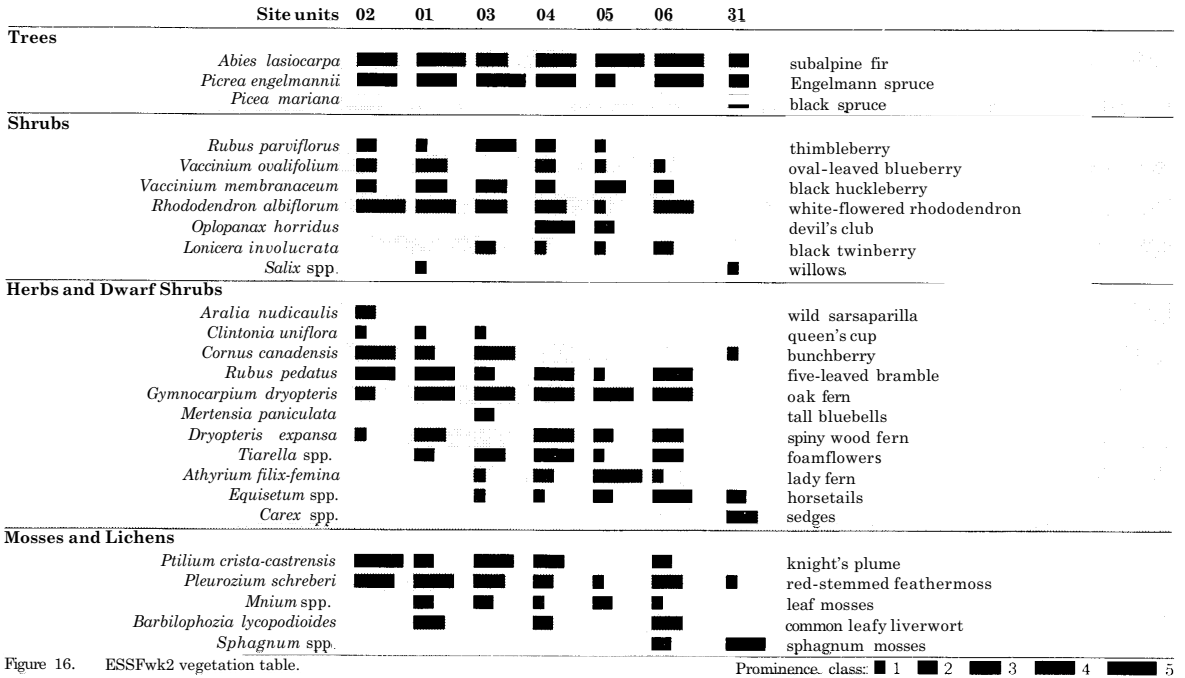


Figure 16. ESSFwk2 vegetation table.

ESSFwk2
Site Series Key

1a Black spruce present in canopy; *Carex* spp. (pp. 258-274)[12] moderate to high cover (> 1%): organic soils.

ESSFwk2/31

1b Black spruce absent from canopy; *Carex* spp. absent; soils variable.

2a *Equisetum* spp. (pp. 281-284) high cover (> 10%); mineral soils or organic over mineral soils.

ESSFwk2/06

2b *Equisetum* spp. low cover (< 3%) or absent: mineral soils.

3a Mid to upper slope or crest; *Athyrium filix-femina* (p. 291) or *Dryopteris expansa* (p. 291) low cover (< 1%) or absent.

4a *Rhododendron albiflorum* (p. 41) low to moderate cover (< 10%); *Ribes lacustre* (p. 32) cover (> 3%).

ESSFwk2/03

4b *Rhododendron albiflorum* high cover (> 25%); *Ribes lacustre* low cover (< 2%) or absent.

ESSFwk2/02

3b Mid to toe slope or level; *Athyrium filix-femina* or *Dryopteris expansa* moderate to high cover (> **1%).**

5a *Oplopanax horridus* (p. 36) high cover (usually > 10%).

ESSFwk2/05

5b *Oplopanax horridus* low cover (< 2%) or absent.

6a *Athyrium filix-femina* low cover (< 1%) or absent; seepage water generally absent.

ESSFwk2/01

6b *Athyrium filix-femina* high cover (> 10%); seepage water generally present.

ESSFwk2/04

[12] Page numbers refer to the publication, *Plants of Northern British Columbia* (MacKinnon *et al.* 1992).

ESSFwk2/01

Bl - Oak fern - Knight's plume

Rhododendron albiflorum

Gymnocarpium dryopteris

Rubus pedatus

VEGETATION

Tree Layer: 20% cover
subalpine fir, Engelmann spruce

Shrub Layer: 65% cover

Rhododendron albiflorum	(white-flowered rhododendron)
Vaccinium membranaceum	(black huckleberry)
Vaccinium ovalifolium	(oval-leaved blueberry)
Ribes lacustre	(black gooseberry)
[Rubus parviflorus	(thimbleberry)]
subalpine fir	
Engelmann spruce	

Herb Layer: 65% cover

Gymnocarpium dryopteris	(oak fern)
Rubus pedatus	(five-leaved bramble)
Dryopteris expansa	(spiny wood fern)
Lycopodium annotinum	(stiff clubmoss)
Tiarella unifoliata	(one-leaved foamflower)
Streptopus roseus	(rosy twistedstalk)
[Veratrum viride	(Indian hellebore)]
[Clintonia uniflora	(queen's cup)]
[Cornus canadensis	(bunchberry)]

Moss Layer: 75% cover

Pleurozium schreberi	(red-stemmed feathermoss)
Barbilophozia lycopodioides	(common leafy liverwort)
Ptilium crista-castrensis	(knight's plume)
Mnium spp.	(leafy mosses)
[Calliergon spp.	(water mosses)]

SOIL AND SITE

Moisture Regime:	3-5 (sm-shg)
Nutrient Regime:	B-D (p-r)
Slope Gradient (%):	3-69, often < 30
* Slope Position:	mid (upper)
Parent Material:	variable, often morainal
Soil Texture:	medium (fine - coarse)
Coarse Fragments (%):	3-48
Seepage Water:	rarely present

DISTRIBUTION: extremely common and often large in size

B1- Oak fern - Knight's plume (ESSFwk2/01)

INTERPRETATIONS

Site limitations:
- sites within this unit with thick organic horizons (> 10 cm) have reduced spring soil temperatures, which slows root development; ***reduce organic horizon thickness during site preparation.***

Silviculture system:
- see Section 5.1
- log on firm snowpack to protect advance regeneration.
- under a partial cutting system spruce regeneration requires mineral soil exposure and/or planting.
- minimize or align large slash accumulations when logging to help meet site preparation objectives, reduce snow creep and reduce fire hazard.
- reduce spruce beetle hazard by avoiding high stumps and shaded slash > 15 cm diameter.

Site preparation:
- see Section 5.2

Species choice:
- Bl, Se

Vegetation potential:
- high (thimbleberry, fireweed, white-flowered rhododendron)

Reforestation:
- try to preserve advance regeneration if it is abundant and likely to release and form an acceptable stand.
- advance Bl regeneration should only be accepted if it meets size and acceptability criteria (Section 5.1).
- plant stock with large caliper and low shoot-to-root ratio immediately after harvest.

Concerns:
- site conditions may lead to frost damage of regeneration, especially in any naturally occurring or artificially created depression; ***leaving a partial canopy and/or preserving advance regeneration are advised.***
- heavy snowpack may cause stem deformity, especially on steep slopes; ***obstacle planting is advised.***
- if heavy equipment is used in summer, during or after partial cutting, every attempt should be made to avoid disturbing roots of standing trees.
- spruce beetle may infest partial cut stands after harvesting; ***minimize blowdown and avoid mechanical damage to residuals.***

ESSFwk2/02

Bl - Oak fern - Sarsaparilla

Rhododendron albiflorum

Rubus pedatus

Ptilium crista-castrensis

VEGETATION

Tree Layer: 20% cover
Engelmann spruce, subalpine fir

Shrub Layer: 60% cover

Rhododendron albiflorum	(white-flowered rhododendron)
Vaccinium membranaceum	(black huckleberry)
Rubus parviflorus	(thimbleberry)
Sorbus scopulina	(western mountain-ash)
[Vaccinium ovalifolium	(oval-leaved b1ueberry)]
subalpine fir	
Engelmann spruce	

Herb Layer: 50% cover

Cornus canadensis	(bunchberry)
Rubus pedatus	(five-leaved bramble)
Gymnocarpium dryopteris	(oak fern)
Lycopodium annotinum	(stiff clubmoss)
Clintonia uniflora	(queen's cup)
Streptopus roseus	(rosy twistedstalk)
Aralia nudicaulis	(wild sarsaparilla)
[Dryopteris expansa	(spiny wood fern)]

Moss Layer: 50% cover

Ptilium crista-castrensis	(knight's plume)
Pleurozium schreberi	(red-stemmed feathermoss)
[Neckera pennatal	

SOIL AND SITE

Moisture Regime:	2-3 (sx-sm)
Nutrient Regime:	B-C (p-m)
* Slope Gradient (%):	0-7
* Slope Position:	mid - upper
Parent Material:	fluvial
* Soil Texture:	coarse
Coarse Fragments (%):	50-53

COMMENTS: Bedrock root-restricting layers occur occasionally

DISTRIBUTION: fairly common in upper slope positions

Bl - Oak fern - Sarsaparilla (ESSFwk2/02)

INTERPRETATIONS

Site limitations:
- sites within this unit with high coarse fragment content (> 70%) will have significantly reduced soil moisture holding capacity and will be extremely difficult to plant; ***retain advance regeneration.***

Silviculture system:
- clearcut or partial cut (see Section 5.1)
- log on firm snowpack to protect advance regeneration.
- under a partial cutting system spruce regeneration requires mineral soil exposure and/or planting.
- minimize or align large slash accumulations when logging to help meet site preparation objectives and reduce snow creep and fire hazard.

Site preparation:
- see Section 5.2

Species choice:
- Bl, Se

Vegetation potential:
- low to moderate (white-flowered rhododendron, fireweed, thimbleberry)

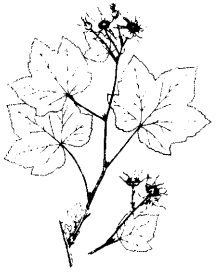
Reforestation:
- try to preserve advance regeneration if it is abundant and likely to release and form an acceptable stand.
- advance Bl regeneration should only be accepted if it meets size and acceptability criteria (Section 5.1).
- planting Pl may be an option on these sites below 1100 m, but provenances from high elevation, high snowpack areas must be used.

Concerns:
- trafficability may be a problem on these sites during the summer.

ESSFwk2/03

Bl - Oak fern - Bluebells

Ribes lacustre



Rubus parviflorus

Gymnocarpium dryopteris

VEGETATION

Tree Layer: 30% cover
Engelmann spruce, subalpine fir

Shrub Layer: 70% cover

Ribes lacustre	(black gooseberry)
Rubus parviflorus	(thimbleberry)
Vaccinium membranaceum	(black huckleberry)
Rhododendron albiflorum	(white-flowered rhododendron)
Ribes glandulosum	(skunk currant)
Rubus idaeus	(red raspberry)
Lonicera involucrata	(black twinberry)
[Spiraea betulifolia	(birch-leaved spirea)]

subalpine fir
Engelmann spruce

Herb Layer: 45% cover

Gymnocarpium dryopteris	(oak fern)
Cornus canadensis	(bunchberry)
Arnica cordifolia	(heart-leaved arnica)
Lycopodium annotinum	(stiff clubmoss)
Rubus pedatus	(five-leaved bramble)
Streptopus amplexifolius	(clasping twistedstalk)
Athyrium filix-femina	(lady fern)
Tiarella trifoliata	(three-leaved foamflower)
Mertensia paniculata	(tall bluebells)
Epilobium angustifolium	(fireweed)

Moss Layer: 70% cover

Ptilium crista-castrensis	(knight's plume)
Pleurozium schreberi	(red-stemmed feathermoss)
Neckera pennata	
Brachythecium hylotapetum	(woodsy ragged moss)

SOIL AND SITE

Moisture Regime:	4-5 (m-shg)
Nutrient Regime:	C-D (m-r)
Slope Gradient (%):	18-78
* Slope Position:	mid (upper)
* Parent Material:	morainal
* Soil Texture:	medium - coarse
Coarse Fragments (%):	15-47

DISTRIBUTION: common on the lee side of the Rocky Mountains

Bl- Oak fern - Bluebells (ESSFwk2/03)

INTERPRETATIONS

Site limitations:
- sites within this unit with thick organic horizons (> 10 cm) have reduced spring soil temperatures, which slows root development: ***reduce organic horizon thickness during site preparation.***

Silviculture system:
- clearcut or partial cut (see Section 5.1)
- log on firm snowpack to protect advance regeneration.
- under a partial cutting system spruce regeneration requires mineral soil exposure and/or planting.
- minimize or align large slash accumulations when logging to help meet site preparation objectives, reduce snow creep and reduce fire hazard.
- reduce spruce beetle hazard by avoiding high stumps and shaded slash > 15 cm diameter.

Site preparation:
- see Section 5.2

Species choice:
- Bl, Se, (Pl)

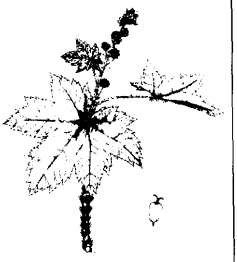
Vegetation potential:
- high (thimbleberry, fireweed, white-flowered rhododendron. lady fern)

Reforestation:
- try to preserve advance regeneration if it is abundant and likely to release and form an acceptable stand.
- advance Bl regeneration should only be accepted if it meets size and acceptability criteria (Section 5.1).
- planting Pl may be an option on these sites below 1100 m, but provenances from high elevation, high snowpack areas must be used.

