds per area (e.g., kg/ha). Seeding rate will depend on the goals and the cost of the seeding project. Seeding rates are adjusted as results from research and operational trials become available. Seeding for silviculture purposes is usually prescribed at rates of 10 - 20 kg/ha. Seeding for erosion control is usually prescribed at 15 - 30 kg/ha for dry seeding and 50 - 80 kg/ha for hydroseeding. Interim forage seeding on cutblocks should be done at lower rates, usually 4 - 6 kg/ha. Seeding for forage production on more permanent pastures is usually prescribed at rates of 6 - 18 kg/ha. Seeding for fire rehabilitation can range upwards from 4 kg/ha.

5. Determine application method. The method used to spread the seed on the disturbed ground will depend on the site conditions, the purpose of the seeding, and the time and money available to do the seeding. There are

several methods for applying seed, including hand scattering, manual cyclone seeders, cyclone seeders attached to helicopters or site preparation equipment, air-blown seeders, and hydro-seeders.

6. Determine timing of seeding. Sites should be seeded promptly after disturbance. The longer the delay, the greater the potential for soil erosion, site degradation, cementing of soils, and growth of undesirable vegetation including noxious weeds. It is important to consider the specific soil moisture and temperature requirements for germination of the species included in the seed mix. Young germinants are susceptible to drought, frost, or excessive moisture or ponding. Timing of seeding should allow for germination and adequate growth before adverse conditions set in.

7. Evaluate seeding projects. Past experience should he used to formulate future prescriptions. Successes and failures must be measured and documented. Several methods are used to evaluate seeding effectiveness, including the simple keeping of photographic records. To evaluate operational seeding, two methods are suggested: that outlined in B.C. Ministry of Environment and Ministry of Forests (1990), and that outlined in Northern Interior Vegetation Management Association (1990) (referred to as the NIVMA method). Assessment of *Rhizobium* infection in legumes should follow B.C. Ministry of Forests (1991).

Alsike clover

Trifolium hybridum

TABLE 7.10. Suggested seed mixes for different uses and site conditions in the PRFR[a]

Species	Silviculture			Erosion control		Fire rehabilitation		Forage mixes		
	Site enhancement	Vegetation management	Roads and landings	Road construction	Unstable sites	Dry sites	Wet sites	Interim grazing of cutblocks	Aspen/open rehabilitation	Meadow rehabilitation
Legumes										
Alfalfa		2	2	2		2		1		
Alsike clover	1	1	1	1	1	2	1	1		
Birds-foot trefoil	1	1	1	1	1	1	1	1	1	1
Red clover	2	2	2	2	2	1				
Sweet-clover			2	2	2	1	1			
White clover	1	1	1	1	1					
Grasses										
Annual rye grass			2	2	2		1			
Chewings fescue	2	1	2			1	1			
Creeping red fescue		2	2	1	1	1		2		
Fall rye			2	2	2					
Kentucky bluegrass		2	2	2	2					
Orchardgrass				1	1	1	1			
Perennial ryegrass			2	2	2	1				
Redtop		2			2					
Reed canarygrass										1
Smooth brome									2	
Tall fescue									2	2
Timothy				2	2		2	2		2

[a] 1 = usually included in the mix, 2 = additional or alternative species; seed mixes should be prescribed by matching specific site conditions with plant species characteristics (Table 7.11) to achieve goals; seed mixes should contain two to five plant species; at least one legume should be included in all mixes.

TABLE 7.11. Attributes and tolerances of recommended grass and legume species for use in seed mixes in the PRFR

