LAND MANAGEMENT HANDBOOK

70

A Field Guide to Ecosystem Classification and Identification for Southeast British Columbia

The South-Central Columbia Mountains

2016

BRITISH COLUMBIA

A Field Guide to Ecosystem Classification and Identification for Southeast British Columbia

The South-Central Columbia Mountains

Deb MacKillop and Audrey Ehman

British Columbia

ISBN 978-0-7726-6947-6 (Print)

ISBN 978-0-7726-6948-3 (Digital)

Citation
MacKillop, D.J. and A.J. Ehman. 2016. A field guide to site classification and identification for southeast British Columbia: the south-central Columbia Mountains. Prov. B.C., Victoria, B.C. Land Manag. Handb. 70.

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Copies of this report may be obtained from:
Crown Publications, Queen's Printer
PO Box 9452 STN PROV GOVT
563 Superior Street, 2nd Floor, Victoria, B.C. V8W 9V7
1 800 663-6105 www.crownpub.bc.ca

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ACKNOWLEDGEMENTS

This field guide has been many years in the making and resulted from the collective work of a great many individuals. Ecological field sampling in southeast British Columbia began in the mid 1970s, during the early years of the Biogeoclimatic Ecosystem Classification (BEC) Program of the British Columbia Forest Service. With strong leadership from Greg Utzig and Gerry Still, the Kootenay BEC program had developed a robust classification and field guide by 1983; many of the plots collected by those crews continue to be used to describe the conditions and variability of ecosystems in this field guide. Original crew members include: Diane Ailman, Tom Braumandl, Anne Comeau, Phil Comeau, Dave Crampton, Gerry Davis, Sharon Hope, Joan Huiberts, Maureen Ketcheson, Donna MacDonald, Dale Martin, Teresa Newsome, Harry Quesnel, Jody Schlatter, Allison Warner, Bill Wells, and Terry Wood. We are forever grateful for their skill in ecosystem descriptions, and also for their informing and entertaining field notes and comments that remain in the database. It is always good to know that they too got snowed on in July (1978), saw piles of "deer scat" in their plot (1979), and were attacked by "PG style mosquitos" (1981).

Subsequent work by Tom Braumandl and Mike Curran, with extensive help from their colleagues in the Forest Sciences section at the Nelson Forest Region, led to the publication of Land Management Handbook 20 in 1992, which has served the region well for over 20 years. We are grateful for the contributions from Gerry Davis, Deb DeLong, Emilee Fanjoy, Maureen Ketcheson, and Harry Quesnel.

In the early 2000s, Dennis Lloyd re-initiated broad-scale BEC revision in the Southern Interior, with extensive work completed both in the overlap BEC units between the Thompson Okanagan and Kootenay-Boundary, and in the Rocky Mountain Trench. Thousands of plots were collected by: Scott Black, Nicole Brand, Mona Doney, Vanessa Larson, Jessica MacDonald, and Mike Ryan. These data have been essential in improving ecosystem classification and descriptions, and in bringing the site classification and biogeoclimatic mapping into alignment across regional boundaries. The colossal effort put forward by Dennis Lloyd, Mike Ryan, and their crews has been fundamental to the production of this field guide.

The rejuvenation of the Kootenay BEC program took flight in 2007 and has led to this field guide. From field planning to sampling, analysis, and review, this guide would not have been possible without the extensive contributions of Tom Braumandl, Gareth Kernaghan, and Evan McKenzie, with field expertise from Derek Marcoux and Mike van Wijk. Field work was always a lot of fun with our exceptional summer students, including Nola Flaws, Kira Hoffman, Bree Mathewman, and Kara Pitman. Will MacKenzie was also instrumental in providing field support throughout the program.

Additional support with field work and/or content review came from the other Ecologists: Allen Banner, Ray Coupé, Corey Erwin, Kim Everett, Erin Hall, Heather Klassen, Dennis Lloyd, Andy MacKinnon, Will MacKenzie, Shirley Mah, Del Meidinger, Bruce Rogers, Mike Ryan, and Sari Saunders. We are grateful for the opportunity to work with such a fantastic team and lament the retirement of so many of them.

Del Meidinger and Ray Coupé offered extremely detailed edit and review comments on the initial drafts. Their ability to both spell in Latin and distinguish between em and en dashes is noteworthy. Management-related review comments were provided by Kevin Astridge, Doug Thorburn, Val Miller, Carmen Cadrin, Jo-Anne Stacey, Karen Yearsley, and Garth Mowat.

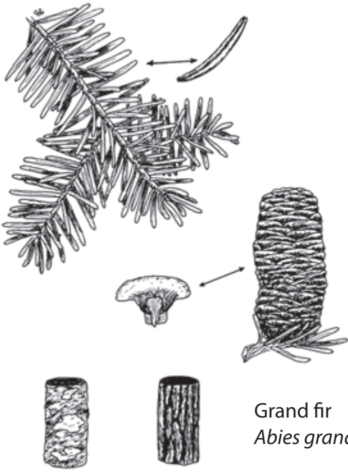
NBEC, or BEC of non-forested and related ecosystems, is a new and dynamic addition to this field guide. We are grateful to Dennis Lloyd, Mike Ryan, and their crews for sampling the full array of ecosystems in the field—from swamps, to cottonwood, to rock outcrops, and avalanche slopes with alder over their heads. Mike Ryan, Will MacKenzie, and Kristi Iverson worked tirelessly with us to finalize the non-forested classification presented here.

Vicky Lipinski's fastest fingers in the west kept the data entered and organized, while Will Burt, Huapeng Chen, and Adrian Walton answered (most of) our stupid GIS questions! Art Stock and Michael Murray provided input on the entomology and pathology issues for each biogeoclimatic unit, while Tom Braumandl provided draft input for the natural disturbance and management issues sections. Marlene Machmer used data and her expert knowledge of the region to write the wildlife descriptions. Deepa Filatow, Maija Finvers, and Evan McKenzie provided critical support and feedback for the soils, geology, and landforms sections. Thomas Hill and Irene Manley (Fish and Wildlife Compensation Program) provided feedback and data for the driest ecosystems in the ICH.

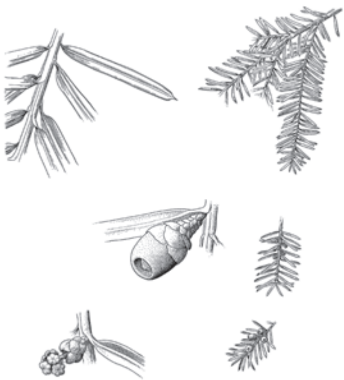
Ongoing support from district staff came from Lyn Konawalk, Denis Petryshen, Kevin Lavelle, Tara DeCourcy, Kristine Sacenieks, Barb Wadey, and Julie Castonguay. Extensive review and comment was provided by a number of local foresters, including Doug Thorburn, Reiner Munter, Mark McCauley (Atco Lumber), Kevin Bollefer (Revelstoke Community Forest Corporation), Kori Vernier (Canadian Forest Products), Nick MacRae (Canadian Forest Products), and the team at BCTS-TKO.

Special thanks to Chris Rowat and Daiva Villa (Chris Rowat Design) for their fantastic layout and design work, to Tracey Hooper for her English editing skills, and to Steven Justin Smith for catching all of our typos in the proof reading stage. Graphics were re-used from many previous government publications, although Nichola Lytle (Pink Dog Designs) created the floodplain diagram in Chapter 6. The publication process was smoothly guided by Paul Nystedt, Art Co-ordinator for the natural resource sector. Without Paul's guidance, we would have been lost in thick bold lines and italic fonts.

Funding for this guide has been extensive with ongoing support from the provincial Land Based Investment Program, first through FIA with support from BCTS, Kaleznikoff Lumber, Atco Lumber, Canfor Industries (previously Tembec), and Interfor, and later through the Forest Analysis and Inventory Branch. Many thanks go to Marcie Belcher, Jane Millar, and Ron Planden for supporting and administering funding. Additional funds were provided through the Research Program of the Ministry of Forests, Lands and Natural Resource Operations. Support, both in-kind and through sharing of resources, has also come from Parks Canada, the Nature Conservancy of Canada, and the Fish and Wildlife Compensation Program – Columbia Basin. Albert Nussbaum and Tim Salkeld have been a great support as data custodian and executive champion. And of course, ongoing support from our Regional Management Team, led by our Regional Executive Director Paul Rassmussen is greatly appreciated.



Grand fir
Abies grandis



Western Yew
Taxus brevifolia

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1 INTRODUCTION

This field guide presents site classification and identification information for ecosystems of the south-central Columbia Mountains, following the Biogeoclimatic Ecosystem Classification (BEC) system (described in Chapter 2). It is part of a four-volume series for southeast British Columbia that updates the biogeoclimatic and site classification previously published for the former Nelson Forest Region (Braumandl and Curran 1992; Braumandl and Dykstra 2005) and for parts of the former Kamloops Forest Region (Lloyd et al. 1990). The areas covered in this volume are shown in Figure 1.1, and include the central and south Selkirk Mountains, along with areas of the south and central Purcell and Monashee Mountains and the Shuswap Highland. The area corresponds to much of the Kootenay Lake and Arrow Timber Supply Areas (TSAs), and portions of the Rocky Mountain, Boundary, and Okanagan TSAs.

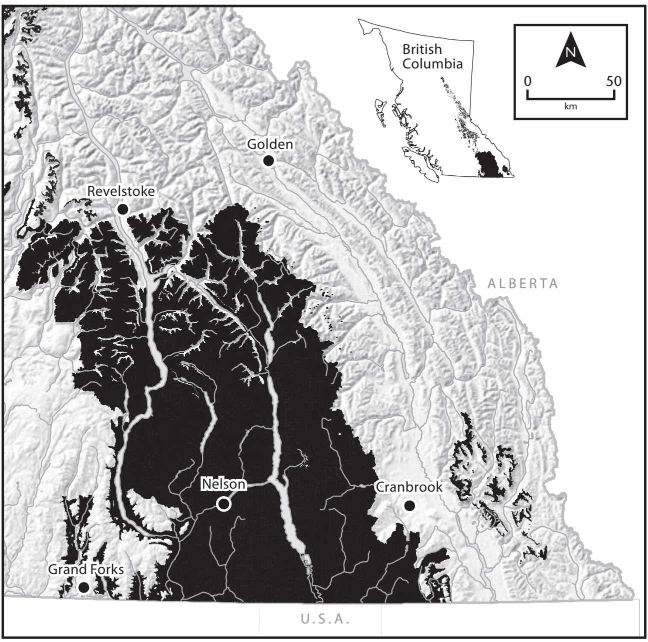


FIGURE 1.1 *Geographic area covered by this guide: south-central Columbia Mountains.*

1.1 Objectives/Scope

Biogeoclimatic Ecosystem Classification has been used to improve resource management in British Columbia since 1975. The BEC program aims to develop a long-term, land-based, ecological classification to organize knowledge about ecosystems and to serve as a framework within which to manage resources. The main objectives of the program are:

- to identify and map regions of similar bioclimate (biogeoclimatic zone, subzone, variant) in British Columbia;
- to describe major ecosystems within each biogeoclimatic unit;
- to provide tools for field identification of classification units;
- to develop management interpretations for site units or groups of site units; and
- to promote the concept of the ecosystem as a fundamental unit of resource management.

The objectives of BEC are:

- to provide a framework for organizing ecological information and management experience regarding ecosystems;
- to promote a better understanding of ecosystems and their interrelationships;
- to develop ecosystem benchmarks for use in climate change projections and future planning/management;
- to provide resource managers with a common "language" to describe ecosystems; and
- to improve users' ability to prescribe and monitor site-specific treatments.

The classification presented in this guide reflects a significant update in biogeoclimatic mapping of almost all zones, subzones, and variants in the study area, and a complete revision of all site series. While there are some similarities to the previous published field guides (Lloyd et al. 1990; Braumandl and Curran 1992; Braumandl and Dykstra 2005), the classifications differ in that:

- nomenclature and coding of biogeoclimatic subzones and variants has changed for many units;
- new provincial standards for the coding of site units are applied; and
- non-forested ecosystems are described for several Wetland, Flood, Grassland, Rock, and Avalanche classes.

Crosswalk tables comparing the names of biogeoclimatic units used in this guide and in the previous field guides are provided in Appendix 2.

The principal goal of this guide is to assist users in describing and identifying terrestrial ecosystems in southeast British Columbia. Management interpretations are not included in this guide but are available through resources such as the Chief Forester's Reference Guide for Tree Species, the Tree Species Selection Tool, the Site Index–Biogeoclimatic Ecosystem Classification (SIBEC) program, and the British Columbia Conservation Data Centre.[1]

1.2 History of Ecosystem Classification in Southeast British Columbia

V.J. Krajina and many of his graduate students at the University of British Columbia undertook extensive ecosystem classification studies in British Columbia during the late 1950s and 1960s. Most of these studies were conducted on British Columbia's coast (e.g., Orlóci 1965; Brooke et al. 1970), although Smith (1963, 1965) and Bell (1964, 1965) worked throughout what is now the ICH in the southern Monashee and Selkirk Ranges.

In the mid 1970s, the B.C. Ministry of Forests adopted BEC as a framework for forest management. The Ministry embarked on a province-wide classification program and recruited ecologists, botanists, soil scientists, and foresters to further develop and refine BEC.

In the late 1970s and early 1980s, the first ecosystem sampling by the Ministry of Forests was conducted in southeast British Columbia. Since that time, extensive ecological sampling has been conducted, and reports, maps, and field guides that describe the biogeoclimatic and site units have been produced. Field sampling and data analysis resulted in successive approximations of ecosystem classifications for the Nelson Forest Region (Utzig 1978; Utzig et al. 1986; Braumandl and Curran 1992; Braumandl and Dykstra 2005). Additional field sampling also led to a series of changes in biogeoclimatic mapping (as published in previous BEC mapping versions). Previous BEC work provided an excellent foundation and significantly informed the development of the revised classification presented in this guide.

The materials in this field guide reflect the first broad-scale, major change in BEC site series since the early 1990s when Lloyd et al. (1990) and Braumandl and Curran (1992) published field guides for the former Kamloops and Nelson Forest Regions. Since that time, the availability of plot data has increased by more than an order of magnitude, and mapping software has improved greatly. This includes targeted sampling for BEC classification as well as extensive field data collected as part of Terrestrial Ecosystem Mapping (TEM), Predictive Ecosystem Mapping (PEM), and SIBEC projects. Much of the field work for these projects was conducted by Maureen Ketcheson and her crews at JMJ Holdings.

[1] Resources are available on ministry websites.

1.3 Other Sources of Information

This guide is to be used in conjunction with biogeoclimatic maps that display the distribution of zones, subzones, and variants across southeast British Columbia. These maps are available in PDF and ArcGIS format at the "Maps" link on the provincial Ecology Program's website "BECWeb" and from the provincial geomatics data warehouse.

A summary of the BEC system is provided in Chapter 2. Additional information, including links to BEC field guides and background information on the BEC system, is available on BECWeb and in Meidinger and Pojar (1991).

For a more detailed discussion of the field methodology used to describe ecosystems, refer to Land Management Handbook (LMH) 25, the *Field Manual for Describing Terrestrial Ecosystems* (Province of British Columbia 2010). LMH 25 also provides tools and useful information for assisting with the collection of field data related to identifying the ecosystems covered in this guide.

1.4 Format of the Field Guide

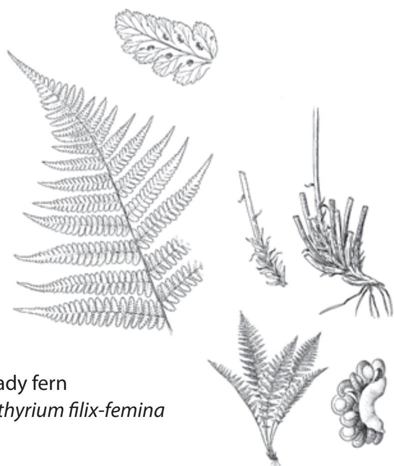
This guide includes the following chapters and appendices:

1. Introduction
2. Biogeoclimatic Ecosystem Classification: an overview of the BEC system
3. How to use this guide: an overview of procedures for site description, identification, and mapping
4. Regional environment: an overview describing climate regions and biogeoclimatic units, including descriptions and comparisons of physiography, bedrock geology, soils, climate, zonal vegetation, and disturbance history
5. Classification and description of biogeoclimatic and forested site series
6. Classification and description of non-forested site units for common wetland, flood, brushland, grassland, rock outcrop, talus, avalanche, and high-elevation ecosystems
7. Literature cited
8. Appendices providing plant species names and codes, vegetation groupings, crosswalk tables for new and old BEC classifications, and important keys and codes for using this guide, including keys to describing site and soil features and tables defining tree codes used throughout the text

The descriptions of the forested site series provided in this guide are based on information from forested field sample plots for 15 biogeoclimatic subzones/variants/phases. The field plots are generally well distributed geographically, and numbers are proportional to the size of the biogeoclimatic unit, except in areas with difficult access. Most ecosystem units are characterized by at least five plots, although less common ecosystems (e.g., on very dry or very wet sites) may be characterized by fewer plot samples.

This field guide does not fully encompass all the complexity and diversity of ecosystems in the south-central Columbia Mountains. The site series described represent the mature and old stages of relatively common ecosystems sampled throughout the subzones and variants. Users are bound to encounter ecosystems that do not appear to “fit” the classification. This may be a result of earlier seral conditions due to natural or anthropogenic disturbances or natural variability. In these cases, consideration of basic site factors (e.g., climate, soil moisture, soil nutrients), silvics of tree species, and effects of various management practices will be essential for decision-making.

Devil's club
Oplopanax horridus



Lady fern
Athyrium filix-femina

2 BIOGEOCLIMATIC ECOSYSTEM CLASSIFICATION

Biogeoclimatic Ecosystem Classification (BEC) is a hierarchical classification system that groups similar ecosystems at three levels of integration: regional, local, and chronological. At the regional or **biogeoclimatic (BGC) mapping scale**,[1] landscapes are divided into zones, subzones, and variants based on climate. At the local or **BEC site series scale**, stand-level ecosystems within a biogeoclimatic unit are classified and differentiated on the basis of site, soil, and vegetation characteristics. The stand and regional scales are linked together through the distribution of vegetation on zonal sites[2] with similar climate conditions (Figure 2.1).

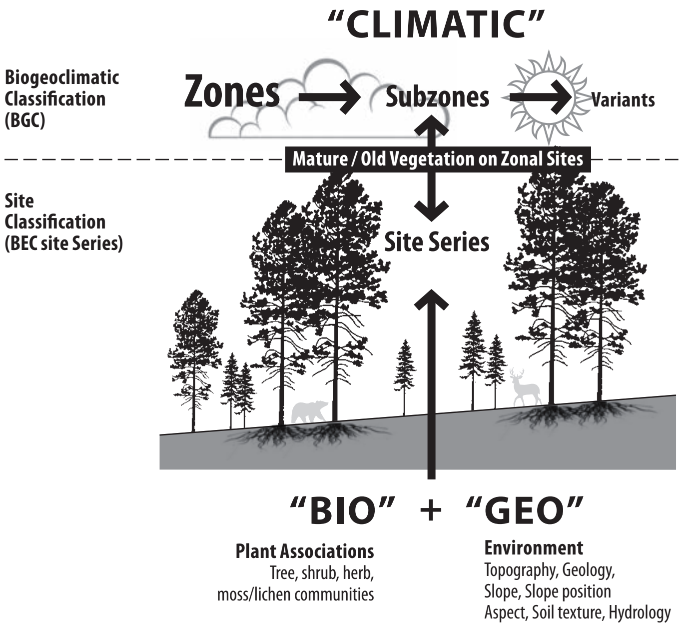


FIGURE 2.1 *Relationship between regional climate and site classification levels of BEC.*

[1] Key words have been highlighted in bold to provide additional emphasis.
[2] Zonal sites support the plant community that best reflects the regional climate of that subzone/variant. See Section 2.1.2.

An ecosystem is the result of complex interactions among living organisms, including plants, animals, and micro-organisms, and their physical (abiotic) environment, including soil, air, water, topography, and climatic conditions, over time. While ecosystems occur across multiple spatial scales from very fine scales (such as the assemblage of mosses and lichens on a tree trunk) to the planetary scale (such as the boreal forests of North America, Europe, and Asia), for the purposes of BEC, ecosystems are described and classified from the stand scale (i.e., site series) to the regional scale (i.e., BGC mapping). The chronological level of the BEC classification system recognizes that plant communities change with time and disturbance (see Section 2.3).

2.1 The Biogeoclimatic Ecosystem Classification System

The BEC system combines four classifications: climate (zonal), site, vegetation, and seral (succession). For practical purposes, users interact primarily with the climate (through the biogeoclimatic mapping) and site classifications (through the field guides). The vegetation classification is used in naming and correlating site units. The seral classification is not well developed at this time (Figure 2.2).

2.1.1 Climate (zonal) classification

Climate is the overarching factor influencing the development of terrestrial ecosystems. Climatic patterns can be expressed at regional scales based on latitude, elevation, and the interaction between dominant weather systems and the mountainous topography of British Columbia. Similar climates support the development of similar vegetation patterns. In BEC, similar climates are classified and mapped as biogeoclimatic units in the climate (or zonal) classification component. These units include zones, subzones, variants, and phases, which are portrayed on maps and comprise the core of the biogeoclimatic component of the BEC system (Figure 2.1).

As used in this guide, climate refers to the regional climate that influences ecosystems over an extended period of time and can be expressed as statistics derived from normals (long-term averages) of precipitation and temperature. The climate classification is also referred to as the "zonal" classification because the extent (mapping) of zones and subzones is based on the distribution of plant communities on zonal sites (see Section 2.1.2); plant communities are used to infer climate conditions, particularly where climate data are sparse.

Biogeoclimatic zones are used at the broadest spatial scale in BEC and reflect large geographic areas with a broadly similar type of macroclimate. A zone has typical patterns of vegetation and associated similarities in

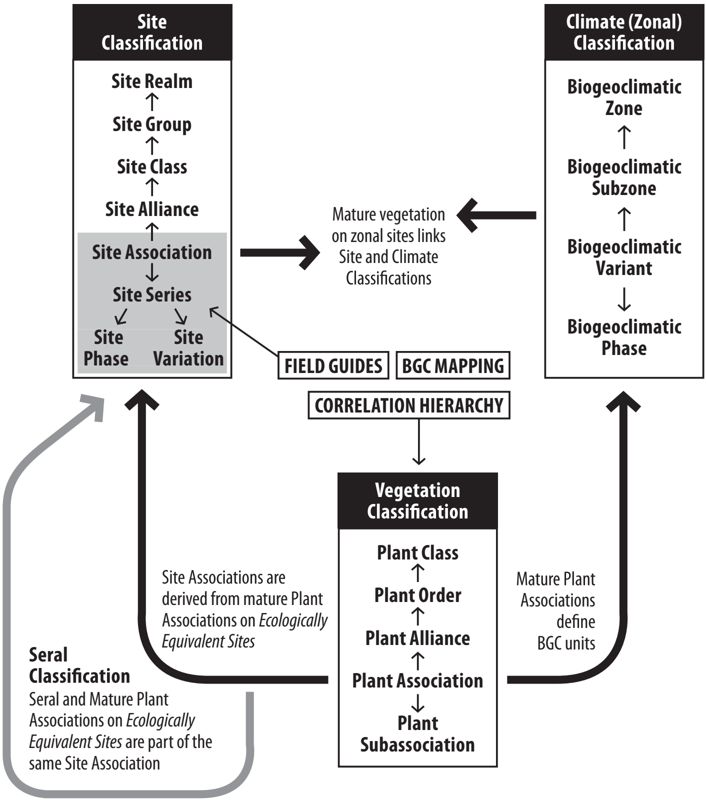


FIGURE 2.2 *Relationship between the components of BEC, including key applications of each: climate (zonal) classification (BGC mapping); site classification (field guides); and vegetation (correlation hierarchy). The shaded grey portion of the site classification shows the units most commonly described in field guides.*

nutrient cycling and soil climate. Zones are usually characterized by having one or more characteristic tree species, such as the Engelmann Spruce – Subalpine Fir (ESSF) Zone, and often contain a suite of typical shrub, herb, or moss layer species that are generally present in the mature vegetation. Non-forested zones such as the Interior Mountain-heather Alpine Zone are characterized by the dominant understorey species.

Zones are named after one or more of the dominant species of mature vegetation on zonal sites, and sometimes include a geographic modifier (e.g., “Interior”). A two- to four-letter code is used to abbreviate the name. For example, ICH denotes the Interior Cedar – Hemlock zone, MS denotes the Montane Spruce zone, and IMA denotes the Interior Mountain-heather Alpine zone.

In developing and organizing the hierarchy of climatic units, the **biogeoclimatic subzone** is the fundamental unit of classification—subzones are grouped into zones, and divided into variants. Biogeoclimatic subzones reflect climate at the regional scale. Subzones reflect the geographic extent of an area where the climate is homogeneous enough to support the same general pattern of plant communities on similar sites. Although access to modelled climate data is improving (e.g., ClimateWNA [Wang et al. 2012]), plant communities are used to infer climatic conditions in the BEC system.

The BEC system uses the mature vegetation on zonal sites and its distribution to define the concept and delineate the geographic extent of each subzone. **Zonal sites** are intermediate in soil moisture and nutrient conditions and generally occur on sites with a neutral aspect, in a mid-slope position in mountainous areas or in level positions on plateaus, and with moderately deep soils of medium texture. These sites are not overly influenced by site conditions such as shallow soils, root-restricting layers, abundant coarse fragments, excessive soil moisture, or localized climate conditions such as frost pockets or excessive insolation, and thus best reflect the growing characteristics of the regional climate. In turn, the geographic extent of the zonal vegetation is used to delineate the extent of the subzone that is portrayed on maps.

