A Field Guide for Site Identification and Interpretation for the Northern Rockies Portion of the Prince George Forest Region

C. DeLong, D. Tanner, and M.J. Jull
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1 INTRODUCTION

1.1 Objectives/Scope

This guide presents site identification and interpretation information for forest ecosystems of the northern Rockies portion of the Prince George Forest Region (Figure 1).

FIGURE 1. Biogeoclimatic units of the northern Rockies portion of the Prince George Forest Region.
The classification system used is the Biogeoclimatic Ecosystem Classification (BEC) developed for the province by the B.C. Ministry of Forests (Pojar et al. 1987, Meidinger and Pojar 1991). The principles have evolved from the work of V.J. Krajina (1965, 1969) and are described in Chapter 2. The objectives of this classification are:

- to provide a framework for organizing ecological information and management experience about ecosystems;
- to promote further understanding of identified ecosystems and the relationships among them;
- to supply resource managers with a common language to describe forest sites; and
- to improve the user’s ability to prescribe and monitor treatment regimes on a site-specific (ecosystem) basis.

The guide has two main goals:

- to assist the user in classifying sample sites in the field; and
- to provide interpretations for these site units that will assist the user in preparing management prescriptions.

This version of the guide results from the recent completion of an inter-regional correlation of the BEC system. The correlation project was completed to ensure the consistency and quality of the ecological information base across the province. This guide replaces the following guides for use in the Prince George Forest Region: MacKinnon and McLeod (1986) for the ESSFwc3 (previously ESSFh3 above 1300 m), MacKinnon and McLeod (1986) for the ESSFwk2 (previously ESSFh3 below 1300 m), MacKinnon and McLeod (1987a) for the ESSFmv2 (previously ESSFn1), and MacKinnon and McLeod (1987b) for the ESSFmv4 (previously ESSFn2). Appendix 1 presents the correlation between the previous site and biogeoclimatic units and this classification.

All sites slated for harvest are required by law to be classified according to the biogeoclimatic classification system, under the 1988 Silviculture Regulations for PHSP’s approved prior to April 1, 1994 and pursuant to the current Silviculture Practices Regulation for PHSP’s approved on or after April 1, 1994. The new Silviculture Practices Regulation also requires a biogeoclimatic map that includes any site-specific variation within the area i.e., site series (Silviculture Practices Regulation 1994).

### 1.2 Other Sources of Information

Vegetation, soils, and ecosystem description and classification information for the northern Rockies portion of the Prince George Forest Region and adjoining areas can be found in Vold (1977) and Harcombe (1978).

A more comprehensive discussion of the BEC system and more complete descriptions of units at broader levels within the hierarchical structure, particularly site associations and site groups, will be available in a series of biogeoclimatic zone reports to be published by the B.C. Ministry of Forests, Research Branch. Information at the biogeoclimatic zone level is available in Ecosystems of British Columbia (Meidinger and Pojar 1991).

An excellent reference for plant identification is Plants of Northern British Columbia (MacKinnon et al. 1992). Page numbers for plants used in site unit identification keys found in each biogeoclimatic unit subsection refer to this
publication. It is available at major book stores or from Lone Pine Publishing in Edmonton, Alberta.

1.3 Guide Contents

This guide consists of five chapters. Chapter 2 follows the introduction and is a brief discussion of the classification system. Chapter 3 provides procedures for site description, identification, mapping, and interpretation. Chapter 4 contains information about the biogeoclimatic units described, tools for identification of biogeoclimatic and site units, descriptions of the site units, and direct management interpretations for the identified site units. Chapter 5 presents indirect interpretations for silvicultural systems, site preparation, and for some wildlife species of management concern.

Biogeoclimatic unit maps (1:250 000 scale) to be used in conjunction with this guide are available from each Ministry of Forests district office or from the Forest Sciences Section, Prince George Forest Region.

The classification is based on approximately 167 plots located in the northern Rockies portion of the Prince George Forest Region. The plots are generally well distributed geographically, proportional to the size of the biogeoclimatic unit. Most site units are characterized by at least five plots, although certain less common sites (i.e., very dry and wet sites) are typically characterized by a smaller number of plots.

1.4 Training Courses

It is assumed that the user of this guide is familiar with the basic concepts and methods of site, soil, and vegetation evaluation and has completed the training programs offered by the Forest Sciences Section. These courses are offered annually in various locations within the region. For information about such training courses, please contact the Forest Sciences Section, Prince George Forest Region.

2 THE BIOGEOCLIMATIC ECOSYSTEM CLASSIFICATION (BEC) SYSTEM

This section briefly describes the biogeoclimatic classification system. For a more complete description refer to Ecosystems of British Columbia (Meidinger and Pojar 1991) or Biogeoclimatic Ecosystem Classification for British Columbia (Pojar et al. 1987).

2.1 Classification System

The BEC system is a hierarchical classification scheme that combines three classifications: climatic (or zonal), vegetation, and site. For practical purposes, users need only be concerned with the zonal and site classifications (Figure 2). The information presented in this guide will allow the user to apply BEC in the field.
Vegetation classification

- plant class
- plant order
- plant alliance
- plant association
- plant subassociation

Climax and zonal concepts

Zonal classification

- biogeoclimatic formation
- biogeoclimatic region
- biogeoclimatic zone
- biogeoclimatic subzone
- biogeoclimatic variant

Site classification

- site association
- site series
- site types

FIGURE 2. Hierarchical relationship between climatic-level (zonal) and site-level classifications (taken from Pojar et al. 1987). The highlighted classifications are described in this guide.
2.2 Zonal (Climatic) Classification

Biogeoclimatic units are the result of zonal (climatic) classification and they represent groups of ecosystems under the influence of the same regional climate. There is a hierarchy of climatic units, with the biogeoclimatic subzone as the basic unit. Subzones are grouped into zones, and divided into variants.

Data from long- and short-term stations have been used to help characterize subzones. Because climate stations are not well distributed within and among subzones, climax vegetation on zonal sites\(^1\) must serve as an indicator of the long-term climate of the area.

Each biogeoclimatic subzone has a distinct climax (or near-climax) plant association on zonal sites. Zonal sites have deep, broadly loamy soils and occupy midslope positions with mesic moisture regimes. The zonal climax vegetation is thought to best reflect the regional climatic conditions of the subzone.

Ecosystems within a subzone are influenced by this one type of regional climate. Edaphic (soil) and topographic conditions influence the climax vegetation of sites that are either drier or wetter than the zonal condition. Thus, subzones have distinctive sequences of related ecosystems ranging from dry to wet sites. For example, in a moist very cold variant of the Engelmann Spruce - Subalpine Fir (ESSF) zone, zonal sites are dominated by a white spruce and subalpine fir canopy with a diverse, moderately well-developed understory of shrubs and herbs; dry sites are dominated by a lodgepole pine and Engelmann spruce canopy with an understory dominated by shrubs; and wet sites in the same variant (regional climate) have Engelmann spruce overstories with an understory dominated by mountain alder and meadow horsetail.

The biogeoclimatic variant was defined because subzones contain considerable geographic variation. Variants reflect further differences in regional climate and are generally recognized for areas that are slightly drier, wetter, snowier, warmer, or colder than other areas in the subzone. For example, the Graham Moist Very Cold variant (ESSFmv4) of the ESSF is cooler and snowier than the Bullmoose Moist Very Cold variant (ESSFmv2) of the ESSF. These climatic differences result in corresponding differences in vegetation, soil, and ecosystem productivity. The differences in vegetation are evident as distinct zonal climax plant subassociations.

Subzones with similar climatic characteristics and zonal ecosystems are grouped into biogeoclimatic zones. A zone is a large geographic area with a broadly similar type of climate. A zone has typical patterns of vegetation and associated similarities in nutrient cycling and soil climate. Zones also have one or more typical zonal climax species of tree, shrub, herb, or moss.

Zones are usually named after one or more of the dominant climax species in zonal ecosystems and a geographic or climatic modifier (e.g., Engelmann Spruce - Subalpine Fir zone). Zones are given a two- to four-letter code that corresponds to the name. For example, the Engelmann Spruce - Subalpine Fir zone code is ESSF.

\(^1\) Zonal sites are sites that best reflect the mesoclimate or regional climate of an area.
Subzone names are derived from classes of relative precipitation and temperature. Subzone codes correspond to the climatic modifiers (Table 1). For example, the ESSFmm refers to the moist mild (mm) subzone of the Engelmann Spruce - Subalpine Fir (ESSF) zone. Variants are named by geographic area and numbered from south to north and from west to east. Hence, the ESSFmv2 variant is more southerly than the ESSFmv4 variant.

TABLE 1. System of naming and coding interior biogeoclimatic units

<table>
<thead>
<tr>
<th>ZONE ab</th>
</tr>
</thead>
<tbody>
<tr>
<td>a = precipitation regime b = temperature regime</td>
</tr>
<tr>
<td>x = very dry h = hot</td>
</tr>
<tr>
<td>d = dry w = warm</td>
</tr>
<tr>
<td>m = moist m = mild</td>
</tr>
<tr>
<td>w = wet k = cool</td>
</tr>
<tr>
<td>v = very wet c = cold v = very cold</td>
</tr>
</tbody>
</table>

2.3 Site Classification

The site series is the most commonly used unit of site classification (Figure 2). Site series occur within a biogeoclimatic subzone or variant. They are defined by using late seral or climax vegetation. This results in site units having similar environmental properties and vegetation. The potential vegetation and selected environmental properties are used in this guide to characterize site series.

Each biogeoclimatic unit has a characteristic sequence of site series according to soil moisture regime (SMR) and, to a lesser degree, soil nutrient regime (SNR). Soil moisture regime is a relative scale of "available water" for plant growth within the climate of the biogeoclimatic unit. An eight-class scale is used; it ranges from 0 or very xeric (bare rock) to 7 or subhydric (water tables at or near the surface year round). Soil nutrient regime is a relative scale of "available nutrients" for plant growth. A five-class scale ranging from A (very poor) to E (very rich) is used. An example of where sites with different combinations of SMR and SNR would occur on a typical landscape within the guide area is presented in Figure 3.

Common names of one to four species are used to name site series, and tree species codes are usually substituted to shorten the name (e.g., Bl - Rhododendron - Oak fern site series).

Similar plant communities can occur in different biogeoclimatic units, but the relative moisture regime that they represent may differ among subzones. These communities belong to the same grouping of site series that is collectively called a site association.3

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2 The site identification section (Section 3.4) contains soil moisture and soil nutrient regime identification information.

3 Site associations are not used in the classification presented in this manual. They are defined in Pojar et al. (1987).
FIGURE 3. Typical sequence of combinations of relative soil moisture and soil nutrient regime within the guide area.
For example:

- ESSFmv2/Bl - Oak fern - Knight's plume site series = ESSFmv2/04
- ESSFwk1/Bl - Oak fern - Knight's plume site series = ESSFwk1/03
- ESSFwk2/Bl - Oak fern - Knight's plume site series = ESSFwk2/01

All three of these site series belong to the same site association, so their climax vegetation is similar, but their occurrence in the landscape, site conditions, and seral vegetation patterns may differ among the three biogeoclimatic units.

Each site series is given a two-digit numeric code that relates to its position on the relative moisture and nutrient scales. Within a biogeoclimatic unit, the forested units are numbered as follows: the 01 site series is the zonal or mesic site, with the rest ranked from driest (02) to wettest (generally 09 to 12) and, secondarily, poorest to richest. Seral and non-forested units use higher-order numbers to keep them distinct from the forested units. For example, grasslands are assigned numbers from 80 to 90.

Management interpretations are often made directly at the site series level. In some cases, however, interpretations are most efficiently dealt with at broader or finer levels of the classification. For example, interpretations less sensitive to site-level differences (e.g., wildlife) can be generalized for a group of related site series, while those affected more by variations in site and soil conditions than by climate or vegetation (e.g., site preparation) must be developed at the site series or finer level. See Sections 3.7 and 5 for further explanation of these interpretations.

### 3 PROCEDURES FOR SITE DESCRIPTION, IDENTIFICATION, MAPPING, AND INTERPRETATION

#### 3.1 Introduction

Ecological site identification consists of collecting accurate site, soil, and vegetation information, and then using the various tools and descriptive material presented in the guide to identify the site unit that best fits the information collected. The development of an appropriate management prescription depends on accurate site description and other site-specific data (e.g., slope gradient, soil texture), as well as correct site unit identification. Combining site identification with the collection of site, soil, and vegetation data provides the most complete ecological description of the site.

The guide user must understand that there is much more natural variability in the forests than is portrayed in this field guide: thus, not every ecosystem encountered will be easily "pigeonholed" into an existing classification unit. The "cookbook" approach to site identification and interpretation is not encouraged. This field guide is intended to promote ecological thinking and a better understanding of forest ecosystems.

The guide assumes that the user has a basic knowledge of ecosystem classification concepts, soils description, and plant identification. Field courses coordinated by regional Forest Sciences staff are held in most forest districts.
(depending on demand) in the Prince George Forest Region every summer. Pre-Harvest Silvicultural Prescription (PHSP) and silviculture survey courses, which have an ecological classification component, are also held annually. Regional Forest Sciences staff are available to assist with problems associated with field descriptions, identification, and management interpretations. The two sections that follow provide a complete description of tools for biogeoclimatic and site unit identification. Once on-site information has been gathered, a site can be identified using the step-by-step procedures outlined in the Site Identification section (Section 3.4). Information for mapping site units and using the interpretations portions of the guide are discussed in Sections 3.6 and 3.7, respectively.

### 3.2 Identifying Biogeoclimatic Units (Subzone/Variant)

The following is a list of the tools available for assisting the user in identifying and describing biogeoclimatic units.

**Biogeoclimatic maps:** Available at a scale of 1:250 000 from the regional Forest Sciences Section or from district offices, these maps provide a relatively detailed portrayal of geographic distribution of the biogeoclimatic units. This information will also be available in digital format within the inventory database so that it can be accessed in a variety of ways using Geographic Information System (GIS) capabilities. The biogeoclimatic map should be referred to before leaving the office, but should not be relied on totally, especially if the area is near biogeoclimatic unit boundaries or in complex, mountainous terrain.

**Biogeoclimatic/Vegetation summary table:** This table displays important vegetative differences among the biogeoclimatic units described as well as for bordering units not described in the guide. This table compares vegetation that is found on zonal sites (refer to Section 2.2). Once a zonal site has been identified, this table can be used either to identify or to reaffirm the identification of a biogeoclimatic unit.

**Biogeoclimatic unit summary page:** This page, located at the front of each biogeoclimatic unit subsection, contains a brief summary of geographic location, elevation range, climate, physiography, and wildlife, and lists key vegetation features to assist in distinguishing between adjoining biogeoclimatic units. The distinguishing features, location, and elevation range information can assist in the identification of a biogeoclimatic unit. The remainder of the information is useful as background material related to the particular biogeoclimatic unit.