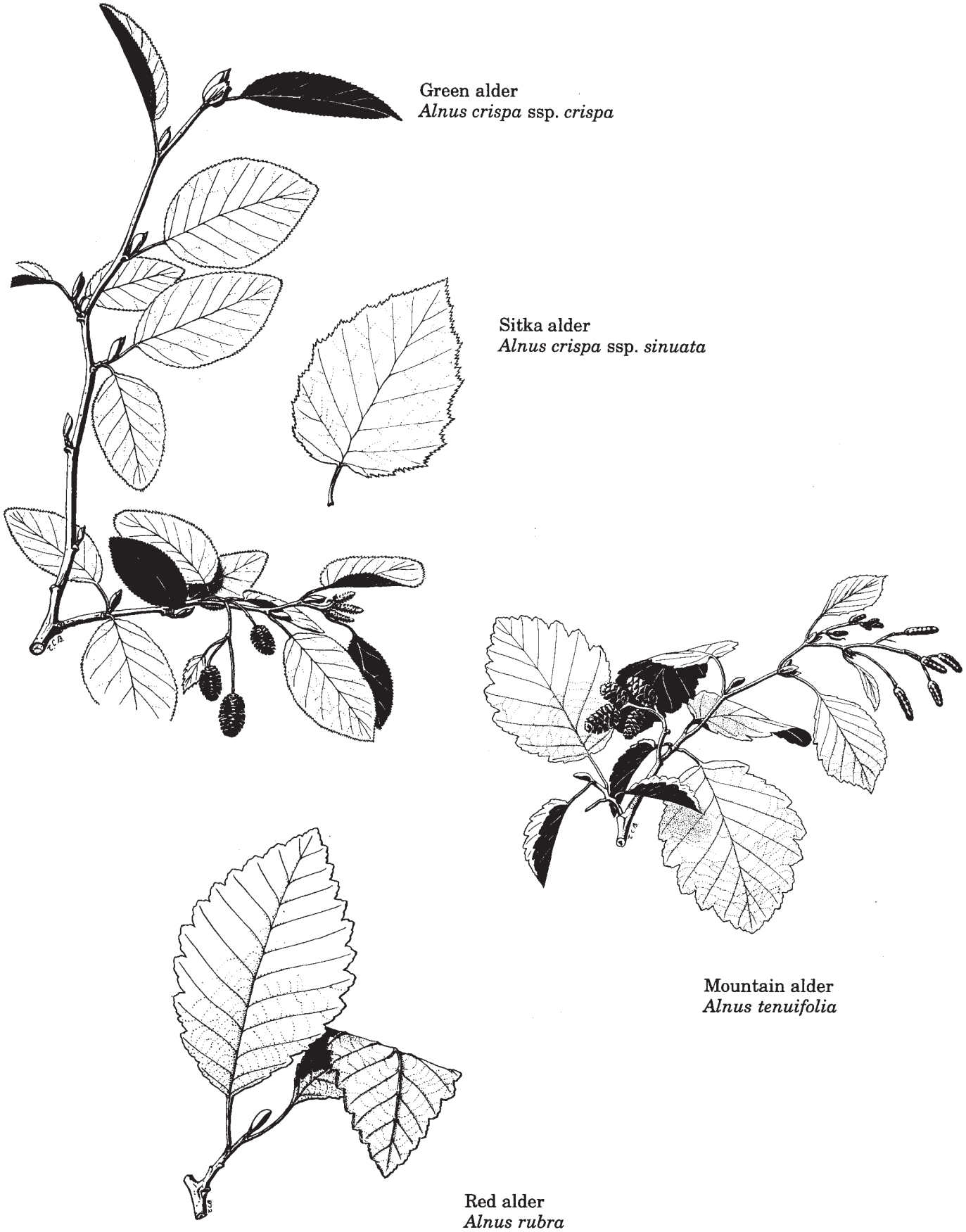
Species	Attributes	Rooting profile	Moisture/climate factors
Legumes			
Alfalfa *Medicago sativa*	- Medium-lived perennial - Up to 1 m tall - Persists 4-10 yr - N-fixer	- Deep, 3-9 m - Taproot - Creeping variety also available	- SBS/ICH - Wide range of conditions - Drought tolerant - Intolerant of extended flooding - Some varieties very winter hardy
Alsike clover *Trifolium hybridum*	- Short-lived perennial - Persists 4-5 yr - Spreads by seed and root fragments - N-fixer	- Deep, into subsoil - Many-branched root	- All zones - Wide range of conditions - Tolerant of moist areas - Tolerant of cold and frost heaving - Intolerant of drought, high temperature, and shade
Birds-foot trefoil *Lotus corniculatus*	- Long-lived perennial - Persists 10+ yr? - Spreads by seed and root fragments	- Deep - Strong taproot, with many side branches	- CWH/ICH/SBS - Unsuitable for dry sites - Withstands flooding
Red clover *Trifolium pratense*	- Short-lived perennial - Persists 2-3 yr - Spreads by seed	- Shallow - Weak taproot with many fibrous, side branches	- All zones - Wide range of conditions - Tolerant of cold and frost heaving
Sweet-clover *Melilotus alba, M. officinalis*	- Biennial - 1-2 m tall - Abundant first few years - Spreads by seed - N-fixer	- Deep - Very strong taproot	- Poor establishment in PRFR - Intolerant of cold, wet, and flooding
White clover *Trifolium repens*	- Long-lived perennial - Persists for several years - Animal-dispersed seed; stoloniferous	- Shallow, 1 m - Taproot - Stolons root at nodes	- All zones, ESSF variable - Low drought tolerance - Requires constant moisture supply - Intolerant of prolonged flooding
Grasses			
Italian rye grass *Lolium multiflorum*	- Short-lived annual (biennial) - Rare after 1 year - Limited seeding	- Very shallow, 5 cm - Dense fibrous mass of roots	- CWH/ICH/SBS - Survives short periods of flooding - Intolerant of drought
Creeping red fescue *Festuca rubra* ssp. *rubra*	- Long-lived perennial - Persists - Spreads by seed and rhizomes	- Shallow - Dense fibrous roots, strong sod-former	- All zones - Tolerates high rainfall, spring flooding, and shade - Withstands some drought