Concerns:
- site conditions may lead to frost damage of regeneration, especially in any naturally occurring or artificially created depression; ***leaving a partial canopy and/or preserving advance regeneration are advised.***
- sites within this unit with fine-textured soils are vulnerable to compaction under wet conditions; ***restrict traffic to winter operations.***
- heavy snowpack may cause stem deformity, especially on steep slopes; ***obstacle planting is advised.***
- spruce beetle may infest partial cut stands after harvesting; ***minimize blowdown and avoid mechanical damage to residuals.***
- tomentosus root rot may cause low to moderate problems in mature spruce-dominated stands.

ESSFwk2/04

Bl - Devil's club - Rhododendron



Oplopanax horridus

Dryopteris expansa

Rubus pedatus

VEGETATION

Tree Layer: 25% cover
Engelmann spruce, subalpine fir

Shrub Layer: 85% cover

Oplopanax horridus	(devil's club)
Alnus crispa spp. *sinuata*	(Sitka alder)
Rhododendron albiflorum	(white-flowered rhododendron)
Vaccinium membranaceum	(black huckleberry)
Vaccinium ovalifolium	(oval-leaved blueberry)
subalpine fir	
Engelmann spruce	

Herb Layer: 70% cover

Dryopteris expansa	(spiny wood fern)
Gymnocarpium dryopteris	(oak fern)
Rubus pedatus	(five-leaved bramble)
Tiarella unifoliata	(one-leaved foamflower)
Veratrum viride	(Indian hellebore)

Moss Layer: 50% cover

Calliergon spp.	(water mosses)
Ptilium crista-castrensis	(knight's plume)
Barbilophozia lycopodioides	(common leafy liverwort)
Pleurozium schreberi	(red-stemmed feathermoss)

SOIL AND SITE

Moisture Regime:	5-6 (shg-h)
Nutrient Regime:	B-C (p-m)
* Slope Gradient (%):	30-40
Slope Position:	lower - toe
* Parent Material:	morainal, occasionally lacustrine
* Soil Texture:	medium - fine
Coarse Fragments (%):	16-24
Seepage Water:	generally absent

DISTRIBUTION: fairly common; associated with areas of imperfect soil moisture drainage

COMMENTS: occasionally associated with compact till

B1- Devil's club - Rhododendron (ESSFwk2/04)

INTERPRETATIONS

Site limitations:
- sites within this unit with thick organic horizons (> 10 cm) have reduced spring soil temperatures, which slows root development; ***reduce organic horizon thickness during site preparation.***
- sites within this unit with medium- to fine-textured lacustrine soils often have poor soil structure, leading to poor root growth; ***plant stock which will achieve better lateral root development (e.g., Cu-treated) or protect advance regeneration.***

Silviculture system:
- clearcut (winter) or partial cut (see Section 5.1)
- log on firm snowpack to protect advance regeneration.
- under a partial cutting system spruce regeneration requires mineral soil exposure and/or planting.
- minimize or align large slash accumulations when logging to help meet site preparation objectives, reduce snow creep and reduce fire hazard.
- reduce spruce beetle hazard by avoiding high stumps and shaded slash > 15 cm diameter.

Site preparation:
- see Section 5.2

Species choice:
- Bl, Se

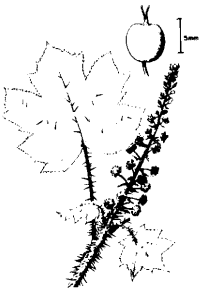
Brush hazard:
- very high (lady fern, white-flowered rhododendron, thimbleberry, fireweed)

Reforestation:
- try to preserve advance regeneration if it is abundant and likely to release and form an acceptable stand.
- advance Bl regeneration should only be accepted if it meets size and acceptability criteria (Section 5.1).
- plant stock with large caliper and low shoot-to-root ratio immediately after harvest.

Concerns:
- site conditions may lead to frost damage of regeneration, especially in any naturally occurring or artificially created depression; ***leaving a partial canopy and/or preserving advance regeneration are advised.***
- sites with restricted rooting and/or thick organic horizons have increased windthrow hazard; ***block layouts must have wind-firm boundaries.***
- spruce beetle may infest partial cut stands after harvesting; ***minimize blowdown and avoid mechanical damage to residuals.***
- tomentosus root rot may cause low to moderate problems in mature spruce-dominated stands.

ESSFwk2/05

B1- Rhododendron - Lady fern



Oplopanax horridus

Dryopteris expansa

Gymnocarpium dryopteris

VEGETATION

Tree Layer: 15% cover
Engelmann spruce, subalpine fir

Shrub Layer: 60% cover

Vaccinium membranaceum	(black huckleberry)
Rhododendron albiflorum	(white-flowered rhododendron)
Rubus parviflorus	(thimbleberry)
Sambucus racemosa	(red elderberry)
subalpine fir	
Engelmann spruce	

Herb Layer: 70% cover

Athyrium filix-femina	(lady fern)
Dryopteris expansa	(spiny wood fern)
Gymnocarpium dryopteris	(oak fern)
Veratrum viride	(Indian hellebore)
Valeriana sitchensis	(Sitka valerian)
Rubus pedatus	(five-leaved bramble)
Tiarella unifoliata	(one-leaved foamflower)

Moss Layer: 90% cover

Mnium spp.	(leafy mosses)
Pleurozium schreberi	(red-stemmed feathermoss)

SOIL AND SITE

Moisture Regime:	5 (shg)
Nutrient Regime:	C-E (m-vr)
* Slope Gradient (%):	0-18
Slope Position:	variable
Parent Material:	morainal, occasionally fluvial or lacustrine
Soil Texture:	medium (fine - coarse)
Coarse Fragments (%):	5-55
* Seepage Water:	generally present

COMMENTS: A variable but distinctive site series; apparently possesses a considerably richer nutrient regime than the ESSFwk2/04

DISTRIBUTION: common and often large in size

Bl- Rhododendron - Lady fern (ESSFwk2/05)

INTERPRETATIONS

Site limitations:
- sites within this unit with thick organic horizons (> 10 cm) have reduced spring soil temperatures, which slows root development; ***reduce organic horizon thickness during site prepamtion.***
- sites within this unit with medium- to fine-textured lacustrine soils often have poor soil structure, leading to poor root growth; ***plant stock which will achieve better lateral root development (e.g., Cu-treated) or protect advance regeneration.***

Silviculture system:
- clearcut (winter) or partial cut (see Section 5.1)
- log on firm snowpack to protect advance regeneration.
- under a partial cutting system spruce regeneration requires mineral soil exposure and/or planting.
- minimize or align large slash accumulations when logging to help meet site preparation objectives and reduce snow creep and fire hazard.
- reduce spruce beetle hazard by avoiding high stumps and shaded slash > 15 cm diameter.

Site preparation:
- see Section 5.2

Species choice:
- Bl, Se

Vegetation potential:
- very high (lady fern, white-flowered rhododendron, fireweed, thimbleberry)

Reforestation:
- try to preserve advance regeneration if it is abundant and likely to release and form an acceptable stand.
- advance Bl regeneration should only be accepted if it meets size and acceptability criteria (Section 5.1).
- plant stock with large caliper and low shoot-to-root ratio immediately after harvest.

Concerns:
- site conditions may lead to frost damage of regeneration, especially in any naturally occurring or artificially created depression; ***leaving a partial canopy and/or preserving advance regeneration are advised.***
- heavy snowpack may cause stem deformity, especially on steep slopes; ***obstacle planting is advised.***
- spruce beetle may infest partial cut stands after harvesting; ***minimize blowdown and avoid mechanical damage to residuals.***
- trafficability will be a problem on these sites during the summer.

ESSFwk2/06

Bl - Horsetail - Sphagnum

Rhododendron albiflorum

Equisetum arvense

Barbilophozia lycopodioides

VEGETATION

Tree Layer: 30% cover
subalpine fir, Engelmann spruce

Shrub Layer: 75% cover

Rhododendron albiflorum	(white-flowered rhododendron)
Vaccinium membranaceum	(black huckleberry)
Alnus crispa ssp. *sinuata*	(Sitka alder)
Lonicera involucrata	(black twinberry)
[Ribes lacustre	(black gooseberry)]
subalpine fir	
Engelmann spruce	

Herb Layer: 75% cover

Equisetum spp.	(horsetails)
Gymnocarpium dryopteris	(oak fern)
Rubus pedatus	(five-leaved bramble)
Tiarella unifoliata	(one-leaved foamflower)
Lycopodium annotinum	(stiff clubmoss)
Dryopteris expansa	(spiny wood fern)
[Valeriana sitchensis	(Sitka valerian)]

Moss Layer: 90% cover

Barbilophozia lycopodioides	(common leafy liverwort)
Pleurozium schreberi	(red-stemmed feathermoss)
Calliergon spp.	(water mosses)
Ptilium crista-castrensis	(knight's plume)
Sphagnum spp.	(sphagnums)

SOIL AND SITE

Moisture Regime:	6 (h)
Nutrient Regime:	C-D (m-r)
Slope Gradient (%):	5-30
* Slope Position:	lower, toe or level
* Parent Material:	lacustrine
* Soil Texture:	fine
Coarse Fragments (%):	0

DISTRIBUTION: uncommon and small in size

Bl- Horsetail - Sphagnum (ESSFwk2/06)

INTERPRETATIONS

Site limitations:
- very difficult sites to manage; ***serious consideration should be given to managing these sites as wildlife corridors.***
- sites within this unit with thick organic horizons (> 10 cm) have reduced spring soil temperatures, which slows root development; ***reduce organic horizon thickness during site preparation.***
- sites within this unit with saturated soils are poorly aerated, which slows root development; ***plant seedlings on naturally or artificially raised microsites.***

Silviculture system:
- clearcut (winter) or partial cut (see Section 5.1)
- log on firm snowpack to protect advance regeneration.
- under a partial cutting system spruce regeneration requires mineral soil exposure and/or planting.

Site preparation:
- see Section 5.2
- creating an excessive number of microsites (e.g., >300/ha) should be avoided, especially on sites with a water table < 30 cm from the surface.

Species choice:
- ***Bl, Se***

Vegetation potential:
- high (white-flowered rhododendron, fireweed, Sitka valerian)

Reforestation:
- plant stock in groups, using available raised microsites, rather than evenly across the site.
- try to preserve advance regeneration if it is abundant and likely to release and form an acceptable stand.
- advance Bl regeneration should only be accepted if it meets size and acceptability criteria (Section 5.1).

Concerns:
- sites with high water tables and thick organic horizons (> 10 cm) have increased windthrow hazard; ***block layouts must have wind-firm boundaries.***
- site conditions may lead to frost damage of regeneration, especially in any naturally occurring or artificially created depression; ***leaving a partial canopy and/or preserving advance regeneration are advised.***
- water table will likely rise above the ground surface in the spring, causing seedling mortality.
- this unit is critical to the control of runoff streamflow.
- these units are important wildlife habitat; ***discuss prescription with fish and wildlife personnel.***

ESSFwk2/31

Non-forested Bog

Salix spp.

Carex spp.

Sphagnum spp.

VEGETATION

Tree Layer: 10% cover
Black spruce, subalpine fir, lodgepole pine, Engelmann spruce

Shrub Layer: 15% cover
[Salix spp. (willows)]
[Betula glandulosa (scrub birch)]
black spruce

Herb Layer: 60% cover
[Kalmia microphylla ssp. *microphylla* (alpine bog-1aurel)]
[Carex spp. (sedges)]

Moss Layer: 95% cover
Sphagnum spp. (sphagnums)
[Aulacomnium palustre (glow moss)]

SOIL AND SITE

Moisture Regime:	6-7 (h-shd)
Nutrient Regime:	A-B (vp-p)
Slope Gradient (%):	0-2, usually 0
* Slope Position:	toe-level
* Parent Material:	organic
Soil Texture:	humic (organic material)
* Coarse Fragments (%):	0
* Seepage Water:	present, often at or near surface

DISTRIBUTION: uncommon

Non-forested Bog (ESSFwk2/31)

INTERPRETATIONS

Site limitations: - the combination of very poor productivity and high wildlife value means that these sites should be protected from harvesting.

Silvicultural System: - avoid logging

5 INDIRECT AND GENERAL INTERPRETATIONS

This section contains general interpretations for identification of silvicultural systems options (Section 5.1), indirect interpretive keys for site preparation (Section 5.2), and important site unit - wildlife habitat relationships (Section 5.3).

5.1 Silvicultural Systems Interpretations

This section is designed to assist the field guide user in the development of site- and stand-specific prescriptions for silvicultural systems that are compatible with stand management objectives. For the users of this section, a sound background knowledge of soils, tree silvics, stand development, and harvesting systems is assumed. This section is not intended as a substitute for adequate education, field experience, professional supervision, or training. This section should not be considered as a "cookbook" of recommended prescriptions.

The choice and execution of a silvicultural system in any given forest type must consider many site-specific and operational factors. The decision must be customized to the site type, stand structure, health, and vigour of the stand, and often unique combinations of local forest management objectives. For this reason, the decision cannot be reduced to simplistic duplication of standard, textbook techniques (Weetman *et al*. 1990). Smith (1986) has pointed out that "a rational silvicultural system for a particular stand should fit logically into the overall management plan for the forest of which the stand is a part. Second, it should represent the best possible amalgam of attempts to satisfy all ... basic forest management objectives." A silvicultural prescription developed for any stand should consider and integrate eight basic site-specific objectives (adapted from Cole 1985 and Smith 1986):

- development of stand conditions necessary for meeting stand-level integrated resource management goals over the longest possible time;
- provision for regeneration:
- enough control over competing vegetation to allow establishment of adequate numbers of trees growing at acceptable rates;
- development or maintenance of stand structures, species compositions, and stand conditions that minimize damage from pests, wind, and fire;
- effective use of growing space, and maintenance or improvement of existing stand and site productivity;
- compatibility with acceptable logging practices, so that future stands can be cultured and harvested:
- efficient use of resources and arrangement of operations; and
- provision for periodic monitoring and assessment of long-term silvicultural performance.