Subzone names and codes reflect climatic differences based on precipitation and temperature[3] relative to the zone. A two-letter code is added to the zone code: the first letter connotes precipitation; the second connotes temperature (Table 2.1). For example, ICHxw represents the very dry, warm ICH subzone. A third letter modifier can be used to identify a parkland or wood-

[3] For coastal subzones of the BEC system, the second letter modifier differentiates subzones by continentality rather than temperature.

land subzone. For example, the ESSFwcw is the wet, cold ESSF woodland subzone, while the ESSFwcp is the wet, cold ESSF parkland subzone. These subzones will have climatic and floristic characteristics that are intermediate between the ESSFwc subzone below and the alpine above.

TABLE 2.1. *Connotative codes used in subzone names in British Columbia's interior*

Temperature	Code	Precipitation	Code
very hot	x	very dry	x
hot	h	dry	d
warm	w	moist	m
mild	m	wet	w
cool	k	very wet	v
cold	c		
very cold	v		

Subzones can contain considerable variation, and may be subdivided into biogeoclimatic **variants**. Variants are generally recognized for areas that are slightly drier, wetter, snowier, warmer, or colder than other areas within a subzone, although geographic distribution and differences in mountain ranges or underlying soils and geology can also be drivers for differentiating variants. The zonal vegetation of variants within a subzone will generally be similar and may have relatively minor differences (reflected in different plant subassociations) (see Section 2.1.3). Non-zonal site series may be substantially different between variants.

Variants are coded with a number and named using geographic labels that reflect their general distribution within a subzone. For example, the Wet Mild Engelmann Spruce – Subalpine Fir (ESSFwm) subzone is divided into four variants: ESSFwm1 – Fernie Wet Mild Engelmann Spruce – Subalpine Fir in the cooler Rocky Mountains, ESSFwm2 – St. Mary Wet Mild Engelmann Spruce – Subalpine Fir in the central Purcell Mountains where precipitation is moderate, ESSFwm3 – Ymir Wet Mild Engelmann Spruce – Subalpine Fir in the snowier Selkirk Mountains, and ESSFwm4 – Moyie Wet Mild Engelmann Spruce – Subalpine Fir in the drier, warmer southern Purcell Mountains.

Biogeoclimatic phases can be used where local climates have an unusual effect on the distribution, composition, pattern, or structure of vegetation communities. Biogeoclimatic phases are used to designate areas of ecosystems that are, for topographic or topoedaphic reasons, atypical for the regional climate. This generally includes areas of extensive warm aspects or cold air accumulation where local site conditions are hotter and drier, cooler and moister, or otherwise different than expected within the broader subzone or variant. Considerable differences in classification and management guidance from the adjacent subzone/variant apply.

The climate classification is linked to both the vegetation and site classifications (Figure 2.2). Zones, subzones, and variants are distinguished and named by the mature plant associations (defined in the vegetation classification) that occur on zonal sites. Subzones and variants are **mapped** (and spatially defined) by the geographic distribution of the mature plant association on zonal sites.

Throughout most of southeast British Columbia, subzones and variants are mapped using a GIS-based model that incorporates 1:20 000 TRIM elevation and aspect data. Elevation limits for each subzone/variant are determined for relatively consistent geographic sub-areas (e.g., a sub range of a larger mountain range, the cool aspect side of a valley, or the headwaters of a major river system). Elevation rules to distinguish between adjacent subzones/variants are determined for warm, neutral, and cool aspects for each subzone/variant in an elevation sequence (e.g., from ICHdw1 to ICHmw2, ESSFwh1, ESSFwh4, ESSFwcw, ESSFwcp, and IMAun). The elevations used in the model for each subzone/variant on each aspect are based on field data and observations, Vegetation Resource Inventory (VRI) mapping, and aerial imagery.

2.1.2 Site classification

The site classification system includes a hierarchy from site realms at the broadest level, through site groups, site classes, site associations, site series, and site phases or variations at the finest levels (Figure 2.2). The most commonly used units of site classification are site series and site associations.

The **site association** is the fundamental unit of the site classification. Site associations can be subdivided into site series or grouped into higher levels of the site classification. Site associations provide a linkage between the vegetation (plant associations) and climate classifications at the **subzone** level (Figure 2.2): the spatial distribution of a subzone reflects the geographic area where the climate conditions are consistent enough to support the same mature plant community (i.e., site association) on zonal sites.

Site associations group sites that are capable of producing the same vegetation (i.e., plant associations or subassociations), regardless of biogeoclimatic unit. This occurs due to "**ecological equivalence**," where sites with the same or very similar moisture and nutrient availability have the same or similar vegetation potential but may occur in different locations on the landscape within different climates. For example, the *CwHw – Devil's club – Lady fern* site association occurs on zonal sites in the ICHvk (generally mid slopes), on subhygric sites (typically lower slopes) in the ICHwk, and on hygric sites in the ICHmw (generally moist toe slopes). Because site associations are more variable in climatic and site conditions than site series, they are less predictable for management applications.

It is important to recognize that a particular site association can support a variety of plant communities depending on the disturbance history and successional stage, but the site association will likely produce one kind of plant community in mature and old structural stages. For example, devil's club may be absent from the *CwHw – Devil's club – Lady fern* site association when sun exposure is high following stand replacement but will typically re-colonize once shade increases and light levels decline. Site associations are named after the mature plant association (see Section 2.1.3), but because they are **site-based**, they include both the seral and mature plant associations that occur on the same ecologically equivalent sites. The site association does not change when an old-growth forest is burned and a new, early seral forest starts to grow.

Biogeoclimatic ecosystem classification field guides and many forest management applications focus primarily on the description and identification of site series. **Site series** refer to those **sites within a biogeoclimatic subzone or variant** that are capable of producing mature plant communities that would belong to the same plant association (and site association). Each subzone/variant has a characteristic sequence of site series occurring on sites with the same relative soil moisture and nutrient regime,[4] along with other environmental drivers such as flooding regime, soil depth, or cold air ponding. Within a given subzone/variant, **the zonal site series supports the plant community that best reflects the regional climate of that subzone/variant**. Sites that are wetter or drier, or richer or poorer than the zonal ecosystem are influenced not only by the regional climate but also by soil and topographic features at local scales.

Although site series are usually the most detailed level of site classification, they can be further subdivided into site phases and site variations. A **site phase** is used where site conditions are different but mature vegetation

[4] Section 3.2.2 defines and describes relative soil moisture and soil nutrient regimes.

is too similar to differentiate distinct plant associations for the two site conditions. For example, the ICHdm/102 site series commonly occurs on sites with exposed bedrock, and on steep, warm-aspect sites with coarse, moderately shallow soils. Two phases can be used to describe these situations: a xeric bedrock phase (ICHdm/102a) and a subxeric shallow/coarse soils phase (ICHdm/102b). A site phase may also be differentiated on the basis of slope class, aspect, parent material, soil climate, humus form, soil chemistry, or bedrock geology. For some users, these features may need to be identified for management purposes.

A **site variation** is used where mature vegetation is different but site conditions are too similar to differentiate at the site series level. For example, in the ESSFwm4/103, similar sites are commonly dominated by either grouseberry and low bilberry or bear-grass. Two variations are used to describe these situations: ESSFwm4/103.1 describes the grouseberry/low bilberry variation, while ESSFwm4/103.2 describes the bear-grass–dominated sites. Site variations typically have similar tree productivity but may differ in habitat potential. Different successional stages of ecosystem development on a site (see Section 2.3) do not constitute site variations.

Site variations, phases, site series, and site associations can be grouped into broader classes. Site associations can be rolled up into site classes, which can be combined into site groups and site realms. **Site realms** are the broadest level of site unit classification in the BEC system. This guide addresses ecosystems in the Terrestrial and Wetland realms, and does not address Marine or Freshwater realms (see MacKenzie 2012). Realms are subdivided into **site groups**, which describe broad sets of functionally similar ecosystems that are controlled by the same dominant ecological drivers; for example, snow depth and duration in the alpine environment, or flooding along watercourses. **Site classes** describe ecosystems that span a similar range of the dominant environmental gradients (e.g., hydrology) and support similar characteristic vegetation physiognomy and species guilds at maturity. **Site alliances** group site associations with broadly similar soil moisture and nutrient regimes, climatic conditions, and associated mature plant communities. No site alliances are defined at this time.

Site realms, groups, and classes are more commonly used in management and description of non-forested ecosystem units (Section 2.4). For example, alpine meadows (Am) are a subdivision of the Alpine group and the Meadow class in the Terrestrial realm, while fen wetlands (Wf) are part of the Peatland group in the Wetland realm. Non-forested ecosystems are described in Chapter 6.

2.1.3 Vegetation classification

Vegetation is integral to development and integration of both the site and climate (zonal) classifications. Vegetation is emphasized in the BEC system because it is readily visible and can be used to integrate the climate, abiotic environment, and ecological history of a site.

Because vegetation communities change with time and disturbance, the vegetation classification uses the "potential vegetation" of a group of sites, along with selected environmental properties, to delineate site units; in practice, mature and old plant communities form the basis of the vegetation classification.

Plant associations are diagnostically defined[5] plant communities and are the basic unit of the vegetation classification hierarchy. Plant associations can be more finely differentiated into **subassociations**, or combined into broader **alliances**, **orders**, and **classes** (Figure 2.2). Each unit in the vegetation classification hierarchy is differentiated by a diagnostic combination of species. Tree species are emphasized at the upper levels of the hierarchy (class, order), while understorey vegetation plays a larger role at the lower levels (alliance, association, and subassociation). Plant associations and subassociations are important for naming and differentiating biogeoclimatic subzones and variants (climatic classification) and site associations/site series (site classification). Vegetation is used in the field to identify both climatic and site units, but the vegetation hierarchy is typically in the "background" for most users of the BEC system who typically interact with it only through the names of forested site series or non-forested site associations.

2.2 Naming and Numbering of Site Units

Site associations are named using species from the mature plant association or subassociation that occurs in older successional stages. For forested associations, this is generally one or two tree species, followed by one or two understorey plant species. While the species chosen for naming the site association are often predominant in these communities, less common but characteristic species are sometimes used to ensure that the site unit has a unique name within the provincial classification. Site series generally use the same name as the site association, preceded by the appropriate biogeoclimatic subzone or variant symbol. For example, *ESSFwh1/BlHw – Rhododendron – Foamflower* represents the zonal site series in the ESSFwh1 variant.

Historically, forested site series were given a two-digit numeric code, from 01 to 29, with 01 always zonal, and site series numbered from dry to wet and secondarily from very poor to very rich. This guide uses a new

[5] Criteria for diagnostic differentiation are provided in Meidinger and Pojar (1991).

system designed to eliminate any confusion that may arise from changes in site series concepts and with additions of site series in the new classification. The new system uses a three-digit site series code (Figure 2.3). The first number indicates the revision version of the classification; thus, "101" is the designation for the zonal ecosystem in this guide, which presents the first revision to the subzone/variant classification (the zonal site series was previously numbered "01"). Site series numbers from 102 to 109 are reserved for forested units that are drier and/or poorer than zonal, with 102 being the driest and poorest and the numbering proceeding left to right, top to bottom. Numbers from 110 to 119 are reserved for forested units that are wetter or richer than zonal, with the numbering proceeding left to right, top to bottom. For more information on the new coding schemes, see Extension Note 106 (MacKenzie 2011).

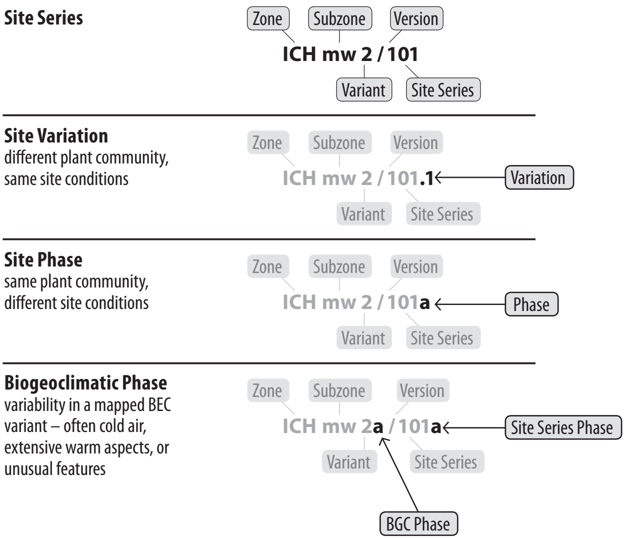


FIGURE 2.3 *Coding for site series, site variations, site phases, and biogeoclimatic phases.*

2.3 Seral Vegetation Classification

Vegetation composition (the species present) and structure (size distribution and spatial arrangement of trees and plants) changes over time—a process traditionally called succession. Within BEC, the mature plant communities of later successional stages are used to form the basis of the classification. This is because younger, post-disturbance plant communities are typically more variable than older stands and often contain a variety of weedy or otherwise opportunistic species that seldom persist as stands grow and develop. Although it is recognized that "succession" involves highly variable, non-linear processes and many alternative trajectories, mature and older forests tend to display a higher degree of convergence in vegetation composition and structure.

As shown in Figure 2.2, mature plant associations on ecologically equivalent sites define a site association; however, because of succession and different disturbance histories, multiple plant associations (plant communities of younger or disturbed sites) on ecologically equivalent sites are part of the same site association. For example, a thimbleberry-dominated shrub stage of a forest on a zonal site would be part of the 101 site series for the subzone/variant it occurs in, but it would be part of a different (seral) plant association than the site association is named for.

Seral vegetation, or younger/disturbed stands, are coded within the BEC system using a "$" to denote the younger stand or vegetation association. Where information is available, codes for structural stage (1 through 7)[6] and dominant vegetation composition (Conifer, Broadleaf, Mixed) can be used. This coding was introduced in Extension Note 106 (MacKenzie 2011). For example, a young, broadleaf-dominated forest on a subhygric site in the ICHdw1 could be coded as ICHdw1/110$5B. In this guide, there are no formal seral ecosystem descriptions, although seral conditions are often described in the "variability" section of the site series descriptions. Seral classification applies to forested and non-forested plant communities (Figure 2.4).

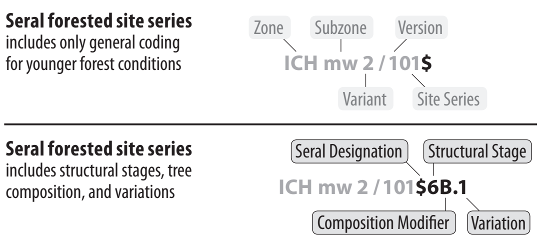


FIGURE 2.4 *Coding for seral (younger or disturbed) ecosystems.*

[6] Structural stage is defined in the Site Description chapter of Land Management Handbook 25: Field Manual for Describing Terrestrial Ecosystems (Province of British Columbia 2010) and ranges from 1 (Sparse/Cryptogam) to 7 (Old Forest).

2.4 Non-forested Ecosystem Naming and Coding

New coding for non-forested ecosystems follows the convention for wetlands introduced by MacKenzie and Moran (2004) and further developed by MacKenzie (2011, 2012) for a wide range of site groups. In their full form, the codes are four characters, where the first two digits are alphabetic and reflect the higher site levels of site realm/group and site class (Figure 2.5). The last two digits, where used (i.e., where sufficient data are available), are numeric and reflect differentiation at finer scales. Coding of these units does not change with biogeoclimatic unit—these are provincial codes—although non-forest units can be expressed as site associations (e.g., Wm01) or as site series, with the subzone/variant recorded (e.g., ICHmw2/Wm01). More information on non-forested ecosystems is provided in Chapter 6.

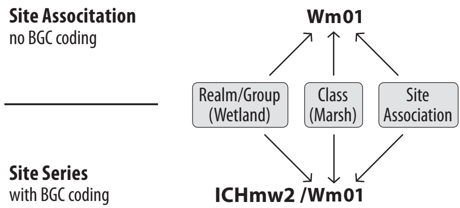


FIGURE 2.5 *Coding for non-forested units, as site association or site series.*

2.5 Managing across Ecological Gradients and Transitions

Boundaries between ecosystems on the landscape are occasionally abrupt, but ecosystems more often tend to grade slowly from one type to another, both at the site series and biogeoclimatic level. This confers inherent variability in biotic and abiotic conditions. Where ecosystems are transitional between two (or more) site or biogeoclimatic units, the transitional nature of the ecosystem should be taken into consideration: slight shifts in species abundance and distribution are often expected in the transition from, for example, wetter to drier or warmer to colder conditions.

Descriptions and subsequent management decisions should include an understanding of transitional characteristics. For example, a silviculture prescription in an area that is transitional between two biogeoclimatic units may include a description such as "the site is transitional between the ICH and ESSF; as such, minor Fd will be accepted in the regenerating stand." In forests that are transitional between two site series, a similar rationale may be provided, such as "the site fits the 101 best but has minor oak fern, suggesting slightly moister conditions; as such, the regenerating stand will include more Cw and less Fd than is typical on 101 sites."

2.6 Modern Ecological Theory and Biogeoclimatic Ecosystem Classification

When the BEC system was originally developed for British Columbia in the 1950s through to the 1990s, the researchers relied heavily on the notion of "climax" vegetation occurring in a stable equilibrium with climate. While many of the original considerations are still applicable, the fundamentals of ecological theory have evolved and progressed over time, and so too have the scientific underpinnings of BEC. More recent ecological theories that rely on concepts such as complexity, heterogeneity, non-linearity, stochastisity, non-equilibrium dynamics, and non-stable climates (e.g., Hollings 1992; Gunderson 2000; Meffe et al. 2002; Campbell et al. 2009; Gunderson et al. 2009; Puettmann et al. 2009; Haeussler 2011; Millar et al. 2014) are being incorporated into the way ecosystems are considered and defined in the BEC system.

Traditional notions of succession, climax, and potential vegetation are still useful concepts, but they need to be contextualized with an understanding of actual complexity and dynamic changes on the ground. The BEC framework relies on theoretical climax vegetation communities in the absence of stand-replacing disturbance to describe both biogeoclimatic units (zones and subzones) and site series. However, it is recognized that disturbance is pervasive at multiple scales, from the individual tree to stands and landscapes. Describing "site potential vegetation" is not intended to suggest that every stand is on a single, deterministic successional trajectory to a climax but that the vegetation on a specific site in a specific area usually aligns with a describable pattern.

In her essay on "Rethinking biogeoclimatic ecosystem classification for a changing world," Haeussler (2011) suggests that there can be multiple "attractors" that help determine past, current, and future ecosystem condition. Attractors are defined as "a set of states of a dynamic physical system toward which the system tends to evolve, regardless of the starting conditions of the system." These can include a number of traditional ecosystem "drivers" used in BEC, such as regional climate, topographic position, soil nutrient regime, and typical patterns of vegetation development.

BEC is a **tool** to support resource professionals in making good choices for stewardship. It provides a framework for simplifying complex systems into a common language that can be translated into a variety of management and conservation activities. In the context of this field guide, the site series and biogeoclimatic descriptions describe the most common conditions on mature and older sites. However, it is recognized that ecosystems are variable and that some sites may not fit a defined site unit well due to a number of factors, across multiple spatial and temporal scales, and this should be expected. It is incumbent on both the BEC system and users of the system to understand and incorporate the complexity and dynamic nature of ecosystems into their understanding and management of ecosystems within the BEC framework.

Modern ways of framing and understanding ecosystems are incorporated into BEC mapping, classification, and field guide materials. For example, the vegetation descriptions focus on the most probable plant community in mature and old forests on a given site type; this does not mean that all of that site type will have the same vegetation—diversity and variability are always expected. The use of grey bars, black bars, and stars in the vegetation tables is one example of how expected ecosystem variability is being incorporated into the BEC framework. Site series variations are another example; where more than one plant community is highly probable on a site type, the most common types are described. The BEC system is still relying on current conditions, but introducing concepts of variability and diversity should help users think creatively about ecosystem complexity in their application of the tools.

A number of factors (or attractors) influence the development and condition of ecosystems: fire, insects, and other natural disturbances; changing climates; inherent natural variability and random chance (stochasticity); invasive species; and harvesting, road building, and other human disturbances, to name a few. These varied attractors or processes are non-linear and continue to change and interact in complex ways at multiple scales. Understanding that ecosystems are complex and that we must consider as many influences as possible will help users apply the BEC system to management decisions that support good stewardship.

2.7 Biogeoclimatic Ecosystem Classification and Climate Change

Climate–vegetation relationships are integral to the development of the climate and site classifications of BEC. Accordingly, the impacts of climate change need to be considered in the development and application of BEC.

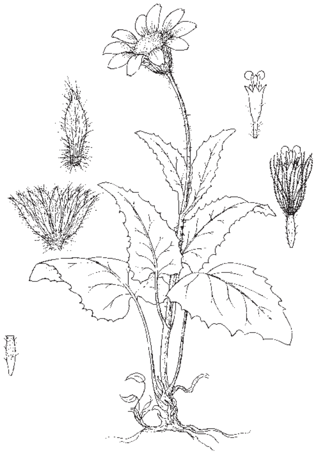
Climate change impacts on ecosystems are likely to be expressed initially as changes in vigour, relative productivity, and disturbance susceptibility, and later as changes in the range and distribution of species already present and likely to be introduced or lost. At longer time scales, climate change is likely to have an impact on the biogeoclimatic zonation of BEC. Changes in temperature regimes and/or moisture conditions will occur. Information about these projected changes is being evaluated for long-term planning, and for application in the short term, to reduce management impacts of shifts in the relationships described by the current classification.

Although general trends are suggested by global climate models (IPCC 2014), the nature and intensity of climate change and its impacts on ecosystems are highly uncertain. Specific details of the anticipated changes cannot be known at this time; however, vegetation will continue to reflect site conditions even with climate change, but the specific vegetation indicators for a site type will have to evolve with time. Overall, the impacts of climate change on mature vegetation communities and vegetation–site relationships are expected to occur at time scales that will allow the classification to be modified as required and remain relevant for management applications for at least several decades.

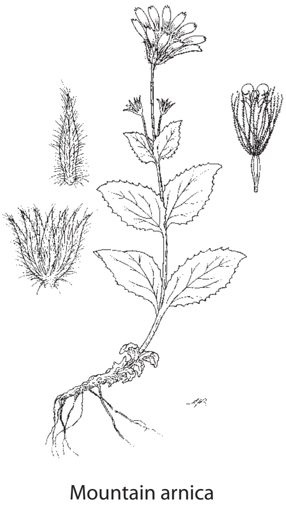
The database used for the BEC classification in this field guide currently includes more than 60 000 sites sampled throughout the province. These data provide a historical record of the site, soils, and vegetation features that have occurred on the landscape since the 1960s. This information, along with biogeoclimatic mapping and the **BEC classification**, provides an excellent source of **baseline information** by which future changes in vegetation can be detected in response to climate change.

A key strength of the BEC system for climate change adaptation is its linkages between vegetation, climate, and site. Because BEC incorporates climate and site scales into the same integrated system, the effects of changing climate on vegetation can be modelled at the biogeoclimatic scale (e.g., subzone or variant) and subsequently downscaled to the stand level. In addition, as climatic shifts occur, enduring site features will remain stable: a subxeric site in a current biogeoclimatic unit will still be a subxeric site in a future climate. However, the climatic conditions and, subsequently, the plant community likely to grow on that subxeric site will shift. This could mean, for example, a shift from an ICH climate to an IDF climate at the regional scale, and a change from western hemlock to ponderosa pine on the subxeric site at the stand (or site series) scale. Although users will be able to continue using BEC to identify and classify sites, the management decisions they make will need to evolve with a changing climate and our improved understanding of those changes.

Whatever the future climate, land managers will remain interested in understanding ecosystems to properly manage the diversity of ecosystems and ecosystem services. An ecological framework that integrates the essential ecosystem components required for this understanding will remain essential. An evolving BEC system can continue to provide this framework for diverse applications, including ecosystem representation/conservation, wildlife habitat assessment, silviculture, interpreting ecosystems for the occurrence/abundance of culturally important plants, and protecting ecosystems at risk.



Heart-leaved arnica
Arnica cordifolia



Mountain arnica
Arnica latifolia

3 HOW TO USE THIS GUIDE

This field guide is designed to help users arrive at consistent site descriptions and classifications across complex and variable environments. A number of tools and descriptions are provided. This chapter is essentially the "how-to" part of the field guide. It describes the procedures and tools for identifying biogeoclimatic units and the procedures for describing and identifying site units, using the various tools and information provided in Chapters 4, 5, and 6, and in the appendices.

Site description and ecosystem classification are different but complementary processes. Site description produces a simple list of biotic and abiotic features for an ecosystem. No two ecosystems will have the exact same list of site characteristics, and each site could be considered unique. However, to apply knowledge gained on one site more widely, groups of sites with similar ecological function must be recognized. Ecosystem classification distills the commonality among sites into recognizable groups based on a few ecologically important factors.

Site classification involves two major steps (Figure 3.1). The first is to identify the biogeoclimatic subzone or variant; the second is to determine the site unit. These steps are accomplished through field assessment of site characteristics (site description) and comparison of these characteristics to the biogeoclimatic mapping available and to the information presented in this field guide.

Due to the importance of correct site classification for subsequent decisions regarding land use and management, it is essential that site description data be collected as consistently and accurately as possible.

3.1 How to Identify Biogeoclimatic Units

The first step to identifying biogeoclimatic units involves consulting a map. Biogeoclimatic zones, subzones, variants, and phases have been mapped throughout the Southern Interior using the 1:20 000 Terrain Resource Information Mapping (TRIM) as a base; any future updates to official BEC mapping will be available through the provincial government's geomatics system and the Ecology Program's "BECWeb" site.

Maps should be used to identify the biogeoclimatic unit or units within the study area, as well as the proximity to adjacent units. As described in Chapter 2, boundaries between ecosystems occur along continuous gradients and transitions from one unit to another are rarely abrupt. When changes in BEC mapping are approached, transitional characteristics may become evident, particularly along north/south gradients and higher/lower elevations.