Soil factors	Other considerations and special uses
- Well-drained soils, high lime content - Some alkalinity/salinity - - Sensitive to acid - Growth is limited at low pH	- Very competitive - Good N-fixer, enhances degraded sites - Can compete with tree seedlings
- Suited to acidic, organic soils - Heavy, moist alkaline soils - Waterlogged soils	- Quick and easy to establish - Good nurse crop for accompanying species - Good N-fixer, improves soil
- Waterlogged soils - Acid soils, low fertility	- More consistent to establish compared with white clover
- Acid soils	- Sometimes an alternative for alsike clover, but doesn't do as well in poorly drained areas
- Fertile, well-drained, clayey to clay-loamy soils - Sensitive to acid soils - Intolerant of waterlogged soils, poor drainage	- Breaks up subsurface compaction - Height can cause problems for tree seedlings for 3-4 years
- Slightly acidic soils - Low tolerance for saline or alkaline soils - Poor response on waterlogged soils	- Slow to establish, but persists (not as consistent as alsike or trefoil) - Mat-forming, very effective in preventing soil erosion and for soil enhancement
- Wide range of soil types - Heavy clay, poorly drained soils - Medium to high soil fertility	- Establishes very quickly - Good for minimizing soil erosion and weed infestation - Nurse crop for slower-establishing species
- Clayey, loamy and sandy soils - Very tolerant of acidity, low fertility, salinity, and waterlogged soils	- Prefers well-disturbed seedbed - Good for erosion control, broadcast burns - Specify turf type for silvicultural seeding - Grows in areas too dry for timothy

TABLE 7.11 (Continued)

Species	Attributes	Rooting profile	Moisture/climate factors
Chewings fescue *Festuca rubra* var. *comm.*	- Long-lived perennial - Forms dense stands - Spreads vegetatively and by seeds	- Shallow - Dense fibrous roots	- ICH/SBS/probably CWH - Tolerant of some shading and drought
Fall rye *Secale* spp.	- Short-lived annual - Persists 1-2 yr - Spreads by seed	--	- ICH/possibly all zones
Kentucky bluegrass *Poa pratensis*	- Long-lived perennial - Spreads by seeds and rhizomes	- Shallow, 5 cm - Roots extensively branched, forming a very dense sod	- All zones - Best in cool, humid climates - Tolerant of severe drought - Slightly shade tolerant
Orchardgrass *Dactylis glomerata*	- Long-lived perennial - Bunchgrass - Spreads by seed and tillering	- Deep - Dense, fibrous root system	- All zones - Relatively drought tolerant - Most shade tolerant of the grasses
Perennial ryegrass *Lolium perenne*	- Short-lived perennial - 1-2 yr	- Shallow - Fibrous root system	- CWH/ICH/SBS - Survives short periods of flooding - Intolerant of drought
Redtop *Agrostis alba*	- Long-lived perennial - Sod-grass - Spreads by seed and rhizomes	- Shallow - Extensively branched roots	- All zones
Reed canarygrass *Phalaris arundinacea*	- Long-lived perennial - Sod-grass - Spreads by rhizomes and seed	- Deep - Grows in clumps with rhizomes that form dense sods	- Ponds and bogs in all zones - Thrives under flooded conditions or in areas with heavy rainfall - Somewhat drought tolerant
Smooth brome *Bromus inermis*	- Long-lived perennial - Sod-grass - Spreads aggressively by rhizomes	- Deep - Rhizomatous	- SBS/probably ICH - Tolerates some flooding in spring
Tall fescue *Festuca arundinacea*	- Long-lived - Bunchgrass - Spreads by seed and underground stems	- Deep - Roots can break up compacted soil at lower depths	- SBS/ICH/probably all zones - Wide range of conditions, best under cool conditions - Good drought tolerance
Timothy *Phleum pratense*	- Perennial - Spreads by new shoots from the base of older culms; prolific seed-producer	- Shallow, but can reach depths of 1 m - Fibrous roots	- SBS/ICH/probably all zones - Cool moist areas - Withstands some spring flooding - Low drought tolerance - Winter hardy