### 3.3 Identifying Site Units

The following is a list of the tools available for assisting the user in identifying site units.

**Edatopic grid** The edatopic grid displays the relative position of each of the site series along the gradients of moisture and nutrient regime within a subzone or variant. Once relative moisture and nutrient regimes are determined (see Section 3.4), the unit(s) generally associated with that moisture and nutrient regime can be identified from the grid.
Vegetation table: This table indicates the prominence of widespread diagnostic species by site series for each biogeoclimatic unit. Prominence values are derived by multiplying the square root of species constancy by mean cover. For example, when a species is present in 100% of sample plots (i.e., constancy = 100) and has a mean cover of 5%, the prominence equals 50. Five prominence value classes are displayed by different-sized bars within the tables.

<table>
<thead>
<tr>
<th>Prominence Value</th>
<th>Prominence Class</th>
<th>Schematic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5 - 15</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>16 - 50</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>51 - 100</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>101 - 200</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>201+</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

In general, the vegetation tables contain species that are useful in differentiating among site units. The actual abundance of plant species on any given site depends on several factors, including the successional status of the site and the type and degree of disturbance that initiated succession. The table values are derived from plots in mature forests (80 years or older). These tables should not be used in seral (i.e., early successional) stands that do not have a closed canopy (see Section 3.5). A possible solution is to find a mature stand adjacent to the seral stand, but the user must be fairly certain that this stand represents the same ecological unit as the site being assessed (e.g., same slope position, soil texture, etc.).

Site series key: The dichotomous key uses a series of paired statements containing a combination of site, soil, and vegetation features to direct the user to a site series identification. Since the lead statements often refer to the tree canopy and any understory vegetation comments relate to mature sites, the keys work best on sites that have achieved crown closure. When attempting to use the keys on disturbed sites, the user must have some knowledge of the canopy dominance prior to disturbance and must not rely on the understory vegetation features described in the key. Alternatively, an adjacent mature stand could be used, though the user must be fairly certain that the stand represents the same ecological unit as the site being assessed (e.g., same slope position, soil texture, etc.).

Site series summary page: For each site series there is a one-page summary of vegetation, site, and soil features. The vegetation list contains species that are found consistently (> 60% constancy) and develop reasonable cover (>1%). They are listed in order of constancy, and then in order of percent cover within the same level of constancy. Species in square brackets do not occur consistently (i.e., < 60% constancy), but when they do occur they have high cover. Three plants that generally characterize the unit are illustrated along the left-hand margin. For each site and soil feature, the range in conditions encountered during BEC sampling is indicated. Note that the range indicated may not completely express the true range of variability that may be encountered. Soil texture classes refer to those displayed on the soil texture triangle in Figure 5. Features preceded by an asterisk (*) are ones that can generally be relied on to differentiate or characterize the site.
3.4 Site Identification

This section outlines a step-by-step procedure to identify a site series. This procedure should be used until the user becomes intimately familiar with the site identification process and the site units in his or her area of operation.

Step 1

Locate an area for your assessment that appears to be representative of the unit being sampled, and is as homogeneous in plant cover and overstory canopy condition as possible. Avoid locating the sample area on sites that have recently received significant natural or artificial disturbance (e.g., landings).

Step 2

Determine and record site and soil information important for site identification and the prescription process. Table 2 lists some of the more important site and soil factors to be collected. (Note that more detailed site and soil information may be required for certain purposes.) Tools that will help you assess some of the factors include the mesoslope position diagram (Figure 4), soil texture table and key (Section 3.4.1), and humus form summary table (Table 5).

TABLE 2. Site and soil factors to be collected

<table>
<thead>
<tr>
<th>Factor</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope gradient (%)</td>
<td>measure of a slope’s incline; equals vertical rise divided by horizontal distance (100% slope = 45° angle).</td>
</tr>
<tr>
<td>Aspect (°)</td>
<td>the compass direction a slope is facing.</td>
</tr>
<tr>
<td>Slope position</td>
<td>relative position of sampling site within a catchment area (e.g., between slope breaks affecting surface water flow; see Figure 4).</td>
</tr>
<tr>
<td>Soil texture</td>
<td>relative proportion of sand, silt, and clay; defined proportions comprising textural classes (see Section 3.4.1).</td>
</tr>
<tr>
<td>Coarse fragments (%)</td>
<td>% by volume of mineral soil fragments greater than 2 mm in diameter.</td>
</tr>
<tr>
<td>Effective rooting depth (cm)</td>
<td>subjective assessment indicating the greatest depth to which root systems of forest trees freely penetrate; depth at which rooting abundance classes drop to “few” (see Luttmerding et al. 1990).</td>
</tr>
<tr>
<td>Depth to a restricting layer (cm)</td>
<td>depth to a soil layer or condition that severely restricts root penetration (e.g., compact parent material or bedrock).</td>
</tr>
<tr>
<td>Depth to seepage water (gleying) (cm)</td>
<td>depth to area in soil profile from which water is seeping out; evidence of periodic seepage during the growing season may be indicated by gleying (orange-coloured mottles within a generally olive- to blue-coloured soil matrix).</td>
</tr>
<tr>
<td>Humus depth (cm)</td>
<td>depth of group of horizons located at the soil surface that have formed primarily from organic materials, and that may include mineral soil intermixed with organic material.</td>
</tr>
<tr>
<td>Humus form</td>
<td>the quality of the humus layer classed into three main orders (mor, moder, mull) based on the rate and mode (fungal vs. animal) of decomposition within the layer (Table 5).</td>
</tr>
</tbody>
</table>
3.4.1 Hand texturing guides

Soil texture refers to the relative proportions of the sand, silt, and clay separates within a soil. These separates have their own distinctive properties of "feel," allowing one to estimate their proportions in a sample of soil by hand texturing. To obtain accurate results, texturing must be done with a sample that has the correct moisture content as described below. Both a table (Table 3) and a key procedure (Figure 5) are provided. The user should become familiar with both and use the procedure that feels most comfortable.

PROCEDURE FOR HAND TEXTURING USING TABLE 3

1. Crush a small handful of soil in the hand, and remove coarse fragments (particles greater than 2 mm in diameter).

2. Gradually add water to the soil and, with a soil knife or fingers, work it into a moist putty. The correct moisture content is important. If the putty flows with the force of gravity it is too wet. If it crumbles when rolled it is too dry. It should have the consistency of filler putty. Determine stickiness of the soil putty by working it between the thumb and forefinger, pressing and then separating the digits. An estimate of clay content can be made in this way. (Clay limits below are approximate.)

    - **non-sticky:** Practically no soil material adheres to the thumb and forefinger (less than 10% clay).
    - **slightly sticky:** Soil material adheres only to one of the digits and comes off the other rather cleanly. The soil does not stretch appreciably when digits are separated (10-25% clay).
    - **sticky:** Soil material adheres to both digits and stretches slightly before breaking when digits are pulled apart (25-40% clay).
**very sticky:** Soil putty adheres strongly to both digits and stretches distinctly before breaking (greater than 40% clay).

4. Determine the graininess of the soil putty by rubbing it between thumb and forefinger. An estimate of sand content can be made in this way. (Sand limits below are approximate.)

- **non-grainy:** Little or no graininess can be felt (less than 20% sand).
- **slightly grainy:** Some graininess is felt, but non-grainy material (silt and clay) is dominant (20-50% sand).
- **grainy:** Sand is felt as the dominant material. Some non-grainy material can be felt between sand grains (50-80% sand).
- **very grainy:** Sand is the only material felt. Little or no non-grainy material is present (> 80% sand).

5. After stickiness and graininess have been determined, use the texturing table as an approximate guide to the textural class of the soil. The textural triangle found in Figure 5 can be used for more accurately determining the textural class and it also displays the textural class used in the site unit descriptions.

### TABLE 3. Hand texturing guide**a**

<table>
<thead>
<tr>
<th>Very Sticky</th>
<th>Non-grainy (&lt;20% sand)</th>
<th>Slightly Grainy (20-50% sand)</th>
<th>Grainy (50-80% sand)</th>
<th>Very Grainy (&gt;80% sand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&gt;40% clay)</td>
<td>Silty Clay</td>
<td>Clay</td>
<td>Sandy Clay</td>
<td></td>
</tr>
<tr>
<td>Sticky</td>
<td>Silty Clay</td>
<td>Clay Loam</td>
<td>Sandy Clay</td>
<td></td>
</tr>
<tr>
<td>(25-40% clay)</td>
<td>Loam</td>
<td></td>
<td>Loam</td>
<td></td>
</tr>
<tr>
<td>Slightly Sticky</td>
<td>Silt Loam or Silt</td>
<td>Loam^b</td>
<td>Sandy Loam</td>
<td></td>
</tr>
<tr>
<td>(10-25% clay)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-sticky</td>
<td></td>
<td></td>
<td>Loamy Sand</td>
<td></td>
</tr>
<tr>
<td>(&lt;10% clay)</td>
<td></td>
<td></td>
<td>or Sand</td>
<td></td>
</tr>
</tbody>
</table>

**a** Sand and clay limits are approximate.

**b** A loam is a textural class exhibiting physical properties intermediate between those of sand, silt, and clay.

### TABLE 4. Properties of soil separates

<table>
<thead>
<tr>
<th>Clay</th>
<th>Silt</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>very hard when dry; feels smooth and is very sticky when wet; feels smooth when placed between teeth.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>slightly hard to soft when dry; powder is floury when dry; feels slippery and slightly sticky when wet; silt cannot be felt as grains between thumb and forefinger, but can be felt as a fine graininess when placed between teeth.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>loose grains when dry; very grainy when felt between thumb and forefinger; non-sticky when wet.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Soil Texturing Key

Taste Test**
Worm Test
Stickiness Test

Moist Cast Test
Graininess Test
Moist Cast Test
Taste Test (grittiness)
(Grainy Matter Test)
Stickiness Test
Soupiness Test
Worm Test

START

SAND
non-gritty
non-sticky
worm: none
(85-100% sand)

forms no cast
(<10% clay)

moderate cast
(easily handled)
non to s.sticky
(<30% clay)

SILT
s.gritty
s.soapy
worm: none or >3 mm dia
(0-20% sand)

SILT LOAM
gritty to v.gritty
soapy to v.soapy
worm: none, or 3 mm dia
(0-50% sand)

LOAM
s.gritty to gritty
s.soapy to soapy
worm: none, or may equal 3 mm dia
(25-50% sand)

SILTY CLAY LOAM
s.gritty to gritty
s.soapy to soapy
worm: 3-1.5 mm dia
(0-20% sand)

CLAY LOAM
non-gritty to s.gritty
non-soapy to s.soapy
worm: 3-1.5 mm dia
(20-45% sand)

LOAMY SAND
non to s.gritty
non to s.sticky
worm: none
(70-90% sand)

v.weak cast
(no handling)
(<15% clay)

SL
weak cast
(careful handling)
(<20% clay)

SL
strong cast
(v.easily handled)
sticky
(30-40% clay)

FINE SANDY LOAM
gritty to v.gritty
non to s.sticky
worm: none, or 3 mm dia
(45-85% fine sand)

moderate cast
(easily handled)
(<20% clay)

SILTY SAND
v.gritty
v.soapy
worm: none or >3 mm dia
(0-20% sand)

SILT
v.gritty
v.soapy
worm: none or >3 mm dia
(0-20% sand)

FINE CLAY LOAM
non-gritty to s.gritty
non-soapy to s.soapy
worm: 3-1.5 mm dia
(20-45% sand)
SANDY CLAY LOAM SCL
non to s.gritty
s.sticky to sticky
worm: 3 mm dia
(45-80% sand)

SANDY CLAY SC
non-gritty
sticky to v sticky
worm: 3-1.5 mm dia
(45-65% sand)

SILTY CLAY SIC
s.gritty to gritty
s.soapy to soapy
worm: strong, 1.5 mm dia
(0-20% sand)

CLAY or C or HEAVY CLAY HC
non-gritty to s.gritty
non-soapy to s.soapy
worm: strong, 1.5 mm dia
(0-45% sand)

>30% organic matter
v.strong cast
(v.easily handled)

ORGANIC
(o) (no texture)

Silt feels slippery or soapy when wet; fine sand feels
tiffer, like grinding compound or fine sand paper.

Key to Abbreviations Measurement Conversions
s = slightly
v = very
dia = diameter

3.0 mm = 1/8" 1.5 mm = 1/16"

Fine Fraction (particle diameter)
SAND ------------ (S) 2 - .05 mm
SILT ----------- (Si) .05 - .002 mm
CLAY ----------- (C) <.002 mm
HEAVY CLAY - (HC) >60% Clay
LOAM ----------- (L) mix of Sand, Silt, and Clay

FIGURE 5. Soil texturing key (from Braumandl and Curran 1992).
DESCRIPTION OF SOIL TEXTURING TESTS

1. **Organic matter test:** Well-decomposed organic matter (humus) imparts silt-like properties to the soil. It feels floury when dry and slippery or spongy when moist, but not sticky and not plastic. However, when subjected to a taste test (see below), it feels non-gritty. It is generally very dark when moist or wet, and stains the hands brown or black.

2. **Graininess test:** Rub the soil between your fingers. If sand is present, it will feel "grainy." Determine whether sand comprises more or less than 50% of the sample. Sandy soils often sound gritty when worked in the hand.

3. **Moist cast test:** Compress some moist (not wet) soil by clenching it in your hand. If the soil holds together (i.e., forms a "cast"), then test the durability of the cast by tossing it from hand to hand. The more durable it is (e.g., like plasticine), the more clay is present.

4. **Stickiness test:** Wet the soil thoroughly and compress between thumb and forefinger. Determine the degree of stickiness by noting how strongly the soil adheres to the thumb and forefinger when you release the pressure, and by how much it stretches. Stickiness increases with clay content.

5. **Taste test:** Work a small amount of soil between your front teeth. Silt particles are distinguished as fine "grittiness" (e.g., like driving on a dusty road), unlike sand, which is distinguished as individual grains (i.e., graininess). Clay has absolutely no grittiness.

6. **Soapiness test:** Slide thumb and forefinger over wet soil. Degree of soapiness is determined by how soapy/slippery it feels and how much resistance to slip there is (i.e., from clay and sand particles).