After maps are consulted, the variant or subzone should be confirmed through observation in the field. The user should check the general floristic features of the area—primarily the dominant tree and understorey plant species. Subzone/variant identification should be based as much as possible on the examination of zonal or mesic sites; that is, sites that represent average soil moisture and nutrient conditions for the subzone or variant (see Section 2.2). In the steep, mountainous terrain of the south-central Columbia Mountains, this is often not possible because true zonal sites are uncommon. Instead, users must also evaluate the vegetation on submesic or drier sites to help differentiate between adjacent biogeoclimatic subzones/variants. The primary tools for use in the field include:

- maps showing the distribution of each biogeoclimatic subzone/variant (Chapter 5);
- written descriptions of each biogeoclimatic subzone/variant (Chapter 5);
- tables for distinguishing the subzone/variant from adjacent biogeoclimatic units (Chapter 5);
- Tables 4.8 and 4.9: zonal vegetation comparisons (Chapter 4); and
- Tables 4.5 and 4.6: comparison of climates (Chapter 4).

If an area is located in the transition between two variants, or if doubt remains after verification in the field using the information and tools in Chapters 4 and 5, then both possible variants should be considered when making site unit diagnosis and management decisions.

If an area does not fit the officially mapped biogeoclimatic subzone/variant, it is acceptable to manage using an adjacent biogeoclimatic unit where it is a better fit. However, a valid justification and detailed rationale must be documented and kept on file for all management-related decisions. Managing to a different BEC is not surprising nor is it unexpected when the area in question is near a boundary (e.g., within ~100 m elevation of the boundary or within 1–2 km in subdued terrain). Where the area in question is more extensive or not immediately near a transition to an adjacent BGC unit, the resource professional should notify the Regional Ecologist so that the area can be evaluated and, if necessary, the mapping updated.

1. Identifying the Biogeoclimatic Unit (Subzone/Variant)

Identify possible BGC units pre-field by:

- referring to most recent BEC map/GIS layer (available on "BECWeb")
- reviewing the geographic extent and descriptions of potential biogeoclimatic units in Chapter 5

Confirm the BGC unit en route to the site by:

- observing vegetation on zonal or mesic sites in the area
- referring to BGC descriptions in Chapter 5, and zonal vegetation comparisons in Chapter 4

Example: ICHmw2

2. Identifying the Site Unit (Site Series/Site Association)

Describe the site by:

- selecting a sample area (Section 3.2.1)
- describing the site characteristics (Table 3.1)
- describing the soil characteristics (Table 3.1)
- estimating percent cover for vegetation
- determining soil moisture and nutrient regime (Section 3.2.2 and Keys in Appendix 3)

Classify the site by:

- examining site unit descriptions in Chapter 5 (Forested) or Chapter 6 (Non-forested)
- integrating site, soil, and vegetation information using site unit tools (edatopic grids, flowcharts, vegetation tables, environment tables, and descriptions; Section 3.2.2)

Example: ICHmw2/104

FIGURE 3.1 *Procedure for identifying biogeoclimatic subzones/variants and site units.*

3.2 How to Describe and Classify Site Units

Site unit classification requires:

1. accurate description (determination and recording) of site, soil, and vegetation characteristics; and
2. thoughtful use of the various aids and descriptive materials in this guide to determine the site unit that best matches these characteristics.

Ecosystem description, identification, and classification are not an end in themselves. The vegetation, soils, and site data collected to identify a site series have a wide variety of uses. For example, the site information can be applied directly to harvesting and silviculture decisions, regeneration surveys, site sensitivity evaluation, environmental assessment processes, wildlife habitat studies, and many other applications. With such wide application, it is very important that field crews collect site information, not just vegetation lists. Using established field forms with associated databases is also encouraged to ensure that consistent and complete data standards and collection are followed.[1]

It is important to note that there is much more natural variability in the forests than is portrayed in this field guide; users should not expect that a field site will perfectly match all details in the description of a site unit in this guide. Sites that are classified within a site unit represent a cluster around a central concept. The site should reasonably match the concept and principal features of a site unit but may not perfectly match all the details of the site unit description. Each site should be described to best reflect the reality of that site; there is no benefit in attempting to replicate the description presented in this field guide. In this way, it is hoped that an appreciation for the complexity and interconnectedness of ecosystems is fostered.

The classifications and descriptions of site units in this guide represent much of the variability expected to be encountered in the forests within the biogeoclimatic units addressed in this field guide, but some forest ecosystems likely will not fit any described site unit well. This may be because the ecosystem is located in a geographic area that is transitional between two or more biogeoclimatic variants, so that the ecosystem reflects the transitional climate. As described in Section 3.1, the descriptions for both variants should be compared. Alternatively, a "poor fit" may be because the site from which data were collected is in a location that is transitional between two site units or it overlaps two different site units. In this case, the plot might be relocated to represent more accurately the typical ecosystems within the area of interest. If this is not practical, then the characteristics of the site as compared to both site units should be considered; in some cases, it may be necessary to record both site units.[2] Lastly, a "poor fit" may result if a new ecosystem that has not yet been described for the subzone or variant is encountered. If this is the case, it should be brought to the attention of the Regional Ecologist.

[1] Appropriate field forms and databases vary by application. For example, ecosystem data collection should follow the standards and databasing for the Ecosystem Field Form (FS882) or Site Visit Form (FS1333) described in LMH 25 (Province of British Columbia 2010), while silviculture prescription development can follow the FS39 in LMH 47 (Curran et al. 2000).

[2] The Trans/Distr field in the FS882 field form in LMH 25 can be used to record two separate site units in one plot; this may be necessary for randomly located plots or other management needs.

3.2.1 How to describe sites

Accurate descriptions of the site, soil, and vegetation features of all ecosystems within an area should be completed in the field. Appendix 3 outlines the information required for assessing a site, and contains several keys and codes to assist in the process. These are based on information and keys provided in Land Management Handbook (LMH) 25, the *Field Manual for Describing Terrestrial Ecosystems* (Province of British Columbia 2010). LMH 25 provides detailed information about methods and codes for describing ecosystems in the field, including forms (FS882 Full Forms and FS1333 SIVI – Site Visit Forms) with codes and definitions for all fields. The handbook provides chapters (and forms) for:

- Site Description
- Soil Description
- Vegetation
- Mensuration
- Wildlife Habitat Assessment
- Tree Attributes for Wildlife
- Coarse Woody Debris
- Site Visit (SIVI) Standards

The following steps are recommended for describing a stand or site:

Step 1. Select a sample area: Locate an area that appears to be representative of the site being sampled and is as homogeneous in plant cover and overstorey canopy condition as possible. The area should not include pronounced differences in site, soil, or vegetation that may indicate another site unit, and should exclude edge effects and disturbances such as roads or paths. Disturbed sites may be assessed to meet other management objectives (see Section 3.3), while assessment of non-homogeneous sites may involve assigning more than one site unit to the plot.

The assessment area should normally be 0.04 ha (20 × 20 m, or 11.28 m radius for circular plots). The size and shape of the plot can be modified, particularly for ecosystems that typically occupy a small discrete area, such as a rock outcrop, or form a narrow linear band, such as riparian areas adjacent to streams or ponds.

Record the georeferencing information—either in UTM or latitude/longitude. It is important to collect this information even if it is not expected to be needed in the future. Questions regarding the collected field data often arise during reviews or audits, and they cannot be resolved if location information is inadequate or missing.

Step 2. Describe site and soil characteristics: Determine and record site and soil information that is important for site identification. Table 3.1 lists some of the more important site and soil features to be collected. More detailed site and soil information may be required for certain purposes (e.g., setting benchmarks for long-term studies or development projects); in such cases, more information is available in LMH 25.

TABLE 3.1 *Site and soil features that are important in site assessment*

Site features	Soil features	
Elevation	Soil texture	Humus thickness
Slope position	Percent coarse fragments	Humus form
Slope grade (%)	Soil depth	Type of A and B horizons
Aspect (°)	Rooting depth	Drainage
Georeferenced location	Root-restricting layer type and depth (if present)	Presence of mottles or gleying
Disturbance history/type	Depth to water table	Bedrock/coarse fragment geology
		Surficial materials/ terrain type

Step 3. Describe vegetation: Record as many of the plant species (including tree, shrub, herb, and moss layer species) in the plot as possible. Surveyors should be familiar with the key indicator species for the subzones/variants in which they are working (i.e., those listed in Chapter 5). Estimate the percent cover of each species. Unknown species that are prominent on the site should be collected for subsequent identification in the office. See Appendix 3.7 for comparison charts for visual estimation of foliage cover.

Step 4. Determine soil moisture and nutrient regime: Using the site and soil factors recorded in Step 2, determine the relative soil moisture regime and relative soil nutrient regime using the keys provided in Appendix 3.1.

3.2.2 Tools for identifying site units

Once site, soil, and vegetation information has been recorded for a given area, the site unit (i.e., site series, variation, or phase, or site association for non-forested units) can be identified and named. Several aids are presented in Chapter 5 (forested ecosystems) and Chapter 6 (non-forested and other ecosystems) to assist in the identification of site series for each biogeoclimatic subzone/variant. These aids include edatopic grids that show the characteristic range of soil nutrient and moisture for sites, environment and vegetation tables, flowcharts for identifying site units, and descriptive summaries of each site series and its important distinguishing features. The aids provided in Chapter 6 for identifying and classifying non-forested ecosystems are similar to those for forested ecosystems but are tailored to each type of non-forest ecosystem.

Edatopic grid: soil moisture regime and soil nutrient regime

The edatopic grid is a two-dimensional schematic representation of soil moisture (SMR) and soil nutrient (SNR) regimes for all site units within a subzone or variant (Figure 3.2).

Soil nutrient regime (SNR) indicates the soil's ability to supply the major nutrients required for plant growth. It is displayed along the horizontal axis of the edatopic grid and ranges from very poor (A) to very rich (E). SNR values are estimated on a relative scale within a given biogeoclimatic subzone/variant. Many factors can influence the ability of the soil to store nutrients, including geological source of the parent material; soil depth, texture, and coarse fragment content; seepage water; and humus form. Appendix 3.1.3 provides keys for determining SNR in the field that illustrate and use the roles of these factors.

Relative soil moisture regime (rSMR) refers to the **relative** amount of soil moisture available for plant growth, and is relative to the climate within a subzone. Soil moisture regimes represent the soil's ability to receive and store moisture, and can be inferred from slope position and gradient, soil depth and texture, coarse fragment content, aspect, and seepage sources. Relative soil moisture regime is located on the left vertical axis of the edatopic grid and ranges from driest (very xeric or 0) to wettest (subhydric or 7). Zonal sites are centred around mesic relative soil moisture regimes (rSMR 4), with shedding and receiving sites being relatively drier or wetter. On xeric sites (rSMR 1), for example, precipitation may be the only source of moisture. This moisture may be lost rapidly due to any combination of factors: shallow soils, steep slopes, or coarse-textured soils. Conversely, a subhygric site (rSMR 5) may have additional inputs of subsurface flow that may be further retained on a site due to the presence of fine-textured soils or a concave slope shape. Using available Geographic Information Systems (GIS) layers either prior to or in the field may help users understand the site at a broader context and in relation to the rest of the slope. Appendix 3.1.2 provides keys for identifying relative soil moisture regime.

Together, SNR and rSMR can be used to consolidate the site and soil factors that identify a site series. Site units are displayed with no overlap of the units on the grid to simplify presentation. The potential for two or more site units to occupy the same soil moisture and nutrient condition in the field is illustrated by the sharing of grid cells by more than one site unit on the edatopic grid.

It should be remembered that edatopic grids are a qualitative representation of the moisture and nutrient status of sites within a subzone, and are

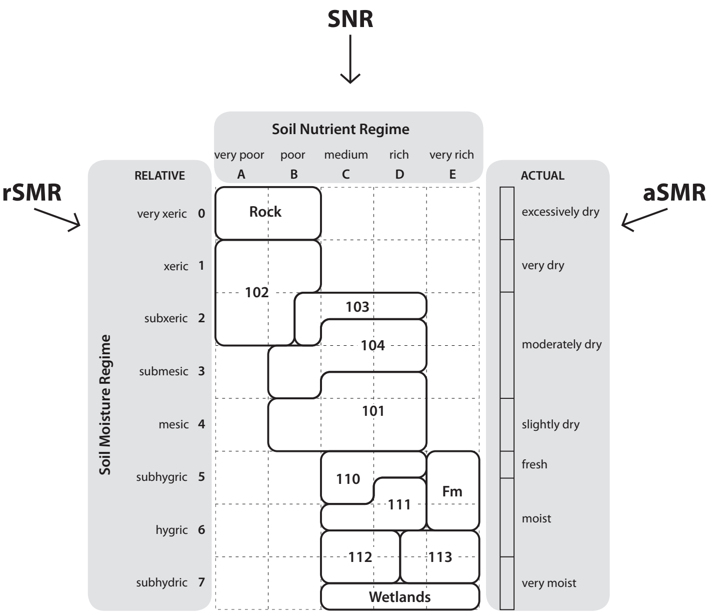


FIGURE 3.2 *Example of an edatopic grid.*

inferred from site, soil, and vegetation characteristics. Assessment of SMR and SNR is inferred from observations but is rarely based on quantitative data.

The **actual soil moisture regime (aSMR)** is provided on the right vertical axis of the edatopic grid; it is a reflection of the **absolute** water availability and is not scaled to the climate of the subzone. Actual soil moisture regime is based on a water balance approach (Klinka et al. 2000), and uses the presence and extent of water deficits and groundwater in the rooting zone to derive a calculated value that can be converted into categories that range from driest (Excessively Dry or ED) to wettest (Very Wet or VW). Actual soil moisture regime estimates on the edatopic grids in this field guide are based on calculated values using Version 5 of the online ClimateBC data (Wang et al. 2012)[3] as an input to the Hargreaves equation (Hargreaves and Allen 2003). Values were compared to estimates and adjusted in some cases. Actual soil moisture regime categories are defined in Table 3.2.

Actual soil moisture regime can be used to understand the relationship between site and climate across subzones and variants. For example, the *CwHw – Devil's club – Lady fern* site association in the ICH has a "Moist" aSMR. However, this site association occurs on hygric (rSMR 6) sites in the dry and moist ICH (e.g., ICHmw2), on subhygric (rSMR 5) sites in the wet ICH (e.g., ICHwk1), and on mesic sites (rSMR 4) in the very wet ICH (e.g. ICHvk1). The differences in site conditions are reflected in different landscape positions—this site association occurs in riparian areas in the ICHmw2, on lower-slope receiving sites in the ICHwk1, and on mid-slope zonal sites in the ICHvk1. This is due to differences in precipitation and **actual** soil moisture availability. Understanding the relationship between rSMR and aSMR allows users to integrate the local site conditions with regional climate. This can help users evaluate future site conditions under a range of potential climate change scenarios since the rSMR (relative moisture availability within a given climate) will not differ with climate change, but the aSMR (actual soil moisture) will.

Flowcharts for identifying site series

Flowcharts have been created to help users identify site series for each subzone or variant. The flowcharts start by dividing the biogeoclimatic subzone/variant into groups based on broad soil moisture categories: dry, moist, wet. Users can rapidly select the category for the site being described. Each broad category typically has arrows to two or more text boxes, each with a series of statements about site characteristics associated with each site series.

[3] Accessed online from the Centre for Forest Conservation Genetics, University of British Columbia.

TABLE 3.2 *Classification of actual soil moisture regimes (aSMR) based on water deficit calculations*[a,b]

Differentiating criteria	Class
Water deficit occurs. Rooting-zone groundwater absent during the growing season.	
Soil-stored reserve is used up and drought begins if current precipitation is insufficient for plants needs	
Deficit > 7 months (AET/PET ≤ 30%)	extremely dry
Deficit > 5 months but ≤ 7 months (AET/PET ≤ 55% but > 30%)	excessively dry
Deficit > 3 months but ≤ 5 months (AET/PET ≤ 75 but > 55%)	very dry
Deficit > 1.5 months but ≤ 3 months (AET/PET ≤ 90 but > 75%)	moderately dry
Deficit > 0 months but ≤ 1.5 months (AET/PET > 90%)	slightly dry
No water deficit occurs. Rooting-zone groundwater usually absent during growing season.	
Utilization (and recharge) occurs (current need for water exceeds supply and soil-stored water is used)	fresh
No utilization (current need for water does not exceed supply; temporary groundwater table [> 60 cm deep] may be present)	moist
No water deficit occurs. Rooting-zone groundwater usually present during growing season.	
Groundwater table > 30–60 cm deep	very moist
Groundwater table > 0 but ≤ 30 cm deep	wet
Groundwater table at or above the ground surface	very wet

[a] Modified from Klinka et al. (2000).
[b] ET – actual evapotranspiration; PET – potential evapotranspiration.

The flowcharts generally contain abbreviated information extracted from the vegetation and environment tables and site unit descriptions. The flowcharts emphasize features that can be identified quickly and easily.

Vegetation tables and species names

Throughout this field guide, common names are used in the text. Scientific names are provided in vegetation tables. Where the scientific name is not used in a vegetation table (e.g., in a BGC section in Chapter 5 or a non-forest group in Chapter 6), common name and the scientific name are provided in the text.

Plant species names used in this field guide follow the current provincial standard for both scientific and common names. Useful references for plant identification include the eFlora BC website, *Plants of Southern Interior British Columbia* (Parish et al. 1996), *Illustrated Flora of British Columbia* (Douglas et al. 1998–2002), and the Flora of North America website. However, nomenclature for the scientific names of plants of North America is undergoing a wide-spread updating process, and the names for many plant species in published books are not current. Provincial plant lists are updated annually to incorporate scientific or common plant name changes. For the most up-to-date nomenclature, see the table of taxonomic and nomenclature names in the "Official Provincial Plant Species Codes" on BECWeb or from the British Columbia Conservation Data Centre.

Vegetation tables provide a general guide to the dominant and indicator species that best characterize each site unit. The actual abundance of plant species on any given site will vary depending on several factors including the successional status of the site, the type and degree of disturbance history, and chance. The tables display classes of presence/mean cover values for characteristic plant species (or groups of species) for trees (woody plants > 10 m in height), shrubs (most woody plants and regenerating trees < 10 m in height), herbs (including forbs, grasses, and dwarf shrubs), and the moss layer (including mosses, lichens, liverworts, and hornworts). Both the scientific (left side) and common (right side) names are displayed on the tables. The symbols used in the vegetation table to represent constancy (the percentage of sampled plots in which the species occurred) and mean percent cover are shown in Table 3.3.

Species grouped across genera, but with similar lifeform and ecosystem indicator value, are listed in Appendix 1.1, while species grouped within a genus are listed in Appendix 1.2. Appendix 1.3 shows the current and retired/old names for species that have recently had name changes. A list of plant illustrations shown in this field guide is provided in Appendix 1.4. A full list of species scientific and common names referred to in this field guide, along with species codes, is available on the BECweb site.

TABLE 3.3. *Symbols used in vegetation tables*

Mean cover:	■	■■	■■■	■■■■	■■■■■	*
	< 1%	1–3%	3–10%	10–25%	> 25%	25–50% of plots and >1% cover

Constancy[a]: ■ > 70% of plots
■ 50–70% of plots

[a] Species constancy represents the percentage of sampled plots in which the species occurs.

The vegetation tables in Chapter 5 are derived from data collected in the sample plots that were used to classify and describe site units within a biogeoclimatic unit. The plots were sampled in stands of mature vegetation. Some plants may be unique to a particular site unit. This usually occurs at the extremes of the environmental gradient (e.g., in the driest or wettest ecosystems). Most sites, however, do not have exclusive plants, and it is usually the relative abundance as well as the presence or absence of a group of plants that distinguishes one site series from another.

Environment tables

An environment table is provided for each subzone/variant to summarize the common site and soil features of each site series or site series phase (where applicable). Because of compensating factors, a site series may occur across a wide range of conditions, including variation in soil textures, slope positions, and aspects, but the general trends can help users recognize "typical" site conditions and the resulting common site sensitivities and characteristics.

In the environment tables presented in this guide, a number of common variables are listed, but parentheses ( ) are used to indicate less common conditions. Note that the environment conditions provided in this guide do not cover all situations where a site series may occur.

Soil moisture regime: The typical range of rSMR is provided for each site series. Parentheses are used where a value is less common. Keys for determining rSMR are provided in Appendix 3.1.

Soil nutrient regime: The typical range of SNR is provided for each site series. Parentheses are used where a value is less common. Keys for determining SNR are provided in Appendix 3.1.

Slope position: Slope position affects soil water movement on a slope and is critical for determining hydrologic flow and moisture availability. In the environment tables and associated keys (e.g., rSMR keys in Appendix 3.1.2), this refers to the "mesoslope" scale, which is relative to the immediate catchment area of a site. Upper slopes shed water and are drier; lower slopes receive additional water and dissolved nutrients and are wetter and richer; middle slopes are in balance. Slope position is evaluated for the slope segment that directly affects water movement on the site. Table 3.4 defines the eight slope positions and their abbreviations used in environment tables. Figure 3.3 provides a schematic depiction of each mesoslope position.

TABLE 3.4. *Definition of slope positions and abbreviations used*

Mesoslope position	Abbreviation	Definition
Crest	CR	The generally convex uppermost portion of a hill; usually convex in all directions with no distinct aspect.
Upper	UP	The generally convex upper portion of the slope immediately below the crest of a hill; has a specific aspect.
Middle	MD	Area between the upper and lower slope; the surface profile is generally neither distinctly concave nor convex; has a straight or somewhat sigmoid surface profile with a specific aspect.
Lower	LW	The area toward the base of a slope; generally has a concave surface profile with a specific aspect.
Toe	TO	The area demarcated from the lower slope by an abrupt decrease in slope gradient; seepage is typically present.
Level	LV	Any level meso-scale area not immediately adjacent to a meso-scale slope; the surface profile is generally horizontal and straight with no significant aspect.
Depression	DP	Any area concave in all directions; may be at the base of a meso-scale slope or in a generally level area.
Gully	GU	An area in a double toe slope position where the receiving area is also sloped (perpendicular to the toe slopes).

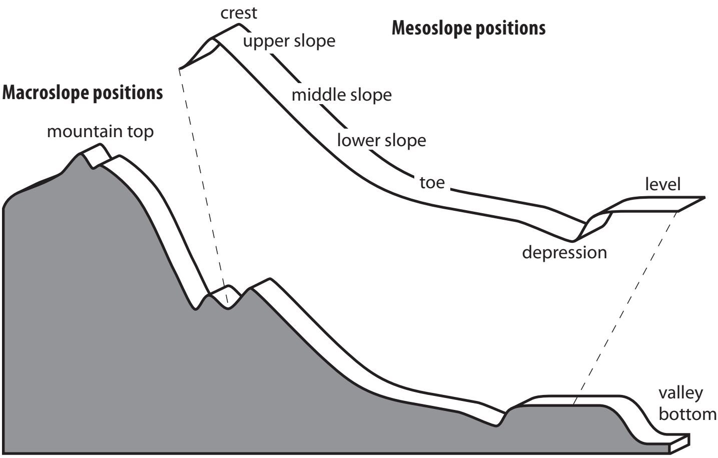


FIGURE 3.3 *Mesoslope positions.*

Typical slope/aspect and common compensating conditions: In many cases, the interaction between environmental factors is the most critical component in determining site conditions. For example, submesic sites often occur on medium-textured soils on mid slopes of warm aspects or on moderately coarse, upper, shedding slopes of cool to neutral aspects. To highlight the importance of these interacting effects, data are summarized by "typical slope/aspect" and "common compensating conditions." Only the most common conditions are listed; any given site series may occur in a number of different conditions.

Soil texture: The most commonly encountered soil textures on each site series are presented, with less common soil textures shown in parentheses ( ). Due to compensating factors, additional soil textures (that are not listed) may occur. Soil textures listed refer to the typical soil textures that occur in the rooting zone of trees, and do not reflect all horizons in a standard soil profile. Keys to soil texture are provided in Appendix 3.2.

Surficial materials: Appendix 3.5 provides a key to surficial materials. Surficial material abbreviations used in the environment tables and landscape profiles are defined in Table 3.5. Surficial materials can be important in determining key environmental characteristics, including soil nutrient availability, soil texture, and soil drainage. The definitions and distribution of surficial materials are also discussed in Section 4.5.

TABLE 3.5 *Abbreviations used to describe surficial materials (modified from Howes and Kenk 1997)*

Abbreviation	Surficial material
C	Colluvial
E	Eolian
F	Fluvial
FG	Glaciofluvial
L	Lacustrine
LG	Glaciolacustrine
M	Morainal
O	Organic
R	Bedrock
D	Weathered bedrock (in situ)
A	Anthropogenic (human modified)

Coarse fragment content: A categorical summary of coarse fragment content is provided to represent the percentage of the soil occupied by coarse particles (> 2 mm diameter) (see Appendix 3.2 for more information and keys). Coarse fragments often vary throughout the soil profile, and the values provided in this guide refer to the primary rooting zone of trees, typically the upper 30–60 cm of soil. The categories are defined in Table 3.6.

Important features: This reflects common features that are important to ecosystem function and management, such as the presence of restricting layers (for rooting or water movement), solar insolation, cold air accumulation, surficial material veneers, and water table or seepage depth.

TABLE 3.6 *Coarse fragment content categories used in environment tables*

Category	Coarse fragment content
Sparse	< 10%
Low	10–25%
Moderate	25–50%
High	50–70%
Fragmental	> 70%

Site series written descriptions

Near the end of each biogeoclimatic subzone/variant section the overall concept of each site series is described for each forested site series. The descriptions begin with general environmental features and commonly associated terrain, soils, and vegetation characteristics. The site and soil features described are commonly associated with, or distinctive of, the unit (e.g., warm aspects, riparian-associated, or shallow soils). The typical plant species are also described, with notes about their cover or distribution. Species with the greatest indicator value are shown in **bold type**. They are not necessarily the most abundant or (in some cases) most consistently present species, but collectively, they are the most useful in characterizing or identifying the site unit. Sections on "Variability" and "Differentiating from Other Site Series" are also provided for each site unit.