Soil factors	Other considerations and special uses
- Clayey, loamy, and sandy soils - Very tolerant of acidity, low fertility, salinity, and waterlogged soils	- Suppresses unwanted vegetation such as fireweed and thimbleberry - Successfully seeded on broadcast burns
- Relatively tolerant of low acidity, low fertility, high clay or sand content, or poor drainage	- Good nurse crop - Establishes quickly, good for erosion control, weed control, and aesthetic purposes
- Well-drained, highly productive limestone-derived soils - Slightly acid tolerant	- Slow establishment, but very aggressive - Palatable
- Requires good drainage - Tolerant of moderate salinity and acidity	- Very high yields of quality forage - Quick regrowth following grazing - Use winter-hardy varieties in windblown areas
- Medium to high fertility - Wide range of soils, including those with high clay content, and poor drainage	- A nurse crop assisting longer-lived species to establish - Quick to establish for erosion and weed control
- Tolerates high acidity, clay soils, low fertility, and poor drainage	- Very aggressive - Low palatability - Used in coastal areas for erosion control
- Very tolerant of waterlogging - Withstands acidity, alkalinity - Can be used on organic soils	- Requires a good seedbed - Slow to establish - Expensive and in short supply
- Wide range of soils - Prefers good drainage - Tolerates alkalinity, salinity, and acidity	- Slow to establish, but very persistent - Good forage species
- Wide range of soil conditions - Tolerates poor drainage, alkalinity, acidity, and salinity	- Slow to establish - Good soil improver
- Very tolerant of acidity - Suited to peaty areas, and waterlogged soils - Thrives on clayey, silty, and sandy soils	- Good for seeding wet areas, between reed canarygrass and orchardgrass - Good forage species



Green alder
Alnus crispa ssp. *crispa*

Sitka alder
Alnus crispa ssp. *sinuata*

Mountain alder
Alnus tenuifolia

Red alder
Alnus rubra

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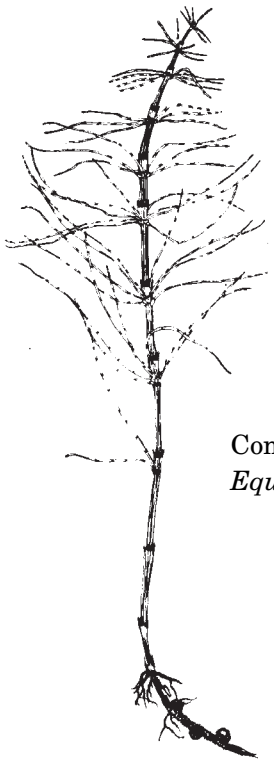
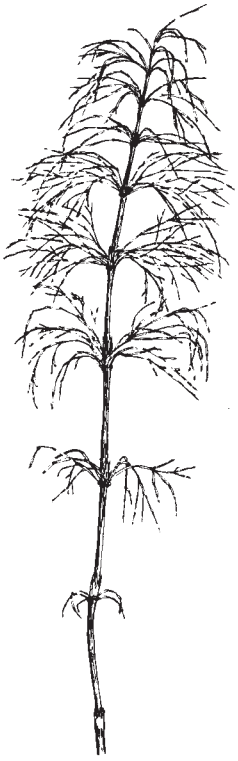