7. **Worm test:** Roll some moist soil on your palm with your finger to form the longest, thinnest "worm" possible. The more clay there is in the soil, the longer, thinner, and more durable the worm will be. Try with wetter or drier soil to ensure that you have the correct moisture content (best worm).
### TABLE 5. Identification of upland humus forms

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mors</td>
<td>- matted F horizon&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>- common fungal mycelium</td>
</tr>
<tr>
<td></td>
<td>- little or no intermixing of organic and mineral materials</td>
</tr>
<tr>
<td></td>
<td>- abrupt boundary between organic and mineral horizons</td>
</tr>
<tr>
<td></td>
<td>- loosely arranged F horizon</td>
</tr>
<tr>
<td></td>
<td>- friable&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>- insect droppings</td>
</tr>
<tr>
<td></td>
<td>- fungal mycelium and soil organisms (arthropods and occasional earthworms)</td>
</tr>
<tr>
<td></td>
<td>- intermixing of organic and mineral horizons</td>
</tr>
<tr>
<td></td>
<td>- gradual transition between mineral and organic horizons</td>
</tr>
<tr>
<td>Moders</td>
<td>- often no F or H horizons &lt;sup&gt;c&lt;/sup&gt; (thin if present)</td>
</tr>
<tr>
<td></td>
<td>- insect droppings abundant</td>
</tr>
<tr>
<td></td>
<td>- usually many soil organisms, but may form from decomposition of a dense network of roots (usually abundant earthworms)</td>
</tr>
<tr>
<td></td>
<td>- considerable intermixing of mineral and organic layers, with incorporation of organic matter into surface mineral soil (Ah horizon&lt;sup&gt;d&lt;/sup&gt;)</td>
</tr>
<tr>
<td>Mulls</td>
<td>- dense network of roots (usually abundant earthworms)</td>
</tr>
<tr>
<td></td>
<td>- incorporation of organic matter into surface mineral soil (Ah horizon)</td>
</tr>
</tbody>
</table>

<sup>a</sup> F horizon: horizon in which partial (rather than entire) macroscopically recognizable vegetative structures are dominant (i.e., the horizon is partially decomposed). Residues break down upon rubbing.

<sup>b</sup> Friable: Residues break down upon rubbing.

<sup>c</sup> H horizon: horizon of highly decomposed organic matter in which original plant vegetative structures are no longer identifiable.

<sup>d</sup> Ah horizon: surface mineral horizon enriched with organic matter (characteristically darker in colour than lower soil layers).
Step 3

Using the site and soil factors recorded, determine the relative moisture regime and relative nutrient regime using the keys provided (Figure 6 and 7), and then proceed to Step 4.

TABLE 6. Definitions of terms used in the identification of relative soil moisture regimes

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ridge crest</td>
<td>height of land; usually convex slope shape.</td>
</tr>
<tr>
<td>Upper slope</td>
<td>the generally convex-shaped, upper portion of a slope.</td>
</tr>
<tr>
<td>Middle slope</td>
<td>the portion of a slope between the upper and lower slopes; the slope shape is usually straight.</td>
</tr>
<tr>
<td>Lower slope</td>
<td>the area towards the base of a slope; the slope shape is usually concave. It includes toe slopes, which are generally level areas located directly below and adjacent to the lower slope.</td>
</tr>
<tr>
<td>Flat</td>
<td>any level area (excluding the slopes); the surface shape is generally horizontal with no significant aspect.</td>
</tr>
<tr>
<td>Alluvium</td>
<td>post-glacial, active floodplain deposits along rivers and streams in valley bottoms; usually a series of low benches and channels.</td>
</tr>
<tr>
<td>Depression</td>
<td>any area that is concave in all directions; usually at the foot of a slope or in flat topography.</td>
</tr>
<tr>
<td>Soil depth</td>
<td>depth from the mineral soil surface to a restricting layer, such as bedrock, strongly compacted materials, or strongly cemented materials (e.g., &quot;hardpan&quot;).</td>
</tr>
<tr>
<td>Gleyed</td>
<td>soils that have orange-coloured mottles indicative of a fluctuating water table. Permanently gleyed sods are dull yellowish, blue, or olive in colour.</td>
</tr>
<tr>
<td>Soil particle size coarse</td>
<td>sand$^b$ with $&gt; 35%$ volume of coarse fragments, or loamy$^b$ with $&gt; 70%$ volume of coarse fragments.</td>
</tr>
<tr>
<td>Soil particle size fine</td>
<td>silty$^b$ or clayey$^b$ with $&lt; 20%$ volume of coarse fragments.</td>
</tr>
</tbody>
</table>

$^a$ Adapted from Lloyd et al. (1990) and Green et al. (1984).

$^b$ Sandy - LS, S; loamy - SL, L, SCL, clayey - SiCL, CL, SC, SiC, C; silty - SiL, Si.

Relative soil moisture regimes: Figure 6 is intended to assist the user in identifying relative soil moisture regimes using readily observable environmental features. It should be applied with caution on ridge crests, upper slopes, and middle slopes that have soils with thick (> 20 cm) organic layers, and on steep, northerly facing slopes. Moisture regime in these cases will generally be higher than indicated. The soil moisture regime classes 1 - 7, shown in the key, correspond to the terms very xeric (0) to subhydric (7) (see Figure 3). Table 6 provides definitions for the categories used in the key shown in Figure 6.
A key to the identification of soil moisture regimes

FIGURE 6. A key to the identification of relative soil moisture regimes.

1 Generally moister if aspect is N or NE
2 Generally drier if aspects S or SW
1a Coarse textured 

2a High coarse fragments (> 50%), very shallow soil (< 30 cm), and/or shallow rooting depth (< 15 cm)

3a Mor humus form Very Poor
3b Moder humus form Poor - Medium

2b Moderate to low coarse fragments without restricted rooting depth

4a Mor humus form Poor
4b Moder humus form Medium
4c Mull humus form Rich - Very Rich

1b Moderately coarse and medium textured

5a High coarse fragments (> 50%), very shallow soil (< 30 cm), and/or shallow rooting depth (< 15 cm)

6a Mor humus form Poor
6b Moder humus form Medium

5b Moderate to low coarse fragments without restricted rooting depth

7a Mor humus form Poor - Medium
7b Moder humus form Medium - Rich
7c Mull humus form Very Rich

1c Moderately fine and tine textured

8a High coarse fragments (rare), very shallow soil (< 30 cm), and/or shallow rooting depth (< 15 cm)

9a Mor humus form Poor - Very Poor
9b Moder humus form Poor - Medium
9c Mull humus form Rich

8b Moderate to low coarse fragments without restricted rooting depth

10a Mor humus form Medium
10b Moder or Mull humus form Rich

FIGURE 7. Key for estimating relative soil nutrient regimes. Note: presence of base-rich parent materials (limestone, shale, basalt) may improve nutrient status.

---

4 Refer to soil textural triangle (p.15) for derivation of soil textures.
Step 4

From a plot area of at least 0.04 ha (20 x 20 m), identify and record as many of the plant species (including tree species) in the plot as possible. Estimate the percent cover of each of the dominant species (i.e., species covering > 5% of the plot). Attempt to adjust the list and coverage estimates according to what you have seen over the remainder of the area covered by the same unit.

Step 5

If the biogeoclimatic unit has been previously determined, proceed to the appropriate biogeoclimatic unit subsection (Table 7). If not, use Figure 8 to determine it. Note that the vegetation used in Figure 8 is that occurring on zonal sites (e.g., edatopic grid 4-C) (see Section 2.2). If the site unit is other than zonal, try to locate a zonal site in the area and note the general floristic features (e.g., dominant tree and understory species), and compare this information to that found in Figure 8. If the area in question is near a subzone boundary and doubt remains after the verification step using Figure 8, then identify the site unit for both possible biogeoclimatic units. The descriptions and interpretations for both units should then be compared, and the most appropriate information applied.

<table>
<thead>
<tr>
<th>Biogeoclimatic Unit</th>
<th>Section</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESSFmv2</td>
<td>4.1</td>
<td>31</td>
</tr>
<tr>
<td>ESSFmv4</td>
<td>4.2</td>
<td>49</td>
</tr>
<tr>
<td>ESSFwc3</td>
<td>4.3</td>
<td>65</td>
</tr>
<tr>
<td>ESSFwk2</td>
<td>4.4</td>
<td>77</td>
</tr>
<tr>
<td>Biogeoclimatic units</td>
<td>SBS mk2</td>
<td>ESSF mv2</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>Trees</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinus contorta</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Picea glauca × engelmannii</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Abies lasiocarpa</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosa acicularis</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Viburnum edule</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Vaccinium membranaceum</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Rhododendron albiflorum</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Oplonanx horridus</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td><strong>Herbs and Dwarf Shrubs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aralia nudicaulis</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Clintonia uniflora</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Arnica cordifolia</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Rubus pubescens</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Rubus pedatus</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Veratrum viride</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Valeriana sitchensis</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Tiarella trifoliata</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Gymnocarpium dryopteris</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td><strong>Mosses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hylocomium splendens</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Mnium spp.</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

Figure 8. Zonal vegetation of biogeoclimatic units within and adjacent to area covered by the guide.
3.5 Identifying Seral Ecosystems

The biogeoclimatic classification was developed based on samples of climax and late seral vegetation (forest stands older than 80 years). Because of this, environmental features must be more heavily relied upon when attempting to assess recently disturbed or seral sites. Since there can be considerable overlap in environmental features among site series, disturbed sites are often difficult to identify. Remnant climax vegetation found in portions of the site not subjected to burning or heavy mechanical site preparation may help in the assessment. Otherwise, vegetation found in an adjacent mature stand with similar environmental features (e.g., same slope position, soil texture, etc.) can be used.

3.6 Mapping Site Units

An ecosystem map is an extremely useful tool for effective integrated planning within a management area. It provides a permanent record of the location and distribution of ecosystems, and thus a basic framework for developing site-specific management prescriptions that can be prepared for many resource values. A map also provides a means of monitoring prescriptions in the long term, and of refining interpretations. Pre-Harvest Silviculture Prescriptions (PHSPs) legally require biogeoclimatic classification of proposed cutblocks. Having done this, the extra effort required to produce a map of a small management area during an ecological stand survey is minimal. If the survey is initiated with mapping in mind, a more systematic, efficient, and thorough survey will result.

The steps involved in producing an ecosystem (or treatment unit) map at a scale of 1:5000 to 1:20 000 for a relatively small management unit (less than 500 ha) are outlined below. More complex ecosystem maps of large study areas (watersheds or local resource use planning areas) are generally produced by mapping specialists. Several consultants with experience in these larger projects are available throughout the province. Mitchell et al. (1989) outline standard methods and terminology for ecosystem mapping used by the Ministry of Forests, and Courtin et al. (1989) describe an approach to woodlot management that incorporates ecological stand mapping. The user should refer to these publications for greater detail on mapping concepts and procedures. The major steps required to produce an ecological stand map are: (1) production of a preliminary legend, (2) pre-stratification (typing polygons) of aerial photographs, (3) systematic field survey, (4) refinement of photo typing and labelling of map polygons, and (5) production of the final map.

3.6.1 Producing a preliminary legend

In its simplest form, a legend is a listing and explanation of abbreviations (numbers, letters, symbols) used to denote the site units that occur within the map area. For the most part, the listing of site units described for each of the biogeoclimatic units will serve as a preliminary legend. Other stand or site attributes can also be added, depending on the requirements of the survey. For example, symbols for stand age, tree species composition, or percentage of slope might supplement the site unit numbers or letters. Such a legend will enable you to place a preliminary label on polygons (map delineations) outlined on the aerial photos.
3.6.2 Typing aerial photographs

Assuming that aerial photographs of an appropriate scale are available (preferably 1:10 000 colour, but 1:20 000 or 1:15 840 black-and-white are also used), the next step is to delineate (using a stereoscope and grease pencil) logical, homogeneous units on the photos that reflect ecological site characteristics. Many features visible on aerial photos provide clues to identifying ecological site units. Important features to note are landform, slope position and degree, slope shape (concave versus convex), aspect, drainage pattern, and canopy characteristics (based on tone and texture) that will reflect crown closure, species composition, and relative growth or productivity. Skills improve with practice and with ground truthing of photo typing to calibrate the eyes. Use the various tools in the guide, and your experience, to predict which site units occur in each of your types (polygons). Then, put a tentative label (using site series numbers or other abbreviations from your legend) on each. Complex polygons comprised of two or three units require more checking on the ground. Polygons should not generally be smaller than 1 cm², which represents 0.25 ha and 1 ha at 1:5000 and 1:10 000 scales, respectively. Exceptions to this would be small, easily recognizable features such as wetlands and clearings, which aid in orientation and or may require special consideration.

3.6.3 Field surveys (ground truthing)

Accurately typed photos facilitate efficient field sampling. Once the typing is complete, compile a sampling plan, ensuring that at least two plots are present in each type. Complex types may require more plots. After establishing plots, sample and describe each of the types and identify site units as outlined in Section 3.4. Transects through the area should be walked with a compass and hip chain, in order to cover all the polygons that were pre-stratified. Take care to locate your plots and transects accurately on the photo. In addition to recording the plot information, take notes as you walk, and record changes that occur at specified distances along the transects.

3.6.4 Refining and labelling map polygons

The next step is to refine the map polygon boundaries and labels on the aerial photos, based on the results of the field survey. As the transects and sample plots are completed in the field, type lines and labels are modified while the information is fresh in your mind. The legend may have to be modified to accommodate previously undescribed units. Once back in the office, finalize the linework, polygon labels, and legend. It may be desirable to combine similar polygons into "treatment units" if you feel that the units are not significantly different ecologically to warrant different operational treatments. It is preferable, however, to maintain as much detail as possible on the original map. From this, more generalized interpretive maps can be produced for specific applications.

3.6.5 Producing the final map

The exact form of the final map will depend on its proposed use and the resources available to produce it. The final product may range from a simple sketch map to a sophisticated colour-themed digital (computer-generated) map. For small settings, where the topography does not vary
much and the map is not very complex, it may be adequate to trace the photo linework and some of the important planimetric detail (streams, lakes, roads) onto a mylar in order to produce the final map. For larger maps encompassing more than two aerial photos, or where the topography is variable and steep, the linework will have to be transferred to a base map using special plotting equipment (e.g., a Kail plotter, zoom transfer scope, or epidiascope) that corrects for distortion of scale on the photos. There are several mapping firms throughout the province that specialize in Geographic Information Systems (GIS) and the production of digital map products, either directly from aerial photos or from a plotted map. Digital maps are extremely useful for permanent storage of a large amount of field data by map polygon. They are ideal for producing interpretive maps and monitoring long-term treatments tied to specific map units.

3.7 Management Interpretations

Interpretations are provided in two areas of the guide. Within the biogeoclimatic unit subsections (4.1 - 4.4) are direct interpretations. These relate to specific site units and are contained on the page facing the appropriate unit. Section 5 contains interpretations that can be made at a more general level than the site series or those that are best handled by indirect interpretation methods that incorporate factors other than moisture and nutrient regime.

3.7.1 Direct interpretations

On the page facing each site unit description is a variety of direct interpretations that have been grouped under the subheadings described below.