5.1.1 General terminology

Definitions of some key terms are essential for an understanding of silvicultural systems. A **reproduction method** is defined as any procedure (intentional or otherwise) that leads to the establishment of vigorous regeneration and growth of a new stand of trees (Smith 1986; Daniel *et al*. 1979). Reproduction methods can include the partial or complete removal of the old stand, establishment of the new one, and any treatments applied to create and maintain its early growth. Reproduction methods are broadly categorized by the pattern of cutting and the type of stand created. These include even-aged methods (clearcutting, seed-tree, or shelterwood) or uneven-aged (selection) methods (Smith 1986). The term **silvicultural system** is more comprehensive, however, and includes a planned program of silvicultural treatment throughout the life of a forest stand. This can include one or a series of reproduction cuttings, and any intermediate cuttings or other stand treatments. Figure 17 describes schematically the major types of silvicultural systems. Tables 10 and 11 are useful comparisons of silviculture systems.

Stand structure is defined, for the purposes of these interpretations, as the vertical arrangement and stocking of trees within individual crown classes (canopy layers) in a stand. **Natural stand structure** (referred to in Section 5.1.3, Step 5) describes the structure of an existing stand irrespective of any management interpretations. **Effective stand structure** (as referred to in Section 5.1.3, Step 5) is an interpretation of the natural stand structure. Determination of effective stand structure focuses only on trees within the stand that meet physical acceptability criteria for given management objectives (see Section 5.1.4). Effective stand structure may or may not be equivalent to the natural stand structure. It will depend on the unique distribution of acceptable and unacceptable trees within an individual stand. Therefore, identification of silvicultural system options for a given stand, site, and management objective is based on effective stand structure and not the existing natural stand structure.

Partial cutting is a generic term that includes certain even-aged and uneven-aged reproduction methods. These methods involve the partial or complete post-harvest retention of specific crown classes or species from the original stand (seed-tree, shelterwood. and selection). Partial cutting is used to refer to both present and historical harvesting methods that are not clearcutting (DeLong 1991). A partial cutting method, however, is not a reproduction method if it does not result in an adequately regenerated and stocked site. Like any reproduction method, a successful partial cutting treatment is only one element of a larger silvicultural system. For example, a partial cut designed to develop an uneven-aged stand is selection cutting only if subsequent operations are consistent with the original objective and result in the eventual development of the desired multi-layered stand.

It must also be stressed that the term **selective logging** should not be used in, or associated with, partial cutting prescriptions of any kind. Selective logging has no legitimate silvicultural meaning. To professional foresters and many others, this term is associated with uncontrolled logging practices in the past that high-graded many stands of their most valuable and highest-quality trees (Figure 18) (Weetman *et al.* 1990).

TABLE 10. Comparison of objectives of silvicultural system prescriptions

Method Approximated	Eventual Stand Form Produced	Silvicultural Goals of Prescription: Gap Width Created	Establishment of New Regeneration	Release of Advanced Regeneration <12.5 cm dbh	Sanitation Removal of Unacceptable Trees	Quality Increment on Large Stems > 12.5 cm dbh	Residual Basal Area Objective	Maintain Specified Q-value, Max dbh
Balanced Single-tree Selection	Uneven-aged	<1/2 H[1] max.	Yes	Yes	Yes	Yes	Yes	Yes
Small-group Selection	Uneven-aged	2 H max.	Yes	Yes	Yes, within groups	Yes	R[2]	R
Selection with Reserves	Uneven-aged	Similar to above selection options, but with long-term retention of appropriate stand components through one or more cutting cycles for biodiversity and integrated resource management objectives.						
Uniform Shelterwood	Even-aged	<1/2 H max.	Yes	(Possible)	Yes	Yes	Desirable	--[3]
Group or Strip Shelterwood	Even-aged	2 H max.	Yes	(Possible)	Yes, within openings	--	R	R
One-cut (Natural) Shelterwood or Overstory Removal	Even-aged to Multi-aged	Minimal	Fill-planting of gaps	Yes	Yes	--	--	--
Shelterwood with Reserves	Two-aged	Similar to above shelterwood options, but with long-term retention of appropriate stand components through one or more rotations for biodiversity and integrated-resource management objectives.						

TABLE 10. (Continued)

Method Approximated	Eventual Stand Form Produced	Gap Width Created	Silvicultural Goals of Prescription: Establishment of New Regeneration	Release of Advanced Regeneration < 12.5 cm dbh	Sanitation Removal of Unacceptable Trees	Quality Increment on Large Stems > 12.5 cm dbh	Residual Basal Area Objective	Maintain Specified Q-value Max dbh
Clearcut	Even-aged	Variable, > 100 m	Planted or natural	(Minor)	Yes	--	--	--
Clearcut with Reserves	Even-aged with veterans	Similar to clearcut option but with long-term retention of appropriate stand components through one or more rotations for biodiversity and integrated resource management objectives.						

[1] H = Canopy height

[2] R = Regulation of cut by percentage of total stand area harvested per stand entry. For group selection, < 33% of the stand area is harvested per stand entry. For group or strip shelterwood, > 33% of the stand area is harvested per stand entry.

[3] -- = Minimal concern or not applicable

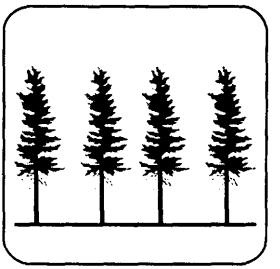
TABLE 11. Comparison of residual stand structures retained after initial partial cutting stand entry

Reproduction Method Approximated	Eventual Stand Form Produced	Gap Width Created	Crown Classes Retained (1st Cut) C1 Overstory	C2 Intermediate	C3 Understory	C4 Seedling
Balanced Single-tree Selection	Uneven-aged	<l/2 H[1] max.	P[2]	P	P	P
Small-group Selection	Uneven-aged	2 H max.	P	P	P	C[3]
Selection with Reserves	Uneven-aged	Similar to above options, but with planned long-term retention of appropriate stand components through one or more cutting cycles for biodiversity and integrated resource management objectives.				
Uniform Shelterwood	Even-aged	< 1/2 H	P	T[4]	T	T
Group or Strip Shelterwood	Even-aged	2 H max	(Cut and leave patches are spatially separated)			
One-cut (Natural) Shelterwood / Overstory Removal	Even-aged	Minimal	T	T	(P)	C
Shelterwood with Reserves	Two-aged	Similar to above options, but with planned long-term retention of appropriate stand components through one or more rotations for biodiversity and integrated-resource management objectives.				
Clearcut	Even-aged	> 100m	T	T	T	T
Clearcut with Reserves	Even-aged with veterans	Similar to above options but with planned long-term retention of appropriate stand component for biodiversity and integrated resource management objectives.				

[1] H = Canopy height
[2] P = Partial Retention (25-75%)
[3] C = Complete Retention (76-100%)
[4] T = Total Removal (0% retention)

Even-aged systems

- clearcut systems
- seed-tree systems
- shelterwood systems



Uneven-aged systems

- selection systems

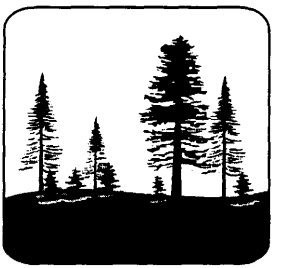


FIGURE 17. The major types of silvicultural systems.

5.1.2 Descriptions of reproduction methods

The ultimate distinction between reproduction methods is the form of forest produced. The size, shape, and position of the areas cut over, as well as the proportion of the timber removed, determine the arrangement of age classes within the stand. In a managed forest, each reproduction method is the chief factor governing forest form and, when systematically applied, produces a characteristic stand structure (Smith 1986).

The primary objective of all reproduction methods is the regeneration and perpetuation of a forest stand. Reproduction methods that use timber harvesting normally have wood production as one of their important

objectives. Stands may also be managed partially or exclusively for the provision of other non-timber resources. These include habitat for many faunal and floral species, landscape diversity, protection of water quality, scenic values, recreation, and spiritual values. Forests managed only for wood production do not necessarily contain characteristics that support other uses. Where it is decided that specified non-timber forest values should be integrated with conventional timber management, determinations must be made whether integrated management objectives can be best achieved at the stand or landscape level. It is not always practical, and may not be possible, to manage for all forest values within single stands. Similarly, it is unlikely that one silvicultural system, applied everywhere across the landscape, will achieve the diversity of forest values that is often desired.

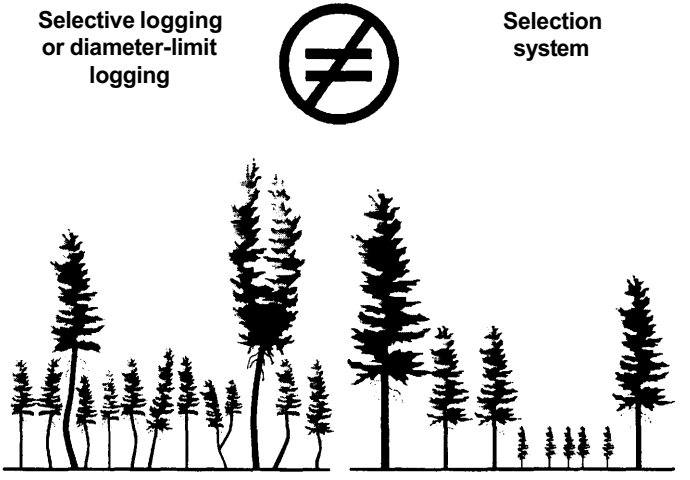


FIGURE 18. Schematic comparing selective logging to a true selection system.

Where specific combinations of forest resource values are to be integrated in the management of a single stand, the specific stand characteristics and components important to each resource value (e.g., large dominant trees of a certain species, understory cover, or coarse woody debris) must be identified in the prescription. For example, cavity-nesting birds such as woodpeckers may require a certain number of large decayed trees to be maintained in the stand, or some ungulates may require winter range areas that have stands containing large, arboreal lichen-bearing, standing live and dead trees. In many cases, specified stand characteristics can be incorporated within certain conventional silvicultural systems with, perhaps, long-term retention of certain live or dead trees for several rotations or cutting cycles. Specialized prescriptions in sensitive areas should be developed in consultation with appropriate agencies and organizations.

The success or failure of any silvicultural prescription should be evaluated by regular stand monitoring and by comparison to similar prescriptions carried out on similar site types located nearby. Long-term assessment carried out in this way will provide the feedback necessary to incorporate long-term results into future prescriptions.

5.1.2.1 Clearcutting methods

Background: The clearcutting method, like the seed-tree and shelterwood method, is a form of even-aged stand management. Clearcutting methods involve the complete removal of the entire stand in one cutting. Regeneration is obtained by planting, or by natural seeding from adjacent stands and cones shed from trees cut in the logging operation (Smith 1986). In concept, clearcutting is the simplest way of harvesting and replacing mature stands. It can mimic some of the conditions created by catastrophic disturbances. These conditions are responsible for regenerating certain species, particularly shade-intolerant and exposure-tolerant species. In some instances, catastrophic or rapidly deteriorating conditions in natural stands caused by insect epidemic, root disease, fire, or very heavy incidence of rots or dwarf mistletoes will dictate the use of clearcutting.

Open area dominates and edge situations are minimal in a clearcut (Daniel *et al.* 1979). Clearcutting as a technical term should not be used to refer to heavy overstory removal cuttings that release new stands already established beneath them as advanced growth. These types of cuttings are more appropriately referred to as one-cut (natural) shelterwoods and/or shelterwood overstory removals. The distinction is particularly important where site exposure after true clearcutting would greatly inhibit establishment of new seedlings. On such sites, preservation of pre-established advanced growth can be a distinct silvicultural advantage.

Silvicultural Objectives: Regeneration after clearcutting can be achieved by natural regeneration, planting, or a combination of both. Under appropriate conditions, natural regeneration of conifers can occur by seeding from the stand edges adjacent to clearcuts, or, in the case of lodgepole pine, by lopping and scattering of serotinous cones during harvest operations. The clearcut system can have a number of advantages. Clearcutting is an efficient means of harvesting timber and

completely clearing the site for (possible) intensive site preparation and planting of nursery-grown seedlings. Planting and even-aged plantation management can allow better control over a stand's species and genetic composition than natural regeneration. Plantations can potentially allow establishment of more uniform and evenly stocked stands, provide prompt occupation of the site by trees where competing vegetation is a problem, and reduce natural regeneration delays. The disadvantages of clearcutting with planting include: high planting costs; risks of plantation failure; long-term costs of plantation maintenance (brushing, weeding, and thinning); and possible reduction of stand-level biodiversity in the absence of natural regeneration or retention of larger residual trees and organic debris.

Clearcutting methods are the simplest silvicultural systems to plan and harvest. By definition, clearcuts remove all of the original stand and advanced regeneration is not specifically protected. Typically, site series, soil type, and terrain are the only determinants of logging method, desired species, stocking standards, and site preparation method. However, in extreme environments such as high-elevation sites, frost pockets, heavy snow zones, brush-prone areas, or areas with high sensitivity to mass wasting, the silvicultural benefits and costs of clearcutting systems should be assessed carefully. Because of undesirable aesthetic impacts, clearcutting should be used with discretion and in conjunction with careful planning in high-use recreational areas and highway scenic corridors. In particular, cutblock size, shape, and orientation may need to be modified to mitigate impacts.