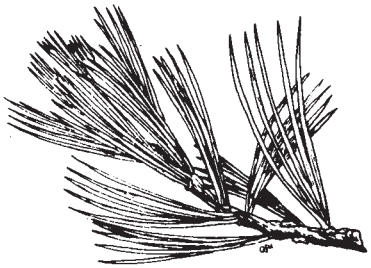
Common horsetail
Equisetum arvense



Wood horsetail
Equisetum sylvaticum

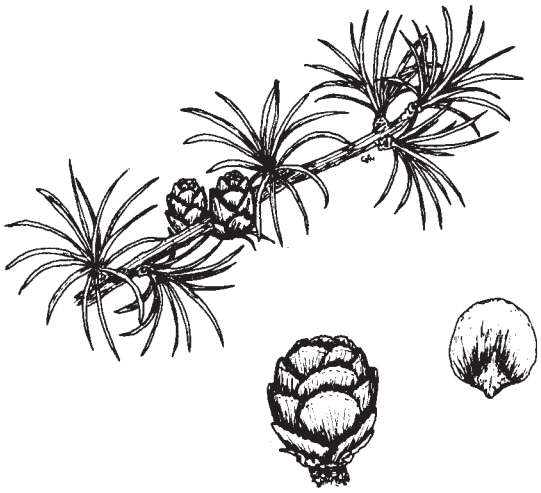
Swamp horsetail
Equisetum fluviatile

APPENDICES



Whitebark pine
Pinus albicaulis

Lodgepole pine
Pinus contorta
var. *latifolia*

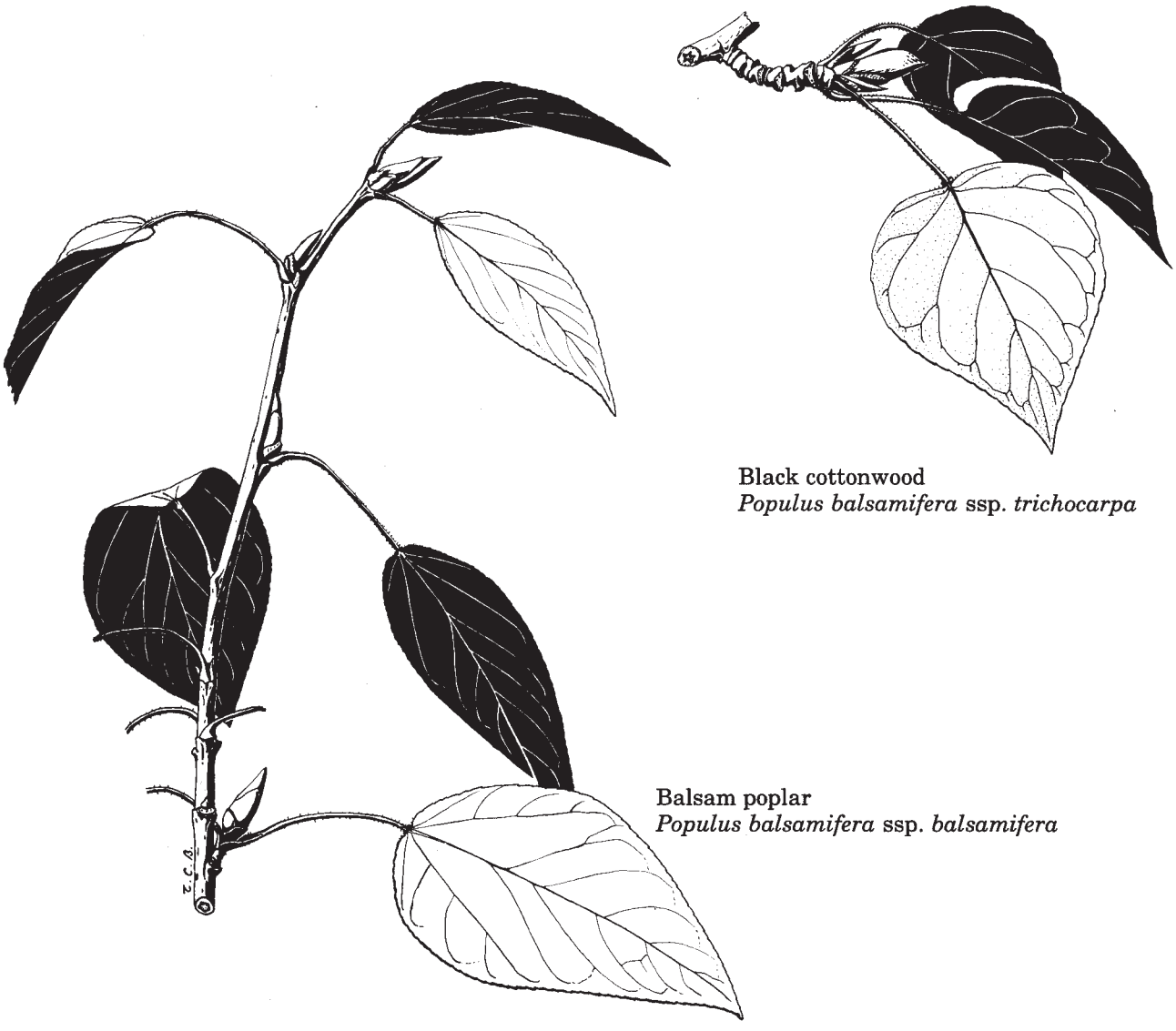


Tamarack
Larix laricina

Yellow-cedar
Chamaecyparis nootkatensis

Western redcedar
Thuja plicata

Trembling aspen
Populus tremuloides



Black cottonwood
Populus balsamifera ssp. *trichocarpa*

Balsam poplar
Populus balsamifera ssp. *balsamifera*

APPENDIX 1. Ecosystem classification, interpretive, and plant guide references relevant to the PRFR

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APPENDIX 2. Correlation between old and new biogeoclimatic and site units

These tables provide old and new biogeoclimatic and site unit symbols and numbers. Table A2.1 contains biogeoclimatic names used in Pojar et al. 1988 and in publications previous to 1988. Tables A2.2 - 2.5 provide site unit numbers used in Silviculture Manual Insert A (1990) and in publications previous to 1990.

TABLE A2.1. Biogeoclimatic units for all zones and their previous equivalents

Current BGC unit	**Pojar *et al.* 1988**	**Pre-1988**
AT	AT	AT
BWBSdkl	BWBSa1	BWBSa2
BWBSdk2	BWBSe	BWBSe
CWHvh2	CWHvh	CCPH, CWHd, CWHhm
CWHvm1	CWHvm1	CWHi1, CWHb1
CWHvm2	CWHvm2	CWHi2, CWHb2
CWHwm	CWHwm	CWHj
CWHws1	CWHws1	CWHf1