**Site limitations:** This section contains statements about ecological conditions that may place limitations on forest productivity or forest operations. The limitations may be either generally applicable to the site unit, or specific to sites with a particular, identified ecological condition. For example, the phrase "sites within this unit with thick organic horizons (>10 cm) have reduced spring soil temperatures, slowing root development" refers only to sites within the site unit that have organic horizons >10 cm thick. After each site limitation listed there are recommendations to deal with the limitation. This information is in **bold italic**.

**Silviculture system:** This section contains information on silviculture system options, or directs the user to the appropriate section. Harvesting recommendations or cautions are also contained here.

**Site preparation:** This section contains site preparation options or directs the user to site preparation keys in Section 5.2. Specific comments relating to site preparation may also be found here.

**Species choice:** This section contains species selection information that has been correlated at the site series level across the province. General use species are shown in normal type. Species that have one or more restrictions are in **bold italic**. The restrictions relating to species in **bold**
italic are found in one of three sections: site limitations, reforestation, or concerns. When users encounter a species in bold italic, restrictions applicable to that species should be determined by examining these sections. Species found in square brackets (e.g., [Pl]) are species of secondary choice due to a lower ranking of reliability, productivity, or silvicultural feasibility. Species indicated with round brackets (e.g., (Sb)) are generally significantly less productive than other ecologically acceptable species on the site unit. These species are restricted to comprising a minor proportion (e.g., 20-30%) of the stand or area. These species could be used in only a few localities or blocks within an area, as a minor component of all plantations, or only in test trials. The most recent version of the correlated tree species selection guidelines (Silvicultural Interpretations Working Group 1993) was used to compile the species choice lists. Minor discrepancies may surface, however, so the user of the guide should attempt to get the most up-to-date guidelines before making final choices.

Vegetation potential: This section subjectively rates the potential of the site to produce shrubby and herbaceous vegetation following disturbances such as timber harvesting. Plant species posing the greatest potential threat to the crop trees target growth are listed in brackets when the potential is rated moderate or greater. Before treatments are prescribed to manage these species, the Wildlife Interpretations Section (Section 5.3) should be used to determine the importance of the species present to wildlife.

Reforestation: This section contains specific instructions related to reforestation on the site unit (e.g., try to preserve advance regeneration if it is abundant and likely to release and form an acceptable stand).

Concerns: This section contains concerns of which the user should be aware when preparing a prescription or carrying out forestry operations on a site. Potential solutions to alleviate these concerns are indicated in bold italic where appropriate.

3.7.2 Indirect and general interpretations

Indirect and general interpretations are contained within the following sections: Silviculture Systems (Section 5.1), Site Preparation (Section 5.2), and Wildlife (Section 5.3). Users should familiarize themselves with this information when using the guide.
4 BIOGEOCLIMATIC AND SITE UNIT DESCRIPTIONS AND DIRECT INTERPRETATIONS

The area which this guide covers is entirely within the Engelmann Spruce - Subalpine Fir (ESSF) zone (Figure 1). The ESSF biogeoclimatic units covered by this guide occur above the Interior Cedar Hemlock (ICH) zone in the southwest, above the Sub-boreal Spruce (SBS) zone in the northwest, and above the Boreal White and Black Spruce (BWBS) zone in the east. Above the ESSF forests are open parkland forests and alpine tundra. Being at high elevation (generally > 1000 m), the climate of the area is cold. Precipitation is variable with the windward slopes of the Rocky Mountains, characterized by the ESSFwk2 and ESSFwc3, being wetter than the lee slopes, characterized by the ESSFmv2 and ESSFmv4 (Table 8).

The ESSF has climax forests dominated by Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). In the ESSFmv variants, lodgepole pine (*Pinus contorta*) predominates on drier sites, and is found in combination with black spruce (*Picea mariana*) on poor sites. The understory is characteristically dominated by white-flowered rhododendron (*Rhododendron albiflorum*) which differentiates these sites from surrounding sites in other zones. Figure 8 compares characteristic vegetation of the different biogeoclimatic units described and can be a useful tool in determining biogeoclimatic units in the field, especially near unit boundaries. Table 9 summarizes important wildlife species which use the variants described. The four variants described in this guide are: ESSFmv2, ESSFmv4, ESSFwk2, and ESSFwc3.
TABLE 8. Summary of climate data for biogeoclimatic units within the guide area

<table>
<thead>
<tr>
<th>Climatic Characteristics</th>
<th>ESSFwc3</th>
<th>ESSFwk2</th>
<th>ESSFmv2</th>
<th>ESSFmv4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Precipitation (mm)</td>
<td>Mean</td>
<td>1408.5</td>
<td>1537.8</td>
<td>780.4</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>1177.1-1624.7</td>
<td>1190.4-1737.8</td>
<td>414.2 - 1259.3</td>
</tr>
<tr>
<td>Growing Season Precipitation (mm)</td>
<td>Mean</td>
<td>510.3</td>
<td>456.7</td>
<td>368.9</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>401.6-631.0</td>
<td>229.9-683.7</td>
<td>243.8 - 507.5</td>
</tr>
<tr>
<td>Annual Snowfall (cm)</td>
<td>Mean</td>
<td>782.1</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual Temperature (°C)</td>
<td>Mean</td>
<td>-1.0</td>
<td>0.3</td>
<td>-0.3</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>-3.1-1.1</td>
<td>-0.5-1.0</td>
<td>-0.9-1.9</td>
</tr>
<tr>
<td>Growing Degree Days (&gt;5° C)</td>
<td>Mean</td>
<td>671</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Frost-Free Period (days)</td>
<td>Mean</td>
<td>75</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>


<sup>b</sup> N/A: not available.
TABLE 9. Some important wildlife species that utilize ESSF variants described in the guide

<table>
<thead>
<tr>
<th>Species</th>
<th>ESSFmv2</th>
<th>ESSFmv4</th>
<th>ESSFwk2</th>
<th>ESSFwc3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain Goat</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Rocky Mountain Bighorn Sheep *</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone Sheep</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Caribou a</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elk</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moose</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Mule Deer</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>White-tailed Deer</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Grizzly Bear a</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Furbearers</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

4.1 Bullmoose Moist Very Cold Engelmann Spruce - Subalpine Fir\(^5\)

**Location**
The ESSFmv2 occurs predominantly east of the Rocky Mountain divide as far south as Willmore Wilderness Park and as far north as the Peace Arm of Williston Reservoir. It generally occurs between 1000 - 1400 m, and above the SBSwk2 (MacKinnon et al. 1990) or BWBSwk1 (Delong et al. 1990).

**Elevation range**
950 - 1550 m

**Climate**
The ESSFmv2 variant is the driest and coldest of the lower elevation ESSF variants, for which there are data, in the Prince George Forest Region. The coldness of this variant reflects its northern position and its dryness reflects its lee position with respect to the Rocky Mountains (Table 8).

**Soils, Geology and Landforms**
This variant lies within the Rocky Mountain Foothills. Bedrock types consist predominantly of sandstones and shales of Jurassic and Cretaceous age, with minor amounts of limestone and dolomite of Devonian age. Colluvial deposits have gravely coarse and medium textures related to the bedrock from which they were derived, and have soil profiles somewhat less strongly developed than those occurring on morainal materials of similar texture (i.e., Regosols and Brunisols vs. Podzols, Luvisols and Brunisols).

**Distinguishing the ESSFmv2 from adjoining biogeoclimatic units**

- **SBSwk2 has:**
  - more highbush-cranberry but less white-flowered rhododendron in the shrub layer; and
  - trembling aspen and paper birch that occur occasionally in the canopy.

- **BWBSwk1 has:**
  - less subalpine fir present in the canopy;
  - prickly rose but no white-flowered rhododendron in the shrub layer; and
  - more trailing raspberry but less five-leaved bramble in the herb layer, especially on mesic sites.

- **ESSFmv4 has:**
  - fewer sites dominated by devil's club and oak fern.

- **ESSFwk2 has:**
  - more oak fern and one- and three-leaved foamflower on mesic and wetter sites.

**Forests**
Like most ESSF forests, climax forests in the ESSFmv2 are dominated by Engelmann spruce and subalpine fir. A greater incidence of fire than is found in most ESSF forests has led to a larger portion of the stands being dominated by lodgepole pine. Mixtures of lodgepole pine and black spruce also occur on

---

\(^5\) Formerly ESSFn1
poor sites at the lower elevational extent of this variant.

**Wildlife**
The ESSFmv2 supports a wide variety of wildlife. Towards the southern portions of this variant, wind-swept ridges with terrestrial lichen are used by Caribou during heavy snowfall years. Alpine habitat associated with high elevation sites near tree line are used by Caribou in the summer. More rugged sites near escape terrain are used by Mountain Goats, especially in the winter. South of Narraway River, the most northerly population of Rocky Mountain Bighorn Sheep frequently summer near tree line if in proximity to high elevation lakes. Stone Sheep use lower elevation grass/shrub sites near the Peace Arm of Williston Reservoir and upper elevation grass/shrub sites north of the Hart Highway when these habitats are located near escape terrain. Coniferous stands are used by Elk during their annual movements from summer alpine habitats to winter open grass/aspen shrubland habitats. Moose are found throughout this variant in the summer. The higher foothills and mountain slopes support Mule Deer and White-tailed Deer in the summer. Mature coniferous forests are used by Wolverine, Marten, Red Squirrel, and Spruce Grouse. Mixed-aged stands with small openings and edges support Wolverine, Fisher, Grizzly Bear, and Great Horned Owl.
Soil nutrient regime

Very poor  Poor  Medium  Rich  Very rich
A         B         C         D         E

Soil moisture regime

Very xeric

Xeric

Subxeric

Submesic

Mesic

Subhygic

Hygric

Subhydric

01 Bl- Rhododendron - Feathermoss
02 Bl- Lingonberry
03 BlSb - Labrador tea
04 Bl- Oak fern - Knight's plume
05 Bl- Devil's club - Rhododendron
06 Bl- Alder - Horsetail

FIGURE 9. Edatopic grid displaying site series of the ESSFmv2 variant.
<table>
<thead>
<tr>
<th>Site units</th>
<th>02</th>
<th>03</th>
<th>01</th>
<th>04</th>
<th>05</th>
<th>06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinus contorta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picea mariana</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abies lasiocarpa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picea engelmannii</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shrubs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shepherdia canadensis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccinium membranaceum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ledum groenlandicum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhododendron albiflorum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ribes lacustre</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oplopanax horridus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubus idaeus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbs and Dwarf Shrubs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccinium vitis-idaea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linnaea borealis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubus pedatus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lycopodium annotinum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cornus canadensis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnocarpium dryopteris</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tiarella spp.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Equisetum spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mosses and Lichens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cladonia spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plueroziun schreberi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mnium spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 10. ESSFmv2 vegetation table.
1a Canopy dominated by lodgepole pine or a combination of black spruce and lodgepole pine; occurring on mid to crest slope positions.

2a Canopy dominated by a combination of black spruce and lodgepole pine; Ledum groenlandicum (p. 40) present; generally occurring on mid-slope position.

ESSFmv2/03

2b Canopy dominated by lodgepole pine; Ledum groenlandicum absent; generally occurring on upper or crest slope positions.

ESSFmv2/02

1b Canopy dominated by Engelmann spruce or subalpine fir, black spruce and/or lodgepole pine minor or absent; occurring on mid to level and depressional slope positions.

3a Canopy often dominated by Engelmann spruce; Oplopanax horridus (p. 36) or Equisetum spp. (p. 280) abundant (> 10% cover).

4a Occurring on level or depressional slope positions near open water or bogs; Equisetum spp. abundant, Oplopanax horridus absent.

ESSFmv2/06

4b Generally occurring on lower slope or toe slope positions; Equisetum spp. absent, Oplopanax horridus abundant.

ESSFmv2/05

3b Canopy dominated by Engelmann spruce or subalpine fir; Oplopanax horridus and Equisetum spp. low cover (< 1% cover) or absent.

5a Generally occurring in mid to lower slope positions; Gymnocarpium dryopteris (p. 293) moderate cover (> 1% cover).

ESSFmv2/04

5b Slope position variable but often mid; Gymnocarpium dryopteris low cover (< 1% cover) or absent.

ESSFmv2/01

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6 Page numbers refer to the publication Plants of Northern British Columbia (MacKinnon et al. 1992).
VEGETATION

Tree Layer: 40% cover
Engelmann spruce, subalpine fir, (lodgepole pine)

Shrub Layer: 60% cover
Rhododendron albiflorum (white-flowered rhododendron)
Vaccinium membranaceum (black huckleberry)
Ribes lacustre (black gooseberry)
subalpine fir

Herb Layer: 35% cover
Cornus canadensis (bunchberry)
Orthilia secunda (one-sided wintergreen)
Lycopodium annotinum (stiff clubmoss)
Arnica cordifolia (heart-leaved arnica)
[Rubus pedatus (five-leaved bramble)]
[Linnaea borealis (twinflower)]

Moss Layer: 70% cover
Ptilium crista-castrensis (knight's plume)
Pleurozium schreberi (red-stemmed feathermoss)
[Hylocomium splendens (step moss)]

SOIL AND SITE

Moisture Regime: 3-4 (sm-m)
Nutrient Regime: B-C (p-m)
Slope Gradient (%): 0-53
* Slope Position: mid (upper - lower)
* Parent Material: variable, often morainal or colluvial over rock

* Soil Texture:
Coarse Fragments (%): 6-57 (usually less than 30)
Seepage Water: rarely present

DISTRIBUTION: very common
**Bl · Rhododendron · Feathermoss (ESSFmv2/01)**

## 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 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:
- moderate (white-flowered rhododendron, 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.**
- 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.**
- tomentosus root rot may cause low to moderate problems in mature spruce-dominated stands.
VEGETATION

Tree Layer: 35% cover
Lodgepole pine, Engelmann spruce

Shrub Layer: 80% cover
Vaccinium membranaceum (black huckleberry)
Rhododendron albiflorum (white-flowered rhododendron)
[Alnus tenuifolia (mountain alder)]
[Alnus crispa ssp. sinuata (Sitka alder)]
subalpine fir

Herb Layer: 20% cover
Cornus canadensis (bunchberry)
Linnaea borealis (twinflower)
Orthilia secunda (one-sided wintergreen)
[Vaccinium vitis-idaea (lingonberry)]

Moss Layer: 40% cover
Pleurozium schreberi (red-stemmed feathermoss)
Ptilium crista-castrensis (knight’s plume)
Cladonia spp. (cladonia lichens)
Peltigera spp. (peltigera lichens)
[Dicranum spp. (dicranum mosses)]
[Hylocomium splendens (step moss)]

SOIL AND SITE

Moisture Regime: 2-3 (sx-sm)
Nutrient Regime: B-C (p-m)
Slope Gradient (%): 0-49
* Slope Position: crest or upper
colluvial or morainal over rock
* Parent Material: coarse
* Soil Texture:
Coarse Fragments (%): 20-75

DISTRIBUTION: uncommon

COMMENTS: based on limited data
BI - Lingonberry (ESSFmv2/02)

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
VEGETATION

Tree Layer: 35% cover
Lodgepole pine, black spruce

Shrub Layer: 60% cover
- *Vaccinium membranaceum* (black huckleberry)
- *Ledum groenlandicum* (Labrador tea)
- *Rhododendron albiflorum* (white-flowered rhododendron)
- *Vaccinium myrtillusoides* (velvet-leaved blueberry)
- Subalpine fir
- Black spruce

Herb Layer: 12% cover
- *Cornus canadensis* (bunchberry)
- *Vaccinium vitis-idaea* (lingonberry)
- *Rubus pedatus* (five-leaved bramble)
- *Lycopodium annotinum* (stiff clubmoss)
- *Empetrum nigrum* (crowberry)
- *Linnaea borealis* (twinflower)

Moss Layer: 80% cover
- *Pleurozium schreberi* (red-stemmed feathermoss)
- *Cladonia spp.* (cladonia lichens)
- *Ptilium crista-castrensis* (knight’s plume)
- *Hylocomium splendens* (step moss)
- *Peltigera spp.* (peltigera lichens)

SOIL AND SITE

- Moisture Regime: 3-6 (sm-hg)
- Nutrient Regime: A-B (vp-p)
- *Slope Gradient (%): 0-49, generally < 10
- *Slope Position: variable, often level or mid
- *Parent Material: morainal or colluvial
- *Soil Texture: coarse to medium
- *Coarse Fragments (%): 0-80, often > 40

DISTRIBUTION: common

COMMENTS: sites in this unit always have one or both of black spruce and *Ledum groenlandicum*
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.
- soils are saturated in the spring, but may experience drought in summer, both resulting in poor root development; poor productivity resulting from these limitations should dictate a limited intensive silvicultural investment.