Comments on "Management Issues" are provided to give an overview of the general concerns or opportunities regarding each site series. They range from concerns about drought or excessive moisture to opportunities for maintaining high tree species diversity. Some site series are "not recommended for harvest." This does not mean that they are not to be harvested; rather, these sites may have timber with economic value, but specific site issues (e.g., too dry, too wet, other hazards) make regeneration of these sites extremely difficult, and resource professionals should carefully consider the hazards and risks prior to prescribing harvest activities.

3.2.3 Using appendices and keys for additional information

Additional information is provided in Appendices 1–3. Appendix 3 (keys and codes) is intended to provide field users with the information required to use the tools in Chapter 5 (forested site series) and Chapter 6 (non-forested sites). The appendices include the following information:

Appendix 1: Plant species names and illustrations
- 1.1 Species grouped across genera
- 1.2 Species grouped to genera
- 1.3 Recently changed plant names
- 1.4 Index of plant illustrations

Appendix 2: Crosswalks
- 2.1 Biogeoclimatic subzones/variants
- 2.2 Site series

Appendix 3: Keys and codes—presents keys that are useful for describing site, soil, and vegetation cover information. Users are encouraged to refer to the keys frequently while collecting field data. The keys focus on:
- 3.1 Soil moisture and nutrient regimes
- 3.2 Soil texture
- 3.3 Humus form classification
- 3.4 Rock identification and characteristics
- 3.5 Common surficial materials
- 3.6 Tree species codes
- 3.7 Visual estimates of percent cover

3.2.4 Integrating site and vegetation information

The aids described above will assist the user in making a preliminary identification of the site series or perhaps lead the user to a choice between two similar units. Final confirmation of the site unit must be done by comparing the site, soil, and vegetation information collected with site unit summary descriptions provided in the guide for each subzone/variant. The user should look for the site series that has the best fit of plant indicator species and site and soil features. Where stands have been disturbed by harvesting, fire, or broad-scale biotic or abiotic factors, plant species presence and abundance is often less useful in field site identification than soil and site characters.

Site identification derived from both environmental and vegetation analysis will usually coincide. However, where vegetation analysis gives a wide-ranging or unreliable result because of challenging floristic conditions (e.g., recently logged or burned), users must place greater emphasis on environmental analysis. If vegetation analysis gives a strong and distinct result that differs significantly from environmental analysis, users should look more closely at the environmental analysis to attempt to explain the discrepancy. For example, a flat, coarse-textured site that initially appears relatively dry based on environmental properties may have plants that indicate a moist soil moisture regime. A closer examination of the soil (e.g., deeper soil pit) may reveal the presence of a fine-textured layer that creates a temporary perched water table.

If neither vegetation analysis nor environmental analysis provides a reasonably accurate identification, the area may be in a climatic transition. If it is, users should check site series in the grid for the adjacent biogeoclimatic subzone/variant. Environmental gradients are common in natural environments. Users should explain anomalies if they occur and document rationales for management decisions on these sites.

3.3 How to Identify Site Series in Seral and Disturbed Stands

The vegetation tables in this guide are based on sampling of mature ecosystems. Disturbances such as fire, wind, insects, and pathogens are an integral component of the structure, function, and composition of forests. In areas with wetter climatic conditions, old-growth forests historically covered extensive areas. In the driest climates, fires were historically frequent and low severity, creating "stand-maintaining" conditions with widespread, open forests. In most cases, mixed-severity disturbances are common, where a combination of stand-replacing and stand-maintaining fires occur.

Younger seral vegetation, including second-growth forest, occurs where forest harvesting or stand-replacing / high-severity natural disturbances have occurred. The descriptions of vegetation in the ecosystems presented in this guide are based on measurements of mature forests (later seral or old-growth forests), and so will differ in some characteristics from young seral forests.

Younger seral plant communities (particularly the shrub–herb stages that develop soon after disturbance) do not always reflect the moisture and nutrient status of the site as clearly as do mature forests. Following disturbance, for example, some species increase in response to greater light (e.g., pinegrass [*Calamagrostis rubescens*] in the IDF and MS), while other species may decrease with exposure to light (e.g., devil's club [*Oplopanax horridus*] in the ICH). During early establishment, the vegetation often reflects changes in light availability or soil disturbance, and not the soil nutrient and moisture regime of the site. Opportunistic or weedy species are also commonly abundant.

For site series identification on sites with younger seral plant communities, it is necessary to rely more on physical site indicators such as slope position, aspect, and soil features than on plant indicators. Observation of adjacent undisturbed forests can also be helpful, as long as the site and soil conditions are equivalent. Brief descriptions of seral vegetation differences are generally provided in the "Variability" sections of the site series written descriptions.

Where disturbed sites are sampled, it is important to record the type of disturbance, and if known, the date of disturbance. Disturbance codes are provided in the Keys and Codes section of LMH 25 (Province of British Columbia 2010). If codes are unknown, a brief description should still be used (e.g., write a note indicating that the site was selectively logged and burned 3 years ago, has extensive cattle grazing, or other disturbance types).

Although it is recognized that succession is often a non-linear and complex process (see Chapter 2), **mid-seral forests** also differ from mature and old stands, and often have the following characteristics:

- a greater density of more uniformly sized trees;
- a lack of very large live trees and very large dead trees; and
- a dense, uniform (i.e., gap-less) canopy, with darker understoreys and less understorey vegetation.

3.4 Mapping Site Units

An ecosystem map is a useful tool for effective resource planning and management. A map provides a permanent record of the location and distribution of ecosystems, and thus acts as a spatial framework for developing site-specific management prescriptions for all potential resource values. A map also provides a means for the long-term monitoring of management impacts and the subsequent refining of management interpretations.

Ecosystem maps can be developed and used at multiple scales for many management applications. The most common applications of site-level ecosystem mapping are site plan maps for forest harvesting activities (e.g., silviculture prescriptions and harvest layout plans) and ecosystem inventory maps based on Terrestrial Ecosystem Map (TEM) or Predictive Ecosystem Map (PEM) methods. For silviculture site plans, accurate maps showing the spatial distribution of site series are important for long-term monitoring of forest regeneration success. Both of these applications use the biogeoclimatic zone, subzone, variant mapping that accompanies this field guide, along with the site units provided in Chapter 5 (forested site series) and Chapter 6 (non-forested ecosystems).

As for any sampling methodology, an effective routine of pre-stratification, followed by ground truthing, will provide a more time efficient and accurate depiction of the spatial distribution of site series. Useful tools for pre-stratification would include aerial photography and imaging, contour maps, VRI forest cover mapping, and (if available) LiDAR-derived terrain and tree maps. These steps are applicable for both ecosystem mapping and silviculture prescription development.

At broad, inventory scales, TEM or PEM provide maps of site series for forested ecosystems, site classes (occasionally site associations) for non-forested ecosystems, and map codes for anthropogenic units. TEM is based on aerial photography interpretation and involves hand delineation of ecosystem map units with up to three ecosystems mapped per polygon. PEM maps are based on computer-algorithms that incorporate multiple spatial layers. They typically include a component of aerial image interpretation for "exceptions," or areas with atypical environmental conditions such as shallow soils, avalanche chutes, wetlands, or rock outcrops. PEM polygons are pixel-based and can be used as raster or vector. Coarse-scale inventory maps (PEM and TEM) are typically developed at 1:20 000 scales and cover broad areas. Finer-scale TEM maps (1:5000 or 1:10 000) are often created for specific projects such as environmental assessment.

PEM and TEM spatial products have been developed on an ongoing basis across the Southern Interior. These map layers are useful for broad planning purposes, but the degree of ground-checking and accuracy assessment varies from one area to the next; prior to any stand-level management activities, field verification is essential. Maps based on older versions of BEC may require updating or replacing for management applications. See the B.C. Ministry of Environment website for more information about TEM and PEM.

4 THE ENVIRONMENT OF THE SOUTH-CENTRAL COLUMBIA MOUNTAINS: REGIONAL OVERVIEW

The environment of southeast British Columbia is highly diverse. The following sections provide an overview of the south-central Columbia Mountains, including the biogeoclimatic subzones/variants, climate, physiography, patterns of bedrock geology, surficial materials, soils, and zonal vegetation. A description of the typical pattern of site series is also provided.

4.1 Overview of Biogeoclimatic Units

Eighteen BGC subzones/variants/phases are described in this field guide. They occur within three zones: Interior Mountain-heather Alpine (IMA), Engelmann Spruce – Subalpine Fir (ESSF), and Interior Cedar – Hemlock (ICH) (Table 4.1). Drier areas occur to the east and west of the field guide area where the Interior Douglas-fir (IDF) and Montane Spruce (MS) zones are common; these are referenced in some of the sections in this chapter for comparison. Maps for each forested subzone/variant are available in Chapter 5 and in GIS through the BECWeb site. High-elevation subzones are described in Section 6.7.

ICH forests in the south-central Columbia Mountains are characterized by very high tree species diversity, commonly referred to as the "Kootenay mix." Cw, Hw, Fd, Lw, Pl, Pw, Ep, At, and Act[1] are common across all variants. Bg and Py are common in the warmer biogeoclimatic units (ICHxw, ICHxwa, ICHdw1). Bl and Sxw are moderately common in the ICHdm and occur at upper elevations and on cold sites in the ICHmw2 and ICHmw4. A transitional subzone with three variants typically occurs between the ICH and the ESSF: the ESSFwh (wet hot; wh1, wh2, wh3) has abundant Se, Bl, Hw, and Cw on mesic sites, along with Fd, Lw, Pl, and occasionally Pw on drier sites. This mix of species is also common at lower elevations in the ESSFwm4, which does not have a transitional wet hot ESSF mapped. In the cooler ESSF (ESSFwc4, ESSFwm2, ESSFwm3, mid-upper ESSFwm4), tree species are primarily Bl and Se, with various amounts of Pl, and limited Pa and La. The ESSF woodland and parkland subzones occur at higher elevations, where Bl is dominant, Se is moderately common, and Pa and La are typically restricted to drier sites.

The largest subzones/variants/phases in the south-central Columbia Mountains are the ICHmw2, ICHdw1, ESSFwc4, ESSFwcw, and ESSFwh1. The smallest are the ICHxwa, ESSFwh2, ESSFwmp, and ESSFwm3 (Table 4.1).

[1] Tree species codes are described in Appendix 3.6.

TABLE 4.1 *Area covered by each biogeoclimatic subzone/variant/phase in the south-central Columbia Mountains*

Zone	Subzone/ variant/phase	Name	Area (ha)[a]
Alpine	IMAun[b]	Undifferentiated Interior Mountain-heather Alpine	122 478
ESSF	ESSFwh1	Columbia Wet Hot Engelmann Spruce – Subalpine Fir	214 661
	ESSFwh2	Saint Mary Wet Hot Engelmann Spruce – Subalpine Fir	47 324
	ESSFwh3	Salmo Wet Hot Engelmann Spruce – Subalpine Fir	87 397
	ESSFwc4	Selkirk Wet Cold Engelmann Spruce – Subalpine Fir	350 338
	ESSFwm2	Purcell Wet Mild Engelmann Spruce – Subalpine Fir	99 968
	ESSFwm3	Ymir Wet Mild Engelmann Spruce – Subalpine Fir	72 673
	ESSFwm4	Yahk Wet Mild Engelmann Spruce – Subalpine Fir	162 823
	ESSFwcw[b]	Wet Cold Woodland Engelmann Spruce – Subalpine Fir	236 103
	ESSFwmw[b]	Wet Mild Woodland Engelmann Spruce – Subalpine Fir	118 326
	ESSFwcp[b]	Wet Cold Parkland Engelmann Spruce – Subalpine Fir	164 457
	ESSFwmp[b]	Wet Mild Parkland Engelmann Spruce – Subalpine Fir	62 985
ICH	ICHxwa	Very Dry Warm Interior Cedar – Hemlock - Warm Phase	14 709
	ICHxw	Very Dry Warm Interior Cedar – Hemlock	110 116
	ICHdw1	West Kootenay Dry Warm Interior Cedar – Hemlock	327 255
	ICHdm	Dry Mild Interior Cedar – Hemlock	182 608
	ICHmw2	Slocan Moist Warm Interior Cedar – Hemlock	455 423
	ICHmw4	Ymir Moist Warm Interior Cedar – Hemlock	101 437
TOTAL			**2 931 081**

[a] Excluding major water bodies. Based on BEC ver 10.
[b] Includes only the area of the IMA and woodland/parkland variants where they occur in the south-central Columbia Mountains; total areas for alpine, woodland, and parkland "variants" are listed in Table 4.2.

TABLE 4.2 *Area covered by alpine, woodland, and parkland variants*

Subzone	Variant	Geographic area/field guide	Area (ha)[a]
ESSFwcw	ESSFwcw2	North Columbia Mountains	170 253
	ESSFwcw3[b]	North Columbia Mountains	72 386
	ESSFwcw4	South-central Columbia Mountains	236 103
		TOTAL	478 741
ESSFwcp	ESSFwcp2	North Columbia Mountains	138 867
	ESSFwcp3[b]	North Columbia Mountains	136 778
	ESSFwcp4	South-central Columbia Mountains	164 457
		TOTAL	440 102
ESSFwmw	ESSFwmw1[c]	East Kootenay	27 853
	ESSFwmw2	South-central Columbia Mountains	70 644
	ESSFwmw3	South-central Columbia Mountains	26 056
	ESSFwmw4	South-central Columbia Mountains	21 626
		TOTAL	146 179
ESSFwmp	ESSFwmp1[c]	East Kootenay	7 712
	ESSFwmp2	South-central Columbia Mountains	55 217
	ESSFwmp3	South-central Columbia Mountains	3 003
	ESSFwmp4	South-central Columbia Mountains	4 765
		TOTAL	70 697
IMAun	IMAun	Interior Mountain-heather Alpine	374 958

[a] Excluding major water bodies. Based on BEC version 10.
[b] Where the ESSFwcp3 occurs in the Prince George Timber Supply Area, no woodland is mapped; ESSFwcw3 values will be higher in this variant once mapping is revised.
[c] ESSFwm1 will be covered in the East Kootenay field guide.

High-elevation biogeoclimatic units are described at broader scales than other ecosystems in this guide. Site series classifications are provided in Chapter 5 for the woodland (ESSFwcw and ESSFwmw), but this field guide only briefly describes the IMA and parkland (ESSFwcp and ESSFwmp) (see Section 6.7). Subsequent publications are expected to provide classification details for high-elevation site associations. The woodland and parkland units are primarily described at the subzone level rather than the variant level in this field guide, but can also be described as separate variants based on the ESSF variant at lower elevations. For example, the ESSFwcw covers a very extensive area across the Columbia Mountains; it occurs above the ESSFwc2, ESSFwc3, and ESSFwc4.[1] Table 4.2 shows the area of each variant of the woodland and parkland unit described in this guide.

4.2 Climate Overview

Southeast British Columbia is an extremely diverse area in which climatic conditions change across very short distances. Key climate gradients include elevational shifts, north–south latitudinal changes, increasing west-to-east continentality, transitions from plateaus to mountain ranges, potential for cold air pooling, and amount of rainshadow effects. To express this variability at broad, regional scales, the area has been divided into three climate subregions: Dry, Moist, and Wet (Figure 4.1). Climate subregions correspond to differing biogeoclimatic zone and subzone/variant sequences across changes in elevation.

The **Dry climate subregion** occupies rainshadows of the Coast and Columbia Mountains. In the west, the subregion includes the Okanagan Highland and the Kettle River, lower Granby River, and southernmost Columbia River areas in the southern Monashee Mountains. To the east, the Dry climate subregion occurs in the Rocky Mountain Trench and much of the southern Rocky and Purcell Mountains in the East Kootenay. The **Moist climate subregion** occurs in the central Monashee and Purcell ranges, the south and central Selkirk Mountains, the lower Elk Valley in the Rocky Mountains, and along much of the Kinbasket Reservoir in the Rocky Mountains and northern Selkirks. The **Wet climate subregion** occurs in the northern Monashee and Selkirk Mountains and incorporates the wettest portions of the Inland Temperate Rainforest, which also extends north and west into the Northern Interior and Cariboo areas.

Within the BEC system, each biogeoclimatic subzone/variant reflects a "bioclimate envelope"—a set of climatic conditions that supports relatively homogeneous patterns of vegetation communities on similar sites. Although there is considerable variation in climate, both across the geographic range of a subzone/variant and across wet/dry or hot/cool years, similarity in climate conditions within a given biogeoclimatic unit has been demonstrated in several studies (e.g., Hamman and Wang 2006; Delong et al. 2010). Transitional climates occur in areas where two climate subregions are found in the same valley. For example, the central Selkirk and Monashee Mountains are at the wetter end of the climate envelope for the ESSFwc4 and ESSFwh1 (Moist climate subregion) where the ICHwk1 and occasionally the ICHvk1 (Wet climate subregion) occur at lower elevations.

[1] The ESSFwc4 is included in this field guide, but new descriptions and classification for the ESSFwc2 and ESSFwc3 will be provided in future field guides.

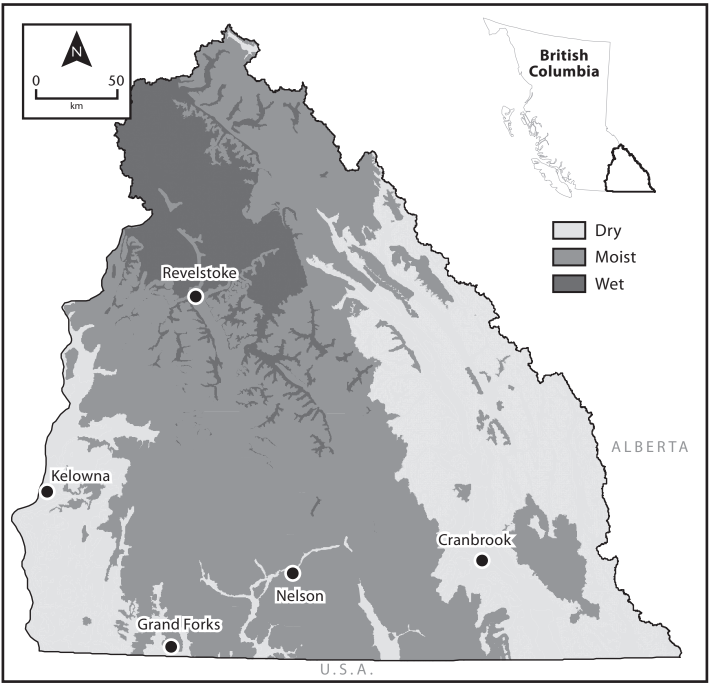


FIGURE 4.1 *Climate subregions of southeast British Columbia.*

A categorical approach was used to develop descriptions of climate for biogeoclimatic units. Categories for average seasonal (winter, spring, summer, fall) temperature and precipitation are provided in Table 4.3. Table 4.4 presents categories for average snowfall and snowpack. Summaries of the climate variable categories for the ESSF are provided in Table 4.5. Table 4.6 presents summaries of the climate variable categories for the ICH for subzones/variants in and adjacent to the south-central Columbia Mountains. Categories are based on province-wide data and are presented to show relative similarities and differences across subzones/variants.

TABLE 4.3 *Categories for mean seasonal temperature and precipitation*

Winter temperature categories	**Winter precipitation categories**
Very cold: < -10°C	Very dry: < 150 mm
Cold: -10– -8°C	Dry: 150–300 mm
Cool: -8– -5°C	Moist: 300–450 mm
Mild: -5–1°C	Wet: 450–600 mm
Very mild: > 1°C	Very wet: 600–900 mm
	Extremely wet[a]: > 900 mm

Spring temperature categories	**Spring precipitation categories**
Cold: < 0°C	Very dry: < 100 mm
Cool: 0–2.5°C	Dry: 100–150 mm
Mild : 2.5–5°C	Moist: 150–200 mm
Warm : 5–7.5°C	Wet: 200–300 mm
Hot: > 5°C	Very wet: 300–500 mm
	Extremely wet[a]: > 500 mm

Summer temperature categories	**Summer precipitation categories**
Cold: < 10°C	Very dry: < 130 mm
Cool: 10–12.5°C	Dry: 130–150 mm
Warm: 12.5–14.5°C	Moist: 150–200 mm
Hot: 14.5–16.5°C	Wet: 200–275 mm
Very hot: > 16.5°C	Very wet: 275–350 mm
	Extremely wet[a]: > 350 mm

Fall temperature categories	**Fall precipitation categories**
Cold: < 1°C	Very dry: < 150 mm
Cool: 1–2.5°C	Dry: 150–250 mm
Warm: 2.5–5°C	Moist: 250–350 mm
Hot: 5–7.5°C	Wet: 350–450 mm
Very hot: > 5°C	Very wet: 450–800 mm
	Extremely wet[a]: > 800 mm

[a] Occurs only in coastal climates.

Although not included here, many other climate variables are important for defining a bioclimate envelope: extreme climate values, moisture deficit indices, continentality, frost variables, and humidity, for example. Annual and interannual variability can also influence vegetation–climate relationships. Additional climate variables can be obtained from both historical station data and modelled outputs.

TABLE 4.4 *Categories for mean snowfall and snowpack*

Snowfall category	**Description of snowfall and snowpack**
Shallow	Mean annual snowfall is < 150 cm. Snowpack, if present, is usually shallow (< 30 cm) and ephemeral. Snowpacks > 50 cm are uncommon.
Moderate	Mean annual snowfall is 150–300 cm. Snowpack is usually < 75 cm, but > 75 cm snowpack can be persistent for multiple weeks. Snowpacks > 50 cm occur every year, on average.
Moderately deep	Mean annual snowfall is 300–450 cm. Snowpack is usually < 150 cm, but > 150 cm snowpack can be persistent for multiple weeks.
Deep	Mean annual snowfall is 450–750 cm. Snowpack is deep (> 150 cm) and persistent for most of the winter (November/December through March/April). Average late-winter (March/April) snowpack is > 2 m.
Very deep	Mean annual snowfall is > 750 cm. Snowpack is typically > 250 cm and persistent for most of the winter (November through May/June). Average late-winter snowpack (March/April) is > 3 m.

Climate information presented in this field guide is based on modelled values from ClimateBC (Version 5.10, accessed online December 2014) (Wang et al. 2012) with 1961–1990 climate normals. ClimateBC is a modelling tool that uses actual climate-station data with Global Circulation Models to downscale climate variable estimates for historic and future conditions across a continuous surface throughout British Columbia and North America. Values were also compared to Environment Canada historical climate station data summaries (available online) and the Reynolds climate summaries (Reynolds 1989) for the same time period (1961–1990) where data were available. Where station and modelled data showed large discrepancies for a seasonal attribute, categories in Tables 4.5 and 4.6 were adjusted. Modelled data were selected as the primary source because the

TABLE 4.5 *Comparison of climates across the ESSF using categories for seasonal temperature and precipitation variables*

		Temperature				Precipitation				Snowfall
Geographic area	**BGC unit**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Annual**
South-central Columbia Mountains	**ESSFwh1**	Cool	Cool	Cool	Cool	Wet	Wet	Wet	Wet	Deep
	ESSFwc4	Cool	Cool	Cool	Cool	Wet	Wet	Wet	Wet	Very deep
	ESSFwcp	Cold	Cold	Cold	Cold	Wet	Wet	Very wet	Wet	Very deep
	ESSFwcw	Cold	Cold	Cold	Cold	Wet	Wet	Very wet	Wet	Very deep
Monashees Shuswap Highland	**ESSFmh**	Cool	Cool	Warm	Warm	Moist	Moist	Moist	Dry	Moderately deep
	ESSFdc1	Cool	Cool	Cool	Cool	Moist	Wet	Moist	Moist	Deep
Elk Valley	**ESSFwm1**	Cold	Cool	Cool	Cool	Moist	Wet	Wet	Moist	Deep
Purcells and South Selkirks	**ESSFwh2**	Cool	Cool	Warm	Cool	Moist	Wet	Moist[a]	Moist	Deep
	ESSFwm2	Cold	Cool	Cool	Cool	Moist	Wet	Moist[a]	Moist	Deep
	ESSFwh3	Cool	Cool	Warm	Warm	Wet	Wet	Moist[a]	Wet	Deep
	ESSFwm3	Cool	Cool	Cool	Cool	Wet	Wet	Wet	Wet	Very deep
	ESSFwm4	Cold	Cool	Cool	Cool	Moist	Moist	Dry[a]	Dry	Deep
	ESSFwmp	Cold	Cold	Cold	Cold	Moist	Wet	Wet	Moist	Very deep
	ESSFwmw	Cold	Cold	Cold	Cold	Moist	Wet	Wet	Moist	Very deep
North Columbia	**ESSFvc**	Cold	Cool	Cool	Cool	Very wet	Wet	Very wet	Very wet	Very deep
	ESSFvm	Cool	Cool	Cool	Cool	Wet	Wet	Wet	Wet	Very deep
	ESSFwc2	Cold	Cool	Cool	Cool	Wet	Wet	Wet	Wet	Very deep

[a] Indicates that summer precipitation values are based on July/August data only because June precipitation is proportionally much higher; including June precipitation data would shift the values to one category wetter.

TABLE 4.6 *Comparison of climates across the ICH using categories for seasonal temperature and precipitation variables*

		Temperature				Precipitation				Snowfall
Geographic area	**BGC unit**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Annual**
South-central Columbia Mountains Shuswap Highland	**ICHdw4**	Mild	Warm	Very hot	Hot	Dry	Dry	Dry	Dry	Moderate
	ICHxw	Mild	Warm	Very hot	Hot	Dry	Dry	Very dry	Dry	Moderate
	ICHdw1	Mild	Warm	Hot	Hot	Dry	Moist	Dry	Dry	Moderate
	ICHdm	Cool	Mild	Warm	Warm	Dry	Moist	Dry[a]	Dry	Moderately deep
	ICHmw2	Cool	Mild	Warm	Warm	Moist	Moist	Moist	Dry	Moderately deep
	ICHmw4	Cool	Mild	Warm	Warm	Moist	Wet	Moist[a]	Moist	Deep
	ICHmw5	Cool	Mild	Warm	Warm	Dry	Moist	Moist	Dry	Moderately deep
Elk Valley	**ICHmk4**	Cool	Mild	Warm	Warm	Dry	Moist	Moist	Dry	Moderately deep
North Columbia	**ICHmw3**	Cool	Mild	Hot	Warm	Dry	Dry	Moist	Dry	Moderately deep
	ICHvk1	Cool	Mild	Warm	Warm	Wet	Wet	Wet	Wet	Deep
	ICHwk1	Cool	Mild	Warm	Warm	Moist	Moist	Wet	Moist	Deep

[a] Indicates that summer precipitation values are based on July/August data only because June precipitation is proportionally much higher; including June precipitation data would shift the values to one category wetter.

number and distribution of weather stations is extremely limited, particularly across mid- and upper-elevation areas.