CWHws2	CWHws2	CWHf2, CWHi3
ESSFmc	ESSFk	ESSFk
ESSFmk	ESSF1	ESSF1
ESSFwv	ESSFi	ESSFi
ICHmc1	ICHmc2	ICHg1
ICHmc1a	ICHmc2	ICHg1a
ICHmc2	ICHmc3	ICHg2, g3
ICHvc	ICHvc	ICHg4
ICHwc	ICHvc	ICHg5
MHmm1	MHa	MHa, MHd
MHmm2	MHb	MHb, MHe
MHwh1	MHc1	MHc1
SBPSmc	SBPSmc	SBSa2
SBSdk	SBSdk	SBSd
SBSmc2	SBSmc	SBSe1

APPENDIX 2. (Continued)

TABLE A2.2. Site units in the BWBS and SBS zones and their previous equivalents

Current site unit	BWBSdk1	BWBSdk2	SBPSmc	SBSdk	SBSmc2
		Previous BWBS and SBS equivalents			
01	e/01[a] e/01[b] dk1/01[c]	a/01[b] dk2/01[c]	SBSa2/01,03[b] SBPSmc/01[c]	d/01[b] dk/01[c]	el/01,04[b] mc2/01[c]
02	e/02,03 e/02,03 dk 1 /02	a/02 dk2/02	SBSa2/02 SBPSmc/02	d/02 dk/02	e1/02,03 mc2/02
03	npe[d] e/06 dk1/03	a/04 dk2/04,09	SBSa2/04 SBPSmc/03	d/03 dk/03	e1/05 mc2/03
04	a/05 e/07 dk1/04	a/07 dk2/05,06	SBSa2/05 SBPSmc/04	d/06 dk/05	na
05	npe npe dk1/05	npe dk2/07	SBSa2/06 SBPSmc/05	d/07 dk/06	e1/06
06	npe e/08 dk1/06	a/05,06 dk2/08,10	SBSa2/07 SBPSmc/06	d/08 dk/08	e1/07 mc2/07
07	npe npe dk1/07	a/08 dk2/11	SBSa2/08 SBPSmc/07	d/09 dk/09	e1/10 mc2/04
08	a/06 e/10 dk1/08	a/09 dk2/12	na	d/10 dk/10	na
09	a/07 e/09 dk 1 /09	na	na	d/12 dk/11	e1/08 mc2/09
10	a/09 e/12 dk1/10	na	na	d/11 dk/12	e1/09 mc2/10
11	e/08,10 e/11,13 dk1/11	na	na	na	na
12	na[e]	na	na	na	e1/11 mc2/ 12
31	npe	npe	npe	npe	npe
32	npe	npe	npe	npe	na
81	npe	a/03 dk2/03	na	d/04 dk/04	na
82	na		na	d/05 dk/07	na

[a] As per Trowbridge *et al*. 1983.