Silviculture system: - see Section 5.1
- minimize or align large slash accumulations when logging to help meet site preparation objectives and reduce fire hazard.

Site preparation: - light scarification for seed bed preparation or summer logging with no site preparation.

Species choice: - Bl, Pl, Se, (Sb)

Vegetation potential: - low

Reforestation: - attempt to regenerate naturally if potential exists.

Concerns: - full tree harvesting will lead to nutrient depletion and seriously reduce cones; woody debris and cones should be distributed across these sites (i.e., lop and scatter).
- frost will cause regeneration damage, especially in any naturally occurring or artificially created depressions; leaving a partial canopy and/or planting a frost-resistant species (e.g., Pl) is advised.
- heavy snowpack may cause stem deformity, especially on steep slopes; obstacle planting is advised.
- trafficability may be a problem on these sites during the summer.
- western gall rust can cause stem damage and mortality in lodgepole pine stands.
VEGETATION

Tree Layer: 40% cover
Engelmann spruce, subalpine fir, [lodgepole pine]

Shrub Layer: 40% cover

- *Rhododendron albiflorum* (white-flowered rhododendron)
- *Vaccinium membranaceum* (black huckleberry)
- *Ribes lacustre* (black gooseberry)
- *Sorbus scopulina* (western mountain-ash)
subalpine fir
Engelmann spruce

Herb Layer: 55% cover

- *Gymnocarpium dryopteris* (oak fern)
- *Rubus pedatus* (five-leaved bramble)
- *Cornus canadensis* (bunchberry)
- *Lycopodium annotinum* (stiff clubmoss)
- *Streptopus amplexifolius* (clasping twistedstalk)
- *Valeriana sitchensis* (Sitka valerian)
- *Orthilia secunda* (one-sided wintergreen)
- *Veratrum viride* (Indian hellebore)
- *[Tiarella trifoliata]* (three-leaved foamflower)

Moss Layer: 50% cover

- *Pleurozium schreberi* (red-stemmed feathermoss)
- *Ptilium crista-castrensis* (knight’s plume)
- *[Hylocomium splendens]* (step moss)
- *[Mnium spp.]* (leafy mosses)

SOIL AND SITE

- Moisture Regime: 4-5 (m-shg)
- Nutrient Regime: C-D (m-r)
- * Slope Gradient (%): 0-50, often < 20
- * Slope Position: mid - toe or depression
- * Parent Material: variable, often morainal
- * Soil Texture: medium - coarse
- * Coarse Fragments (%): 5-58

DISTRIBUTION: common
**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.
- 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 (white-flowered rhododendron, fireweed, Sitka alder)

**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.*
- if heavy equipment is used in summer, during or after partial cutting, every attempt should be made to avoid disturbing roots of standing trees.
- tomentosus root rot may cause low to moderate problems in mature spruce-dominated stands.
### VEGETATION

**Tree Layer:** 25% cover  
Engelmann spruce, subalpine fir

**Shrub Layer:** 70% cover  
*Rhododendron albiflorum* (white-flowered rhododendron)  
*Oplopanax horridus* (devil's club)  
*Ribes lacustre* (black gooseberry)  
*Vaccinium ovalifoillum* (oval-leaved blueberry)  
*Rubus parviflorus* (thimbleberry)  
*Vaccinium membranaceum* (black huckleberry)  
subalpine fir

**Herb Layer:** 80% cover  
*Cornus canadensis* (bunchberry)  
*Gymnocarpium dryopteris* (oak fern)  
*Tiarella trifoliata* (three-leaved foamflower)  
*Rubus pedatus* (five-leaved bramble)  
*Streptopus roseus* (rosy twistedstalk)  
*Clintonia uniflora* (queen's cup)  
*Lycopus ovalifoillum* (stiff clubmoss)  
*Streptopus amplexifolius* (clasping twistedstalk)

**Moss Layer:** 60% cover  
*Pleurozium schreberi* (red-stemmed feathermoss)  
*Ptilium crista-castrensis* (knight’s plume)  
*Dicranum fuscescens* (curly heron’s-bill moss)

### SOIL AND SITE

- **Moisture Regime:** 5 (shg)  
- **Nutrient Regime:** D-E (r-vr)  
- **Slope Gradient (%):** 0-53  
- **Slope Position:** lower toe  
- **Parent Material:** morainal, colluvial, or glaciofluvial  
- **Soil Texture:** variable  
- **Coarse Fragments (%):** 11-57

### DISTRIBUTION: common
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 (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.
- 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: - very high (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.**
- if heavy equipment is used in summer, during or after partial cutting, every attempt should be made to avoid disturbing roots of standing trees.
- sites within this unit with fine-textured soils are vulnerable to compaction under wet conditions; **restrict traffic to winter operations.**
- sites within this unit with 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.
VEGETATION

Tree Layer: 25% cover
Engelmann spruce, lodgepole pine

Shrub Layer: 70% cover
- *Alnus tenuifolia* (mountain alder)
- *Rhododendron albiflorum* (white-flowered rhododendron)
- *Ribes lacustre* (black gooseberry)
- *Rubus idaeus* (red raspberry)

Herb Layer: 80% cover
- *Equisetum pratense* (meadow horsetail)
- *Cornus canadensis* (bunchberry)
- *Gymnocarpium dryopteris* (oak fern)
- *Calamagrostis canadensis* (bluejoint)
- *Rubus pubescens* (trailing raspberry)
- *Arnica cordifolia* (heart-leaved arnica)
- *Equisetum arvense* (common horsetail)

Moss Layer: 80% cover
- *Brachythecium* spp. (ragged mosses)
- *Ptilium crista-castrensis* (knight’s plume)
- *Hylocomium splendens* (step moss)
- *Mnium* spp. (leafy mosses)

SOIL AND SITE

- Moisture Regime: 5-6 (shg-h)
- Nutrient Regime: C-D (m-r)
- Slope Gradient (%): 0-12
- Slope Position: level or depressional
- Parent Material: morainal or fluvial
- Soil Texture: coarse to medium
- Coarse Fragments (%): 0-35

DISTRIBUTION: uncommon and small in size

COMMENTS: based on limited data
**B1- Alder - Horsetail (ESSFmv2/06)**

**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.**
- 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)
- 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, [Pl]**

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

**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:**
- 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 high water tables, combined with thick organic horizons (>10 cm), have increased windthrow hazard; **block layouts must have wind-firm boundaries.**
- Water table will likely rise above the ground surface in the spring, causing seedling mortality.
- These units represent important wildlife habitat; **discuss prescription with fish and wildlife personnel.**
- This unit is critical to the control of runoff streamflow.
4.2 Graham Moist Very Cold Engelmann Spruce - Subalpine Fir

Location
The ESSFmv4 occurs predominantly east of the Rocky Mountain divide as far south as the Peace Arm of Williston Reservoir and as far north as Cypress Creek. It generally occurs between the elevations of 1000 - 1400 m, and above the SBSwk2 (MacKinnon et al. 1990) or BWBSwk2 (DeLong et al. 1990).

Elevation range
950 - 1550 m

Climate
There are no available climatic data for the ESSFmv4 variant but it likely has a similar climate to the ESSFmv2 (Section 4.1). Since it is situated north of the ESSFmv2 it is likely to be somewhat colder, especially during the winter.

Soils, geology and landforms
The bulk of this subzone is within the Muskwa Range of the Rocky Mountains and the adjacent foothills. Bedrock consists of Precambrian metamorphic and sedimentary rocks east of the Williston Reservoir, and Paleozoic limestone, sandstone, and shales farther east. Parent materials are predominantly morainal and colluvial with variable textures related to the underlying bedrock. Soil genetic types consist dominantly of Brunisols and Luvisols in the Rocky Mountain Foothills, with Podzols occurring mostly on non-calcareous parent materials in the Rocky Mountains. A small portion of this subzone lies west of the Williston Reservoir within the Butler Range of the Omineca Mountains. Colluvial and morainal materials of varying thickness cover the underlying Precambrian sedimentary bedrock. Soils include Humo-Ferric Podzols and Dystric Brunisols.

Distinguishing the ESSFmv4 from adjoining biogeoclimatic units
SBSwk2 has:
- more highbush-cranberry but less white-flowered rhododendron in the shrub layer; and
- trembling aspen and paper birch that occur occasionally in the canopy.

BWBSwk2 has:
- less subalpine fir in the canopy;
- prickly rose but no white-flowered rhododendron in the shrub layer; and
- more trailing raspberry but less five-leaved bramble in the herb layer, especially on mesic sites.

ESSFmv2 has:
- more sites dominated by devil's club and oak fern.

ESSFwk2 has:
- more oak fern and one- and three-leaved foamflower on mesic and wetter sites.

7 Formerly ESSFn2.
Forests
Like most ESSF forests, climax forests in the ESSFmv4 are dominated by Engelmann spruce and subalpine fir. However, because fire occurs more frequently than in most of the ESSF in the region, a larger portion of the stands are dominated by lodgepole pine. Mixtures of lodgepole pine and black spruce also occur on poor sites at the lower elevational extent of this variant.

Wildlife
Steep high elevation shrub/grass habitats are used by Stone Sheep in the summer, while the more rugged sites near escape terrain are used by Mountain Goat. Avalanche tracks are important in the spring for Grizzly Bear and are also used by Mountain Goat, Caribou, Willow Ptarmigan and White-tailed Ptarmigan. Mature high elevation subalpine fir stands which contain arboreal lichen support Caribou during the winter. In summer, subalpine meadows are used by Moose, Caribou, a small number of Mule Deer, and Willow Ptarmigan. Older stands near the Peace Arm of Williston Reservoir are used by Elk in the summer. Mature coniferous forests support Wolverine, Marten, and Red Squirrel as well as Spruce Grouse, Great Gray Owl, Barred Owl, and Hawk Owl. Mixed age stands with small openings and edges support Grizzly Bear, Wolverine, Fisher and Great Homed Owl.
Soil nutrient regime

<table>
<thead>
<tr>
<th>Very poor</th>
<th>Poor</th>
<th>Medium</th>
<th>Rich</th>
<th>Very rich</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
</tbody>
</table>

Very xeric 0

Xeric 1

Subxeric 2

Submesic 3

Mesic 4

Subhygic 5

Hygric 6

Subhydric 7

01 Bl - Rhododendron - Feathermoss
02 BlPI - Crowberry - Cladina
03 BlSb - Labrador tea
04 Bl - Rhododendron - Horsetail
05 Bl - Alder - Horsetail

FIGURE 11. Edatopic grid displaying site series of the ESSFmv4 variant.
### Site Units

<table>
<thead>
<tr>
<th>Site Units</th>
<th>02</th>
<th>03</th>
<th>01</th>
<th>04</th>
<th>05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pinus contorta</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>lodgepole pine</td>
</tr>
<tr>
<td><em>Picea mariana</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>black spruce</td>
</tr>
<tr>
<td><em>Abies lasiocarpa</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>subalpine fir</td>
</tr>
<tr>
<td><em>Picea engelmannii</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Engelmann spruce</td>
</tr>
<tr>
<td>Shrubs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rhododendron albidiflorum</em></td>
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<td></td>
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<td>white-flowered rhododendron</td>
</tr>
<tr>
<td><em>Ledum groenlandicum</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Labrador tea</td>
</tr>
<tr>
<td><em>Vaccinium membranaceum</em></td>
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<td>black huckleberry</td>
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<td><em>Lonicera involucrata</em></td>
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<td>black twinberry</td>
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<td><em>Alnus crispa ssp. sinuata</em></td>
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<td></td>
<td></td>
<td>Sitka alder</td>
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<td>Herbs and Dwarf Shrubs</td>
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<td><em>Empetrum nigrum</em></td>
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<td></td>
<td></td>
<td></td>
<td>crowberry</td>
</tr>
<tr>
<td><em>Linnaea borealis</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>twinfower</td>
</tr>
<tr>
<td><em>Lycopodium annotinum</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>stiff clubmoss</td>
</tr>
<tr>
<td><em>Arnica cordifolia</em></td>
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<td></td>
<td>heart-leaved arnica</td>
</tr>
<tr>
<td><em>Cornus canadensis</em></td>
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<td></td>
<td></td>
<td></td>
<td>bunchberry</td>
</tr>
<tr>
<td><em>Mertensia paniculata</em></td>
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<td></td>
<td></td>
<td></td>
<td>tall bluebells</td>
</tr>
<tr>
<td><em>Equisetum spp.</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>horsetails</td>
</tr>
<tr>
<td><em>Cladina spp.</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>cladina lichens</td>
</tr>
<tr>
<td><em>Pleurozium schreberi</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>red-stemmed feathermoss</td>
</tr>
<tr>
<td><em>Mnium spp.</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>leafy mosses</td>
</tr>
</tbody>
</table>

Figure 12. ESSFm4 vegetation table.