Refer to Tables 10 and 11 to compare clearcutting systems with other silvicultural systems.

5.1.2.2 Shelterwood methods

Background: Shelterwood methods are even-aged management techniques in which a stand of timber is gradually removed in a series of cuts. These cuts extend over a relatively short portion of the rotation and are intended to facilitate understory regeneration and development. Regeneration is established by natural seedfall or supplemented by under-planting, and growth occurs under the overhead or lateral shelter of an existing overstory. Preparatory shelterwood cuttings may be uniformly dispersed throughout the stand (uniform shelterwood), or they may take place as a series of edge cuttings in patches or strips that are less than two tree heights wide (group or strip shelterwood). A portion of the stand in a group shelterwood may be reserved until later in the rotation creating a series of small, even-aged patches (Figure 19). In stands where an understory of acceptable natural regeneration already exists, one-cut shelterwoods, which completely remove overstory trees while protecting existing regeneration, are an option if the regeneration is tolerant of sudden exposure. Although the classical intent of a shelterwood is to eventually remove all of the overstory, modern variations may call for retention of part of the overstory in order to meet wildlife, biodiversity, aesthetic, or increment objectives.

Silviculture Objectives: For a preparatory shelterwood cut, leave at least 50% of the main tree canopy (C1 crown class) intact (75-200 stems

per hectare (sph) or 10-30 m^2/ha basal area). This will help maintain windfirmness, provide protection to young advanced regeneration and new seedlings, and reduce understory vegetation competition. The trees will also serve for a number of years as an ongoing seed supply for natural regeneration. Many of the most thrifty and windfirm trees and tree groups are retained (Figure 20). Species and genotype of resulting regeneration under the shelterwood can be influenced by selection of shelterwood leave-trees of desirable species and form. Identified overstory leave-trees must be marked-to-leave on all four sides of the tree with conspicuous blue paint. Shelterwood preparatory cuts involve one or several overstory partial harvests. These are designed to gradually open up the canopy, simulate regeneration establishment and vigour, and create the desired stand structure in preparation for final overstory removal and regeneration release. This process will generally be completed 5-25 years after the first cut. Careful seedbed scarification (mineral soil exposure) is necessary for Se regeneration establishment, and desirable for prompt establishment of Bl. Conventional ground-based skidding or feller-bunchers can be used in winter for Se and Bl.

FIGURE 19. Application of reserves within a silvicultural system.

It must be ensured that root systems of leave-trees are not disturbed. In some natural stands and old partial cuts, past light disturbancesor other favourable conditions have stimulated the establishment of a vigorous, well-stocked advanced regeneration layer. In such stands, preparatory cuts may be unnecessary, and one-cut (natural) shelterwoods with complete overstory removal may be feasible. Careful pre-harvest skid trail layout, appropriate logging machinery (i.e., small tracked skidders), skilled operators, and intensive supervision are all important factors for ensuring the protection of existing regeneration. Post-harvest sanitation thinning will be necessary to remove badly scarred and broken stems of advanced regeneration, especially those of subalpine fir.

Refer to Tables 10 and 11 to compare shelterwood systems with other silvicultural systems.

FIGURE 20. Criteria for leave tree selection in seed-tree and shelterwood systems.

5.1.2.3 Selection methods

Background: Selection methods refer to a series of planned treatments and partial harvests designed to create or maintain managed, uneven-aged stands. An uneven-aged stand contains at least three well-defined, intermingled age classes (not just size classes). In single-tree selection, the management unit of interest is the individual tree, or very small clumps of trees less than one-half of canopy tree height in width. Group selection involves the management of discrete even-aged groups of trees. Under the group selection system, even-aged aggregations of trees in the stand are small by definition and have a width less than twice the height of the tallest trees. A single-tree selection system prescription must include regulation of cut by basal area and diameter distribution (q-value).[13] Post-harvest maximum residual diameter of trees to be left should also be specified. Pre-harvest marking of trees to cut is strongly recommended as the means to achieve desired stand objectives. Group selection prescriptions include regulation of cut by the percentage of area harvested per stand entry. This is usually < 33%. The location of selected groups and access skid trails should be determined prior to harvest, and should be designed to accomodate future volume removals. Regeneration is continuous from natural seedfall and may be supplemented by under-planting. Continuous forest cover is maintained. Variations upon the selection system can be complex and numerous. Further discussion can be found in Smith (1986), Daniel *et al.* (1979), Matthews (1989), or the Silviculture Interpretations Working Group (1992).

Silviculture Objectives: Leave as complete a distribution of age and size classes as possible while improving stand vigour and quality (Figure 21). A residual basal area of at least 20 to 25 m^2/ha and 50% of the pre-harvest stand basal area must be protected and retained during harvest. Maximum residual diameter and diameter distribution (specified q-value) of stems in each diameter class must be determined for the PHSP and approximated operationally. The cutting cycle, or period of years between selection harvests, should be specified. A detailed inventory of all tree size classes, vigour, and pathological condition should be conducted (as per section 5.1.4). This assists in determining stand suitability and planning tree marking. Trees to be harvested should be marked-to-cut with conspicuous red paint on all sides of the tree or, conversely, acceptable trees marked-to-leave with blue paint.

As with shelterwood systems, important factors for achieving a successful selection stand entry are: careful and knowledgeable skid road and landing layout; appropriate logging machinery (i.e., small tracked skidders); skilled operators; and rigourous harvest supervision. Winter logging on a compressible snowpack of 1 m is recommended to protect small advanced regeneration from damage during stand entries. Post-harvest seedbed preparation may be necessary to create mineral soil seedbeds for Se. Post-harvest sanitation thinning will be necessary to remove badly scarred and broken residual stems, especially those of subalpine fir.

[13] Fractional increase in number of trees per hectare in a given diameter class over the number in the next higher diameter class.

Refer to Tables 10 and 11 to compare selection systems with other silvicultural systems.

Single-Tree Selection System

- the ideal balanced structural goal

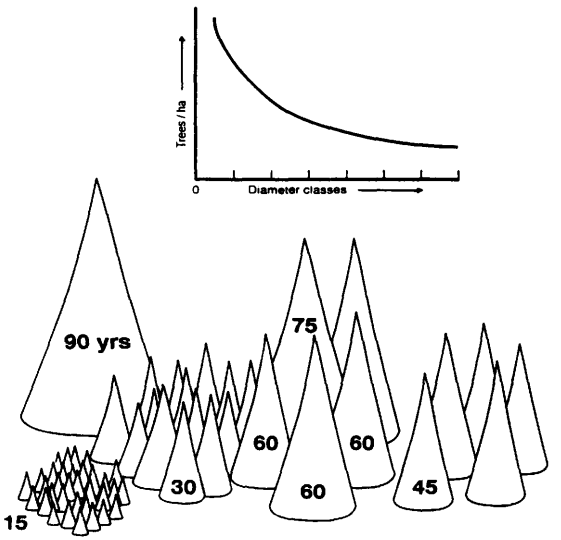


FIGURE 21. Ideal diameter distribution under a single-tree selection system.

5.1.3 Steps for choosing an appropriate silvicultural system

The choice of an appropriate silvicultural system for a stand and site is complex and site-specific. For example, Tables 13 and 14 detail the requirements for implementing selection and non-selection silvicultural systems in Mountain Caribou habitat. The following materials are provided as decision aids. Careful examination of site characteristics and the existing stand will identify one or several ecologically suitable silvicultural system options. The final choice of a silvicultural system from these available options must be the best possible compromise of short- and long-term silvicultural objectives, technical (harvesting) feasibility, economic criteria, visual quality objectives (VQO's). and stand- and landscape-level biodiversity goals.

In the preparation of the silviculture prescription for an area, the following 7-step procedure should be followed:

Step 1

Identify and establish priorities for short-term and long-term stand-level and landscape-level management objectives and constraints. Be specific. Translate objectives into general stand structure goals.

Step 2

Based on aerial photos and a thorough field reconnaissance of the stand and site, stratify the area into relatively homogeneous units (see Section 3.6). This is important, because attempts to combine information from markedly different strata will result in errors in interpretation over the entire area.

Step 3

All site, soil, and vegetation information for the strata should be collected as described in Section 3.4 and Section 4 of this field guide. In particular, map out blowdown-prone sites with high water tables or root-restricting soil layers.

Step 4

Collect detailed stand information as described in Section 5.1.4 in conjunction, if desired, with standard timber-cruising activities.

Step 5

Using the stand structure key (Figure 22) identify the natural stand structure (refer to Section 5.1.1) of the existing stand based on total basal area of the C1 (overstory) and C2 (intermediate) crown classes, and total stems per hectare of the C3 (understory) and C4 (seedling) crown classes. Again using the key (Figure 22), identify the effective stand structure based on acceptable basal area of the C1 (overstory) and C2 (intermediate) crown classes, and acceptable stems per hectare of the C3 (understory) and C4 (seedling) crown classes.

Step 6

Based on the effective stand structure, use Table 12 to determine which silvicultural systems options are potentially suited to the site unit, stand structure, species composition of the existing stand, and site-specific ecological requirements of the desired tree species.

Step 7

Refer to the descriptions of the different silvicultural systems (Section 5.1.2). Determine which options identified in Step 6 are most likely to meet management objectives, constraints, and related stand structure goals as stated in Step 1. When the most desirable option is identified, a detailed Pre-Harvest Silviculture Prescription (PHSP) for that silvicultural system should be prepared in accordance with regional guidelines and procedures. If no silvicultural system options meet both the management objectives and constraints in the short term, then deferral or rejection of current harvesting proposals for the stand should be considered.

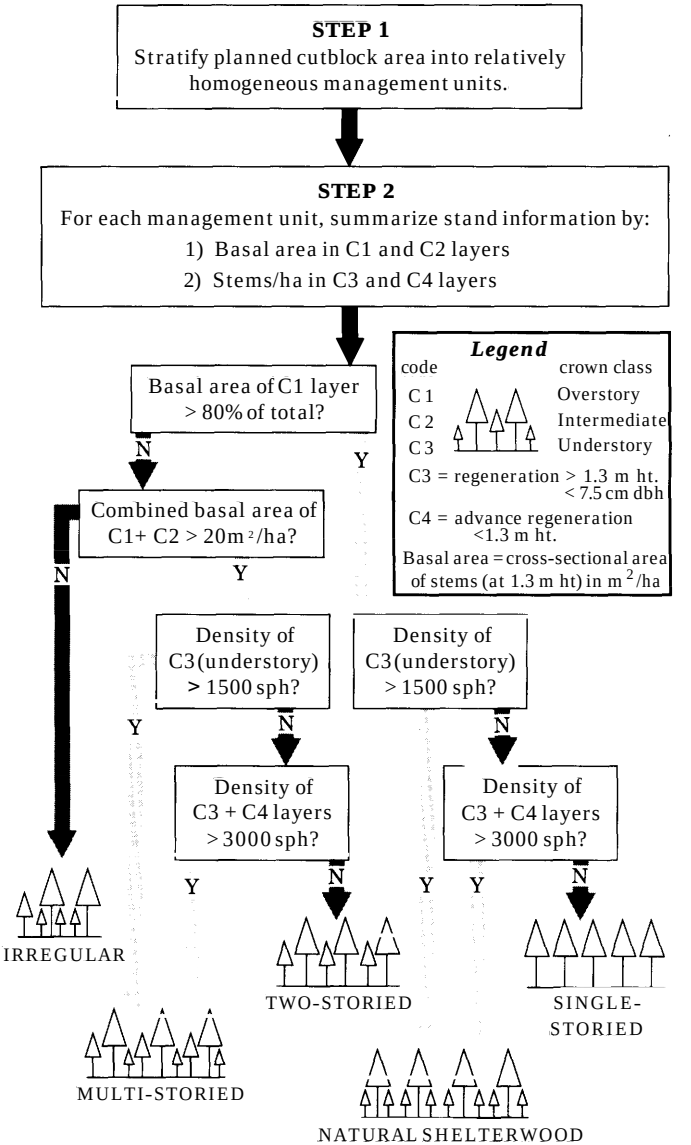


FIGURE 22. Key for identification of stand structure type (modified from Weetman *et al.*, 1990).

5.1.4 Collection of stand data

Stands and sites should be stratified into relatively homogeneous strata in the field before intensive sampling is started. The following data collection procedure has been developed in part from Weetman *et al.* (1990), Prince Rupert Forest Region (1991), and the Silviculture Interpretations Working Group (1992).

To determine potential silvicultural system options for a given stratum, detailed information on stand structure, vigour, condition, and species composition is required. Therefore, cruise data that is normally collected in all areas to be logged in British Columbia must be supplemented with additional information. Stand infomation will be collected from fixed-radius or prism plots located in representative areas within each treatment unit. It is recommended that a minimum of four to five plots be systematicallyestablished in each stratum being evaluated for possible silvicultural system options. The plot size should be large enough to contain an average of 20 trees > 7.5 cm dbh. Data to be collected for each tree > 7.5 cm dbh include:

- Diameter
- Species
- Crown class, defined as:

  C1 (Overstory) = trees occupying top 1/3 of canopy
  C2 (Intermediate) = trees > 7.5 cm dbh occupying middle 1/3 of canopy or possibly lower

- Indicate whether each tree is acceptable or unacceptable as post-harvest leave-trees, where:

  Acceptable leave-trees
  = live crown ratio > 50%
  = stem free of rots, physical defects or pathological indicators
  = species ecologically suited to site as per Tree Species Selection and Stocking Standards

  Unacceptable leave trees
  = live crown ratio < 50%
  = stem contains physical defects or pathological indicators
  = species not ecologically suited to site as per Tree Species Selection and Stocking Standards

Approved modifications to the above acceptability criteria may be required in specific localities to meet site-specific, non-timber integrated resource objectives.