[b] As per Silviculture Manual Insert 11, April 1989.

[c] As per Silviculture Manual Insert A, Appendix 11 (1990).

[d] No previous equivalent (npe).

[e] Site unit does not occur in this biogeoclimatic unit in the PRFR (na).

APPENDIX 2. (Continued)

TABLE A2.3. Site units in the CWH zone and their previous equivalents

Current site unit	CWHvh2	CWHvm1	CWHvm2	CWHwm	CWHws1	CWHws2
			Previous CWH equivalents			
01	hm/0 l[a] vh2/01[b]	i1/01[a] vm1/01[b]	i2/01[a] vm2/01[b]	j/01[a] wm/01[b]	f1/01[a] ws1/01[b]	f2/01[a] ws2/01[b]
02	hm/02 vh2/02	i1/02 vm1/02	npe npe	j/02,03 wm/02	fl/02(1) ws1/02	npe npe
03	hm/03 vh2/03	il/03 vm1/03	i2/02 vm2/02	j/04 wm/03	fl/02 ws1/03	f2/02 ws2/02
04	hm/05 vh2/04	il/04(1) vm1/04	na	j/06 wm/04	f l/03 wsl/04	f2/03 ws2/03
05	hm/06(2) vh2/05	i1/04(l) vm1/05	i2/04 vm2/03	j/05	npe ws1/05	npe
06	hm/06,07 vh2/06	i1/04 vm1/06	i2/04 vm2/04	npe wm/06	f l/04 ws1/06	f2/04 ws2/04
07	hm/08 vh2/07	na	na	npe wm/07	f l/05 ws1/07	npe
08	hm/09.1 vh2/08	i1/05 vm1/08	i2/05 vm2/05	npe wm/09	fl/05(1) ws1/08	npe
09	hm/09.2 vh2/09	i1/06 vml/09	i2/03 vm2/06	j/07 wm/10	npe ws1/09	npe
10	npe[c] vh2/10	npe vm1/10	i2/06 npe	j/08 wm/11	f l/07 ws1/11	npe
11	hm/11 vh2/11	npe vm1/11	npe	na	fl/06 ws1/10	npe
12	hm/12 vh2/12	npe	na	na	na	na
13	hm/10 vh2/13	npe vm1/13	na	na	na	na
14	hm/04 vh2/17	i1/07 vm1/12	na	na	na	na
15	hm/04 02/18	na	na	na	na	na
16	hm/04 vh2/19	na	na	na	na	na
17	npe vh2/20	na	na	na	na	na
18	npe vh2/21	na	na	na	na	na
19	npe	na	na	na	na	na
31	hm/13 vh2/ 14	npe	npe	npe	npe	npe
32	hm/14 vh2/15	npe	npe	npe wm/12	npe	npe
33	hm/15 vh2/16	na	na	na	na	na
51	na[d]	npe	npe	npe wm/08	na	npe

[a] As per Silviculture Manual Insert 11, April 1989.

[b] As per Silviculture Manual Insert A, Appendix II (1990).

[c] No previous equivalent (npe).

[d] Site unit does not occur in this biogeoclimatic unit in the PRFR (na).

APPENDIX 2. (Continued)

TABLE A2.4 Site units in the ESSF and MH zones and their previous equivalents

Current site unit	ESSFmc	ESSFmk	ESSFwv	MHmm	MHwh1
			Previous ESSF and MH equivalents		
01	k/01[a] mc/01[b]	l/01[a] mk/01[b]	i/01[a] wv/01[b]	MH/01[a] mm/01[b]	MH/01[a] wh1/01
02	k/02 mc/02	l/02 mk/02	i/02 wv/02	npe mm/02	npe wh1/02
03	k/03 mc/03	l/03 mk/03	i/03 wv/03	npe mm/03	npe wh1/03
04	k/04 mc/04	l/04 mk/04	i/04 wv/04	npe mm/04	npe wh1/04
05	k/05 mc/05	l/05 mk/05	i/05 wv/05	npe mm/05	npe wh1/05
06	k/06 mc/06	l/06 mk/06	i/06 wv/06	npe mm/06	npe wh1/06
07	k/07 mc/07	l/06 mk/07	i/07 wv/07	MH02 mm/07	MH/02 wh1/07
08	k/08 mc/09	na[d]	npe wv/08	MH04 mm/08	MH/04 wh1/08
09	k/10 mc/08	na	i/08 wv/09	MH03 mm/09	MH03 wh1/09
10	k/09 mc/10	na	na	na	na
31	npe[c]	npe	npe	npe	npe
51	npe	npe	npe	npe	na