Climate normals from the 1961–1990 period were used as a baseline in the biogeoclimatic subzone/variant descriptions because this time period is considered to be the best balance between reliable, moderately well-distributed climate-station data and actual conditions under which forests and ecosystems have developed (i.e., minimal climate change influence compared to more recent times). Climate change data from 1990 to present and in future projections are not included here but can be calculated or sourced from weather-station data or modelled approaches (e.g., ClimateBC, ClimateWNA).

4.3 Physiographic Regions

Physiographic regions represent unique assemblages of geology, landforms, surficial materials, and soil development. These factors, along with climate, influence the distribution of ecosystems. Southeast British Columbia covers an extremely diverse landscape. For the purposes of this field guide, southeast British Columbia is described using four physiographic regions: the Columbia Mountains, the Highlands (Okanagan and Shuswap), the Rocky Mountains, and the Rocky Mountain Trench (see Holland 1976; Ryder 1978; Church and Ryder 2010) (Figure 4.2).

This field guide covers much of the southern and central Columbia Mountains and part of the Shuswap Highland. The **Columbia Mountains** include the Monashee, Selkirk, Purcell, and Cariboo Ranges (Figure 4.2). The Cariboo Mountains are addressed only in the broad classification presented for the ESSFwcw. The Monashee, Selkirk, and Purcell Ranges each trend north–south. The Selkirk and Purcell Mountains are separated by Kootenay Lake (and the Beaver River in the north), while the Monashee and Selkirk Mountains are divided by the Columbia River. Subdivisions of these areas are described in the text and in tables (e.g., Table 4.7) where they are relevant to the ecology, climate, or geology of a broader physiographic region. Subsequent field guides will address (1) the southern Rocky Mountains, the Rocky Mountain Trench, (2) the southern Monashee Mountains and the Okanagan–Shuswap Highlands, and (3) the North Columbia Mountains and northern portion of the Rocky Mountains.

The **Monashee Mountains** are comprised mainly of folded sedimentary and metamorphic rock with intrusions of coarse-grained igneous rock. The northern portion of this range contains higher, sharper peaks, while mountains in the south have less relief with more rounded and subdued peaks. The Monashee Mountains are drained by the Columbia River to the east and the North Thompson and Fraser Rivers and the Okanagan Basin to the west.

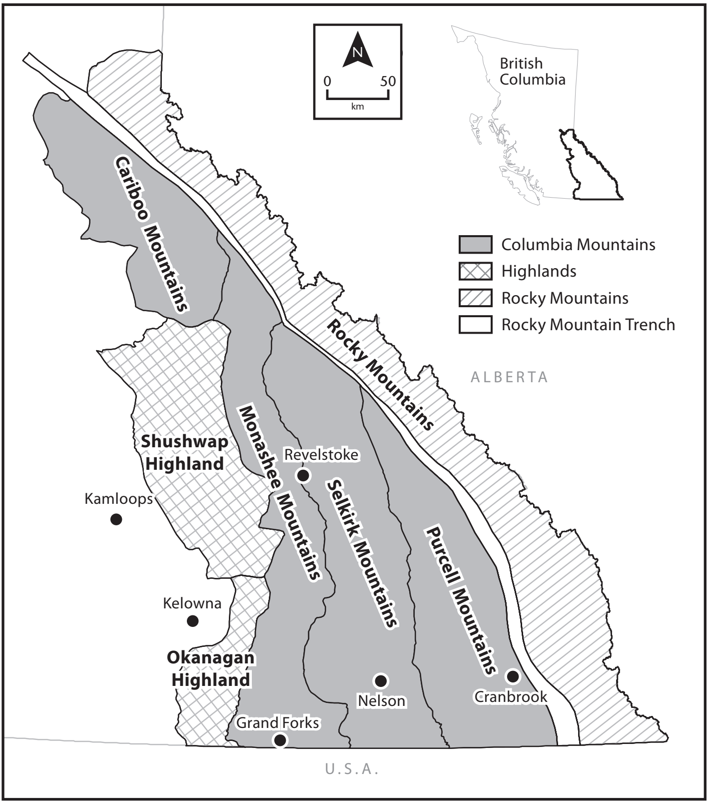


FIGURE 4.2 *Physiographic regions of southeast British Columbia.*

The **Selkirk Mountains** contain deeply incised valleys with steep sidewalls. This range is underlain by sedimentary and volcanic parent material in the central and northern portions, and is dominated by coarse-grained igneous intrusive rock (batholiths) to the south. These are high, rugged mountains that increase in elevation from south to north, although the south Selkirk Mountains are higher and have sharper peaks than mountains at similar latitudes in the southern Monashee and Purcell Mountains. The Selkirk Mountains are drained by the Kootenay and Columbia Rivers.

The **Purcell Mountains** originally formed as the western coast of North America in the Mesoproterozoic eon (up to 1.5 billion years ago); continental drift and subsequent metamorphic processes have created complex geological history in the Purcell Mountains. The Purcells are dominated by sedimentary and metamorphic rocks, including shale, mudstone, siltstone, and phyllite. Coarse-grained intrusions of granodiorite and areas of limestone are also common. As in the Monashee and Selkirk Ranges, the largest peaks occur in the north. Steep east–west trending valleys drain into Kootenay Lake and the Duncan River valley to the west and either the Kootenay or Columbia River systems to the east.

The **Shuswap Highland** forms the foothills in the transition from the Thompson Plateau to the west and the Monashee Mountains to the east. The Shuswap Highland is characterized by gentle to moderately high, rolling mountains, often with steep valley slopes. Steeper mountainous terrain occurs in the north as the foothills approach the Monashee Mountains. The area is underlain predominantly with gneiss and schist. Numerous large lakes, including Murtle, Shuswap, Adams, and Mabel, occupy the valley bottoms. The Okanagan Highland is located south of the Shuswap Highland.

4.4 Bedrock Geology

Geological forces, including plate tectonics, uplift, and erosion, over millions of years have led to the formation of the mountain ranges of British Columbia. The distribution of bedrock types exposed at the surface is the result of sedimentary, metamorphic, volcanic, and igneous intrusive processes and their interactions over very long time periods. The nature of bedrock strongly influences site characteristics, including the extent of rock outcrops and shallow soils, the steepness and complexity of slopes, the physical (texture, coarse fragments) and chemical (nutritional status) nature of weathered materials and soils, and the type and frequency of mass wasting, erosion, and redistribution of materials.

A wide variety of bedrock types occurs in southeast British Columbia. Common types include fine to coarse sedimentary and metamorphic sedimentary (metasedimentary) rocks, coarse-grained intrusive rocks, metamorphic igneous rock complexes, limestone, dolomite and other calcareous rocks, and volcanic rocks. The most common bedrock types in the mountain landscapes throughout the region are summarized by physiographic area in Table 4.7 (see Ryder 1978 for more information). Keys to rock types, including detailed summaries of rock characteristics and their effect on ecosystems, are also provided in Appendix 3.4.

4.5 Common Surficial Materials

Surficial materials are unconsolidated mineral or organic materials that overlie bedrock (Soil Classification Working Group 1998). They form the parent materials of soils, and thus help define the physical, chemical, and biological nature of ecosystems. Surficial materials have been transported, deposited, and modified over time by glaciation, gravity, water, wind, living organisms, and other natural or anthropogenic disturbances. These materials can be closely related to bedrock geology such as in weathered bedrock or veneers of locally derived glacial till and colluvium. They can also be greatly modified by their mode of transport and deposition. For example, river gravels or glaciolacustrine silts and clays that have been washed and sorted by water can have properties from a number of sources, including local and distant parent materials.

Eleven types of surficial materials are common in southeast British Columbia: morainal (till), colluvial, eolian, fluvial, glaciofluvial, lacustrine, glaciolacustrine, bedrock, weathered bedrock, organic, and anthropogenic (Howes and Kenk 1997; Province of British Columbia 2010). These are listed with abbreviated codes in Table 3.5. They are frequently described based on the depth of the deposit, with blankets (b) being greater than 1 m deep and veneers less than 1 m deep. Veneers (v) can be further divided into shallow veneers (x) that are up to 20 cm in depth.

Each surficial material type is formed through distinct processes and typically has a set of environmental characteristics that influence soil properties such as soil texture and drainage:

- Morainal materials were deposited directly by glaciers. Morainal materials are also called "till" and are further separated into ablation till (from ice melting in situ), deformation till (reworked from previous glaciation events), and basal till (deposited at the bottom of the glacier).
- Glaciofluvial and glaciolacustrine materials are the result of meltwaters at the time of glacial retreat. Glaciofluvial materials were deposited by moving waters and tend to have rounded coarse fragments, while glaciolacustrine materials resulted from sediment fallout in stagnant or slow-moving waters behind ice dams and generally lack coarse fragments.
- Fluvial and lacustrine deposits are typically more recent than the last glaciation and are generally derived from rivers and lakes that are still visible on the landscape.
- Colluvium results from mass wasting (rockfalls, landslides, mudslides) and the effects of gravity on soils, including very slow soil creep on slopes steeper than 50%. Colluvium typically has angular coarse fragments.

TABLE 4.7 *Common bedrock types within physiographic regions*[a]

Physiographic region	Area	Dominant rock types	Subdominant rock types	Resulting soil textures[b] and characteristics	Dominant BGC units described in this field guide[c]
Highlands	Shuswap	Metamorphic rock types, including gneiss, schist, and amphibolite, with areas of sedimentary rocks such as mudstone, siltstone, and shale	Granitic intrusive rocks; basalt and andesite	Nutrient-poor, sandy to loamy (coarse) textured soils are very common, with areas of nutrient- rich, silty to loamy textured soils	ICHmw2, ESSFwh1, ESSFwc4 ESSFwcw
	Okanagan	Metamorphic rock types, including gneiss, schist, amphibolite, quartzite, and marble	Intrusive rocks such as granite, granodiorite, and monzonite	Nutrient-poor, sandy to loamy (coarse) textured soils are very common, with areas of nutrient- rich, silty to loamy textured soils	BGC units described in other field guides
Monashee Mountains	Northern	Mixture of metamorphic rocks such as gneiss, schist, and amphibolite	Sedimentary rocks, including mudstone, siltstone, and shale; phyllite, quartzite, and granites	Nutrient medium to poor; loamy to sandy textures dominate, with areas of richer, loamy to silty textured soils	BGC units described in other field guides
	Central	Mixture of metamorphic bedrock, including gneiss, schist, marble, quartzite, and amphibolite	Small areas with sedimentary rock types such as sandstone, mudstone, limestone, siltstone, and shale; granites and slate	Nutrient-poor, loamy to sandy textures dominate, with areas of richer, loamy to silty textured soils	ICHmw2, ESSFwh1, ESSFwc4, ESSFwcw
	Southern	Intrusive medium- to coarse- grained rocks such as granite and granodiorite; coarse-grained metamorphics such as gneiss	Metamorphic rocks, including quartzite, marble, and amphibolite; volcanics, including basalt, andesite, and rhyolite	Nutrient-poor, loamy to sandy textures dominate, with areas of richer, loamy to silty textured soils	ICHxw, ICHdw1

Selkirk Mountains	Northern	Mixed sedimentary and metamorphic rocks such as mudstone, siltstone, shale, quartzite, and amphibolite	Intrusions of granodiorite and granitic gneiss	Nutrient-rich, silty to loamy textured soils, with areas of nutrient-poor, sandy to loamy textured soils	BGC units described in other field guides
	Central	Coarse-grained intrusive rocks such as monzonite, granodiorite, and granite; metasedimentary rocks such as slate, siltstone, and argillite	Conglomerates, quartzite, and mudstone	Nutrient-poor, loamy (coarse) to sandy textured soils in areas dominated by intrusive rocks; medium to rich loamy soils in areas of metasedimentary rock	ICHmw2, ESSFwh1, ESSFwc4, ESSFwcw
	Southern	Coarse-grained intrusive rocks such as granite and granodiorite; gneiss	Bands of sedimentary and metamorphic phyllite, quartzite, siltstone, grey-wacke, and conglomerates; basalt	Nutrient-poor, (coarse) loamy to sandy textured soils, with infrequently occurring areas of nutrient-rich, loamy soils	ICHxw, ICHdw1, ICHmw4, ESSFwh3, ESSFwm3, ESSFwmw
Purcell Mountains	Northern	Sedimentary and metamorphic rocks such as phyllite, mudstone, siltstone, shale, and quartzite	Small granodiorite intrusions	Nutrient-rich, loamy textured soils, with areas of nutrient-poor, coarse-textured soils where intrusive rocks occur	ICHmw2, ESSFwh1, ESSFwc4, ESSFwcw
	Central	Sedimentary rocks such as siltstone, sandstones, conglomerates, and dolomite; granodiorite intrusive rocks; phyllite	Small areas of limestone	Nutrient-rich, loamy textured soils with areas of nutrient-poor, coarse-textured soils where intrusive rocks occur	ICHmw2, ESSFwh2, ESSFwm2, ESSFwmw
	Southern	Mixture of metamorphic and sedimentary rocks such as argillite, siltstone, sandstone, conglomerates, and dolomite	Granodiorite intrusive rocks; limestone and phyllite	Medium to rich nutrient content, (coarse) loamy textured soils; lesser amounts of nutrient-poor, coarse-textured soils where intrusive rocks occur	ICHdm, ESSFwm4, ESSFwmw

[a] Appendix 3.4 provides details on rock identification and characteristics.
[b] Soil texture descriptions are amalgamated from the following soil texture classes: Sandy = LS, S; Loamy (SL, FSL, L, SCL); Silty = SiL, Si; Clayey (SiCL, CL, SC, SiC, C).
[c] Several other BGC units occur in each of the physiographic units but are described in other guides.

- Eolian materials are deposited by wind; they typically lack coarse fragments and are comprised of silt and fine sand particles.
- Bedrock is divided into unweathered rock materials and rock that has weathered in situ.
- Organic materials are the result of the accumulation of previously living matter in basins and depressions; some mixing of soil may occur, but sand, silt, and clay particles do not comprise a significant component.
- Anthropogenic materials have been modified by humans.

Appendix 3.5 provides a detailed overview of surficial material types.

The distribution of surficial materials in southeast British Columbia is closely tied to glacial and post-glacial history. Figure 4.3 shows how each surficial material type is typically distributed across local mountainous landscapes. Morainal materials are usually dominant where glaciers scoured peaks and created extensive valleys. Glaciofluvial materials can be abundant, particularly at the bottom of larger U-shaped valleys and as kame terraces along mountain sidewalls at mid to upper elevations.[2] Fine-textured glaciolacustrine silts and sands are uncommon but occur where ice-dammed lakes formed, usually at the confluence of the main valleys and large tributaries.[3]

Eolian deposits are locally common, particularly on gentle slopes and terraces. They are most commonly derived post-glaciation. Deposits of fine ash are also common throughout the Columbia Mountains and the Highlands. These consist of materials from the Mount Mazama eruptions 7700 years ago, as well as Mount St. Helens, primarily from eruptions in the 1400s, with minor amounts from the 1980s.[4] Mazama ash is usually deeper in the soil profile and has an orange–brown colour, while Mount St. Helens ash often forms a thin (< 2 cm) discontinuous layer with the A soil horizon (see Page-Dumroese et al. 2007).

Colluvium is characteristic on steep slopes, which are common in mountainous terrain. Colluvium is the second most common surficial material (after morainal) throughout the area covered by this field guide. Exposed bedrock is also common at higher elevations and on steep-sided valley walls at all elevations, particularly along large river valleys (e.g., Arrow, Kootenay Lake, Duncan, Slocan).

2 Kame terraces form where glacial meltwaters flowed off lobes of glacial ice at mid to upper elevations of the glacier.

3 These are visible, for example, in the southern Slocan Valley (from Highway 6) and at mid elevations near the confluence of the Columbia and Kootenay Rivers around Castlegar.

4 Mount Mazama is located at Crater Lake, Oregon; Mount St. Helens is in Skamania County in Washington State.

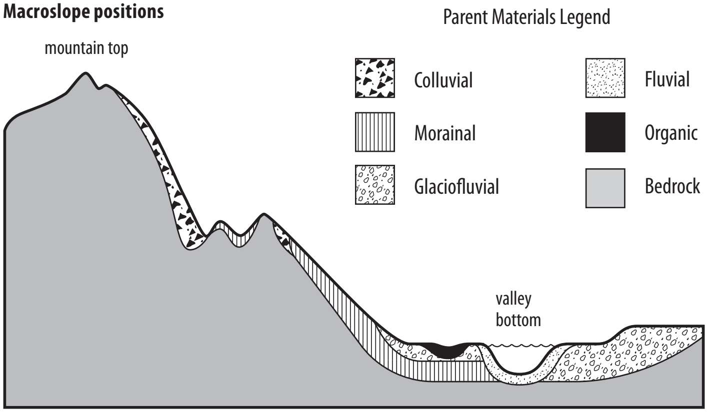


FIGURE 4.3 *Generalized distribution of surficial materials in the mountainous terrain of the south-central Columbia Mountains.*

Since deglaciation, water, gravity, wind, and biota have further modified the landscape. Present-day rivers have formed floodplains and fans. Rockfalls and landslides have created fans, cones, talus slopes, and undulating landslide deposits. Organic materials continue to accumulate in wet depressions. These are uncommon, and the largest organic deposits are in major valley bottoms such as the Creston and Slocan Valleys. Human-related development of settlements, agriculture, road building, mining, and hydroelectric projects has changed surficial materials.

Map layers of surficial materials are available through the Terrestrial Ecosystem Information (TEI) data managed by the B.C. Ministry of Environment (available online and through the Provincial geomatics warehouse). These maps provide details at the landscape scale, although assessment is best done in the field to capture finer scale differences at stand scales.

4.6 Patterns of Soil Development

Soils provide vital ecosystem services, including water and nutrient storage and the physical medium for plant rooting. They support the cycling of gases, nutrients, and water. Soil formation is the combined result of topography, parent material, time, climate, and biota. For example, warmer, wetter climates tend to have faster soil development than cooler, drier climates, while finer-textured, softer, darker rocks often weather to soils with higher nutrient content than coarse-textured, hard, light-coloured rocks.

Soil characteristics are critical for determining ecosystem characteristics. Soil is classified according to its development based on *The Canadian System of Soil Classification* (Soil Classification Working Group 1998). Soil or terrain map units are named by their parent material, development process, BEC zone, and drainage, and are described in the following historic soil survey reports: *Biophysical Resources of the East Kootenay Area: Soils* (Lacelle 1990), *Soils Resources of the Nelson Map Area* (Jungen 1980), and *Soil Resources of the Lardeau Area* (Wittenben 1980). Soil types are closely tied to the physiography, geology, surficial materials, climate, and vegetation patterns described in other sections in this chapter.

Soil classification types vary by elevation and climate. In the Columbia Mountains, Brunisols are the most common soil type at lower elevations in the ICH, with Eutric (higher-nutrient) Brunisols more common in hotter, drier climates, and Dystric (more acidic) Brunisols typical in moist, warm climates. The ESSF is dominated by Humo-Ferric Podzols that reflect acidic parent materials, coniferous forests, higher precipitation, and cooler temperatures. Ferro-Humic Podzols can be more common in the wettest ESSF (or upper ICH) climates. At higher elevations in parkland and alpine environments, soil development is often slower, and Regosols are common. Soil Orders and Great Groups are described in detail in *The Canadian System of Soil Classification* (Soil Classification Working Group 1998). Keys to soil classification are provided in the Keys and Codes section of LMH 25 – *Field Manual for Describing Terrestrial Ecosystems* (Province of British Columbia 2010).

4.7 Zonal Vegetation in Subzones of the ICH and ESSF

Comparisons of zonal vegetation are shown in Tables 4.8 (ICH) and 4.9 (ESSF) to illustrate the effects of regional climate on vegetation in biogeoclimatic units described in this field guide and in adjacent areas. Zonal vegetation summaries are provided at the subzone (not variant) scale. Full species lists for zonal site series are provided in Chapter 5 for each biogeoclimatic subzone/variant.

Zonal vegetation comparison tables show the major patterns of tree, shrub, herb, and moss layer species distribution across subzones. For example, Fd and Lw occur on mature forested zonal sites in the drier ICH subzones, such as ICHxw, dw, dm, and occasionally mw, but not wetter subzones, such as ICHwk or vk. In contrast, oak fern is characteristic of zonal sites in the ICHwk and vk but is absent or sparse in drier climates.

4.8 Typical Site Series Pattern across Landscapes in the Mountainous Terrain of Southeast British Columbia

The pattern of site series distribution across mountainous terrain is based primarily on topoedaphic[5] factors: (1) slope gradient and aspect, (2) slope position, and (3) soil depth and texture. The following are some common principles that influence ecosystem distribution in mountainous terrain:

- upper slopes tend to shed moisture, while lower slopes receive and accumulate moisture, and mid slopes both shed and receive moisture;
- warm aspects have increased evapotranspiration rates and drying; and
- coarse soils shed moisture faster than fine-textured soils.

These factors contribute to the determination of relative soil moisture regime (rSMR)[6] on a site. As a relative measure, the pattern of drier and moister sites is similar in similar terrain, even though the amount of actual soil moisture availability will differ across biogeoclimatic units due to differences in regional climate. The wettest sites provide a simple example of this. In ICH climates, the wettest site series is typically the *CwSxw – Skunk cabbage* ecosystem, while ESSF climates support *SeBl – Horsetail* plant communities on similar gentle, lower-slope, moisture-receiving sites. Similarly, the driest ecosystems in the ICHdw1 support Fd and Py on sites with extensive bedrock, while Pl, Pa, and minor amounts of Se or Bl occur on similar bedrock-dominated sites in the ESSFwm3.

These principles translate into a predictable pattern of site series (and their associated plant communities) across topoedaphic sites within a subzone/variant and are reflected in the definition (and numbering) of site series throughout this field guide. Figures 4.4 and 4.5 show schematics of this pattern within a single biogeoclimatic subzone/variant and across a standardized landscape of multiple biogeoclimatic subzones/variants. Table 4.10 summarizes the common site characteristics and rSMRs for the typical site series pattern in most biogeoclimatic subzones/variants.

[5] The interaction between topography and soil factors.
[6] See Section 3.2.2 for a detailed definition of actual and relative soil moisture regimes.