To collect information on stems less than 7.5 cm dbh, a fixed-radius plot of 5.64 m radius (0.01 ha) should be established at the same plot centre as for other stand data collections. The following information should be recorded:

- Acceptable sph by

  a) species; and

  b) crown class, defined as:

     C3 (Understory) = < 7.5 cm dbh but > 1.3 m height

     C4 (Seedling) = > 0.3 m height but < 1.3 m height

- Total sph by crown class (C3 and C4)

Finally, return to Step 5 in Section 5.1.3 to enter stand information into Figure 22. Stand data for each sampling strata should be summarized by:

- Acceptable basal area by species, and total basal area for each of the C1 and C2 crown classes; and

- Acceptable sph by species and total sph for each of the C3 and C4 crown classes.

Natural stand structure can be identified in Figure 22 using total basal area and sph while effective stand structure can be identified in Figure 22 using acceptable basal area and acceptable sph.

TABLE 12. Potential silvicultural system options based on effective stand structure

Effective Stand Structure	Clearcut	Uniform Shelterwood Preparatory Cut	One-cut Shelterwood / Overstory Removal	Selection / or Uneven-aged
Single-storied	Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.	Se and Bl. Light removal, leave at least 50% of original basal area. Seedbed disturbance required for Se.	At least 1 preparatory or seed cut and successful regeneration required before overstory removal.	Difficult. At least 2-3 light stand entries needed to create desired multi-storied structure. At least 20-25 m^2/ha and 50% of basal area must be retained. Sanitation cutting likely.
Natural Shelterwood	Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.	Not required if understory can be protected and is acceptable species. density, and quality. See Shelterwood Overstory Removal.	Ideal if advanced regeneration can be protected during harvest and is of acceptable species, density, and quality	At least 2 light to moderate stand entries needed to create desired stand structure. At least 20-25 m^2/ha and 50% of basal area must be retained. Sanitation cutting.
Two-storied	Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.	Se and Bl. Harvest intermediate layer and weaker co-dominant trees. Light removal, leave at least 50% of original basal area Seedbed disturbance required for Se.	Release C2 (intermediate) layer if adequate stocking and quality. Basal area stocking targets may be appropriate.	1 or more stand entries needed to stimulate new regeneration and create desired stand structure. As above for natural shelterwoods.

TABLE 12. (Continued)

Effective Stand Structure	Clearcut	Uniform Shelterwood Preparatory Cut	One–cut Shelterwood / Overstory Removal	Selection / or Uneven-aged
Multi-storied	Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.	Se and Bl. Not necessary if understory can be protected and is of acceptable species, density, and quality. Selection systems may be more appropriate.	Release either C2 or C3/C4 layer if either crown class has adequate stocking and quality. Advanced growth must be protected. Selection systems also appropriate.	Ideal initial structure. Cuts must maintain and enhance existing structure, quality, composition, and stocking. 20-25 m^2/ha and 50% of basal area must be retained.
Irregular	Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.	If sufficient stocking of dominant and co-dominant layer. Harvest intermediates Selection systems or overstory removal may be more appropriate.	As above for multi-storied stands.	At least 1 stand entry needed to attain target stand structure and stocking. In previously high-graded stands, an extended cutting cycle may be necessary to allow basal area stocking to recover to optimum levels of 20 m^2/ha or more. Sanitation cutting likely.

TABLE 13. Recommended prescriptions for implementing preferred silvicultural systems in Mountain Caribou habitat

Effective Pre-Harvest Stand Structure	Single-tree Selection System	Group Selection System
Single-storied Stand Structure	Difficult and protracted prescription: Conversion to multi-storied stand structure requires at least 2 to 3 light stand entries on 40-year cutting cycles (maintain 75% of initial basal area and B-level stocking targets) to promote desired stand condition. Careful post-harvest sanitation stand-tending is essential. Protect and maintain high-rated lichen-bearing trees. Mineral soil exposure or underplanting is necessary to promote spruce regeneration if existing stocking is unacceptable.	Harvested groups must be less than 0.5 ha in size and the stand and soil type should be reasonably windfirm. Each stand entry should remove no more than 30% of the stand by area or volume. Cutting cycles should be 50 to 70 years. Mineral soil exposure or planting of cut patches may facilitate regeneration of desired species. Group selection may be preferred over single-tree selection due to the difficulty in converting these stands to a multi-storied structure.
Natural Shelterwood Stand Structure	At least 2 light to moderate stand entries (maintain 60 to 75% of initial basal area and B-level stocking targets) to promote growth of advanced regeneration and develop multi-storied stand structure. Careful post-harvest sanitation stand-tending is essential. Protect and maintain existing high-rated lichen-bearing trees. Winter logging on deep compressible snowpack will help protect advanced regeneration during harvest.	In natural shelterwoods, implementation of either group selection systems (with protection, where feasible, of existing advanced regeneration within groups) or conversion to multi-storied stands through single-tree selection are equally acceptable. For single-storied stands, removal over a 40 - 60 year cycle should be < 30% of the stand. Winter logging on a deep compressible snowpack will assist in protection of advanced regeneration during harvest.
Two-storied Stand Structure	One or more moderate stand entries (maintain 60 to 65% of initial basal area as well as B-level stocking targets) to release thrifty C2 (pole-sized intermediate trees), stimulate seed production in overstory, and promote understory regeneration. Mineral soil exposure or underplanting is necessary to promote spruce regeneration if existing stocking is unacceptable. Careful post-harvest sanitation stand-tending is essential. Protect and maintain high-rated lichen trees. Ensure protection of pole-sized trees during felling and skidding. 50 to 70-year cutting cycle.	On suitable terrain, conversion of two-storied stands to multi-storied stands via single-tree selection is preferable to group selection systems. Group selection is acceptable under terrain conditions that preclude single-tree selection or where retention of snags is a management objective. For group selection in these stands, follow recommendations for single-storied stands.

TABLE 13. (Continued)

Effective Pre-Harvest Stand structure	Single-tree Selection System	Group Selection System
Multi-storied Stand Structure	Ideal initial structure for single-tree selection management. Stand entries must maintain and enhance existing structure, species composition quality, and stocking. Moderate removals (B-level stocking) are acceptable depending on the wind exposure of the stand. Maintain at least 20 m^2/ha of basal area per entry. Careful post-harvest sanitation thinning is essential. Protect and maintain high-rated lichen-bearing trees. Mineral soil exposure or underplanting is necessary to promote spruce regeneration if existing stocking is unacceptable.	Single-tree selection should be used to maintain this stand structure wherever terrain and harvest feasibility permit. Group selection should be used on moderately difficult terrain where single-tree selection is infeasible, or where snag retention using feller-buncher harvesting is one of the stand management objectives. Follow the recommendations given for group selection in single-stoned stands.
Irregular Stand Structure	At least one stand entry is needed, possibly as an improvement cut, to promote the desired multi-storied stand structure and allow basal area stocking to increase over time to acceptable minimum levels (i.e., $\geq$ 20 m^2/ha). In previously high-graded, diameter-limit cut stands, an extended cutting cycle may be necessary to allow basal area stocking to recover to optimum levels. Post-harvest sanitation stand-tending will be required.	Gradual conversion of irregular stands to multi-storied stands through single-tree selection and extended cutting cycles should be a preferred option wherever terrain and harvest feasibility permits. Group selection can be used on moderately steep terrain where single-tree selection is infeasible, or where snag retention using feller-buncher harvesting is one of the stand management objectives. Follow the recommendations given for group selection in single-storied stands.

TABLE 14. Conditions and constraints on application of non-selection silvicultural systems in Mountain Caribou habitat

Effective Pre-Harvest Stand Structure	Clearcut System	Natural Shelterwood Overstory Removal
Single-Storied Stand Structure	Individual cutblocks may be provisionally acceptable if ALL of the following constraints are met: • Documented stand and terrain conditions preclude application of group selection and single-tree selection systems; • Cutblock and roads are compatible with approved landscape-level habitat management objectives; and • Prescription meets site-specific ecological requirements of desired tree species. Manipulation of block size and shape may mitigate harvest impacts on caribou cover and migration routes.	Individual cutblocks are provisionally acceptable IF; • ALL constraints as with clearcut system in single-storied stands are met; and • At least 1 effective preparatory seed cut and successful regeneration can be achieved before final overstory removal. Mineral soil exposure is needed for spruce regeneration. Shelterwood preparatory cuts can be converted to multi-storied stands and single-tree selection in the future, if desired.
Natural Shelterwood Stand Structure	Individual cutblocks may be provisionally acceptable if ALL of the following constraints are met: • Constraints as with clearcut systems in single-storied stands. Overstory removal harvest and/or retention of advanced regeneration reserve areas will provide vertical structure in the early post-harvest regeneration period.	Individual cutblocks are provisionally acceptable IF: • ALL constraints as with clearcut system in single-storied stands are met; • Sufficient densities of advanced regeneration can be protected during harvest; and • Advanced regeneration is of acceptable species and density. Sanitation cutting will be necessary.
Two-storied Stand Structure	Individual cutblocks may be provisionally acceptable if ALL of the following constraints are met: • Constraints as with clearcut systems in single-storied stands Retention of discrete windfirm reserved areas of pole-sized tree will provide vertical structure in the immediate post-harvest regeneration period.	Individual cutblocks are provisionally acceptable IF: • ALL constraints as with clearcut system in single-storied stands are met; • C2 (intermediate) layer can be protected during harvest, is reasonably windfirm, and is of adequate quality and stocking; and • Basal area stocking targets may be appropriate. Where feasible, convert to multi-storied structure with selection system.

TABLE 14. (Continued)

Effective Pre-Harvest Stand structure	Clearcut System	Natural Shelterwood Overstory Removal
Multi-storied Stand Structure	Individual cutblocks may be provisionally acceptable if ALL of the following constraints are met: • Constraints as with clearcut systems in single-storied stands. Retention of windfirm reserved areas or areas of large advanced regeneration within the cutblock may provide long-term lichen sources and vertical structure.	Individual cutblocks are provisionally acceptable I F • ALL constraints as with clearcut system in single-storied stands are met; and • Sufficient stocking of either C2 or C3/C4 layers can be protected during harvest, and stocking is reasonably windfirm and is of adequate quality. Sanitation cutting will be necessary. If possible, retain windfirm reserve areas within the block for provision of long-term lichen sources and vertical structure. Ideal stand structure for selection system. Maintain multi-storied structure if possible.
Irregular Stand Structure	Individual cutblocks may he provisionally acceptable if ALL of the following constraints are met: • Constraints as with clearcut systems in single-storied stands.	Individual cutblocks are provisionally acceptable IF: • ALL constraints as with natural shelterwoods in multi-storied stands are met; Where feasible. delayed stand entry, improvement cuts, and conversion to selection system will likely be appropriate to promote multi-storied structure. Retain windfirm reserves within block for hiding cover and vertical structure.

5.2 Site Preparation Keys

The keys provided in this section are intended to provide the user with a variety of site preparation treatment options based on the characteristics of the site for which treatments are prescribed. Two publications, *Mechanical Site Preparation Equipment in North Central British Columbia* (Coates and Haeussler 1987) and *Site Preparation Strategies to Manage Soil Disturbance* (Curran *et al.* 1990), were used extensively in preparing these keys. The keys are not meant to replace these documents and they should be consulted before making a final site preparation decision. Another useful reference is Chapters 11 and 12 in *Regenerating British Columbia's Forests* (Lavender *et al.* 1990). Before using the site preparation keys, site and soil information should have been collected and the site unit identified. The following steps should then be followed.

Step 1 Using Table 15, identify the appropriate soil grouping for the site unit using coarse fragment content and soil texture information previously collected.

Step 2 Using Table 16, identify the appropriate site group for the site unit you have previously identified.

Step 3 Proceed to appropriate site group key and, using site and soil information, advance step by step through the key until a site preparation code box is reached.

Step 4 Refer to site preparation code descriptions and decide which site preparation alternative best suits the site limitations and management objectives for the site.