Prominence class: 1 2 3 4 5
1a Canopy dominated by lodgepole pine or a combination of black spruce and lodgepole pine.

2a Canopy dominated by a combination of black spruce and lodgepole pine; *Cladina* spp. (p. 334)8 or *Cladonia* spp. (pp. 332-334) low cover (< 1% cover) or absent. Occurring on lower to upper slope positions.

**ESSFmv4/03**

2b Canopy dominated by lodgepole pine; *Cladina* or *Cladonia* spp. moderate to high cover (> 1%). Occurring on crest slope position.

**ESSFmv4/02**

1b Canopy dominated by Engelmann spruce or subalpine fir, black spruce and/or lodgepole pine minor or absent.

3a Generally occurring on lower to toe slopes or adjacent to open water or bogs; herb layer well developed, *Mertensia paniculata* (p. 218) or *Equisetum* spp. (p. 281-284) moderate cover (> 1% cover).

4a Occurring on level or depressional slope positions near open water or bogs; *Equisetum* spp. abundant (> 10% cover).

**ESSFmv4/05**

4b Generally occurring on mid to lower slope positions; *Equisetum* spp. moderate cover (> 1%) but not abundant (< 10% cover).

**ESSFmv4/04**

3b Generally occurring on mid to upper slopes; herb layer generally poorly developed, *Mertensia paniculata* and *Equisetum* spp. low cover (<1% cover) or absent.

**ESSFmv4/01**

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8 Page numbers refer to the publication *Plants of Northern British Columbia* (Mackinnon *et al.* 1992).
**VEGETATION**

**Tree Layer:** 60% cover  
Engelmann spruce, subalpine fir, [lodgepole pine]

**Shrub Layer:** 65% cover  
*Vaccinium membranaceum* (black huckleberry)  
*Rhododendron albiflorum* (white-flowered rhododendron)  
*Alnus crispa* ssp. *sinuata* (Sitka alder)  
subalpine fir  
[Engelmann spruce]

**Herb Layer:** 25% cover  
*Cornus canadensis* (bunchberry)  
*Orthilia secunda* (one-sided wintergreen)  
*Linnaea borealis* (twinflower)  
*Arnica cordifolia* (heart-leaved arnica)  
*Lycopodium annotinum* (stiff clubmoss)  
[Rubus pedatus (five-leaved bramble)]

**Moss Layer:** 90% cover  
*Hylocomium splendens* (step moss)  
*Pleurozium schreberi* (red-stemmed feathermoss)  
*Ptilium crispa-castrensis* (knight’s plume)  
Peltigera spp. (Peltigera lichens)  
[Barbilophozia lycopodioides (common leafy liverwort)]

**SOIL AND SITE**

Moisture Regime: 3-4 (sm-m)  
Nutrient Regime: B-D (p-r)  
Slope Gradient (%): 0-62  
* Slope Position: variable, often mid - upper  
Parent Material: variable, but generally morainal or colluvial  
* Soil Texture: (coarse -) medium  
Coarse Fragments (%): 0-67

**DISTRIBUTION:** very common and widespread
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 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: - moderate to high (white-flowered rhododendron, 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 in summer with stock which has already set bud.

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.
- tomentosus root rot may cause low to moderate problems in mature spruce-dominated stands.
- spruce beetle may infest partial cut stands after harvesting; minimize blowdown and avoid mechanical damage to residuals.
**VEGETATION**

**Tree Layer:** 25% cover  
Lodgepole pine, Engelmann spruce

**Shrub Layer:** 50% cover  
- *Rhododendron albiflorum* (white-flowered rhododendron)  
- *Vaccinium membranaceum* (black huckleberry)  
- *Sorbus scopulina* (western mountain-ash)  
- *Ledum groenlandicum* (Labrador tea)  
- Subalpine fir

**Herb Layer:** 10% cover  
- *Linnaea borealis* (twinflower)  
- *Empetrum nigrum* (crowberry)  
- *Cornus canadensis* (bunchberry)  
- *Calamagrostis canadensis* (bluejoint)

**Moss Layer:** 80% cover  
- *Pleurozium schreberi* (red-stemmed feathermoss)  
- *Cladonia* spp. (cladonia lichens)  
- *Hylocomium splendens* (step mass)  
- *Peltigera* spp. (peltigera lichens)  
- *Cladina* spp. (cladina lichens)

**SOIL AND SITE**

- **Moisture Regime:** 2-3 (sx-sm)  
- **Nutrient Regime:** B (p)  
- **Slope Gradient (%):** 0-19  
- **Slope Position:** crest - upper  
- **Parent Material:** morainal or fluvial  
- **Soil Texture:** coarse  
- **Coarse Fragments (%):** generally >30

**DISTRIBUTION:** rare and generally small in extent

**COMMENTS:** based on limited data
**Site limitations:** - the combination of very poor productivity and high wildlife values means that these sites should be protected from harvesting.

**Silvicultural system:** - avoid logging
VEGETATION

Tree Layer: 20% cover
Lodgepole pine, black spruce, [Engelmann spruce]

Shrub Layer: 50% cover
Vaccinium membranaceum (black huckleberry)
Rhododendron albiflorum (white-flowered rhododendron)
Ledum groenlandicum (Labrador tea)
[Vaccinium myrtilloides (velvet-leaved blueberry)]
subalpine fir

Herb Layer: 10% cover
Orthilia secunda (one-sided wintergreen)
Cornus canadensis (bunchberry)
Linnaea borealis (twinflower)
[Vaccinium vitis-idaea (lingonberry)]

Moss Layer: 95% cover
Pleurozium schreberi (red-stemmed feathermoss)
Hylocomium splendens (step moss)
Ptilium crista-castrensis (knight's plume)

SOIL AND SITE

Moisture Regime: 3-6 (sm-hg)
Nutrient Regime: A-B (vp-p)
* Aspect: generally northerly
* Slope Gradient (%): 0-45, generally < 20
Slope Position: variable
Parent Material: variable but often morainal
Soil Texture: coarse - medium
Coarse Fragments (%): 7-59

DISTRIBUTION: common
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.**
- soils are saturated in the spring, but may experience drought in summer, both resulting in poor root development, **poor productivity resulting from these limitations should dictate a limited intensive silvicultural investment.**

**Silviculture system:**
- clearcut
- minimize or align large slash accumulations when logging to help meet site preparation objectives and reduce fire hazard.

**Site preparation**
- light scarification for seed bed preparation or summer logging with no site preparation.

**Species choice**
- Bl, P1, Se, (Sb)

**Vegetation potential**
- low

**Reforestation**
- attempt to regenerate naturally if potential exists.
- Sb is significantly less productive than the other tree species on this site.

**Concerns:**
- full tree harvesting will lead to nutrient depletion and seriously reduce cones; **woody debris and cones should be distributed across these sites (i.e., lop and scatter).**
- trafficability may be a problem on these sites during the summer, especially on sites where moisture regime is wetter than mesic
**VEGETATION**

Tree Layer: 25% cover
- Engelmann spruce, subalpine fir, [lodgepole pine]

Shrub Layer: 35% cover
- *Vaccinium membranaceum* (black huckleberry)
- *Rhododendron albiflorum* (white-flowered rhododendron)
- *Shepherdia canadensis* (soopolallie)

Herb Layer: 35% cover
- *Cornus canadensis* (bunchberry)
- *Orthilia secunda* (one-sided wintergreen)
- *Equisetum scirpoides* (dwarf scouring-rush)
- *Mertensia paniculata* (tall bluebells)
- *Linnaea borealis* (twinflower)
- *Lycopodium annotinum* (stiff clubmoss)
- *Mitella nuda* (common mitrewort)
- *Arnica cordifolia* (heart-leaved arnica)
- [Rubus pubescens](trailing raspberry)
- [Aster ciliolatus](fringed aster)

Moss Layer: 95% cover
- *Pleurozium schreberi* (red-stemmed feathermoss)
- *Hylocomium splendens* (step moss)
- *Peltigera spp.* (Peltigera lichens)
- *Ptilium crista-castrensis* (knight’s plume)

**SOIL AND SITE**

- Moisture Regime: 5 (shg)
- Nutrient Regime: C-E (m-vr)
- * Slope Gradient (%): 0-16
- * Slope Position: mid - lower
- Parent Material: morainal
- Soil Texture: coarse - medium
- Coarse Fragments (%): 15-50

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

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

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 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, Pl, Se

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

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 in groups, using available raised microsites, rather than evenly across the site. - 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 choosing a frost-resistant species (e.g., Pl) is advised. - sites within this unit with restricted rooting and/or thick organic layers have a high 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 minor problems in mature spruce-dominated stands.
Bl - Alder - Horsetail

**VEGETATION**

Tree Layer: 15% cover
Engelmann spruce, subalpine fir

Shrub Layer: 15% cover
* Alnus crispa ssp. sinuata (Sitka alder)
* Salix spp. (willows)
* Ledum groenlandicum (Labrador tea)
* Lonicera involucrata (black twinberry)
* Ribes triste (red swamp currant)
subalpine fir
Engelmann spruce

Herb Layer: 85% cover
* Equisetum arvense (common horsetail)
* Aster ciliolatus (fringed aster)
* Mertensia paniculata (tall bluebells)
* Rubus pubescens (trailing raspberry)
* Senecio triangularis (arrow-leaved groundsel)

Moss Layer: 95% cover
* Brachythecium spp. (ragged mosses)
* Mnium spp. (leafy mosses)
* Hylocomium splendens (step moss)
* Drepanocladus spp. (drepanocladus mosses)
* Tomentypnum nitens (golden fuzzy fen moss)

**SOIL AND SITE**

- Moisture Regime: 6 (h)
- Nutrient Regime: B-D (p-r)
- Slope Gradient (%): 0-5
- Slope Position: level or depression
- Parent Material: fluvial
- Soil Texture: medium - fine
- Coarse Fragments (%): generally low

**DISTRIBUTION:** uncommon and small in size

**COMMENTS:** based on limited data
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 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)

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, [Pl]**

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

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:
- 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 high water tables and thick organic horizons (> 10 cm) have increased windthrow hazard; **block layouts must have wind-firm boundaries.**
- water table will likely rise above the ground surface in the spring, causing seedling mortality.
- these units represent important wildlife habitat; **discuss prescription with fish and wildlife personnel.**
- this unit is critical to the control of runoff streamflow.
- tomentosus root rot may cause minor problems in mature spruce-dominated stands.
4.3 Cariboo Wet Cold Engelmann Spruce - Subalpine Fir

Location
The ESSFwc3 in the guide area occurs in the Rocky Mountains above the ESSFwk2, predominantly west of the divide as far south as the Morkill River and as far north as the Ospika Arm of Williston Reservoir.

Elevation range
1300 - 1550 m

Climate
The ESSFwc3 climate is wet and cold. It is similar to the ESSFwk2 but occurs at higher elevations and is therefore colder with a more persistent snowpack.

Soils, geology and landforms
This variant lies south of the Peace River, within the Misinchinka, Hart and Park Ranges of the Rocky Mountains and the McGregor Plateau. The Misinchinka Ranges are the westernmost Rocky Mountain ranges in this subzone and have sedimentary and metamorphosed sedimentary bedrock, including sandstone, conglomerate, and phyllite. These rocks are less resistant to erosion than the limestones and quartzites of the Hart and Park Ranges to the east and southeast, resulting in more rounded summits. Soil parent materials are dominantly morainal and colluvial, with textures ranging from medium to coarse, depending on the underlying bedrock type. Brunisols and Luvisols are associated with calcareous materials (i.e., derived from limestone bedrock), while Podzols are found on non-calcareous parent materials. The McGregor Plateau is at the eastern edge of the Interior Plateau, between the offset ends of the northern and southern portions of the Rocky Mountain Trench. Bedrock types consist of sedimentary and metamorphosed sedimentary rocks of Cambrian and Precambrian age. Humo-Ferric Podzols have formed on parent materials consisting predominantly of medium-textured morainal and colluvial deposits.

Distinguishing the ESSFwc3 from adjoining biogeoclimatic units
ESSFwk2 has:

• more devil’s club but less Indian hellebore and Sitka valerian on mesic and wetter sites.

Forests
Forests in the ESSFwc3 tend to be widely spaced and clumpy and are generally dominated by subalpine fir and/or Engelmann spruce.

Wildlife
High elevation rugged bedrock outcrops on warmer aspects near scrubby stands of subalpine fir and Engelmann spruce are used in winter by Mountain Goat. Moist subalpine sites are used in summer by Mountain Goat, Caribou, Moose, Wolverine, Gray Wolf, and Willow Ptarmigan. In the upper subalpine,
subalpine fir stands with arboreal lichen support Caribou during the winter. Avalanche tracks are important for Grizzly Bear in the spring and are used by Mountain Goat, Caribou, Blue Grouse, Willow Ptarmigan, and White-tailed Ptarmigan.
Soil nutrient regime

Very poor | Poor | Medium | Rich | Very rich
---|---|---|---|---
A | B | C | D | E