[a] As per Silviculture Manual Insert 11, April 1989.
[b] As per Silviculture Manual Insert A, Appendix II (1990).
[c] No previous equivalent (npe).
[d] Site unit does not occur in this biogeoclimatic unit in the PRFR (na).

APPENDIX 2. (Continued)

TABLE 22.5. Site units in the ICH zone and their previous equivalents

Current site unit	ICHmc1	ICHmc1a	ICHmc2	ICHvc	ICHwc
		Previous IC H equivalents			
01	g1/01,03[a] mc1/01[b]	g1a/01,02[a] mc1a/01[b]	g2/01,03[a] g3/01,03[a] mc2/01[b]	g4/01[a] vc1/01[b]	npe
02	g1/02 mc1/02	g1a/03 mc1a/02	g2/02 g3/02 mc2/02	g4/03 vc1/02	npe
03	g1/04 mc1/03	g1 a/04 mc1a03	g2/04 npe mc2/04	g4/04 vc1/03	npe
04	g1/05 mc1/04	na	g2/05 g3/04.1 mc2/05	g4/06 vc1/06	npe
05	g1/07 mc1/05	na	npe g3/05 mc2/06	g4/10 vc1/05	npe
06	g1/06 mc1/06	na	g2/07 g3/11 mc2/07	g4/05 vc1/07	npe
07	na[c]	na	g2/06 g3/06 mc2/09	na	npe
08	na	na	npe g3/07 mc2/08	na	npe
09	na	na	na	na	na
31	npe[d]	na	npe	g4/09 vc1/09	npe
32	na	na	npe	na	npe
51	na	na	npe g3/08 mc2/50	g4/07 vc1/04	npe
52	na	na	npe g3/09 mc2/51	g4/08 vc1/08	npe
53	na	na	npe g3/10 mc2/52	na	na
54	na	na	npe g3/04.2 mc2/03	na	na

[a] As per Silviculture Manual Insert 11, April 1989; note that the old ICHg2 and g3 have now been combined into one variant (ICHmc2).

[b] As per Silviculture Manual Insert A, Appendix II (1990).

[c] Site unit does not occur in this biogeoclimatic unit in the PRFR (na).

[d] No previous equivalent (npe).

APPENDIX 3. Tree species codes and symbols

Tree code[a]	Common name	Scientific name	Symbol
Acb	balsam poplar	*Populus balsamifera* ssp. *balsamifera*	
Act	black cottonwood	*Populus balsamifera* ssp. *trichocarpa*	
At	trembling aspen	*Populus tremuloides*	
Ba	amabilis fir	*Abies amabilis*	
Bl	subalpine fir	*Abies lasiocarpa*	
Cw	western redcedar	*Thuja plicata*	
Dr	red alder	*Alnus rubra*	
Ep	paper birch	*Betula papyrifera*	
Fd	Douglas-fir	*Pseudotsuga menziesii*	
Jr	Rocky Mountain juniper	*Juniperus scopulorum*	

[a] Tree species codes follow B.C. Ministry of Forests, Inventory Branch standards.

APPENDIX 3. (Continued)

Tree code	Common name	Scientific name	Symbol
Hm	mountain hemlock	*Tsuga mertensiana*	
Hw	western hemlock	*Tsuga heterophylla*	
Lt	tamarack	*Larix laricina*	
Pa	whitebark pine	*Pinus albicaulis*	
Pl	lodgepole/ shore pine	*Pinus contorta*	
Sb	black spruce	*Picea mariana*	
Sw	white spruce	*Picea glauca*	
Sxw	hybrid white spruce	*Picea glauca* x *engelmannii*	
Ss	Sitka spruce	*Picea sitchensis*	
Sxs	Roche spruce	*Picea sitchensis* x *glauca*	
Sx	Roche spruce	*Picea glauca* x *sitchensis* x *engelmannii* (*P.* x *lutzii*)	
Yc	yellow-cedar	*Chamaecyparis nootkatensis*