TABLE 15. Soil grouping for all combinations of coarse fragment content and soil texture (from Lewis and Carr 1993)

Texture	**Coarse Fragment Content**		
	< 30%	**30 - 70%**	**> 70%**
S, Ls, SL	Coarse	Very Coarse	Very Coarse
vfSL, Si	Medium	Coarse	Very Coarse
SiL, Loam	Medium	Medium	Coarse
SC, Sic, SCL SiCL, CL, C	Fine	Medium	Medium

S = sand, sandy C = clay, clayey vfSL = very fine sandy loam
Si = silt, silty L = loam, loamy

TABLE 16. Figure and page numbers for site preparation keys

Site Series	Site Group	Figure Number	Page Number
ESSFmv2/01 ESSFmv4/01,04	Bl - Rhododendron - Knight's plume	24	124
ESSFmv2/04 ESSFwk2/01,02,03,04	Bl - Rhododendron - Oak fern	23	122
ESSFmv2/05 ESSFwk2/05	Bl - Devil's club	23	122
ESSFmv4/05	Bl - Horsetail - Sphagnum	25	125
ESSFwk2/06	Bl - Horsetail - Oak fern	25	125
ESSFmv2/06	undescribed	25	125

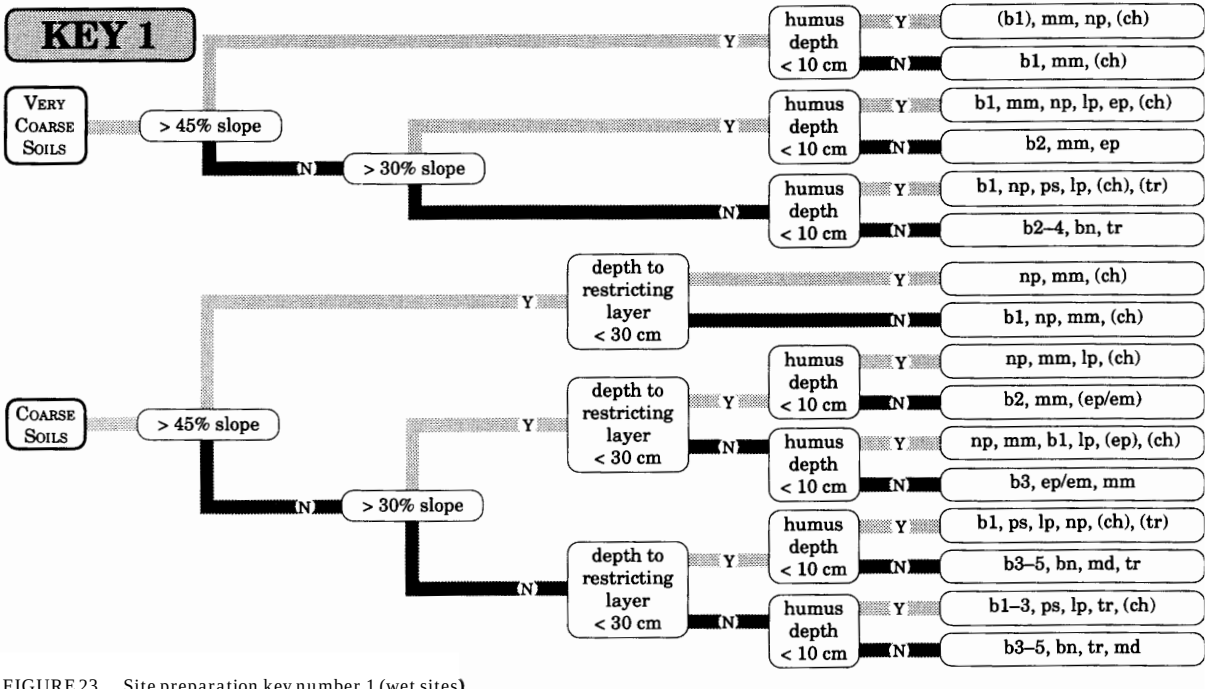
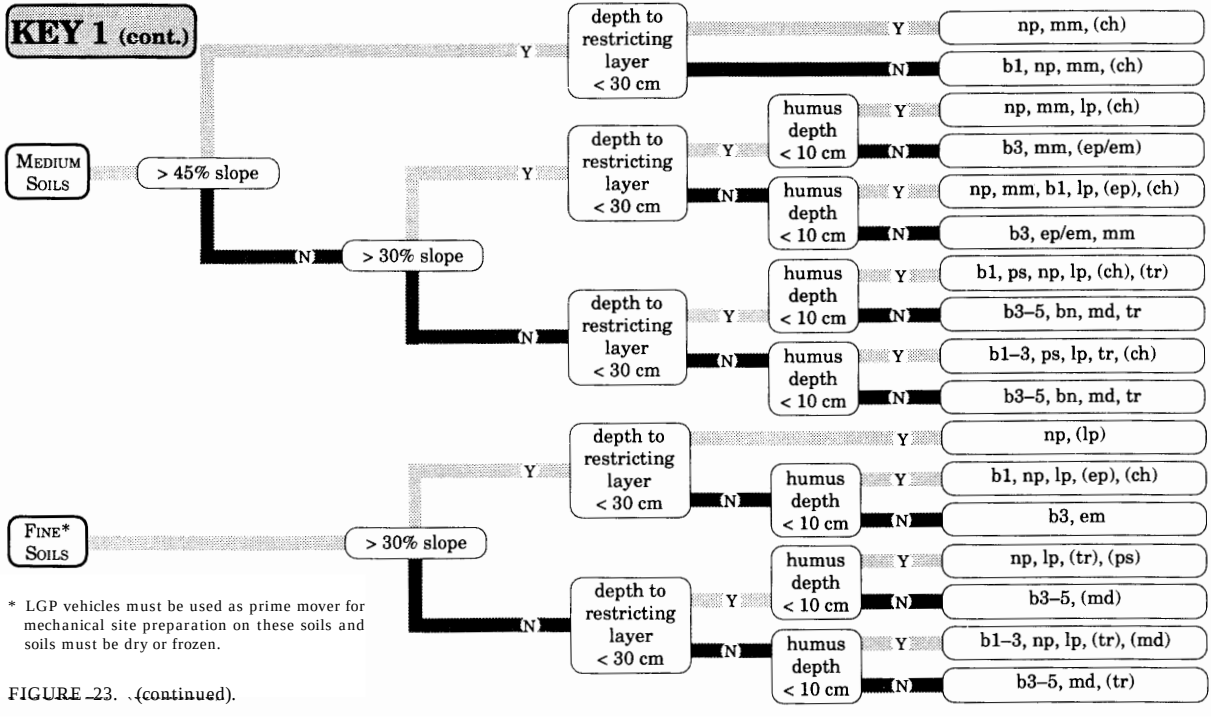
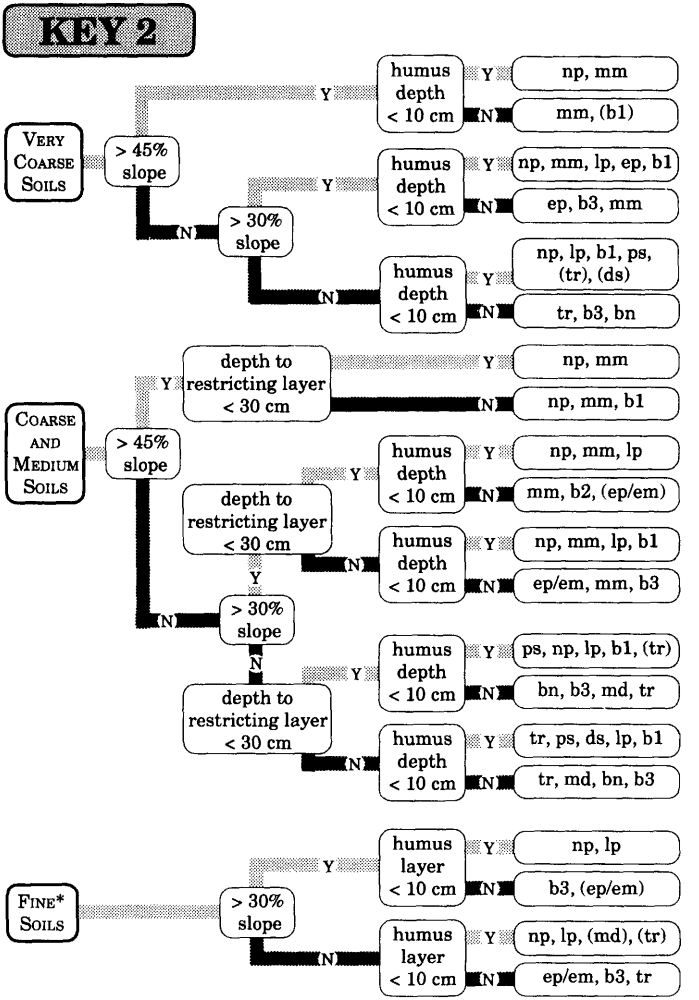


FIGURE 23. Site preparation key number 1 (wet sites).



* LGP vehicles must be used as prime mover for mechanical site preparation on these soils and soils must be dry or frozen.

FIGURE 23. (continued).



* LGP vehicles must be used as prime mover for mechanical site preparation on these soils and soils must be dry or frozen.

FIGURE 24. Site preparation key number 2 (moist sites).

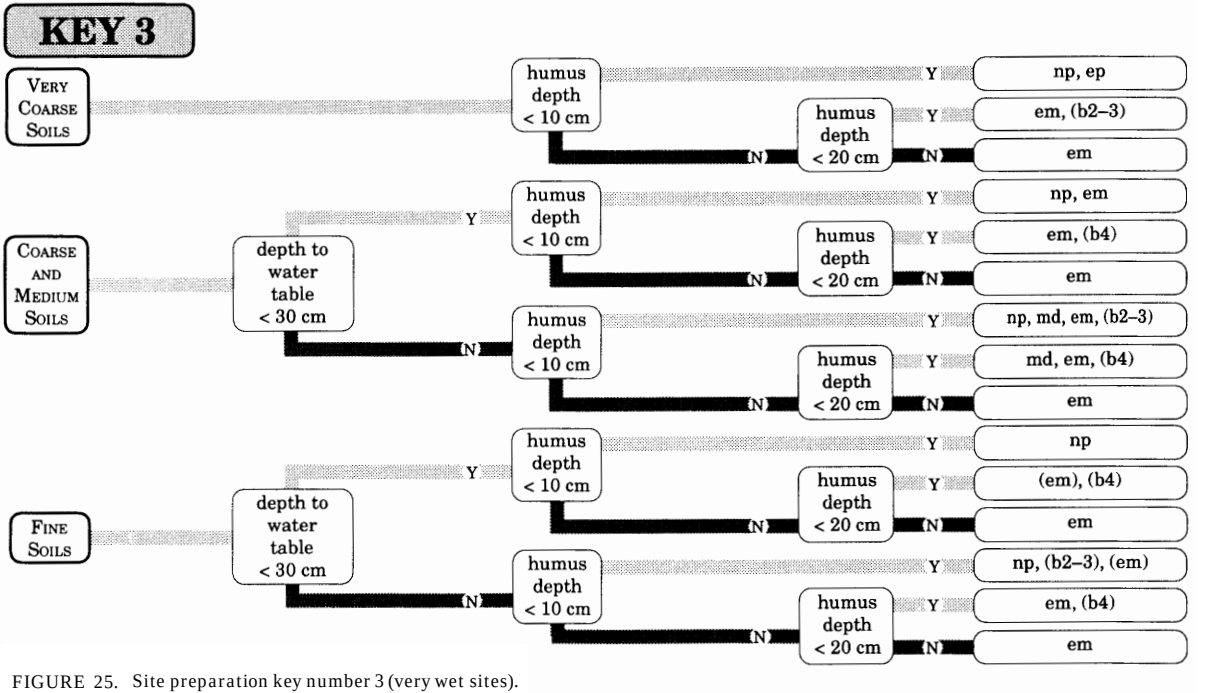


FIGURE 25. Site preparation key number 3 (very wet sites).

SITE PREPARATION CODES

np: **No Site Preparation** - this option requires that slash reduction and alignment of slash become important components of the harvesting prescription (see Section 5.2.1). If brush hazard is high to extreme (see individual site unit interpretations), large sturdy stock should be planted in planter-prepared screefs. Areas receiving no site preparation should be monitored carefully to assess the need for brushing and weeding.

bn: **Brush Blading Normal** - this technique includes all equipment capable of blading on sites up to 30% slope. The intent of this treatment is to pile slash and remove a portion of the organic layer without removing mineral soil. Increasingly complex microtopography makes this treatment more difficult to perform. A skilled operator, small equipment, and close supervision are required for this treatment to be effective without damaging the site.

b#: **Broadcast Burning** - broadcast burning has been separated into severity classes based on Trowbridge *et al.* (1989) (see Table 17). Operational experience will be needed to meet the objectives stated in the tables. When prescribing a broadcast bum it is important to consider other units that may be included in the block to be harvested and are more sensitive to burning (e.g., drier units with thinner humus layers or shallow soils). The probable impact of the treatment on these units will need to be determined. If the treatment is felt to be too severe for these other units, an attempt should be made to either exclude them from the block or guard these areas from the burn impact. Broadcast burning will generally stimulate species that regenerate from buried seed (e.g., raspberry, currants, and gooseberries) or rhizomes (e.g., thimbleberry). Brushing and weeding will be required if these types of species are present.