TABLE 4.8 *Zonal vegetation comparisons for subzones of the ESSF*

Layer	Scientific name	ESSFmh	ESSFwh	ESSFwc	ESSFwm	ESSFdc	ESSFdk	ESSFdcw	ESSFdkw	ESSFwcw	ESSFwmw	Common name
Trees	*Picea engelmannii*	■■■■	■■■■	■■■■	■■■	■■■■	■■■■	■■■	■■■■	■■■	□□□	Engelmann spruce
	Abies lasiocarpa	■■■■	■■■	■■■■	■■■■	■■■■	■■■■	■■■■■	■■■■	■■■■	■■■■	subalpine fir
	Pinus contorta	*				□□	□□□					lodgepole pine
	Tsuga heterophylla		□□□□									western hemlock
Regen	*Abies lasiocarpa*	■■■	■■■	■■■	■■■	■■■■	■■■	■■■■	■■■	■■■	■■■■	subalpine fir
	Picea engelmannii	□□	□	□□	□	■■	□□		□□			Engelmann spruce
	Thuja plicata	□□	*									western redcedar
	Tsuga heterophylla	□	■■■									western hemlock
Shrubs	*Paxistima myrsinites*	■■■	*			*						falsebox
	Vaccinium membranaceum	■■■■	■■■■	■■■■	■■■■	■■■■	□□	*	□□□	■■■■	■■■■	black huckleberry
	Rhododendron albiflorum	■■■■	■■■■	■■■■■	■■■■	■■■■	*	*	□□□□	■■■■	■■■■	white-flowered rhododendron
	Menziesia ferruginea		*	*	□□□□		■■■■		□□□			false azalea
Herbs	*Tiarella trifoliata* var. *unifoliata*	■■■	■■■	■■■	■■■	□□□				*		foamflower
	Clintonia uniflora	■■■	■■■	*	*	□□						queen's cup
	Gymnocarpium dryopteris		■■■	■■■								oak fern
	Arnica spp.		*	□□□	■■■	■■■	■■■	□□□	■■■	■■■■	□□	arnicas
	Valeriana sitchensis			■■■		■■		■■■■	*	■■■■		Sitka valerian
	Veratrum viride			□□	■■					■■		false hellebore
	Luzula spp.			□□	■■■			■■■	*	■■■	■■■■	wood-rushes
	Vaccinium scoparium/ myrtillus				*	□□	■■■	*	■■■■		□□	grouseberry/low bilberry
Moss layer	*Rhytidiopsis robusta*	□□□	■■■■	□□□	*	□□□						pipecleaner moss
	Brachythecium spp.	*	■■■	□□□	■■■	■■■	*	■■■	□□□	■■■	■■	ragged-mosses
	"leafy liverworts"[a]	*	*	□□□	■■■	□□□	*	■■■	□□□□	■■■■	□□□	leafy liverworts

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

TABLE 4.9 *Zonal vegetation comparisons for subzones of the ICH*

Layer	Scientific name	ICHxw	ICHdw	ICHdm	ICHmw	ICHwk	ICHvk	Common name
Trees	*Larix occidentalis*	□□□	□□□	□□□	*			western larch
	Pseudotsuga menziesii	■■■■	■■■		*			Douglas-fir
	Thuja plicata	□□□□	■■■■	■■■	■■■■	■■■■	■■■■■	western redcedar
	Tsuga heterophylla		■■■■	■■■■■	■■■■■	■■■■■	■■■■	western hemlock
	Abies lasiocarpa			□□□				subalpine fir
	Picea engelmannii x *glauca*			□□□		*	*	hybrid white spruce
Regen	*Thuja plicata*	□□□	■■■	□□□	■■■	■■■	■■■	western redcedar
	Tsuga heterophylla		■■■■	■■■■	■■■■	■■■■	■■■	western hemlock
Shrubs	*Corylus cornuta*	■■■						beaked hazelnut
	Amelanchier alnifolia	■■	*					saskatoon
	Acer glabrum	■■■	□□					Douglas maple
	Paxistima myrsinites	*	■■■	■■	■■■			falsebox
	Vaccinium membranaceum	*	■■	■■	■■	■■	*	black huckleberry
	Oplopanax horridus					□□	■■■■■	devil's club
Herbs	*Prosartes* spp.	■■■	*					fairybells
	Linnaea borealis	■■■	■■■	□□	■■			twinflower
	Chimaphila umbellata	□□□	■■■	□□	□			prince's pine
	Clintonia uniflora	■■	■■■	■■	■■■	■■■	■■	queen's cup
	Tiarella trifoliata var. *uniflora*			□□	□□	■■■	■■■	foamflower
	Gymnocarpium dryopteris					■■■■	■■■■	oak fern
	Athyrium filix-femina						■■■■	lady fern
Moss Layer	*Rhytidiopsis robusta*	*	□□□	■■■	□□□□	■■■■	*	pipecleaner moss
	Pleurozium schreberi		□□□	□□□	□□□□	□□□□	□□	red-stemmed feathermoss
	"leafy mosses"[a]					*	■■■	"leafy mosses"

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

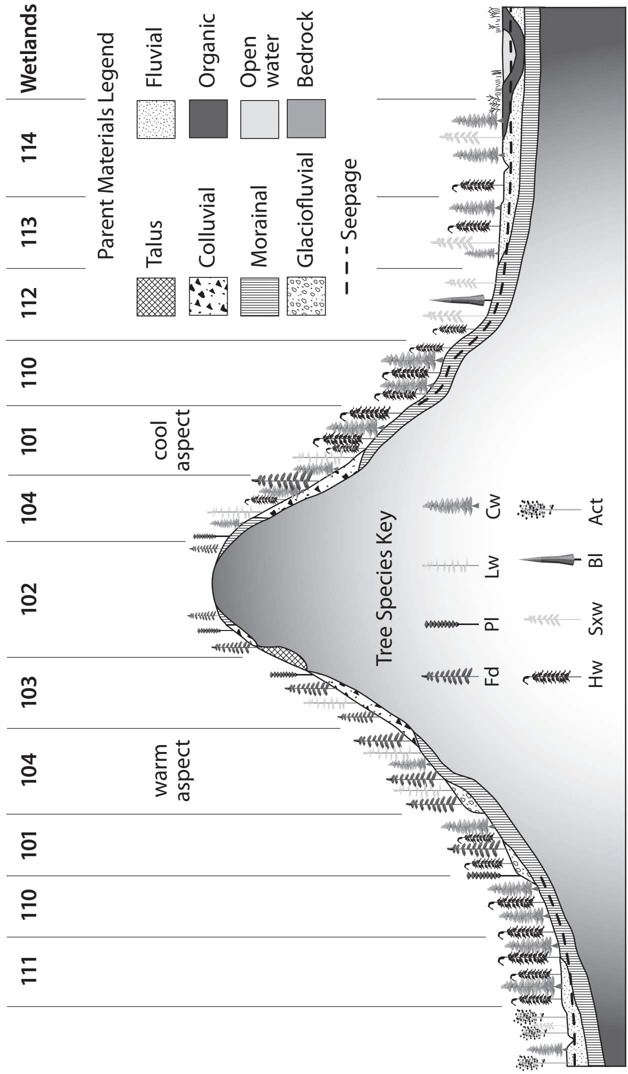


FIGURE 4.4 *Typical pattern of site series distribution within a biogeoclimatic subzone/variant across mountainous terrain of southeast British Columbia.*

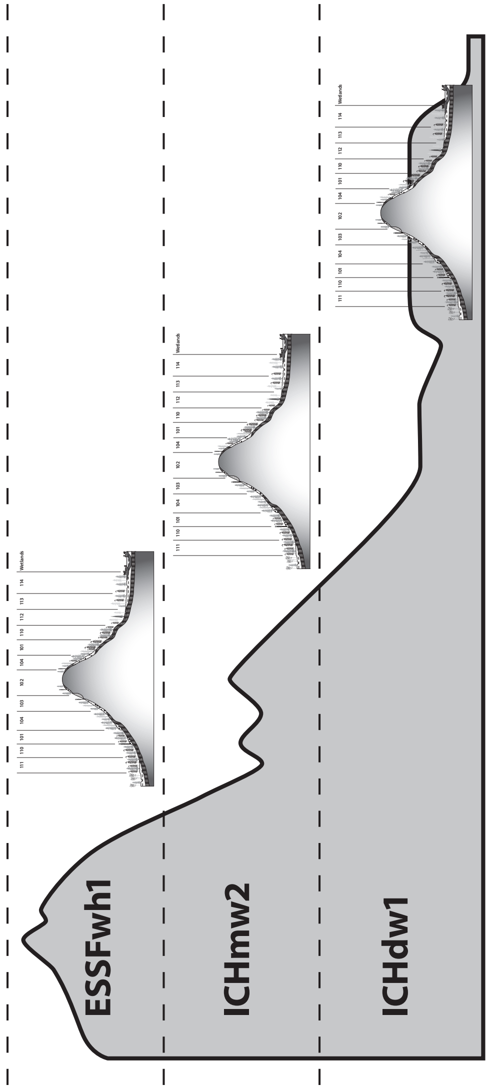


FIGURE 4.5 *Repeating site series patterns across multiple biogeoclimatic subzones/variants in a mountainous landscape.*

TABLE 4.10 *Site series number, site characteristics, landscape prominence, and relative soil moisture regime (rSMR) for the typical site series pattern of ecosystems in mountainous terrain of southeast British Columbia*

Site series	Typical site characteristics	Landscape prominence	rSMR
102	Upper slopes with prominent exposed bedrock and minimal, very shallow soils	Uncommon	1
103	Steep, warm (insolated) sites with shallow or coarse soils, usually on upper or upper/mid slopes	Uncommon	2 (1)
104	Mid slopes of warm aspects with moderate slope gradients and medium soil textures; due to compensating factors, also occurs on upper, moisture-shedding sites on cool to neutral aspects	Common – very common	3 (2–4)
101	Mid slopes of neutral (cool) slopes with moderate slope gradients and medium soil textures	Common – very common	4
110	Receiving sites on lower slope positions; often gentle slopes; seepage or water table at depth throughout the growing season	Uncommon	5
111	Toe slopes and lower slope positions with seepage or water table within the upper 30–50 cm of the soil profile throughout the growing season	Uncommon	6 (5)
112/113	Gentle or level sites with water table at or near the soil surface throughout the growing season	Very uncommon	6–7

4.8.1 Site series landscape prominence: common and uncommon site series

The most common site series across landscapes in the south-central Columbia Mountains are the submesic (typically 104) and mesic/zonal[7] (always 101) site series. These site series generally occur on mid slope positions with deep soils. The submesic site series occurs on warm aspects and/or

[7] The zonal site series supports the plant community that best reflects the regional climate of that subzone/variant.

coarser or shallower soils, while the zonal site series is most common on cool to neutral aspects of mid slopes. Both of these site series also occur on a number of sites with common compensating conditions. The submesic site series is also common on upper, shedding, or coarse sites on cool to neutral aspects, while the mesic site series occurs on gentle slopes, regardless of aspect, and on warm aspects on lower slope positions or on sites with moderately coarse soils.

Drier and wetter sites are generally less common but can be locally abundant in some landscapes. Dry and rocky or steep and coarse sites often cover smaller areas of the landscape than circum-mesic sites. The ICHxwa is an exception to this, where these site series are more common than mesic sites across its mostly steep, warm aspect distribution. In general, ICH forests also tend to have more trees growing on sites with abundant exposed bedrock than moister climates in the ESSF.

Moist to wet sites (110 and higher site series numbers) are usually associated with riparian areas, or occasionally mid-slope seepage sites. These sites are generally limited in distribution in steep, mountainous terrain and are more common in terrain with a flat valley bottom. Moist to wet sites (rSMR 5–6) tend to form narrow bands along streams in moderately steep terrain and are absent or very limited in distribution in very steep terrain (e.g., < 2 m buffer on streams) where mesic or drier conditions are more common adjacent to streams. The wettest sites (rSMR 7–8) are very uncommon in all subzones/variants in the south-central Columbia Mountains, although they were more common at low elevations in the ICH prior to land clearing for human settlements (housing and agriculture) and the development of hydroelectric reservoirs.

There is no correlation between the frequency with which an ecosystem occurs on the landscape and the extent of cells that it occupies on the edatopic grid. Site series that cover a small portion of the grid may cover a large area of the landscape if that combination of SMR and SNR is common. Similarly, site series that cover a large portion of the edatopic grid may be uncommon on the landscape if those conditions are uncommon. Ecosystems at the dry or wet extremes often cover more cells on the edatopic grid but are rare or uncommon on the ground, while the 101 site series may occupy only the 4 B–C cells but can be the most common ecosystem across the landscape.

4.8.2 Exceptions to the patterns

The site series patterns (and associated numbers) described in Table 4.10 and shown in Figures 4.4 and 4.5 are consistent across most biogeoclimatic subzones/variants in the south-central Columbia Mountains, although a number of exceptions occur. These exceptions are addressed by including additional site series for a biogeoclimatic unit or by lumping two typical site types into one site series. Exceptions to the patterns described above include the following:

Cold-air units: Cold air often accumulates in valley-bottom sites in the ICH where Sxw and Bl dominate tree layers but standard ICH tree species such as Cw, Hw, Fd, and Lw grow on the valley sides. Cold-air site series are usually described for subhygric and/or hygric sites and are included in the ICHmw2 (112 site series) and ICHmw4 (111 and 113 site series). Cold-air units are shown on the edatopic grids with square brackets [ ].

Diversity in the wettest forested units*:* In many ICH subzones/variants, two very wet site series often occur with different dominant understorey plants: either skunk cabbage (with deeper organic surface horizons) or horsetails (usually with cold-air influences). Where both occur in a biogeoclimatic unit (ICHxw, ICHdw1, ICHmw2), two site series are described.

Poor nutrient availability*:* Additional ecosystem types occur in biogeoclimatic subzones/variants where sites with poorer soil nutrient availability are common. In the ESSFwm3, a site series is described for steep, cool aspect sites with coarse, often poor soils. These sites have abundant ericaceous shrub cover (usually white-flowered rhododendron, false azalea, and/or black huckleberry), high moss layer cover (particularly leafy liverworts), and sparse herbs. In following the "rules" of BEC site series numbering, this site series is coded 104 (drier and/or poorer than the next site series on the edatopic grid), which shifts the submesic site series to 105.

Phases for sites with different environmental characteristics but similar vegetation*:* In some biogeoclimatic subzones/variants, insufficient data or infrequent distribution of dry, rocky sites result in lumping of two typical types of site series. In these cases, phases are provided for users who require additional information (see Section 2.1.2 for a definition of phases). In the ICHdm and ESSFwm4, the "trees on rock" (typical 102) and steep, warm, shallow/coarse sites (typical 103) are grouped into one site series (102). In these biogeoclimatic subzones/variants, users can separate the 102 site series into two phases: 102a for xeric sites with abundant exposed bedrock (and occasionally talus), and 102b for subxeric sites on steep, warm-aspect sites with shallow/coarse soils. In the ESSFwc4, vegetation differentiation is limited between subxeric and submesic sites, and phases can be used for the 103 site series: 103a for subxeric sites and 103b for submesic sites. In each of these biogeoclimatic subzones/variants, there is no 104 site series.

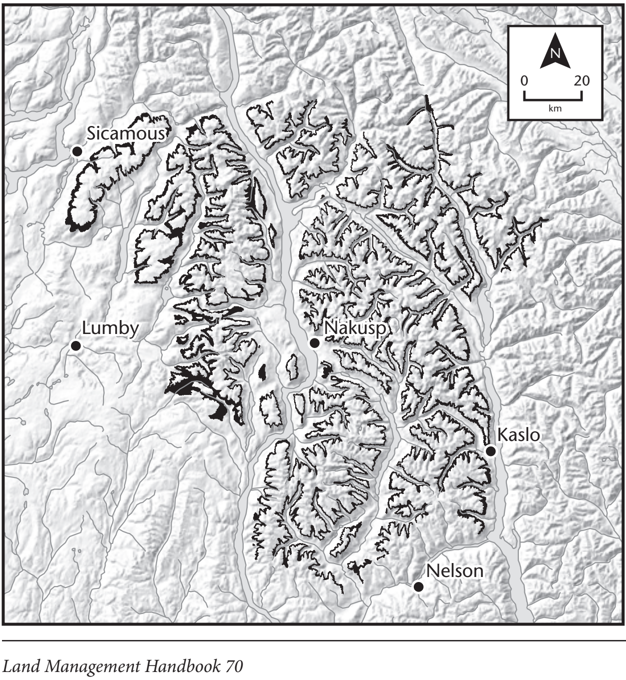
ESSFwh1
Columbia Wet Hot
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwh1 forms a transitional band between the ICH and "true" ESSF in the Selkirk, Monashee, and Purcell Mountains. In the Monashee Mountains, it extends from Three Valley Gap and Mount MacPherson to the Monashee Pass. In the Selkirk Mountains, it ranges from Mount MacKenzie, south to Coffee Creek on Kootenay Lake, throughout the Slocan Valley, and to Sunshine Creek in the Lower Arrow Lakes. In the Purcell Ranges, it occurs from the headwaters of the Duncan River to Howser Creek.

The ESSFwh1 occurs below the ESSFwc4 and above the ICHmw2, ICHmw3, ICHwk1, or ICHvk1. To the south, it is bordered by the ESSFmh in the Monashee Mountains, the ESSFwh3 in the south Selkirk Mountains, and the ESSFwh2 in the Purcell Mountains. In the north, the ESSFvm replaces the ESSFwh1 at similar elevations.

Distribution of the ESSFwh1



Elevation Range

The ESSFwh1 generally occurs from 1400 to 1600 m on cool aspects, 1450–1650 m on neutral aspects, and 1500–1700 m on warm aspects. On the east side of Duncan Lake and in the Kokanee Range, it is approximately 50–100 m higher on all aspects. The ESSFwh1 occurs in the valley bottoms at the upper reaches of most drainages, often at lower than typical elevations due to the influence of cool air.

Climate[1]

The ESSFwh1 occurs in the Moist climate subregion and is characterized by cool, wet seasons (summer, fall, and winter), heavy snowfall, and a deep snowpack that typically persists from November through to April or early May. Rain-on-snow events occur during most winters but are typically infrequent within a single winter. Growing-season moisture deficits can occur on subxeric and drier sites.

Forest and Vegetation Characteristics

The ESSFwh1 forms a highly productive ESSF–ICH transition. Se, Hw, Bl, and Cw are common on **mesic** and **submesic sites**, along with white-flowered rhododendron and black huckleberry. Fd usually dominates **dry**, **warm sites**, typically with a diverse mix of Lw with minor Bl and/or Se. White-flowered rhododendron is often absent on these sites where black huckleberry and falsebox dominate. Pl is moderately uncommon and may be present in earlier seral stands. **Wet sites** often contain mixtures of Se and Bl, with occasionally abundant Hw and varying amounts of Cw, except where cold air limits Cw and Hw. Species that are more abundant in the ICH, such as oak fern, prince's pine, rattlesnake-plantain (*Goodyera oblongifolia*), and queen's cup, mix with species more typical in the ESSF, such as Sitka valerian, mitreworts, bracted lousewort, and false hellebore. Dense Sitka alder (*Alnus viridis* ssp. *sinuata*) often grows along roadsides. Where the ESSFwh1 occurs above the ICHvk1 or ICHwk1, wetter herb, shrub, and tree species are more common, particularly more devil's club, oak fern, and lady fern and less Fd and Lw on warm-aspect sites.

Some stands in the ESSFwh1 look very similar to the ICH. Stands of almost pure Hw or mixed Hw and Cw occasionally occur on mesic to submesic sites within landscapes otherwise dominated by more typical mixed Se, Bl, Hw forests. Many warm-aspect sites dominated by Fd and/or Lw often look like ICH but typically lack very dry species, such as saskatoon (*Amelenchier alnifolia*), tall Oregon-grape (*Mahonia aquifolium*), and pinegrass (*Calamagrostis rubescens*), which occur on comparable sites

[1] See Section 4.2 for more information on climate variables.

in the ICH. In general, Cw and Hw are common codominants of stands in the lower portions of the ESSFwh1, and are often restricted to the shrub and suppressed tree layer at upper elevations closer to the ESSFwc4.

Disturbance

Relatively long intervals occur between stand-replacing **fires** in the ESSFwh1. Occasional mixed-severity burns occur on warmer aspects and on slopes that extend to lower elevations, particularly at the southern extent of the ESSFwh1. In these areas, fire-scarred Fd, Lw, and sometimes Cw are seen. Prior to the **timber harvesting** activities of the last 50 years, **old-growth** Se, Bl, Hw, and Cw stands were very common in the ESSFwh1.

Small forest gaps caused by windthrow, insects, and pathogens are important for creating stand structural complexity in the intervals between stand-replacing fires. Endemic levels of western balsam bark beetle can create small openings that drive regeneration and multi-aged stands. Where Pl is abundant on dry sites, mountain pine beetle has had significant impacts in localized areas. Spruce bark beetles are known to inflict high mortality, particularly following fire or blowdown, or where slash retention is high after harvest, while Douglas-fir bark beetles can cause significant mortality on dry, warm-aspect sites where Douglas-fir is abundant. Spruce weevil can be a growth impediment in planted stands, and gall rusts affect growth of Pl. **Armillaria root rot** creates small gaps in mature stands and can be a major impediment to regeneration of all species, particularly Fd, Lw, and Hw.

The combination of deep snowpacks and steep terrain results in widespread avalanche tracks and a high risk of snowpress on regenerating stands on steep slopes.

Soils, Geology, and Landforms

The wide geographic range of the ESSFwh1 covers highly varied geology: coarse intrusive materials (granodiorite and granite) are common in the central Selkirk Mountains, along with limestone and fine- to medium-grained metasedimentary rocks. Gneiss is dominant in the Monashee Mountains, along with coarse-grained, acidic intrusive rocks (granodiorite, granite, and quartz monzonite) and volcanic rocks (andesite and basalt).

The most common landforms are morainal veneers and blankets on gentle to steep slopes and rubbly colluviums in steep terrain. Thin, eolian cappings of fine sandy loam materials are also widespread. Over much of the area, sandy loam to loamy sand textures occur near the surface and become coarser with depth. Shallow soils interspersed with exposed bedrock are common along the valley walls in the Kootenay, Slocan, and Arrow Lakes valleys, while kame terraces of coarse, gravelly, or sandy glaciofluvial deposits occur frequently along valley walls. In the central Selkirk Mountains, finer-textured parent materials frequently lead to soils with a significant silt or clay component.

Wildlife Habitat

The wet climate and highly productive forests of the ESSFwh1 provide valuable habitat for wide-ranging flagship species such as **mountain caribou**, **grizzly bear**, and **wolverine**. Mountain caribou use the ESSFwh1 in early winter. The ESSFwh1 has high habitat potential for wolverine. Vegetated avalanche chutes provide important spring forage for grizzly bear, and sites dominated by huckleberry are used throughout the summer. **Mountain goats** occur in the ESSFwh1, near steep, rocky escape terrain.

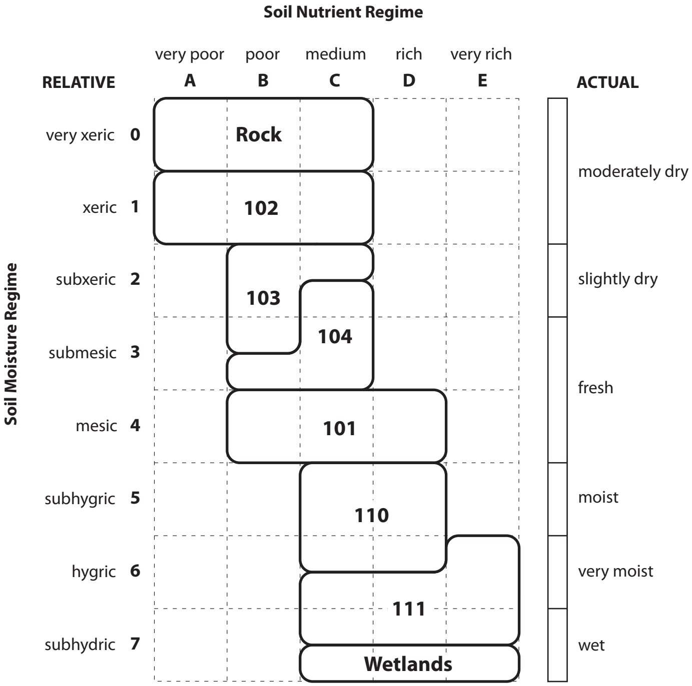
Old-growth forests characterized by complex, multi-layered stands and an abundance of large wildlife trees (i.e., dead and dying trees with hollow stems/cavities and broken tops), hollow logs, coarse woody debris, and associated root balls support dependent **cavity-nesting**, **roosting**, **and denning birds and mammals** as well as their predators (e.g., **northern goshawk**). Common bird species in the ESSFwh1 include hermit thrush, Swainson's thrush, yellow-rumped warbler, dark-eyed junco, and Townsend's warbler. Several listed vascular plant species, including endangered **whitebark pine**, occur in the ESSFwh1.

Oak fern
Gymnocarpium dryopteris

Distinguishing the ESSFwh1 from Adjacent Biogeoclimatic Units

In the **ESSFwc4**, most sites have:	- no Hw or Cw - less falsebox and thimbleberry - more Bl, white-flowered rhododendron, woodrushes, arnica, and liverworts
dry sites have:	- no Fd, Lw, queen's cup, or prince's pine
wet sites have:	- less devils club, lady fern, and cow parsnip - more Sitka valerian, false hellebore, and arrow-leaved groundsel
In the **ESSFwh3**, most sites have:	- more pipecleaner moss - less feathermosses
dry sites have:	- bear-grass - more Pl, Lw, and birch-leaved spirea
wet sites have:	- more false azalea - less Sitka valerian
In the **ESSFmh**, most sites have:	- more pipecleaner moss - less feathermosses
zonal sites have:	- more falsebox - less oak fern
dry sites have:	- grouseberry - more Pl and Lw - less white-flowered rhododendron
In the **ICHmw 2**, most sites have:	- no white-flowered rhododendron - more Lw, Fd, Cw, Hw, Pw, Ep, western yew, baldhip rose, wild sarsaparilla, and fairybells - less Sx and Bl, except in cold-air sites
dry sites have:	- more saskatoon, Oregon-grape, Douglas maple, soopolallie, kinnikinnick, and pinegrass - no Bl
In the **ICHwk1**, most sites have:	- no white-flowered rhododendron - more Cw, Hw, Pw, and western yew - less Sx and Bl, except in cold-air sites
zonal sites have:	- more oak fern
dry sites have:	- more prince's pine and bunchberry - less heron's-bill moss

Edatopic Grid



Site series

101	BlHw – Rhododendron – Foamflower
102	Bl – Huckleberry – Rock-moss
103	BlFd – Huckleberry – Falsebox
104	BlHw – Huckleberry – Pipecleaner moss
110	Se – Devil's club – Lady fern
111	SeBl – Horsetail – Canby's lovage

Site Series Flowchart

VERY DRY to DRY FORESTS

- warm aspects
- shallow, coarse soils
- rhododendron is sparse or absent

→

- SMR 1 (2)
- Bl (Se, Pl, Pa) stands
- exposed (bed)rock is prominent
- no Hw, Cw, queen's cup, or prince's pine

→ **102**

- SMR 2 (3)
- Fd,Bl (Lw,Se, Pl) canopy
- steep, warm aspect; shallow and/or coarse soils
- prince's pine, pipecleaner moss present, and/or < 2% cover of queen's cup

→ **103**

SLIGHTLY DRY to MESIC FORESTS

- mid slopes (usually) with deep soils

→

- SMR 3 (2)
- Se, Hw (Bl, Cw) stands
- < 5% foamflower, > 2% queen's cup cover
- no oak fern

→ **104**

- SMR 4
- Se, Hw, Bl (Cw) stands
- moderate cover of oak fern, five-leaved bramble, and/or foamflower (5–10 %)
- no lady fern, devil`s club, or leafy mosses

→ **101**

MOIST to WET FORESTS

- level, lower, and toe slopes
- seepage or mottles
- often associated with riparian areas

→

- SMR 5 (6)
- Se, Bl (Hw) stands
- lower slopes and receiving sites
- lady fern and/or devil's club abundant (> 10% cover)
- no horsetails or arrow-leaved groundsel

→ **110**

- SMR 6 (7)
- Se, Bl stands
- level to gentle toe slopes
- abundant horsetails (> 7% cover)
- Sitka valerian, Canby's lovage, globeflower, and/or arrow-leaved groundsel with moderate to abundant cover