Soil moisture regime

Very xeric

Xeric

Subxeric

Submesic

Mesic

Subhygic

Hygic

Subhydric

01 Bl. Rhododendron - Oak fern
02 Bl. Rhododendron - Queen's cup
03 Bl. Globeflower - Horsetail

FIGURE 13. Edatopic grid displaying site series of the ESSFwc3 variant.
<table>
<thead>
<tr>
<th>Site Units</th>
<th>02</th>
<th>01</th>
<th>03</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trees</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Abies lasiocarpa</em></td>
<td></td>
<td></td>
<td></td>
<td>subalpine fir</td>
</tr>
<tr>
<td><em>Picea engelmannii</em></td>
<td></td>
<td></td>
<td></td>
<td>Engelmann spruce</td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rhododendron albidiflorum</em></td>
<td></td>
<td></td>
<td></td>
<td>white-flowered rhododendron</td>
</tr>
<tr>
<td><em>Vaccinium membranaceum</em></td>
<td></td>
<td></td>
<td></td>
<td>black huckleberry</td>
</tr>
<tr>
<td><em>Vaccinium ovalifolium</em></td>
<td></td>
<td></td>
<td></td>
<td>oval-leaved blueberry</td>
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<tr>
<td><em>Ribes lacustre</em></td>
<td></td>
<td></td>
<td></td>
<td>black gooseberry</td>
</tr>
<tr>
<td><strong>Herbs and Dwarf Shrubs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Clintonia uniflora</em></td>
<td></td>
<td></td>
<td></td>
<td>queen's cup</td>
</tr>
<tr>
<td><em>Rubus pedatus</em></td>
<td></td>
<td></td>
<td></td>
<td>five-leaved bramble</td>
</tr>
<tr>
<td><em>Gymnocarpium dryopteris</em></td>
<td></td>
<td></td>
<td></td>
<td>oak fern</td>
</tr>
<tr>
<td><em>Dryopteris expansa</em></td>
<td></td>
<td></td>
<td></td>
<td>spiny wood fern</td>
</tr>
<tr>
<td><em>Veratrum viride</em></td>
<td></td>
<td></td>
<td></td>
<td>Indian hellebore</td>
</tr>
<tr>
<td><em>Streptopus roseus</em></td>
<td></td>
<td></td>
<td></td>
<td>rosy twistedstalk</td>
</tr>
<tr>
<td><em>Valeriana sitchensis</em></td>
<td></td>
<td></td>
<td></td>
<td>Sitka valerian</td>
</tr>
<tr>
<td><em>Senecio triangularis</em></td>
<td></td>
<td></td>
<td></td>
<td>arrow-leaved groundsel</td>
</tr>
<tr>
<td><strong>Mosses and Lichens</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cladonia spp.</em></td>
<td></td>
<td></td>
<td></td>
<td>cladonia lichens</td>
</tr>
<tr>
<td><em>Barbilophozia lycopodioides</em></td>
<td></td>
<td></td>
<td></td>
<td>common leafy liverwort</td>
</tr>
<tr>
<td><em>Pleurozium schreberi</em></td>
<td></td>
<td></td>
<td></td>
<td>red-stemmed feathermoss</td>
</tr>
<tr>
<td><em>Rhytiidiopsis robusta</em></td>
<td></td>
<td></td>
<td></td>
<td>pipecleaner moss</td>
</tr>
<tr>
<td><em>Mnium spp.</em></td>
<td></td>
<td></td>
<td></td>
<td>leafy mosses</td>
</tr>
<tr>
<td><em>Brachythecium hylotapetum</em></td>
<td></td>
<td></td>
<td></td>
<td>woodsy ragged moss</td>
</tr>
</tbody>
</table>

Figure 14  ESSFwc3 vegetation table
la Soils generally shallow to bedrock (<35 cm thick); usually upper to crest slope position; lichens dominate the moss layer; *Gymnocarpium dryopteris* (p. 293)\(^\text{10}\) or *Senecio triangularis* (p. 107) generally low cover (< 1% cover) or absent.

ESSFwc3/02

1b Soils generally deep (>35 cm thick); slope position variable; few lichens in moss layer; *Gymnocarpium dryopteris* or *Senecio triangularis* moderate to high cover (> 1% cover).

ESSFwc3/01

2a Seepage water generally absent during dry part of summer; *Rhododendron albiflorum* (p. 41) abundant (> 20% cover), *Senecio triangularis* generally absent.

ESSFwc3/03

2b Seepage water generally present during dry part of summer; *Rhododendron albiflorum* low to moderate cover (< 10%) or absent, *Senecio triangularis* present.

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\(^{10}\) Page numbers refer to the publication *Plants of Northern British Columbia* (MacKinnon *et al.* 1992).
B1- Rhododendron - Oak fern

VEGETATION

Tree Layer: 30%
- subalpine fir, Engelmann spruce

Shrub Layer: 60%
- *Rhododendron albiflorum* (white-flowered rhododendron)
- *Vaccinium membranaceum* (black huckleberry)
- *Vaccinium ovalifolium* (oval-leaved blueberry)
- *Ribes lacustre* (black gooseberry)
- subalpine fir
- Engelmann spruce

Herb Layer: 40%
- *Gymnocarpium dryopteris* (oak fern)
- *Veratrum viride* (Indian hellebore)
- *Valeriana sitchensis* (Sitka valerian)
- *Rubus pedatus* (five-leaved bramble)
- *Tiarella unifoliata* (one-leaved foamflower)
- *Streptopus roseus* (rosy twistedstalk)
- *Dryopteris expansa* (spiny wood fern)
- [Arnica latifolia] (mountain arnica)

Moss Layer: 55%
- *Mnium* spp. (leafy mosses)
- [Pleurozium schreberi] (red-stemmed feathermoss)
- [Rhytidium robustum] (pipecleaner moss)
- [Barbilophozia lycopodioides] (common leafy liverwort)
- [Brachythecium] spp. (ragged mosses)

SOIL AND SITE

- Moisture Regime: 3-4 (sm-m)
- Nutrient Regime: B-C (p-m)
- Slope Gradient (%): 0-60
  * Slope Position: mid - (crest), often mid slope
- Parent Material: morainal or colluvial
  * Soil Texture: medium - coarse
- Coarse Fragments (%): 3-80

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

Silviculture system: - partial cut (see Section 5.1)
- log on firm snowpack to protect advance regeneration.
- reduce spruce beetle hazard by avoiding high stumps and shaded slash > 15 cm diameter.

Site preparation: - motor manual or no site preparation

Species choice: - Bl, Se

Vegetation potential: - high (white-flowered rhododendron. Sitka valerian)
- vegetation competition not reduced during harvesting must be addressed during site preparation.

Reforestation: - very difficult sites to regenerate; must preserve advance regeneration and some overstory trees for protection of the regeneration.

Concerns: - these sites represent important caribou habitat; discuss prescription with wildlife personnel.
- 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.
- trafficability will be a problem on these sites during the summer.
- heavy snowpack may cause stem deformity, especially on steep slopes; obstacle planting is advised.
- sites within this unit 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 minor problems in mature spruce-dominated stands.
VEGETATION

Tree Layer: 20%
- subalpine fir, Engelmann spruce, [lodgepole pine]

Shrub Layer: 75%
- *Rhododendron albiflorum* (white-flowered rhododendron)
- *Vaccinium membranaceum* (black huckleberry)
- subalpine fir

Herb Layer: 10%
- *Rubus pedatus* (trailing raspberry)
- *Arnica latifolia* (mountain arnica)
- *Clintonia uniflora* (queen’s cup)
- *Gymnocarpium dryopteris* (oak fern)

Moss Layer: 75%
- *Cladonia* spp. (cladonia lichens)
- *Pleurozium schreberi* (red-stemmed feathermoss)
- *Barbilophozia lycopodioides* (common leafy liverwort)
- *Barbilophozia floerkei* (mountain leafy liverwort)

SOIL AND SITE

- Moisture Regime: 1-3 (x-sm)
- Nutrient Regime: A-B (vp-p)
- Slope Gradient (%): 0-62, often < 30
- * Slope Position: upper - crest
- Parent Material: colluvial or morainal
- * Soil Texture: coarse - very coarse
- * Coarse Fragments (%): 15-80, usually > 50

DISTRIBUTION: common in rocky areas and on upper slopes

COMMENTS: Shallow to bedrock (< 35 cm)
INTERPRETATIONS

Site limitations: - site and soil conditions of this unit result in marginal productivity; *all attempts should be made to exclude logging from this unit.*

Silvicultural system: - avoid logging
VEGETATION

Tree Layer: 30%
Engelmann spruce, subalpine fir

Shrub Layer: 35%
Vaccinium membranaceum (black huckleberry)
Rhododendron albiflorum (white-flowered rhododendron)
Ribes lacustre (black gooseberry)
subalpine fir
[Engelmann spruce]

Herb Layer: 65%
Senecio triangularis (arrow-leaved groundsel)
Viola spp. (violets)
Valeriana sitchensis (Sitka valerian)
Stréptopus roseus (rosy twistedstalk)
Thalictrum occidentale (western meadowrue)
Veratrum viride (Indian hellebore)
Trollius laxus (globeflower)
Tiarella unifoliata (one-leaved foamflower)
Arnica cordifolia (heart-leaved arnica)
Heracleum lanatum (cow-parsnip)
Mitella breweri (Brewer's mitrewort)
[Equisetum arvense (common horsetail)]

Moss Layer: 60%
Brachythecium hylotapetum (woodsly ragged moss)
Mnium spp. (leafy mosses)
[Marchantia polymorpha (green-tongue liverwort)]

SOIL AND SITE

Moisture Regime: 4-6 (m-h)
Nutrient Regime: C-D (m-r)
* Slope Gradient (%): 0-67, often < 20
* Slope Position: variable, often mid - lower
Parent Material: morainal, colluvial or fluvial
Soil Texture: medium - coarse
Coarse Fragments (%): 34-60

DISTRIBUTION: common

COMMENTS: seepage water generally present
Bl - Globeflower - Horsetail (ESSFwc3/03)

INTERPRETATIONS

**Site limitations:**
- site and soil conditions of this unit result in marginal productivity; *all attempts should be made to exclude logging from this unit.*

**Silviculture system:**
- avoid logging
NOTES
4.4 Misinchinka Wet Cool Engelmann Spruce - Subalpine Fir

Location
The ESSFwk2 occurs predominantly west of the Rocky Mountain divide as far south as the Morkill River and as far north as the Ospika Arm of Williston Reservoir. It occurs above the ICH at its southern boundary, and the SBS over the rest of its range. Throughout its range it occurs below the ESSFwc3.

Elevation range
950 - 1300 m

Climate
The climate of the ESSFwk2 is wetter and warmer than the ESSFmv variants (Table 8). Very high snow accumulations (3 m +) occur in this variant.

Soils, geology and landforms
This variant lies south of the Peace River, within the Misinchinka, Hart and Park ranges of the Rocky Mountains and the McGregor Plateau. The Misinchinka Ranges are the westernmost of Rocky Mountain ranges in this subzone and have sedimentary and metamorphosed sedimentary bedrock, including sandstone, conglomerate, and phyllite. These rocks are less resistant to erosion than the limestones and quartzites of the Hart and Park ranges to the east and southeast, resulting in more rounded summits. Soil parent materials are dominantly morainal and colluvial, with textures ranging from medium to coarse, depending on the underlying bedrock type. Brunisols and Luvisols are associated with calcareous materials (i.e., derived from limestone bedrock), while Podzols are found on non-calcareous parent materials. The McGregor Plateau is at the eastern edge of the Interior Plateau, between the offset ends of the northern and southern portions of the Rocky Mountain Trench. Bedrock types consist of sedimentary and metamorphosed sedimentary rocks of Cambrian and Precambrian age. Humo-Ferric Podzols have formed on parent materials consisting predominantly of medium-textured morainal and colluvial deposits.

Distinguishing the ESSFwk2 from adjoining biogeoclimatic units

SSSwk2 has:
- more highbush-cranberry but no white-flowered rhododendron in the shrub layer; and
- trembling aspen and paper birch that occur occasionally in canopy.

BWBSwk1 has:
- less subalpine fir in the canopy;
- prickly rose but no white-flowered rhododendron in shrub layer; and
- more trailing raspberry but less five-leaved bramble in the herb layer, especially on mesic sites.

ESSFmv2 has:
- more sites dominated by lodgepole pine; and

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11 Formerly ESSFh3 below 1300 m.
• less oak fern and less one- and three-leaved foamflower on mesic and wetter sites.

ESSFmv4 has:
• more sites dominated by lodgepole pine; and
• less sites dominated by devil’s club and oak fern.

Forests
Climax forests are dominated by Engelmann spruce and subalpine fir. Very few seral stands exist in this variant because of the lack of fire history although some lodgepole pine stands do exist, especially at the southern end of the subzone. Sitka alder (*Alnus crispa* ssp. *sinuata*) swales are common, especially on north-facing slopes. These have been determined to be very old (200+ years).

Wildlife
Towards the north, upper elevation subalpine fir/Engelmann spruce forests in conjunction with alpine and subalpine are used by Mountain Goat. Extensive coniferous forests are used by Caribou during migratory periods in the spring and fall. Mature coniferous stands support Wolverine, Marten, Gray Wolf, and Red Squirrel, as well as Spruce Grouse, Great Gray Owl, Barred Owl, and Hawk Owl. Mixed age stands interspersed with openings support Moose, Gray Wolf, Grizzly Bear, Wolverine, Fisher, Blue Grouse, and Great Horned Owl.
Soil nutrient regime

Soil moisture regime

Very poor Poor Medium Rich Very rich
A B C D E

0 01 Bl - Oak fern - Knight's plume 05 B1- Rhododendron - Lady fern
1 02 Bl - Oak fern - Sarsaparilla 06 B1- Horsetail - Sphagnum
2 03 Bl - Oak fern - Bluebells 07 B1- Devil's club - Rhododendron
3 31 Non-forested bog
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Figure 16. ESSFwk2 vegetation table.
ESSFwk2
Site Series Key

1a Black spruce present in canopy; Carex spp. (pp. 258-274)\textsuperscript{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

\textsuperscript{12} Page numbers refer to the publication, \textit{Plants of Northern British Columbia} (MacKinnon \textit{et al.} 1992).
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 cristca 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.*
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 blueberry)
- 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.
Bl - Oak fern - Bluebells

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 (woody 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.
Bl - Devil’s club - Rhododendron

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
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.
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
**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 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.
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
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.*
Non-forested Bog

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-laurel)]
- [Carex spp. (sedges)]
- Sphagnum spp.
- [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
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
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**

<table>
<thead>
<tr>
<th>Method Approximated</th>
<th>Eventual Stand Form Produced</th>
<th>Gap Width Created</th>
<th>Establishment of New Regeneration</th>
<th>Release of Advanced Regeneration &lt; 12.5 cm dbh</th>
<th>Sanitation Removal of Unacceptable Trees</th>
<th>Quality Increment on Large Stems &gt; 12.5 cm dbh</th>
<th>Residual Basal Area Objective</th>
<th>Maintain Specified Q-value, Max dbh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balanced Single-tree Selection</td>
<td>Uneven-aged</td>
<td>&lt;1/2 H₁ max.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Small-group Selection</td>
<td>Uneven-aged</td>
<td>2 H max.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes, within groups</td>
<td>Yes</td>
<td>R²</td>
<td>R</td>
</tr>
<tr>
<td>Selection with Reserves</td>
<td>Uneven-aged</td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uniform Shelterwood</td>
<td>Even-aged</td>
<td>&lt;1/2 H₁ max.</td>
<td>Yes</td>
<td>(Possible)</td>
<td>Yes</td>
<td>Yes</td>
<td>Desirable</td>
<td>--³</td>
</tr>
<tr>
<td>Group or Strip Shelterwood</td>
<td>Even-aged</td>
<td>2 H max.</td>
<td>Yes</td>
<td>(Possible)</td>
<td>Yes, within openings</td>
<td>--</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>One-cut (Natural) Shelterwood or Overstory Removal</td>
<td>Even-aged to Multi-aged</td>
<td>Minimal</td>
<td>Fill-planting of gaps</td>
<td>Yes</td>
<td>Yes</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Shelterwood with Reserves</td>
<td>Two-aged</td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 10. (Continued)