TABLE 17. Fuel consumption for different prescribed burning severities

Severity	Fuel Consumption		
		Slash (%)	
	Duff	<7 cm Diam.	>7 cm Diam.
1	moss/litter	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

ch: **Chemical or Biological** - this technique includes biological controls (e.g., sheep) and any type of chemical or biological herbicide control. If prescribing this option, slash reduction and alignment of slash will become important components of the harvesting prescription (see Section 5.2.1). The Wildlife Interpretation section of this guide (Section 5.3) should be referred to when using this method so that important browse species for wildlife can be identified. Choose the treatment that best meets wildlife and site preparation objectives.

ds: **Drag Scarification** - drag scarification can be used to prepare sites for planting but is more generally used to enhance natural regeneration of lodgepole pine. It is important to include a cone survey in the prescription when implementing drag scarification for natural regeneration. A lop-and-scatter clause may also need to be included if the harvesting is to be done by feller-bunchers. On sites with moderate or higher brush hazard (see individual site unit interpretations), the site should be carefully monitored in case brushing and weeding are required.

em: **Excavator Mounding** - this option requires that slash reduction and alignment of slash become components of the harvesting prescription (see Section 5.2.1), or excavators must windrow at time of mounding. As slash loading increases on slopes, the productivity of the excavator decreases. Vegetation growth generally increases with amount of organic matter incorporated in the mound capping. Careful monitoring will determine if brushing and weeding are required on sites with thick organic layers, although this may not be required where mounds are sufficiently large.

ep: **Excavator Patch Scarification** - the intent of this treatment is to remove zero or a very limited amount of mineral soil during treatment. This option requires that slash reduction and alignment of slash become components of the harvesting prescription (see Section 5.2.1), or excavators must windrow at time of patch scarification. As slash loading increases on slopes, the productivity of the excavator decreases.

lp: **Light Piling** - this category includes any equipment capable of placing slash in piles without the use of a blade (e.g., rake with retractable teeth excavator). This equipment should be capable of piling while causing very minimal disruption of the upper soil layers, including the humus. There will be minimal effect on competing vegetation and no increase in soil warming using this treatment.

md: **Mounding** - this category includes all site preparation equipment capable of producing well-distributed raised profiles of organic and/or mineral soil. On sites where heavy slash accumulations are expected, alignment of slash will become an important component of the harvesting prescription (see Section 5.2.1). Vegetation growth generally increases with amount of organic matter incorporated in the mound capping. Careful monitoring will determine if brushing and weeding are required on sites with thick organic layers. Soils that are fine and have blocky structure should not be mounded, unless using some form of mixed mounds. This is especially true on drier sites or in drier biogeoclimatic units.

mm: **Motor Manual** - this category includes brush saws and hand-held spot scarifiers. This option requires that slash reduction and alignment of slash become important components of the harvesting prescription (see Section 5.2.1). On sites where potentially competing species are present and will be stimulated by the action of the treatment chosen (e.g., thimbleberry if spot scarifying), large sturdy stock should be planted.

ps: **Patch Scarification** - this category includes all site preparation equipment capable of producing well-distributed patches of mineral soil for planting. The intent of this treatment is to remove the humus layer and a thin layer of mineral soil from the prepared patch. On sites where heavy slash accumulations are expected, alignment of slash will become an important component of the harvesting prescription (see Section 5.2.1). Patch scarification will generally stimulate species that regenerate from on-site seeding (e.g., fireweed and grasses) or rhizomes (e.g., thimbleberry). Brushing and weeding will be required if these types of species are present.

tr: **Trenching** - this category includes all site preparation equipment capable of producing shallow continuous trenches (e.g., disc trencher). Trenches should be made by contouring the slope where slopes are continuously or intermittently > 15%. Trenching will generally stimulate species that regenerate from on-site seeding (e.g., fireweed and grasses). Brushing and weeding will be required if these types of species are present. Trees should usually be planted high up on the hinge in the units covered by this guide. Trench depth should never exceed 2/3 of the effective rooting depth on the site (see Table 2).

5.2.1 Reducing slash during harvesting

Slash reduction to reduce fire and pest risks and improve planter access is often one of the reasons that site preparation is conducted. On ecologically sensitive sites, however, many site preparation techniques used to reduce slash may also damage the site. Slash can often be reduced during harvesting if the need is identified in the PHSP. There are several good references on the subject of reducing slash during harvesting. Two which should be referred to are *Treatment of Logging Residues: Alternatives to Prescribed Burning* (Hedin 1991) and *Alternatives to Prescribed Burning* (Burton 1991). Some of the techniques that can be used are slash alignment using feller-bunchers or grapples, increasing utilization, and on-site processing of residue (e.g., chipping).

5.3 Wildlife Interpretations

The following text provides information on habitat characteristics that are important to wildlife species assemblages. Section 5.3.1 provides a description of information found in Tables 18 and 19 and how it might be applied. Section 5.3.2 describes the wildlife habitats required for wildlife species of management concern. Descriptions of the information found in Tables 18 and 19 and how it might be applied are outlined in the following text.

5.3.1 Important Habitat Characteristics of Species Assemblages

Because much of B.C. is forested and many wildlife species have adapted to use forested habitats, maintenance and enhancement of wildlife will largely depend on the integration of forest and wildlife management. Forest road construction, timber harvesting, and silvicultural practices can strongly affect wildlife populations. Wildlife species have ecological requirements that dictate which habitats are suitable for them. These requirements reflect the strategies that species have evolved for finding food, avoiding predation. regulating temperature, or finding mates. By maintaining the ecological requirements for each species, the impact of forest practices on wildlife diversity can be minimized.

Wildlife species assemblages are delineated on the basis of shared habitat characteristics among many wildlife species. Within these species assemblages, certain habitat characteristics are of particular importance to the group. The coding and importance of the various habitat characteristics are outlined in the following commentary:

CWD: Coarse Woody Debris - this includes sound and rotting logs and stumps and provides cover for small mammals and their predators. It is widely used by invertebrates and hence as a foraging substrate by insectivorous birds. CWD provides nesting and denning sites for birds and larger mammals and can be important in courtship rituals. It provides a sheltered environment for reptiles and amphibians that cannot tolerate extremes of temperature or drought. CWD also provides subnivean access routes that are particularly important for Marten. CWD has a limited lifespan, depending on their size and degree of decomposition. CWD is vulnerable to destruction by prescribed fire. However, large diameter wood is generally only charred, especially if fire is used in spring or after heavy rain when fine fuels have dried out but larger fuels have not. Although charred logs are made more durable by fire hardening, they also become less valuable to wildlife in the short term as loose bark is removed and they are made too hard to be utilized by wood-boring insects.

DT: Deciduous Trees - this component is important to songbirds such as warblers, vireos and flycatchers as foraging and nesting areas. Many primary cavity nesters prefer aspen and cottonwood to conifers, probably because cavity excavation is easier. Living and dead cottonwood trees are particularly important because of their large size.

SP: Slash/Brush Piles - this structural feature provides snow interception and cover for small birds and mammals. As it is such an important structural attribute for voles, predators such as Marten, Red Fox, Coyote and weasels will benefit when piles are associated with corridors of standing trees or are within 75 m of block edges. Leaving small slash piles unburned

could increase populations of voles and porcupines.

WT: Wildlife Trees - otherwise known as snags and/or dying trees, these are important for cavity dwellers such as woodpeckers, Common and Barrow's Goldeneye, Marten and Fisher. They also provide perching sites for owls and raptors and foraging substrates for insectivorous birds. Bats commonly roost under the loose bark of snags. Small wildlife trees are used only by small species, such as the Downy Woodpecker, that require a tree of 15 cm dbh for nesting. Larger wildlife trees of at least 50 cm dbh are required by Pileated Woodpeckers for nesting. Many species such as Marten, Fisher, and cavity nesting ducks also require the large cavities excavated by Pileated Woodpeckers. Wildlife trees have a limited lifespan, depending on their size, species, and degree of decomposition, and isolated wildlife trees are of limited value to wildlife. A preferred option for wildlife tree management would be to leave groups of wildlife trees with some large green trees (future wildlife trees), possibly where harvesting would be difficult or uneconomical. Wildlife trees are vulnerable to destruction by prescribed fire, although larger diameter trees may be only charred, especially if fire is used in spring or after heavy rain when fine fuels have dried out but larger fuels have not. Although charred wildlife trees are made more durable by fire hardening, they also become less valuable to wildlife in the short term as loose bark is removed and they are made too hard to be utilized by many wood-boring insects or by cavity-excavating birds.

ED: Edges - these occur between vegetation types (such as mature timber-clearcut or forested wetland-mesic forest) and are important for species that utilize either area. Species using both areas often prefer the juxtaposition of habitat types. Edges also provide habitat for species that prefer the transition zone (ecotone) between them. Induced edge effects can be maximized by creating a few smaller clearcuts instead of one large one, by creating irregularly shaped clearcuts, and by extending the time between passes. Maximizing edge may be detrimental to species that require large tracts of undisturbed habitat.

LGS: Low-Gradient Streams - as one component of riparian habitats, these areas are extremely important for fish and wildlife. These areas provide a water source for many organisms and create a more moderate microclimate than is found in more upland forests. Streams may also function as corridors that facilitate genetic interchange, daily and seasonal movements, and range extension. Streams with gradients < 6% are valuable for many fish and wildlife species.

RU: Riparian Upland - this area is adjacent to the Riparian Area and usually is comprised of large, coniferous trees. The Riparian Upland is an important feeding and travel corridor for many wildlife species, particularly furbearers and large mammals. The effective width of a Riparian Upland depends on factors such as the type of water course (lake versus meandering river) and the surrounding topography (plateau versus steep mountain valley).

RZ: Riparian Area - these areas represent important wildlife habitats. A disproportionately high number of wildlife species are associated with these areas. Riparian Areas are found adjacent to the normal high water line around lakes, ponds, seeps, bogs, wetland meadows, springs, rivers, and streams. The Riparian Area is that domain where water has an influence on

the vegetation. The Riparian Area provides abundant vegetation for forage and cover, horizontal and vertical diversity, large invertebrate populations, and water sources for drinking. For many species, the habitat value of the Riparian Area is contingent on the ecotone created by the presence of the Riparian Upland.

SA: South Aspects - this feature, because of increased solar radiation, is associated with reduced snow accumulation. This favours many species of ungulates and furbearers. These sites are among the first sites to provide spring forage. South aspects have an increasingly marked influence as latitude increases.

SL: Shelter - provides thermal and hiding cover for all wildlife species. Thermal cover intercepts snow, rain, and wind and reduces the energy expenditure of wildlife. Hiding cover reduces the impact of predation on prey species. This is particularly important during birthing and hunting seasons.

SU: Spring use - occurs on those sites that provide important early season foraging opportunities. As such, it is closely related to southerly aspect and early disappearance of snow cover. These areas are important for hibernating species and for those that do not tolerate deep snow.

Seral Stage(s): this column within the tables indicates the seral stage(s) that are important to the wildlife species being managed for. Seral stages are defined on the basis of several attributes that change over time, including stand age, vegetation physiognomy, stand structure, mortality/replacement relationships and stand diversity. Figure 26 offers a schematic representation of various seral stages. The Seral Stage column in Tables 18 and 19 indicates the seral stages that are important for each wildlife species assemblage. For many assemblages a mosaic of seral stages is required across the landscape unit (e.g., a watershed). In certain instances where seral stage features are of critical importance (e.g., old-growth), retention during harvesting may be necessary. The importance, extent, and distribution of a certain ecological unit/seral stage combination within a management area (e.g., watershed) will assist in determining if the unit should be deferred from harvesting. The following descriptions are intended to assist in the recognition and classification of seral stages:

SH: Shrub-herb - this stage develops after a disturbance in which the forest canopy is completely or significantly removed (e.g., after clearcut logging or a severe fire) and typically lasts up to thirty years, although it may persist much longer. The vegetation is characterized by the dominance of shrubs and herbs; young trees are also abundant, although not dominant. Establishment is the primary process: biomass increases rapidly and floristic diversity is often high.

PS: Pole-sapling - this stage typically begins about thirty to fifty years after a disturbance, when the young trees overtop the shrubby or herbaceous vegetation. It usually lasts for up to fifty years, although dense, stagnant stands can persist much longer. Trees at this stage are characterized by their vigorous growth and lack of dead lower branches. Stands are more or less even-aged, having been planted or established naturally within a relatively short time. Establishment remains the dominant process with stand biomass continuing to increase. Understory biomass declines as the canopy closes in.

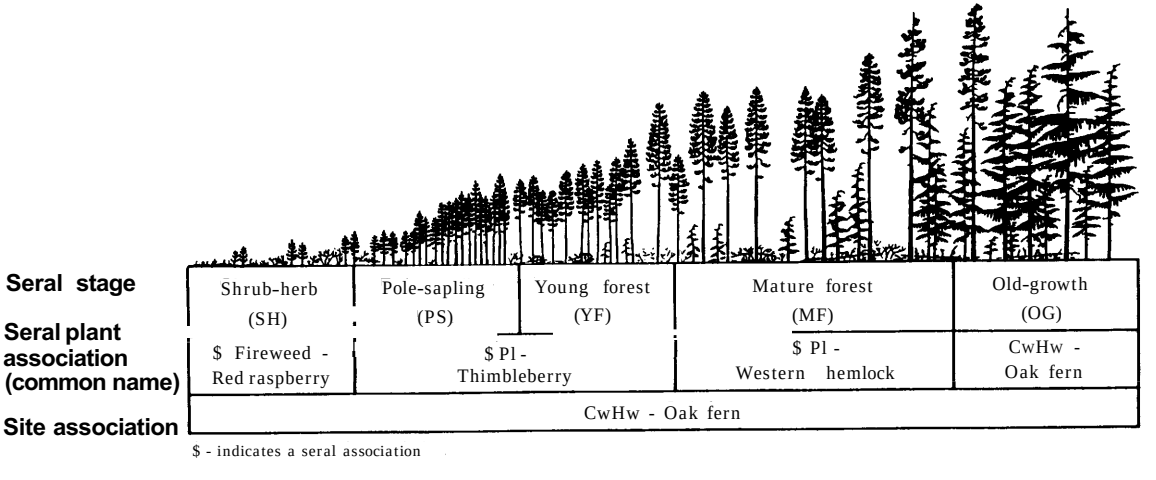


FIGURE 26. Example of forest structure associated with seral stages (from Hamilton 1988).

YF: Young Forest - this stage begins when self-thinning becomes evident. A second cycle of trees begin to show a significant presence in the ground layer by the end of this stage. Differentiation of the initial tree species into dominant, co-dominant and suppressed layers, self-thinning, low stand diversity, and increasing biomass through rapid height growth are characteristic of this stage. Understory development is often limited by the dense forest canopy. This stage usually starts about 80 years after a succession-initiating disturbance and lasts for up to fifty years. In open forests where self-thinning may not be evident and a second cycle of trees is lacking, this stage will be characterized more by the vigorous growth of the trees.

MF: Mature Forest - this stage extends until the initial trees mature, height growth slows, and some of the initial trees begin to die. A second cycle of trees may show a significant presence in the lower tree layers. In some cases the first cycle of trees may begin to die from old age before significant development of a replacement layer begins; in other cases the next cycle of trees may be well developed before significant mortality of the initial trees occurs. Generally, the even age distribution typical of early stages changes as new trees become established and older trees begin to die. Gap phase replacement may begin to be important at this stage. The understory re-develops as the canopy opens.