→ **111**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	Common name
Trees	*Abies lasiocarpa*	■■■■	■■■	■■■	■■■	■■■	■■■	subalpine fir
	Picea engelmannii	□□□	□□□	■■■	■■■■	■■■■	■■■■	Engelmann spruce
	Pinus albicaulis	□□						whitebark pine
	Pseudotsuga menziesii		■■■■	□□				Douglas-fir
	Pinus contorta		□□□					lodgepole pine
	Larix occidentalis		□□□					western larch
	Tsuga heterophylla		*	■■■■	■■■■	□□□		western hemlock
Regen	*Abies lasiocarpa*	■■■	■■■	■■■	■■■	■■■	■■■	subalpine fir
	Picea engelmannii	*	□□	□	*	■■	■■■	Engelmann spruce
	Tsuga heterophylla		□□	■■■	■■■	■■	□	western hemlock
	Thuja plicata		□	■■	*	*		western redcedar
Shrubs	*Vaccinium membranaceum*	■■■■	■■■■	■■■■	■■■■	■■■	■■■	black huckleberry
	Paxistima myrsinites	■■■	■■■■	■■■				falsebox
	Rhododendron albiflorum	□□	□□	■■■	■■■■	■■■	□□□	white-flowered rhododendron
	Vaccinium ovalifolium				*	□□	■■■	oval-leaved blueberry
	Ribes lacustre					■■	□	black gooseberry
	Rubus parviflorus					■■■		thimbleberry
	Oplopanax horridus					■■■		devil's club
Herbs	*Orthilia secunda*	□□	■	■■	*			one-sided wintergreen
	Hieracium albiflorum	□□	□□					white hawkweed
	Pedicularis spp.	□□						louseworts
	Chimaphila umbellate		■■					prince's pine
	Clintonia uniflora		□□	■■■	■■■	■■		queen's cup
	Tiarella trifoliata var. *unifoliata*			□□	■■■	■■■■	■■	one-leaved foamflower
	Rubus pedatus			*	■■■	■■■	□	five-leaved bramble

Layer	Scientific name	102	103	104	101	110	111	Common name
Herbs	*Gymnocarpium dryopteris*				■■■	■■■■	■■■	oak fern
	Dryopteris expansa				□□	■■■	□	spiny wood fern
	Valeriana sitchensis				*	□□□	□□□	Sitka valerian
	Streptopus lanceolatus				*	□□	□□	rosy twistedstalk
	Athyrium filix-femina					■■■■	■■■	lady fern
	"mitreworts"[a]					■■	□□	mitreworts
	Veratrum viride					□□	□□	false hellebore
	Streptopus amplexifolius					■■	■	clasping twistedstalk
	Ligusticum canbyi						□□□	Canby's lovage
	Senecio triangularis						■■■	arrow-leaved groundsel
	Equisetum spp.						■■■■	horsetails
	Leptarrhena pyrolifolia						□□□	leatherleaf saxifrage
	Trollius albiflorus						□□□	globeflower
Moss layer	*Dicranum* spp.	■■■■	□□□	■■■■	□□□	□		heron's-bill mosses
	Racomitrium spp.	□□□						rock-mosses
	Cladonia spp.	■■	*	*				clad lichens
	"leafy liverworts"[a]	□□			□□□	*	□□	leafy liverworts
	Peltigera spp.	■■	□					pelt lichens
	Polytrichum spp.	■	*					haircap mosses
	Brachythecium spp.	*	*	□□	■■■	■■■■	■■■	ragged-mosses
	Rhytidiopsis robusta		■■■	■■■■	■■■	*		pipecleaner moss
	"leafy mosses"[a]				*	■■■■	■■■■	leafy mosses
	Sphagnum spp.						□□□□	peat-mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site series	102	103	104	101	110	111
No. of plots	5	13	17	36	29	6
SMR	1 (2)	2 (3)	3 (2)	4	5 (6)	6 (7)
SNR	A–B (C)	C (A–B)	C (B)	C (B–D)	C–D (E)	D–E (C)
Slope position	MD (UP)	MD–UP (CR)	MD (LW, UP)	MD (LW)	LW (MD, TO)	TO, LV
Typical slope/ aspect	Steep–moderately steep/warm	Steep/warm	Moderate/ warm	Moderate/ neutral (cool)	Gentle–moderate	Gentle–level
Common compensating conditions		Shallow crests; neutral aspects in open valleys with high sun exposure	Upper/cool; shallow–coarse, neutral	Lower/coarse; gentle/warm	Mid-slope receiving sites; moderately coarse toe slopes	
Surficial materials	Cx/R, Mx/R, Dx	Cv, Cb (Mv)	Mb (Cb)	Mb (Cb)	M, F (C)	F (Ov, M)
Soil texture	SL, SiL, LS	SL	SL (L, SiL)	FSL, L (SL, SiL)	SiL, SL, (FSL, SiCL)	SL, FSL, SiL
Coarse fragment content	High–fragmental	Moderate–high (fragmental)	Moderate–high	Moderate–high	Moderate–high (low)	Moderate (low)
Important features	(Bed)rock is prominent and abundant	Insolation			Seasonal seepage within top 50 cm	Water table near surface; can have thin organic veneers; cold air is common

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

BlHw – Rhododendron – Foamflower 101

General Description

SMR 4. 101 forests typically occur on **mid slopes** of **neutral to cool** aspects with **moderate-textured soils**. Due to compensating factors, this site series also occurs on lower slopes of warm aspects with extensive shading from adjacent mountains or with coarse soils. Soils are typically Humo-Ferric Podzols or Orthic Dystric Brunisols with well- to moderately well-drained silt loam, fine sandy loam, or sandy loam textures, and moderate coarse fragment content. Humus forms are usually moderately thick (3–7 cm) Hemimors.

The overstorey and understorey tree layers typically include **Se**, **Hw**, and **Bl**; Cw may be present. Shrub cover is usually moderate to extensive, with **black huckleberry** and **white-flowered rhododendron** dominant. **Oak fern**, **foamflower**, **queen's cup**, and **five-leaved bramble** are typically present. Mosses are varied and include pipecleaner, heron's-bill, and ragged-mosses.

Differentiating from Other Site Series

Slightly drier sites (104) typically have Fd, Lw, and/or falsebox, lack oak fern and five-leaved bramble, and have low (< 3%) cover of foamflower. Moister sites (110) occur on receiving sites with seepage within the upper 75 cm of the soil profile, and typically have abundant oak fern, lady fern, and foamflower (> 10% cover), as well as moderate to high cover of devil's club, thimbleberry, or spiny wood fern (> 5%), and minor black gooseberry, oval-leaved blueberry, clasping twistedstalk, and/or mitreworts.

Variability

Leading species in mature stands can be Se, Hw, Bl, Cw, or a combination of these. Old-growth stands with high Hw (and/or Cw) cover and minor white-flowered rhododendron cover occasionally occur within the ESSFwh1. These forests have many ICH characteristics but fit with the ESSFwh1 where they occur within a landscape matrix with abundant Se, Bl, and white-flowered rhododendron.

Management Issues

These sites have high productivity for the ESSF and few limiting factors for tree growth. This site series is also amenable to the growth of a wide variety of species, and species diversity should be fostered. Snow creep and avalanching may cause damage to tree regeneration on steeper slopes.

102 — Bl – Huckleberry – Rock-moss

General Description

SMR 1 (2). 102 forests occur on sites with **abundant bedrock** or blocky talus where total tree cover is 10% or greater in the overstorey. Soils are variable but shallow within any given stand, and comprise a mixture of bare rock and thin veneers. Soil textures vary considerably based on bedrock types. Where granodiorite is the dominant rock type, soils have sandy loam textures; where finer rock types predominate, soils have silt loam or clay loam textures. The occurrence of this site series is very dependent on soil depth and often occurs as a mosaic with rock outcrops and the 103 site series in areas of variable soil depth.

Tree cover is typically comprised of **sparse Bl** and **Se**. In the Selkirk Mountains, **Pa** can be common. Huckleberry and falsebox are common shrubs, along with occasional dry-site species such as **junipers**. Herbs are usually sparse, with small amounts of white hawkweed, **louseworts** (mostly sickletop [*Pedicularis racemose*] and bracted [*P. bracteosa*]), **saxifrages** (*Saxifraga* spp.), and one-sided wintergreen. Mosses are abundant, particularly heron's-bill mosses, **rock-mosses**, and haircap mosses, as well as **clad lichens**.

Differentiating from Other Site Series

The 102 is the driest forested site series recognized in the ESSFwh1. Drier sites include non-forested rock outcrops (Ro) and talus (Rt) slopes with < 10% tree cover in the stand. Slightly moister sites (103) lack abundant bedrock at the surface and tend to occur on steep, warm aspects with coarse and/or shallow soils. Moister sites also have small amounts of queen's cup, one-sided wintergreen, violets (*Viola* spp.), and/or prince's pine, more pipecleaner moss, and less haircap mosses and clad lichens. Hw and Cw are often present on increasingly moister sites.

Variability

Plant species vary within sites based on soil depth in small microsites; occasionally, moister species may occur in deeper pockets of soil. White-flowered rhododendron is often absent on these very dry sites.

Management Issues

This site series is not recommended for timber harvesting due to limitations in available soil and soil moisture for tree regeneration and growth. These sites may provide habitats for rare and at-risk plant species (e.g., Pa).

BlFd – Huckleberry – Falsebox 103

General Description

SMR 2 (3). 103 forests occur on **warm aspects**, typically with **coarse and/or shallow soils**. They occasionally occur on neutral aspects in broad valleys (e.g., Arrow and Kootenay Lakes) with higher sun exposure and/or on sites with very coarse soils. Soils are usually derived from colluvium but may be glaciofluvial on valley side-walls and terraces. Dystric Brunisols are common.

Fd and **Lw** are often dominant or codominant with Pl, Se, and Bl; Bl is often abundant in the regeneration layer. **Black huckleberry** and **falsebox** have abundant cover, but **white-flowered rhododendron is often absent** or present with sparse cover. Utah honeysuckle (*Lonicera utahensis*) is common. Small amounts of prince's pine, white hawkweed, queen's cup, and one-sided wintergreen are usually present.

Differentiating from Other Site Series

Slightly drier sites (102) are characterized by prominent bedrock or talus and abundant rock mosses. Slightly moister sites (104) occur on gentler slopes and/or cooler aspects with deeper soils. Submesic and mesic sites typically have more Hw, little to no Fd, and contain queen's cup, foamflower, and/or five-leaved bramble.

ESSFwh1/103 stands often look like ICH forests due to the lack of white-flowered rhododendron and abundance of Fd and/or Lw. However, the presence of Bl either in the regeneration layers or canopy is distinctive, along with greater cover or presence of black huckleberry, Utah honeysuckle, mountain ash, and queen's cup, and lower cover or absence of species such as saskatoon, Oregon-grape, soopolallie, Douglas maple, and pinegrass.

Variability

At upper elevations, Se, Bl, and white-flowered rhododendron can be more abundant, with less Fd and Lw. At lower elevations, Bl and Se may be restricted to the regeneration or Subcanopy layer. Earlier seral stands often have more Pl, particularly in the southern half of the ESSFwh1. White-flowered rhododendron cover tends to increase with elevation.

Management Issues

This site series is amenable to the growth of a wide variety of tree species and species diversity should be fostered. Regeneration issues may be encountered due to growing-season moisture deficits. Snow creep and avalanching may cause damage to regeneration on steep slopes in winter, while soil erosion can be a concern on steep slopes during the growing season.

104 BlHw – Huckleberry – Pipecleaner moss

General Description

SMR 3 (2). 104 forests typically occur on **mid slopes** of **warm aspects** with medium- to moderately coarse-textured soils. Due to compensating factors, this unit also occurs on **upper**, **shedding** sites on **cool to neutral** aspects or with coarse- to very coarse-textured soils. Soils are usually well-drained Dystric Brunisols or Humo-Ferric Podzols with loamy to sandy loam textures and moderate to high coarse fragment content.

Hw, **Se**, and **Bl** are typical. Hw can range from dominant with high cover to sparse; Cw may be present in the overstorey and/or understorey, while Fd and Lw may occur at low densities. Shrub cover is typically moderate, while herb cover is varied but usually low. Typical species include **black huckleberry**, **falsebox**, and **white-flowered rhododendron**, with small amounts of queen's cup, one-sided wintergreen, foamflower, violets, and rattlesnake-plantain. Mosses also vary, with pipecleaner moss and heron's-bill mosses most common.

Differentiating from Other Site Series

Slightly drier sites (103) have higher Fd, Pl, and Lw cover, less Hw, and more falsebox, and are typically restricted to very dry, steep, warm-aspect sites with coarse and/or shallow soils. Slightly moister sites (101) typically lack Fd, Lw, Pl, and falsebox, and have moderate cover (> 5%) of foamflower, oak fern, and/or five-leaved bramble.

Variability

White-flowered rhododendron may be sparse or absent at lower elevations where the ESSFwh1 transitions to the ICH. Minor cover of Pw may occur, especially at lower elevations. Lw is more common in the southern extent of the ESSFwh1. Old-growth stands of almost pure Hw, with minor cover of white-flowered rhododendron, Cw, Se, and Bl, occasionally occur within the ESSFwh1. These forests have many ICH characteristics but fit with the ESSFwh1 when they occur in a landscape matrix with abundant Se and Bl.

Management Issues

These sites have high productivity for the ESSF and few limiting factors for tree growth. This site series is also amenable to the growth of a wide variety of tree species, and species diversity should be fostered. On steep slopes, avalanching and snowpress are often concerns in winter, while soil erosion can be a concern during the growing season.

Se – Devil's club – Lady fern **110**

General Description

SMR 5 (6). 110 forests occur on **lower slope, receiving sites** where prolonged **seasonal seepage** occurs at depth (within 50–75 cm). Sites occasionally occur on mid slopes where restricting layers hold seepage closer to the surface, or on coarse-textured toe slopes, and are often associated with **riparian** areas. Soils typically have silt or sandy loam textures and moderate coarse fragment content. Humus forms are either Mors or Moders.

Se and **Bl** are the dominant tree species in the overstorey and understorey, although Hw and Cw can also be abundant. **Devil's club**, **thimbleberry**, and black gooseberry are common shrubs, and white-flowered rhododendron is typically sparse (< 5% cover). **Lady fern**, **oak fern**, **foamflower**, and **spiny wood fern** are abundant, along with small amounts of mitreworts, clasping twistedstalk, false hellebore, and valerian. Leafy mosses and ragged-mosses are typical mosses.

Differentiating from Other Site Series

Slightly drier sites (101) lack devil's club and lady fern, and have less oak fern (< 10%) and more white-flowered rhododendron. Wetter sites (111) have moderate to high cover (> 3–5%) of horsetails, arrow-leaved groundsel, globeflower, and/or Canby's lovage, and seepage near the surface. Similar moisture-receiving sites in the ESSFwc4 (110 and 111) lack Cw, Hw, and devil's club, and have higher cover of white-flowered rhododendron, Sitka valerian, arrow-leaved groundsel, and globeflower.

Variability

Sites are typified by moderate to high cover of devil's club and/or lady fern. Users who require additional information can refer to site variations as:

110.1 Se – Devil's club – Lady fern
for sites with abundant devil's club (> 10%)
110.2 Se – Lady fern – Oak fern
where devil's club is sparse or absent and lady fern is abundant (> 20%)

Management Issues

Tree productivity is high on these sites, and vegetation competition may be a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards, particularly where soils are finer textured (high silt or clay). Harvesting should take place when soils are dry or frozen. Sites frequently provide travel corridors in steep terrain and forage for wildlife.

111 SeBl – Horsetail – Canby's lovage

General Description

SMR 6 (7). 111 forests are uncommon in the ESSFwh1. They occur on **level sites** and **gentle**, **lower** and **toe slopes** with a **high water table** within the **top 30 cm**. Stands are often associated with **riparian** areas and frequently experience **cold air**. Soils are usually imperfectly to poorly drained Gleysols; organic veneers are common. These sites occur adjacent to streams or lakes.

Se and **Bl** dominate the tree layers. **Horsetails** (mostly common horsetail [*Equisetum arvense*]) and **arrow-leaved groundsel** are typically present, along with Canby's lovage, **globeflower**, Sitka valerian, lady fern, mitreworts, and false hellebore. Shrub cover is variable, with black and oval-leaved huckleberries, minor amounts of white-flowered rhododendron, and occasionally black twinberry (*Lonicera involucrata*). Leafy mosses are common, along with bent-leaf moss (*Rhytidiadelphus squarrosus*) and ragged-mosses. Peat-mosses may be present.

Differentiating from Other Site Series

111 sites are easily differentiated from other forested site series by the abundance of horsetails and/or arrow-leaved groundsel; slightly drier forested types (110) are dominated by oak fern, lady fern, and/or devil's club. Wetter sites are typically non-forested (< 10% tree cover) wetlands, primarily shrubby swamps (Ws), fens (Wf), or low bench floodplains (Fl).

Variability

Lady fern may be present and/or abundant. These sites often occur in a mosaic with non-forested wetlands or as narrow strips along floodplains and lake edges. Sites are typically mounded.

The 111 site series is typically riparian-associated. It is usually a high bench flood site, but can be a treed swamp. Users who require additional information can refer to phases to reflect this variability:

111a for riparian flood sites
112b for the swamp phase with a very thick organic veneer and very poor drainage (Ws08.2) (see Section 6.2)

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and water tables may rise once trees are removed. Cold air and frost may limit seedling regeneration. Where tree removal occurs, competition from herbaceous brush can be a concern in regenerating stands. Sites frequently provide forage for wildlife in landscapes where steep terrain is dominant.

Other Ecosystems

The following ecosystems occur within the ESSFwh1; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

In the ESSFwh1, wetlands are uncommon and are generally found in broad, gentle to level areas along the valley floor or in subdued terrain. Fens (Wf), marshes (Wm), and swamps (Ws13, Ws08) all occur. These ecosystems are described in Section 6.2.

Avalanche features

Avalanche paths are common in the steep, snowy mountains of the ESSFwh1 and provide important habitat and landscape diversity. A range of types occurs, including herbaceous (Vh), shrubby (Vs), and treed (Vt) avalanche ecosystems. Descriptions are provided in Section 6.5.

Rock outcrops and talus slopes

Rock outcrop (Ro) and talus (Rt) ecosystems are common in the ESSFwh1 and typically occur adjacent to the driest forested sites. Descriptions of rock outcrops and talus are provided in Section 6.6.

Brewer's mitrewort
Pectiantia breweri

Globeflower
Trollius albiflorus

False hellebore
Veratrum viride

ESSFwc4
Selkirk Wet Cold
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwc4 occurs at upper elevations in the central Selkirk, Monashee, and Purcell Mountains in the Arrow, Slocan, and Kootenay Lake areas and the upper Shuswap River system. Throughout most of its range, the ESSFwc4 occurs above the ESSFwh1, which forms a transition between the ICH and "true" ESSF conditions of the ESSFwc4. At similar elevations the ESSFwc4 abuts the ESSFwm3 in the Selkirk Mountains, the ESSFwm2 in the Purcell Mountains, and the ESSFdc1 in the Monashee Mountains; the ESSFvc occurs to the north in the Monashee and Selkirk Ranges.

Distribution of the ESSFwc4

Elevation Range

The ESSFwc4 generally occurs from 1600 to 1900 m on cool aspects, 1650–1925 m on neutral aspects, and 1700–1950 m on warm aspects. In the northern extent of the range, elevation limits are approximately 100–150 m lower on all aspects; in the Valhalla and Goat Ranges, boundaries are 50–75 m higher.

Climate[1]

The ESSFwc4 is located in the Moist climate subregion, in the transitional area to the Wet climate subregion. It is characterized by cool, wet summers and winters with heavy snowfall and a very deep snowpack that typically persists from November through May. Snow patches in sheltered areas often persist into June. Rain-on-snow events occur during many winters but are very infrequent. Growing-season moisture deficits are uncommon on all but the driest sites.

Forest and Vegetation Characteristics

Se and Bl dominate the ESSFwc4, with abundant white-flowered rhododendron and black huckleberry in the understorey. Other common species are Utah honeysuckle (*Lonicera utahensis*), mountain-ash (*Sorbus* spp.), oval-leaved blueberry, wood-rushes, mountain arnica, leafy liverworts, and ragged mosses. On **zonal** sites, foamflower, oak fern, five-leaved bramble, and Sitka valerian are also common. **Drier sites** often have sparse to moderate herb cover with a variety of low cover species, including mountain arnica, one-sided wintergreen, and foamflower. Pa can occur on rocky and/or warm-aspect sites, although mortality is high due to white pine blister rust and mountain pine beetle. La often occurs on blocky talus sites with cold air in the upper ESSFwc4. **Wetter sites** have high fern cover (oak, lady, spiny wood), particularly in the lower half of the ESSFwc4, as well as abundant Sitka valerian, arrow-leaved groundsel, false hellebore, and/or horsetails.

Tree productivity is moderate in the ESSFwc4 and is intermediate between the productive ESSFwh1 at lower elevations and the mostly non-productive ESSFwcw at higher elevations. Cold air, frost, shorter growing seasons, and high snow limit tree regeneration and growth. In upper portions of the ESSFwc4, wood-rushes are usually more common, and Pa may occur more frequently at low densities.

[1] See Section 4.2 for more information on climate variables.

Disturbance

Old-growth forests are common in the ESSFwc4 where long intervals occur between stand-replacing **fires**. Stand replacement often occurs through small-scale **forest gap dynamics** caused by tree mortality from windthrow, insects, and diseases. Endemic levels of **western balsam bark beetle** are key drivers of regeneration and multi-aged stands. Spruce bark beetles are known to inflict high mortality, particularly following fire or blowdown, or where slash retention is high after harvest. White pine blister rust and, more recently, mountain pine beetle have had devastating effects on whitebark pine. Where Pl is locally abundant, mountain pine beetle can create stand-level disturbances.

The combination of deep snowpacks and steep terrain results in widespread avalanche tracks. Snowpress may affect tree regeneration on moderately steep to steep slopes. **Timber harvesting** has become increasingly prevalent in the ESSF since the 1970s, with significant areas harvested.

Soils, Geology, and Landforms

The ESSFwc4 is characterized by complex, varied geology. In the Selkirk Mountains, coarse intrusive rocks (granodiorite, granite) are common in the Valhalla and Valkyr ranges, while fine- to medium-grained metasedimentary (slate, shale, limestone, and argilite) rocks are typical in the Kokanee, Goat, Badshot, and Lardeau Ranges. Gneiss is dominant in the Monashee Mountains, along with coarse intrusive and volcanic (andesite and basalt) rock types.

The most common landforms are morainal materials on gentle to steep (< 50%) slopes and rubbly colluviums on steep (> 50%) terrain. Rock outcrops and shallow soils are widespread. Over much of the area, sandy loam to loamy sand textures occur near the surface and become coarser with depth. Glaciofluvial coarse, gravelly, or sandy deposits are common as kame terraces along valley walls. Where finer-textured parent materials occur in the central Selkirk Mountains, soils with a significant clay or silt component occur more frequently.

Wildlife Habitat

Much of the ESSFwc4 provides important habitat for wide-ranging flagship wildlife species, such as mountain caribou, grizzly bear, and wolverine. Old-growth forests with abundant arboreal lichens provide critical winter habitat for **mountain caribou**. In the ESSFwc4, **grizzly bears** seek out early seral vegetation in spring (often associated with avalanche run-out zones) and forage on abundant huckleberries throughout the late summer. The ESSFwc4 provides important habitat for **mountain goats** (typically found near steep, rocky escape terrain), and the entire unit has high habitat potential for **wolverine**.

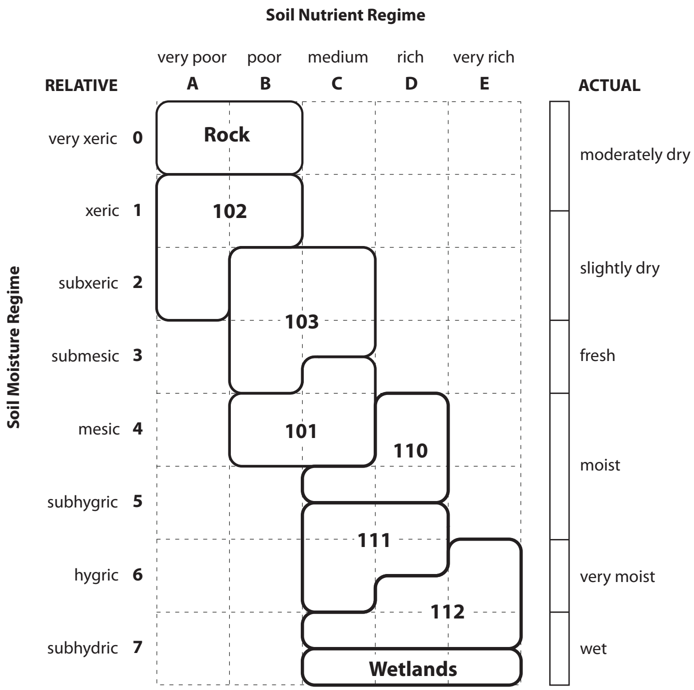
Listed **peregrine falcons** occur in this unit, as do other insectivorous birds at risk (e.g., **olive-sided flycatcher**, **barn swallow**). The listed **magnum mantleslug**, as well as several listed vascular plants, occur in the ESSFwc4, including endangered **Pa.** Hermit thrush, dark-eyed junco, Wilson's warbler, and varied thrush are common bird species.