<table>
<thead>
<tr>
<th>Method Approximated</th>
<th>Eventual Stand Form Produced</th>
<th>Gap Width Created</th>
<th>Establishment of New Regeneration</th>
<th>Release of Advanced Regeneration &lt; 12.5 cm dbh</th>
<th>Sanitation Removal of Unacceptable Trees</th>
<th>Quality Increment on Large Stems &gt; 12.5 cm dbh</th>
<th>Residual Basal Area Objective</th>
<th>Maintain Specified Q-value Max dbh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearcut</td>
<td>Even-aged</td>
<td>Variable, Planted or natural</td>
<td>(Minor)</td>
<td>Yes</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Clearcut with Reserves</td>
<td>Even-aged with veterans</td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Reproduction Method Approximated</th>
<th>Eventual Stand Form Produced</th>
<th>Gap Width Created</th>
<th>C1 Overstory</th>
<th>C2 Intermediate</th>
<th>C3 Understory</th>
<th>C4 Seedling</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Balanced Single-tree Selection</strong></td>
<td>Uneven-aged</td>
<td>&lt;1/2 H (^1) max.</td>
<td>P(^2)</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td><strong>Small-group Selection</strong></td>
<td>Uneven-aged</td>
<td>2 H max.</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>C(^3)</td>
</tr>
<tr>
<td><strong>Selection with Reserves</strong></td>
<td>Uneven-aged</td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Uniform Shelterwood</strong></td>
<td>Even-aged</td>
<td>&lt; 1/2 H</td>
<td>P</td>
<td>T (^4)</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td><strong>Group or Strip Shelterwood</strong></td>
<td>Even-aged</td>
<td>2 H max</td>
<td>(Cut and leave patches are spatially separated)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>One-cut (Natural) Shelterwood / Overstory Removal</strong></td>
<td>Even-aged</td>
<td>Minimal</td>
<td>T</td>
<td>T</td>
<td>(P)</td>
<td>C</td>
</tr>
<tr>
<td><strong>Shelterwood with Reserves</strong></td>
<td>Two-aged</td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Clearcut</strong></td>
<td>Even-aged</td>
<td>&gt; 100m</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td><strong>Clearcut with Reserves</strong></td>
<td>Even-aged with veterans</td>
<td>Similar to above options but with planned long-term retention of appropriate stand component for biodiversity and integrated resource management objectives.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

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 m²/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.

**Can be used when:**

- selected stems of mature trees are left standing over the regeneration
- these mature trees are not removed after normal time periods

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 disturbances or 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.

**Focus for leave-tree selection**
- larger dominant trees
- wind firm
- desirable species
- desirable physical characteristics
- capable of good seed production

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). 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 accommodate 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 m²/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 rigorous 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

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 (VQOs), 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.
STEP 1
Stratify planned cutblock area into relatively homogeneous management units.

STEP 2
For each management unit, summarize stand information by:
1) Basal area in C1 and C2 layers
2) Stems/ha in C3 and C4 layers

Legend

<table>
<thead>
<tr>
<th>Code</th>
<th>Crown Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Overstory</td>
</tr>
<tr>
<td>C2</td>
<td>Intermediate</td>
</tr>
<tr>
<td>C3</td>
<td>Understory</td>
</tr>
<tr>
<td>C4</td>
<td>Advance regeneration</td>
</tr>
</tbody>
</table>

Basal area of C1 layer
>- 80% of total?

Combined basal area of C1+ C2 > 20m²/ha?

Density of C3 (understory) > 1500 sph?

Density of C3 + C4 layers > 3000 sph?

Density of C3 + C4 layers > 3000 sph?

Irregular

Two-storied

Single-storied

Natural shelterwood

FIGURE 22. Key for identification of stand structure type (modified from Westman 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 Westman 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 information 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 systematically established 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

<table>
<thead>
<tr>
<th>Effective Stand Structure</th>
<th>Clearcut</th>
<th>Uniform Shelterwood Preparatory Cut</th>
<th>One-cut Shelterwood / Overstory Removal</th>
<th>Selection / or Uneven-aged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-storied</td>
<td>Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.</td>
<td>Se and Bl. Light removal, leave at least 50% of original basal area. Seedbed disturbance required for Se.</td>
<td>At least 1 preparatory or seed cut and successful regeneration required before overstory removal.</td>
<td>Difficult. At least 2-3 light stand entries needed to create desired multi-storied structure. At least 20-25 m³/ha and 50% of basal area must be retained. Sanitation cutting likely.</td>
</tr>
<tr>
<td>Natural Shelterwood</td>
<td>Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.</td>
<td>Not required if understory can be protected and is acceptable species, density, and quality. See Shelterwood Overstory Removal.</td>
<td>Ideal if advanced regeneration can be protected during harvest and is of acceptable species, density, and quality.</td>
<td>At least 2 light to moderate stand entries needed to create desired stand structure. At least 20-25 m³/ha and 50% of basal area must be retained. Sanitation cutting.</td>
</tr>
<tr>
<td>Two-storied</td>
<td>Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.</td>
<td>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.</td>
<td>Release C2 (intermediate) layer if adequate stocking and quality. Basal area stocking targets may be appropriate.</td>
<td>1 or more stand entries needed to stimulate new regeneration and create desired stand structure. As above for natural shelterwoods.</td>
</tr>
<tr>
<td>Effective Stand Structure</td>
<td>Clearcut</td>
<td>Uniform Shelterwood</td>
<td>One-cut Shelterwood / Overtree Removal</td>
<td>Selection / or Uneven-aged</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------</td>
<td>---------------------</td>
<td>--------------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>Multi-storied</strong></td>
<td>Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.</td>
<td>2- and 3-layer system if understory can be protected and is of acceptable species, density, and quality. Selection systems may be more appropriate.</td>
<td>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.</td>
<td>Ideal initial structure. Cuts must maintain and enhance existing structure, quality, composition, and stocking. 20-25 m²/ha and 50% of basal area must be retained.</td>
</tr>
<tr>
<td><strong>Irregular</strong></td>
<td>Acceptable if compatible with management objectives and site-specific ecological requirements of desired species.</td>
<td>If sufficient stocking of dominant and co-dominant layer. Harvest intermediates. Selection systems or overstory removal may be more appropriate.</td>
<td>As above for multi-storied stands.</td>
<td>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 m²/ha or more. Sanitation cutting likely.</td>
</tr>
</tbody>
</table>
### TABLE 13. Recommended prescriptions for implementing preferred silvicultural systems in Mountain Caribou habitat

<table>
<thead>
<tr>
<th>Effective Pre-Harvest Stand Structure</th>
<th>Single-tree Selection System</th>
<th>Group Selection System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single-storied Stand Structure</strong></td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Natural Shelterwood Stand Structure</strong></td>
<td>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.</td>
<td>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 &lt; 30% of the stand. Winter logging on a deep compressible snowpack will assist in protection of advanced regeneration during harvest.</td>
</tr>
<tr>
<td><strong>Two-storied Stand Structure</strong></td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td>Effective Pre-Harvest Stand Structure</td>
<td>Single-tree Selection System</td>
<td>Group Selection System</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td><strong>Multi-storied Stand Structure</strong></td>
<td>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 m²/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.</td>
<td>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-storied stands.</td>
</tr>
<tr>
<td><strong>Irregular Stand Structure</strong></td>
<td>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., ≥ 20 m²/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.</td>
<td>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.</td>
</tr>
<tr>
<td>Effective Pre-Harvest Stand Structure</td>
<td>Clearcut System</td>
<td>Natural Shelterwood Ovstory Removal</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Single-Storied Stand Structure</strong></td>
<td>Individual cutblocks may be provisionally acceptable if ALL of the following constraints are met:</td>
<td>Individual cutblocks are provisionally acceptable IF:</td>
</tr>
<tr>
<td></td>
<td>• Documented stand and terrain conditions preclude application of group selection and single-tree selection systems;</td>
<td>• ALL constraints as with clearcut system in single-storied stands are met; and</td>
</tr>
<tr>
<td></td>
<td>• Cutblock and roads are compatible with approved landscape-level habitat management objectives; and</td>
<td>• 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.</td>
</tr>
<tr>
<td></td>
<td>• Prescription meets site-specific ecological requirements of desired tree species.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manipulation of block size and shape may mitigate harvest impacts on caribou cover and migration routes.</td>
<td></td>
</tr>
<tr>
<td><strong>Natural Shelterwood Stand Structure</strong></td>
<td>Individual cutblocks may be provisionally acceptable if ALL of the following constraints are met:</td>
<td>Individual cutblocks are provisionally acceptable IF:</td>
</tr>
<tr>
<td></td>
<td>• 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.</td>
<td>• ALL constraints as with clearcut system in single-storied stands are met; and</td>
</tr>
<tr>
<td><strong>Two-storied Stand Structure</strong></td>
<td>Individual cutblocks may be provisionally acceptable if ALL of the following constraints are met:</td>
<td>• Sufficient densities of advanced regeneration can be protected during harvest; and</td>
</tr>
<tr>
<td></td>
<td>• Constraints as with clearcut systems is single-storied stands Retention of discrete windfirm reserved areas of pole-sized tree will provide vertical structure in the immediate post-harvest regeneration period.</td>
<td>• Advanced regeneration is of acceptable species and density. Sanitation cutting will be necessary.</td>
</tr>
</tbody>
</table>

Where feasible, convert to multi-storied structure with selection system.
<table>
<thead>
<tr>
<th>Effective Pre-Harvest Stand Structure</th>
<th>Clearcut System</th>
<th>Natural Shelterwood Overstory Removal</th>
</tr>
</thead>
</table>
| **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 IF  
  - 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 be 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)

<table>
<thead>
<tr>
<th>Texture</th>
<th>Coarse Fragment Content</th>
<th>Coarse Fragment Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>S, Ls, SL</td>
<td>Coarse</td>
<td>Very Coarse</td>
</tr>
<tr>
<td>vfSL, Si</td>
<td>Medium</td>
<td>Coarse</td>
</tr>
<tr>
<td>SiL, Loam</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>SC, Sic, SCL</td>
<td>Fine</td>
<td>Medium</td>
</tr>
<tr>
<td>SiCL, CL, C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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

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

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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 burn 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

<table>
<thead>
<tr>
<th>Severity</th>
<th>Duff</th>
<th>Fuel Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>moss/litter</td>
<td>&lt;7 cm Diam.</td>
</tr>
<tr>
<td>1</td>
<td>1.2 cm</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>2.5 cm</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>5.8 cm</td>
<td>60-70</td>
</tr>
<tr>
<td>4</td>
<td>8.15 cm</td>
<td>80</td>
</tr>
<tr>
<td>5</td>
<td>12 cm</td>
<td>90</td>
</tr>
</tbody>
</table>
**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.

**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.

**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.

**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.

**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.

**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.
**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.

**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.

**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 recognize 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. Wolverines 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

<table>
<thead>
<tr>
<th>Species Assemblages</th>
<th>Representative Species&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Important Habitat Characteristics</th>
<th>Seral Stages</th>
<th>Species of Management Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>primary cavity-nesters, mainly in conifers</td>
<td>Black-backed Woodpecker, Three-toed Woodpecker, Pileated Woodpecker</td>
<td>WT</td>
<td>MF, OG</td>
<td></td>
</tr>
<tr>
<td>primary cavity-nesters, mainly in deciduous trees</td>
<td>Red-breasted Sapsucker, Northern Flicker, Hairy Woodpecker</td>
<td>WT, DT</td>
<td>MF, OG</td>
<td></td>
</tr>
<tr>
<td>secondary cavity-nesters</td>
<td>Barrow’s Goldeneye, Common Goldeneye, Bufflhead, Hooded Merganser, Common Merganser, Northern Hawk Owl, Boreal Owl, Northern Saw-whet Owl; many passerines</td>
<td>WT, RZ, RU, LGS</td>
<td>MF</td>
<td></td>
</tr>
<tr>
<td>ground-nesters near water</td>
<td>Eared Grebe, Canada Goose, Green-winged Teal, Mallard, Northern Pintail, Blue-winged Teal, Cinnamon Teal, American Wigeon, Ring-necked Duck, Lesser Scap, White-winged Scoter</td>
<td>RZ, RU, LGS</td>
<td>MF</td>
<td></td>
</tr>
<tr>
<td>deciduous tree and thicket dwellers</td>
<td>Ruffed Grouse, warblers, vireos, flycatchers, thrushes; other migrating passerines</td>
<td>CWD, ED</td>
<td>ALL&lt;sup&gt;4&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>mature coniferous forest dwellers</td>
<td>Northern Goshawk, Red-breasted Nuthatch, Brown Creeper, Townsend’s Warbler, Red Crossbill, Great Gray Owl</td>
<td>WT</td>
<td>MF, OG</td>
<td></td>
</tr>
<tr>
<td>subalpine parkland dwellers</td>
<td>Golden-crowned Sparrow, Fox Sparrow, American Robin, Rufous Hummingbird</td>
<td>SH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> Red list species are considered endangered or threatened or are being considered as potential designates because they run the risk of extirpation or extinction. Provision of required seral stages must occur as a mosaic across the landscape.
<table>
<thead>
<tr>
<th>Species Assemblage</th>
<th>Representative Species ¹</th>
<th>Important Habitat Characteristics</th>
<th>Seral Stage</th>
<th>Important Forage Species</th>
<th>Species of Management Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphibians</td>
<td>Western Toad, Spotted Frog, Wood Frog, Long-toed Salamander</td>
<td>CWD, RZ, RU, LGS</td>
<td>MF, OG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bats</td>
<td>Little Brown Myotis, Big Brown Bat</td>
<td>WT, RZ, RU</td>
<td>SH, MF, OF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Mammals</td>
<td>shrews, voles, mice, lemmings, Chipmunk, Red Squirrel, Northern Flying Squirrel, Snowshoe Hare, Beaver, Muskrat</td>
<td>WT, CWD, SP, LGS, RZ, RU</td>
<td>ALL ³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-sized Carnivores¹</td>
<td>Fisher, Marten, Ermine, Least Weasel, Mink, Red Fox, Long-tailed Weasel, River Otter</td>
<td>WT, CWD, SP, RZ, RU</td>
<td>ALL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large Carnivores¹</td>
<td>Grizzly Bear, Gray Wolf, Cougar, Black Bear, Lynx, Coyote, Wolverine</td>
<td>ED, SU, SL, RZ, RU</td>
<td>ALL, Equi spp. Herian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ungulates</td>
<td>Rocky Mountain Elk, Mule Deer, White-tailed deer, Rocky Mountain Bighorn Sheep, Mountain Goat, Moose, Stone Sheep, Mountain Caribou</td>
<td>ED, SA, SU, SI, RZ, RU</td>
<td>ALL</td>
<td>Vacc spp. Rubu par Care spp. Forbs Epil ang</td>
<td></td>
</tr>
</tbody>
</table>

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 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

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