OG: Old-growth - old-growth stands generally have an all-age class distribution. Growth slows and volume is lost through rot. Stands show structural heterogeneity as gaps develop in the canopy after trees fall. The understory biomass increases as light becomes available. The presence of dead wildlife trees and rotting logs scattered on the forest floor enhances the value of forests at this seral stage for wildlife. This stage often begins from 150 - 250 years after a succession-initiating disturbance.

Important Forage Species: this column within Table 19 indicates what vegetation is important to each wildlife assemblage. The vegetation species are generally listed by their scientific seven letter code, the first four letters indicating the genus and the second three letters indicating the species. For example, thimbleberry *(Rubus parviflorus)* would be labelled *Rubu par.* Plant species presence and use by wildlife is a very important consideration when choosing site preparation and brushing and weeding options. Information on how some vegetation species are affected by different treatments is provided in A *Preliminary Guide to the Response of Major Species of Competing Vegetation to Silvicultural Treatments* (Coates and Haeussler 1986). In certain cases (e.g., *Bryoria* spp.) the species can only be retained by leaving older trees on the site.

5.3.2 Wildlife Species of Management Concern

Grouping wildlife into species assemblages is useful for broad-based resource management planning. However, there are some species for which this coarse-filter approach is not sufficient. Some species are of particular concern because of low population numbers, specialized habitat or space requirements, or gaps in our understanding of specific ecological requirements. These species require more focused management.

Many of the wildlife species in British Columbia and most of the species of management concern must be managed at the landscape level. These

species have habitat requirements that extend over large areas (10 000 - 90 000 ha). The need for particular habitats may be temporal, such as winter ranges and calving grounds, or spatial, such as denning and feeding sites. Management plans for these species must recognise that the effects of road development and stand level practices are cumulative. The timing and spatial distribution of all forestry activities within the landscape unit must be known in order to determine the implications for these wildlife species.

Grizzly Bear (Blue-listed species) - Manage at the landscape level. Grizzly Bears require large, relatively undeveloped tracts of land with a mosaic of vegetative types and seral stages. Timber harvesting and road layout must be planned to meet spatial and temporal concerns across the entire landscape unit. Critical feeding habitats or areas of high use should be identified and protected. These critical habitats include riparian areas, riparian uplands, berry patches, and avalanche chutes. Grizzly Bears are extremely sensitive to disturbance by humans, and it is essential that human intrusion into grizzly habitat is limited.

Caribou (Blue-listed species) - Manage at the landscape level. Two ecotypes of caribou, Mountain and Northern, exist in British Columbia. In winter, generally, Mountain Caribou feed on arboreal lichens and Northern Caribou crater through the snow and feed on terrestrial lichens. Both ecotypes avoid predation by maintaining low population densities over large undeveloped areas. Timber harvesting and road layout must be planned to meet spatial and temporal concerns across the entire landscape unit. The negative impacts of forestry operations are related to three issues: the impact of logging on winter ranges, the effects of road access on distribution and mortality rates, and the effects of habitat alterations on predator/prey relationships. See Tables 13 and 14 for application of silvicultural systems in Mountain Caribou habitat.

Wolverine (Blue-listed species) - Manage at the landscape level. These animals are solitary and wide-ranging. They require large, relatively undeveloped tracts of land with a mosaic of vegetative types and seral stages. Riparian areas and riparian uplands are critical for feeding and population dispersal. Timber harvesting and road layout must be planned to meet spatial and temporal concerns across the entire landscape unit. Wolverine are sensitive to human intrusions.

Fisher (Blue-listed species) - Manage at the landscape level. Fishers require the characteristics provided by old-growth and mature forests. Snags and coarse woody debris are important habitat elements. Riparian zones and riparian uplands provide for feeding and population dispersal.

Marten - Manage at the landscape level. The characteristics provided by old-growth and mature forests are required. An abundance of vertical and horizontal structure in the form of snags, live trees, and coarse woody debris are essential to provide subnivean access. Riparian zones and uplands are critical for feeding and population dispersal. Marten tend to avoid areas without suitable cover within 100 m. Cutblock design and timber-harvest rotation must be appropriate to maintain suitable habitat.

Little Brown Myotis - This bat requires snags in various states of decay. Day roosts may be under sloughing bark while overwintering roosts will be in caves or large-snag cavities. Riparian areas and riparian uplands are

vital for feeding sites due to the abundance of insects.

Big Brown Bat - Require snags in various states of decay. Day roosts may be under sloughing bark while overwintering roosts will be in caves or large-snag cavities. Riparian zones and riparian uplands are vital for feeding sites due to the abundance of insects.

Pileated Woodpecker - Manage at the landscape level. The species requires large tracts of suitable habitat. The breeding territory for a single pair may be as high as 240 ha. Moreover, large snags (> 50 cm dbh and over 10 m tall) are required for nesting and courtship displays.

Northern Goshawk - Manage at the landscape level. This is an interior-forest species and has habitat requirements linked to mature and old-growth forest characteristics. Maintenance of large tracts of intact mature forests is key to avoiding negative impacts of habitat fragmentation.

Great Gray Owl - Manage at the landscape level. The species requires large snags. This is an interior-forest species and has habitat requirements linked to mature and old-growth forest characteristics. Maintenance of large tracts of intact mature forests is key to avoiding negative impacts of habitat fragmentation.

Warblers - As a group, warblers use a variety of habitats. Some warblers require mature coniferous habitat while others require mature mixedwood or deciduous habitat. See Table 18 for red- and blue-listed species.

Stone Sheep (Blue-listed species) - Although Stone Sheep are associated with alpine and subalpine habitats, timber harvesting can have severe impacts on this species. Forestry roads provide access into remote areas. This has obvious implications for legal and illegal hunting pressures. Timber harvest also has the potential to isolate populations by removing cover from valley corridors that connect alpine areas. Timber harvesting and road layout must be planned to meet spatial and temporal concerns across the entire landscape unit.

Rocky Mountain Bighorn Sheep (Blue-listed species) - Although this species is associated with alpine and subalpine habitats, timber harvest can have severe impacts. Forestry roads provide access into remote areas. This has obvious implications for legal and illegal hunting pressures. Timber harvest also has the potential to isolate populations by removing cover from valley corridors that connect alpine areas. Timber harvesting and road layout must be planned to meet spatial and temporal concerns across the entire landscape unit.

Mountain Goat - Although Mountain Goats are associated with alpine and subalpine habitats, timber harvest can have severe impacts on this species. Mountain Goat populations are extremely sensitive to mortality of individuals. Forestry roads provide access into remote areas. This has obvious implications for legal and illegal hunting pressures, and can lead to animal-vehicle collisions. Timber harvesting also has the potential to isolate Mountain Goat populations by removing cover from valley bottom corridors that connect alpine areas. Timber harvesting and road layout must be planned to meet spatial and temporal concerns across the entire landscape unit.

TABLE 18. General habitat characteristics of representative bird species assemblages

Species Assemblages	Representative Species[1]	Important Habitat Characteristics	Seral Stages	Species of Management Concern
primary cavity-nesters, mainly in conifers	Black-backed Woodpecker, Three-toed Woodpecker, Pileated Woodpecker	WT	MF, OG	Blue List[2] - Swainson's Hawk Surf Scoter Yellow-bellied Flycatcher Short-eared Owl Sandhill Crane Redhead Philadelphia Vireo Long-eared Owl Eared Grebe Canvasback Bald Eagle Bay-breasted Warbler Black-throated Green Warbler Mourning Warbler Red List[3] - Canada Warbler Cape May Warbler Connecticut Warbler Sharp-tailed Sparrow Trumpeter Swan Western Grebe
primary cavity-nesters, mainly in deciduous trees	Red-breasted Sapsucker, Northern Flicker, Hairy Woodpecker	WT, DT	MF, OG	
secondary cavity-nesters	Barrow's Goldeneye, Common Goldeneye, Bufflhead, Hooded Merganser, Common Merganser, Northern Hawk Owl, Boreal Owl, Northern Saw-whet Owl; many passerines	WT, RZ, RU, LGS	MF	
ground-nesters near water	Eared Grebe, Canada Goose, Green-winged Teal, Mallard, Northern Pintail, Blue-winged Teal, Cinnamon Teal, American Wigeon, Ring-necked Duck, Lesser Scaup, White-winged Scoter	RZ, RU, LGS	MF	
deciduous tree and thicket dwellers	Ruffed Grouse, warblers, vireos, flycatchers, thrushes; other migrating passerines	CWD, ED	ALL[4]	
mature coniferous forest dwellers	Northern Goshawk, Red-breasted Nuthatch, Brown Creeper, Townsend's Warbler, Red Crossbill, Great Gray Owl	WT	MF, OG	
subalpine parkland dwellers	Golden-crowned Sparrow, Fox Sparrow, American Robin, Rufous Hummingbird		SH	

[1] Because of insufficient data on species occurrence in the ESSF, representative species and species of management concern are not necessarily found within the biogeoclimatic units covered in the guide.

[2] **Blue list** species are sensitive/vulnerable: indigenous species that are not threatened but are particularly at risk. The reasons include low or declining numbers, and occurrence at the fringe of their range or in restricted areas. Species that are generally suspected of being vulnerable, but for which information is too limited to allow designation in another category, are included in this category.

[3] **Red list** species are considered endangered or threatened or are being considered as potential designates because they run the risk of extirpation or extinction.

[4] Provision of required seral stages must occur as a mosaic across the landscape.

TABLE 19. General habitat characteristics of representative species assemblages

Species Assemblage	Representative Species[1]	Important Habitat Characteristics	Seral Stage	Important Forage Species	Species of Management Concern
Amphibians	Western Toad, Spotted Frog, Wood Frog, Long-toed Salamander	CWD, RZ, RU. LGS	MF, OG		Blue List[2] - Grizzly Bear Fisher Wolverine Mountain Caribou
Bats	Little Brown Myotis, Big Brown Bat	WT, RZ, RU	SH, MF, OF		
Small Mammals	shrews, voles, mice, lemmings, Chipmunk, Red Squirrel, Northern Flying Squirrel, Snowshoe Hare, Beaver, Muskrat	WT, CWD, SP, LGS, RZ, RU	ALL[3]		
Mid-sized Carnivores[4]	Fisher, Marten, Ermine, Least Weasel, Mink, Red Fox, Long-tailed Weasel, River Otter	WT, CWD, SP, RZ, RU	ALL		
Large Carnivores[4]	Grizzly Bear, Gray Wolf, Cougar, Black Bear, Lynx, Coyote, Wolverine	ED, SU, SL, RZ, RU	ALL,	*Equi* spp. *Hera lan*	
Ungulates[4]	Rocky Mountain Elk, Mule Deer, White-tailed deer, Rocky Mountain Bighorn Sheep, Mountain Goat, Moose, Stone Sheep, Mountain Caribou	ED, SA, SU, SI, RZ, RU	ALL	*Vacc* spp. *Rubu par* *Care* spp. Forbs *Epil ang*	

[1] Because of insufficient data on species occurrence in the ESSF, representative species and species of management concern are not necessarily found within the
[2] biogeoclimatic units covered in the guide.
Blue list species are sensitive/vulnerable: indigenous species that are not threatened but are particularly at risk The reasons include low or declining numbers, and occurrence at the fringe of their range or in restricted areas. Species that are generally suspected of being vulnerable, but for which information is too limited to allow designation in another category, are included in this category.
[3] Provision of required seral stages must occur as a mosaic across the landscape.
[4] Management is required at the landscape level.

APPENDIX 1. New names for biogeoclimatic and site units in the Northern Rockies portion of the Prince George Forest Region

Old Biogeoclimatic Units and Ecosystem Associations	New Biogeoclimatic Units and Site Series
ESSFn1	**ESSFmv2**
01 White-flowered Rhododendron - Black huckleberry	01 Bl - Rhododendron - Feathermoss
02 Pine - Black huckleberry	02 Bl - Lingonberry
03 Bunchberry - Stiff Clubmoss	01 Bl - Rhododendron - Feathermoss
04 White-flowered Rhododendron - Oak fern	04 Bl - Oak fern - Knight's plume
05 Pine - Black Spruce	03 BlSb - Labrador tea
06 Devil's club - Oak fern	05 Bl - Devil's club - Rhododendron
Not previously described	06 Bl - Alder - Horsetail
ESSFn2	**ESSFmv4**
01 White-flowered Rhododendron - Black huckleberry	01 Bl - Rhododendron - Feathermoss
02 Pine - Black huckleberry	02 BlPl - Crowberry - Cladina
03 White-flowered Rhododendron - Step moss	01 Bl - Rhododendron - Feathermoss
04 Currant - Gooseberry	04 Bl - Rhododendron - Horsetail
05 Pine - Black Spruce	03 BlSb - Labrador tea
06 Spruce - Horsetail	05 Bl - Alder - Horsetail
ESSFh3 (above 1300 m)	**ESSFwc3**
01 Rhododendron - Oak fern	01 Bl - Rhododendron - Oak fern
Not previously described	02 Bl- Rhododendron - Queen's cup
Not previously described	03 Bl - Globeflower - Horsetail
ESSFh3 (below 1300 m)	**ESSFwk2**
01 Rhododendron - Oak fern	01 Bl - Oakfern - Knight's plume
02 Rhododendron - Black huckleberry	02 Bl - Oakfern - Sarsaparilla
03 Devil's club - Oak fern	04 Bl - Devil's club - Rhododendron
04 Thimbleberry - Oak fern (in part)	03 Bl - Oakfern - Bluebells
04 Thimbleberry - Oak fern (in part)	05 Bl - Rhododendron - Lady fern
05 Rhododendron - Horsetail	06 Bl - Horsetail - Sphagnum
06 Bog Ecosystems	31 Non-forested Bog

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