Arrow-leaved groundsel
Senecio triangularis

Distinguishing the ESSFwc4 from Adjacent Biogeoclimatic Units

In the **ESSFwcw**, most sites have:	- considerably lower tree productivity with more openings - mountain-heathers, anemones, and/or partridge-foot - more leafy liverworts, heron's-bill moss, and/or wood-rushes
zonal sites have:	- less Se - no oak fern, queen's cup, or foamflower
dry sites have:	- more Pa and La
wet sites have:	- no lady fern or oak fern
In the **ESSFwh1**, most sites have:	- Hw and/or Cw - more thimbleberry - less white-flowered rhododendron, wood-rushes, and arnica
zonal sites have:	- less Sitka valerian
dry sites have:	- Fd, Lw, queen's cup, and prince's pine - more falsebox
wet sites have:	- devil's club and lady fern - less Sitka valerian, false hellebore, cow-parsnip, and arrow-leaved groundsel
In the **ESSFdc1**, most sites have:	- grouseberry - more five-leaved bramble and arnica
zonal sites have:	- no oak fern
dry sites have	- more Pl
wet sites have:	- less oval-leaved blueberry, lady fern, and leafy liverworts
In the **ESSFwm3**, most sites have:	- less Sitka valerian and oak fern - more false azalea and wood-rushes
dry sites have:	- bear-grass - more Pl
In the **ESSFwm2**, most sites have:	- false azalea - less five-leaved bramble and Sitka valerian
zonal sites have:	- little to no oak fern or Sitka valerian
dry sites have:	- occasional bear-grass - less foamflower and wood-rushes
wet sites have:	- more Canby's lovage and globeflower
In the **ESSFvc**, most sites have:	- Hm - more oval-leaved blueberry and oak fern - less arnica and wood-rushes

Edatopic Grid



Site series

101 Bl – Rhododendron – Oak fern
102 BlPa – Huckleberry – Clad lichen
103 Bl – Rhododendron – Huckleberry – Heron's-bill moss
110 BlSe – Lady fern – Oak fern
111 Bl – Valerian – Foamflower
112 Se – Horsetail – Valerian

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects with exposed bedrock or talus

→
- SMR 1 (2)
- Bl, Se (Pl, Pa) stands
- rock-mosses, clad lichens, and/or haircap mosses present
- bedrock or talus are prominent

→ **102**

DRY to MESIC FORESTS
- mid slopes or compensating conditions
- foamflower or arnica

→
- SMR 2–3
- Bl, Se canopy
- foamflower and/or arnica > 1% cover
- no oak fern or Sitka valerian

→ **103**

→
- SMR 4 (3)
- Se, Bl stands
- oak fern, foamflower, arnica, five-leaved bramble, Sitka valerian with 3–7% cover
- no lady fern

→ **101**

MOIST to WET FORESTS
- level, lower, and toe slopes
- seepage or mottles
- often associated with riparian areas

→
- SMR 5 (4)
- Se, Bl stands
- usually below 1750 m
- oak fern and foamflower (> 10%)
- lady fern, Sitka valerian, and/or false hellebore typically present
- no globeflower, arrow-leaved groundsel, or horsetail

→ **110**

→
- SMR 6 (5)
- Se,Bl stands
- uncommon below 1750 m
- Sitka valerian > 10% cover
- false hellebore, Canby's lovage, globeflower, and/or arrow-leaved groundsel moderate to abundant (> 5%)

→ **111**

→
- SMR 6 (7)
- Se(Bl) stands
- water table at or near the surface
- horsetail, sedges, and/or bluejoint reedgrass present with > 7% each

→ **112**

Vegetation Table

Layer	Scientific name	102	103	101	110	111	112	Common name
Trees	*Picea engelmannii*	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	Engelmann spruce
	Abies lasiocarpa	■■■■	■■■■	■■■■	■■■■	■■■■	■■■	subalpine fir
	Pinus albicaulis	□□						whitebark pine
Regen	*Abies lasiocarpa*	■■■	■■■	■■■	■■■	■■■	■■■	subalpine fir
	Picea engelmannii	■■	□□	□□	■■	■■	■■	Engelmann spruce
	Pinus albicaulis	□□						whitebark pine
Shrubs	*Vaccinium membranaceum*	■■■■	■■■■	■■■■	■■■■	■■■	■■■	black huckleberry
	Rhododendron albiflorum	■■■	■■■■	■■■■■	■■■■	■■■	■■■	white-flowered rhododendron
	Paxistima myrsinites	□	*					falsebox
	Ribes lacustre			*	■■	□□	*	black gooseberry
	Vaccinium ovalifolium			*	*	*	□□□	oval-leaved blueberry
Herbs	*Luzula* spp.	□	■■	□□	□	■■		wood-rushes
	Orthilia secunda	□	□□	*				one-sided wintergreen
	Hieracium albiflorum	□						white hawkweed
	Arnica latifolia	*	□□□	□□□	□□□	■■■	■■	mountain arnica
	Tiarella trifoliata var. *unifoliata*		■■	■■■	■■■■	■■■	□□	one-leaved foamflower
	Rubus pedatus		*	■■■	□□□	*	□□	five-leaved bramble
	Gymnocarpium dryopteris			■■■	■■■■	□□	■■	oak fern
	Valeriana sitchensis			■■■	■■■	■■■■	■■■	Sitka valerian
	"mitreworts"[a]			■■	■■	■■■	■■	mitreworts
	Veratrum viride			■■	■■	■■■	*	false hellebore
	Athyrium filix-femina				■■■			lady fern
	Senecio triangularis					■■■	■■■	arrow-leaved groundsel
	Trollius albiflorus					■■■	■■	globeflower

Layer	Scientific name	102	103	101	110	111	112	Common name
Herbs	*Equisetum* spp.						■■■■	horsetails
	Calamagrostis canadensis						■■■	bluejoint reedgrass
	Erigeron peregrinus						□□	subalpine daisy
	Leptarrhena pyrolifolia						□	leatherleaf saxifrage
	Caltha leptosepala						□	white mountain marsh-marigold
Moss layer	"leafy liverworts"[a]	■■■■	■■■■	□□□	□□□	□□	*	leafy liverworts
	Dicranum spp.	■■■	■■■	■■■	□□			heron's-bill mosses
	Cladonia spp.	■■■	□					clad lichens
	Racomitrium spp.	■■■						rock-mosses
	Rhytidiopsis robusta	□□	□□	□□□	□□			pipecleaner moss
	Polytrichum spp.	□□	*					haircap mosses
	Brachythecium spp.		■■■	■■■	■■■■	■■■■	■■■	ragged-mosses
	"leafy mosses"[a]			□□	■■■	■■■	■■■	leafy mosses
	Aulacomnium palustre						□□□	glow moss
	Philonotis fontana						□□	spring moss

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site series	102	103	101	110	111	112
No. of plots	8	32	37	19	22	9
SMR	1 (2)	2–3	4 (3)	5 (4)	6 (5)	6 (7)
SNR	B (A)	B–C	C (B)	C–D	D (C)	D (C–E)
Slope position	CR, UP	MD (UP)	MD	LW (TO, MD)	TO, LW (LV)	TO, LV
Typical slope/ aspect	Steep (moderate)/ warm; very shallow soils	Steep–moderately steep/warm	Moderate/cool–neutral	Gentle–moderate	Gentle (level)	Gentle to level
Common compensating conditions		Upper slopes/ neutral aspect; lower slopes/ very coarse soils	Lower slopes/ coarse soils; gentle/warm aspects	Mid-slope receiving; coarse-textured toe slopes	Toe slopes; shallow slopes with moisture near the surface	
Surficial materials	Cx/R, Dx	Mb, Cb (Cv, Mv, FG)	Mb (Cb)	Mb, Fb (Cb)	Mb, Fb	Ov, Mb, Fb
Soil texture	SL (variable)	SL	SL (SiL, L)	SiL (SL, FSL, L)	SiL, SiCL (SL, L)	SiL, SiCL
Coarse fragment content	Moderate–fragmental	Moderate–high (fragmental)	Moderate–high	Moderate–high	Moderate–high (variable)	Low–moderate; sometimes increasing with depth
Important features	Exposed (bed) rock is prominent	Subxeric and submesic phases described		Seepage or mottles within 75 cm; usually below 1750 m	Mottles near the surface; seepage common; usually above 1750 m	Water table at or near surface

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

Bl – Rhododendron – Oak fern **101**

General Description

SMR 4 (3). 101 forests typically occur on the **mid-slope** position of **neutral to cool** aspects with **medium-textured soils**, or on lower slopes with warm aspects and/or coarse-textured soils. Soils are typically derived from morainal materials and have sandy loam textures. Where finer parent materials predominate (e.g., areas of the central Selkirk and Monashee Mountains), loam and silt loam textures are more common. Most soils are Orthic Humo-Ferric Podzols or Dystric Brunisols, with Mor humus forms.

Se and **Bl** dominate the tree layers. Herb, shrub, and moss layers are typically moderate to lush, with common shrubs, including **white-flowered rhododendron** and **black huckleberry**, and sparse **black gooseberry**. Typical herbs are **oak fern**, **foamflower**, **Sitka valerian**, **false hellebore**, **five-leaved bramble**, and mountain arnica. Ragged-mosses are usually dominant, with varying amounts of leafy liverworts, heron's-bill mosses, pipecleaner moss, and leafy mosses.

Differentiating from Other Site Series

Drier sites (103) lack oak fern, Sitka valerian, false hellebore, and leafy mosses, while moister sites (110, 111) tend to have lady fern and small amounts of clasping twistedstalk, spiny wood fern, or arrow-leaved groundsel, and occur in receiving sites with seepage at depth. Oak fern commonly occurs as a component of the plant community on 101 sites but is dominant on 110 sites (> 10% cover).

Variability

Oak fern frequency and abundance typically declines with increasing elevation. Five-leaved bramble is most common in the Monashee Mountains. Hw and Cw may occur as scattered saplings or suppressed trees at very low densities in lower, transitional areas of the ESSFwc4.

Management Issues

Snow creep and avalanching can result in damage to regenerating trees on steeper slopes. High cover of ericaceous shrubs can create brush problems for conifer regeneration.

102 BlPa – Huckleberry – Clad lichen

General Description

SMR 1 (2). 102 forests occur on **warm-aspect** sites with shallow soils and **exposed bedrock** or extensive blocky talus. Sites comprise a mixture of moss- and lichen-covered rocks, bare rock, and thin soil veneers. Soil textures vary considerably based on bedrock type. Where granodiorite is the dominant rock type, soils have sandy loam to loamy sand textures; where finer rock types predominate, soils have silt loam or loam textures. The occurrence of this site series is very dependent on soil depth, and often occurs as a mosaic with rock outcrops (Ro) or talus (Rt), particularly on extensive warm-aspect slopes.

Sites are typified by sparse herb cover and moderate cover in the shrub and moss layers. **Se**, **Bl**, and occasionally **Pa** occupy the open overstorey. The shrub layer is dominated by **black huckleberry**, with lesser amounts of white-flowered rhododendron and small amounts of mountain-ash and/or Utah honeysuckle. Pa and Pl regeneration often occurs at low densities. Heron's-bill mosses, **rock-mosses**, and clad lichens are common.

Differentiating from Other Site Series

The 102 is the driest forested site series recognized in the ESSFwc4. Drier sites include non-forested rock outcrops (Ro) and talus slopes (Rt) with < 10% tree cover. Moister sites (103) lack abundant (bed)rock and associated rock-mosses and lichens, and have more abundant herb cover with mountain arnica, foamflower, five-leaved bramble, Sitka valerian, and/or oak fern.

Variability

Sites described in this guide primarily occur on warm to moderately warm aspects; forested rock sites on cool to neutral aspects may have higher moss cover with sporadic occurrence of slightly moister plants such as five-leaved bramble and foamflower. This site series does not include higher-elevation, cool-air influenced La types, which are described by a separate site association (Rt21).

Management Issues

This site series is not recommended for timber harvesting due to limitations in available soil and soil moisture for tree regeneration and growth. These sites may provide habitats for rare and at-risk plant species (e.g., Pa).

Bl – Rhododendron – Huckleberry – Heron's-bill moss 103

General Description

SMR 2–3. 103 forests occur on a range of sites: **warm-aspect mid slopes** with coarse- to moderately coarse-textured soils, **upper slopes** of **neutral to cool aspects**, particularly with coarse soils, and lower slopes with blocky or very coarse-textured soils. Soils typically have sandy loam textures and are derived from morainal or colluvial materials. Coarse fragment content is usually moderate to high but can be fragmental, particularly on cool to neutral and/or lower slopes. Orthic Humo-Ferric Podzols and Dystric Brunisols with Mor humus forms are widespread.

Se and **Bl** dominate the tree layers. Shrub cover is typically high, with abundant **white-flowered rhododendron**, **black huckleberry**, and Bl regeneration. Herb cover is often sparse, with low to moderate cover of **foam-flower**, **mountain arnica**, one-sided wintergreen, five-leaved bramble, and/or wood-rushes. Leafy liverworts, along with heron's-bill, pipecleaner, and ragged-mosses dominate the moss layer.

Differentiating from Other Site Series

Drier sites (102) have exposed bedrock, blocky talus, and/or very shallow veneers over rock; typically have lower abundance and diversity of herbs; and have higher cover of clad lichens and rock-mosses. Moister sites (101) have higher herb diversity and cover, and typically include moderate to high cover of oak fern, Sitka valerian, and/or false hellebore.

Variability

The 103 commonly occurs on moderately steep sites with medium soil texture but is also found on dry, steep slopes with coarse and/or shallow soils. In most other biogeoclimatic units, a separate site series is identified. Users who require additional information for management decisions can refer to site phases as:

> **103a** for sites on shallow and/or coarse soils on steep, warm-aspect slopes (subxeric phase)
>
> **103b** for sites with deeper soils (submesic phase)

Pl can occur in early to mid-seral stands, particularly in the southern half of the ESSFwc4, and falsebox is often more common and abundant on warm aspects.

Management Issues

On steep slopes, avalanching and snowpress are often concerns in winter, while soil erosion can be a concern during the growing season. High cover of ericaceous shrubs can create brush problems for conifer regeneration.

110 BlSe – Lady fern – Oak fern

General Description

SMR 5 (4). 110 forests typically occur on **lower**, **receiving** slopes but occasionally occur on mid-slope receiving sites with seepage, and on coarse-textured toe slopes that receive abundant moisture. **Seepage** usually occurs within **75 cm** of the soil surface. Soils are Gleyed Humo-Ferric Podzols or Gleyed Dystric Brunisols with silt loam or sandy loam textures. Sites are usually associated with riparian areas.

Se and **Bl** dominate the tree layers. **Black huckleberry** and **white-flowered rhododendron** are the dominant shrubs, with lesser amounts of **black gooseberry.** Indicator herbs include **abundant oak fern**, **Sitka valerian**, **foamflower**, and **lady fern**. Ragged-mosses and leafy mosses are the most common bryophytes.

Differentiating from Other Site Series

This site can be differentiated from slightly drier (101) sites by the dominance of oak fern (> 10%), the presence of lady fern, and/or the abundance of moister species such as mitreworts, arrow-leaved groundsel, false hellebore, and black gooseberry. On 101 sites, oak fern is usually a component of the herb layer, in comparison to the 110 site, where it tends to be dominant. Wetter sites have seepage within the top 30–50 cm of the soil profile, less oak fern, lady fern, and black huckleberry, and more arrow-leaved groundsel, globeflower, false hellebore, and Sitka valerian.

Variability

The 110 unit is uncommon above ~1750 m, where oak fern, lady fern, and spiny wood fern occur infrequently.

Management Issues

Competition from herbaceous and shrubby brush can be a serious concern in regenerating stands. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Cold air and frost can limit regeneration success.

Bl – Valerian – Foamflower 111

General Description

SMR 6 (5). 111 forests occur on **toe-slope positions** and **level areas** with **seepage** within the **top 30–50 cm**, or occasionally on gentle mid slopes with seepage near the surface. Soils are usually Gleysols or Gleyed Podzols with fine- to medium-textured silt loam, silty clay loam, loam, or sandy loam textures. These sites most commonly occur on richer sites (SNR D) and are almost always associated with **riparian** (stream or lake) areas.

Se and **Bl** dominate the tree layers. Understorey vegetation usually consists of moderate to sparse shrubs, abundant and lush herbs, and moderate to abundant mosses. Shrub cover is comprised primarily of **black huckleberry** and **white-flowered rhododendron**. **Sitka valerian**, **arrow-leaved groundsel**, **globeflower**, and **false hellebore** are typically abundant. Ragged-mosses and leafy mosses characterize the moss layer.

Differentiating from Other Site Series

Drier sites (110) tend to have seepage and mottles lower in the soil profile, more oak fern and lady fern, and less (or no) arrow-leaved groundsel, globeflower, or Sitka valerian. Wetter sites (112) have seepage or a water table at or just beneath the surface and horsetails, bluejoint reedgrass, spring moss, and glow moss are typically abundant.

Variability

The 111 unit is less common below 1750 m, unless cold air is present.

Management Issues

Competition from herbaceous and shrubby brush is often a concern in regenerating stands. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Cold air and frost can limit regeneration success.

112 Se – Horsetail – Valerian

General Description

SMR 6 (7). 112 sites are uncommon throughout the ESSFwc4. They occur on **level to gentle** sites, usually in **riparian** areas, with thick forest floor (LFH) layers or **organic veneers**, and a **water table** at or just beneath the soil surface. Soils are typically fluvial or lacustrine derived Gleysols but can be Humisols where thicker organic veneers occur.

Se, with lesser amounts of Bl, dominates the tree layers. **Horsetails**, including common (*Equisetum arvense*), meadow (*E. pratense*), and wood (*E. sylvaticum*) typify this site series. Other common species include bluejoint reedgrass, leafy mosses, spring moss, and glow moss, as well as small to moderate amounts of globeflower, arrow-leaved groundsel, oval-leaved blueberry, and occasionally peat-mosses.

Differentiating from Other Site Series

Slightly drier (111) sites lack abundant horsetail and have more arrow-leaved groundsel, globeflower, Sitka valerian, false hellebore, and ragged-mosses. Wetter sites tend to be sparsely treed or non-treed wetlands, primarily fens (Wf) with more abundant peat-mosses, sedges, or cotton-grass, and occasionally swamps (Ws).

Variability

Variability in species composition is high in these very diverse sites. Naturally mounded sites are common, with trees, shrubs, and drier indicator species often on elevated sites, and wetter indicator species such as sedges, wet mosses, horsetails, and leatherleaf saxifrage in depressions where seepage is at or close to the surface. Bluejoint reedgrass can be very abundant, particularly on disturbed or earlier seral sites.

The 112 site series is typically riparian-associated. It is usually a high bench flood site, but can be a treed swamp. Users who require additional information can use phases to reflect this variability:

- **112a** for riparian flood sites
- **112b** for the swamp phase with a thick organic veneer and very poor drainage (Ws08.1) (see Section 6.2)

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and water tables may rise once trees are removed. Where harvesting occurs, competition from herbaceous brush can be a concern in regenerating stands. Cold air and frost can limit regeneration success.

Other Ecosystems

The following ecosystems occur within the ESSFwc4; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

The most common wetland types in the ESSFwc4 are fens (Wf), although marshes (Wm) and swamps (Ws) also occur. Alpine wetlands (Wa) occur on very cold sites. Wetland ecosystems are described in Section 6.2.

Avalanche features

The mountainous terrain and snowy winters of the ESSFwc4 make avalanche features very common. Herb meadow (Vh), shrub thicket (Vs), and treed (Vt) avalanche ecosystems are common in the ESSFwc4. Section 6.5 describes these ecosystems in detail.

Rock outcrops and talus slopes

Several rock outcrop (Ro) and talus (Rt) ecosystems commonly occur, often adjacent to the driest forested ecosystems in the ESSFwc4. Descriptions of rock ecosystems are provided in Section 6.6.

Sitka valerian
Valeriana sitchensis

Hitchcock's wood-rush
Luzula hitchcockii

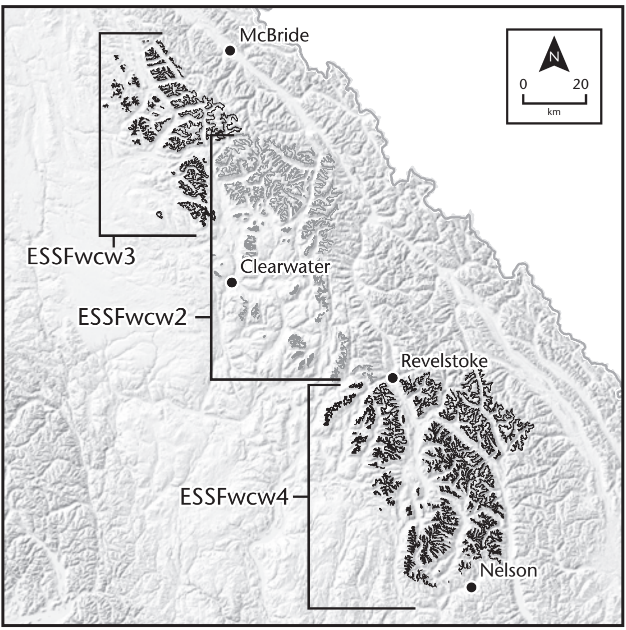
Small-flowered wood-rush
Luzula parviflora

ESSFwcw
Wet Cold Woodland
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwcw occurs throughout the Columbia Mountains at the uppermost forested elevations. Tree cover is consistently present, but productivity is reduced due to high snowpack, cold temperatures, frost, and short growing seasons. The ESSFwcw occurs below the ESSFwcp and above the ESSFwc2, ESSFwc3, ESSFwc4. It is bordered by the ESSFwmw to the southeast, the ESSFdcw to the southwest, and the ESSFvcw and ESSFmmw to the northeast. Although the ESSFwcw is described in this field guide as one biogeoclimatic unit, users who require additional information can separate the ESSFwcw into variants: ESSFwcw2, ESSFwcw3, and ESSFwcw4 (described below). The ESSFwcw4 occurs within the area covered by the remainder of this field guide.

Distribution of the ESSFwcw



Elevation Range

The ESSFwcw elevation range varies broadly with latitude. At its southern extent, above the ESSFwc4, it extends from approximately 1950 to 2150 m. Further north, above the transition between the ESSFwc4 and ESSFwc2, it occurs from 1800 to 2000 m on cool aspects and from 1850 to 2050 m on warm aspects. In the more subdued terrain of the Shuswap Highland, parkland and alpine areas are less common, and the ESSFwcw often extends from approximately 1800 m to mountain tops. In the remainder of the woodland area above the ESSFwc2, elevations range from approximately 1750 or 1800 m to 1950 or 2000 m. The ESSFwcw3 generally occurs above 1800 m in the Cariboo Mountains, and extends to 1900–2000 m; higher upper-elevation limits are common where deep soil occurs on steep slopes. Mapping for the ESSFwcw3 in the northern Cariboo Mountains was still under way when this field guide was written.

Climate[1]

The ESSFwcw is located in the Moist climate subregion and is characterized by cold, wet summers and cold, very wet winters with heavy snow and a very deep snowpack that typically persists from October through June or early July. Snow patches in sheltered areas often last into the summer. Glaciers and persistent snowfields are common. Growing-season moisture deficits are uncommon on all but the driest sites.

Forest and Vegetation Characteristics

Bl is the dominant tree species in the ESSFwcw; Se is usually present at lower densities and is more abundant on mesic and moister sites. Black huckleberry and white-flowered rhododendron are typical in the shrub layer, although cover and presence are variable. The abundance of mountain-heathers, wood-rushes, and/or partridge-foot differentiates the woodland from the wet cold ESSF variants at lower elevations. Leafy liverworts (mostly common [*Barbilophozia lycopodioides*] and mountain [*Neoorthocaulis floerkei*]) and heron's-bill mosses are characteristic in the moderately well-developed moss layer. **Drier sites** usually have variable shrub cover and sparse herb layers. **Submesic sites** are typically mountain-heather dominated, with pink, yellow (*Phyllodoce glanduliflora*), and white mountain-heathers. Herb cover is more diverse on **zonal sites**, with abundant Sitka valerian, mitreworts, and false hellebore most common. On **wetter sites**, herb cover is lush and diverse, with arrow-leaved groundsel, false hellebore, globeflower, and sedges common along with western pasqueflower, subalpine daisy, and paintbrushes.

[1] See Section 4.2 for more information on climate variables.

Because it is a broadly distributed biogeoclimatic unit, there is considerable variation in plant communities across the ESSFwcw. Much of this variability can be described by separating the woodland into variants based on the ESSFwc that occurs below it. At the southern extent of the ESSFwcw in the **ESSFwcw4**, Pa is more common, La may be present, wood-rushes are abundant, and partridge-foot is uncommon. Moving north to the **ESSFwcw2**, Pa occurs with moderate frequency, La is absent, false azalea may be present, and partridge-foot replaces wood-rushes as the characteristic species on sites drier than mesic. In the **ESSFwcw3**, Pa is scattered on dry ridges, mountain sagewort occurs on mesic and drier sites, and crowberry occurs on submesic and drier sites.

The woodland is a transition between productive subalpine forests and non-forested higher-elevation parkland and alpine ecosystems. As a result, higher-elevation non-forested ecosystems are commonly scattered throughout the mostly forested ESSFwcw. The most common ecosystems are small meadows in moist openings (Am), heather-dominated heath (Ah), late snowmelt patches on sheltered cool aspects (As), mixed sedge, dwarf shrub, and forb tundra communities, largely on warmer aspects (At), and krummholz types on drier, cold-air sites (Sk). (see Section 6.7). With high snowfall and steep mountain slopes, avalanche tracks are common (see Section 6.5)

Tree productivity is low across the ESSFwcw. Large-diameter Se are relatively common, especially on mesic and wetter sites, but trees tend to have shorter heights (< 20 m at maturity), higher taper, and lower growth rates than trees at lower elevations in the ESSF.

Disturbance

Old forests are common in the ESSFwcw where long intervals occur between stand-replacing fires. Timber harvesting history is limited. **Small-scale forest gap dynamics** caused by windthrow, insects, and pathogens are the primary stand-replacing processes. Endemic levels of **western balsam bark beetle** are key drivers of regeneration and multi-aged stands. Spruce beetle can occur but tends to have a low impact. White pine blister rust and, more recently, mountain pine beetle have had devastating effects on whitebark pine.

Soils, Geology, and Landforms

The broad distribution of the ESSFwcw covers a wide range of soil, geology, and landform types. Medium- to fine-grained bedrock types, including argillite, quartzite, shale, slate, and limestone, are common in the north and central Selkirk and Purcell Mountains where soils commonly have sandy loam to clay loam surface textures. Coarse-grained intrusive and metamorphic rocks, including gneiss, granites, and granodiorites, are dominant in the central Monashee Mountains, the Shuswap Highland, and at the southern extent of the ESSFwcw in the Selkirk Ranges; soil textures are commonly sandy loam to loamy sand with moderate (20–50%) to high (50–70%) coarse fragment content. Soils derived from medium- to fine-grained bedrock types such as phyllite, schist, mudstone, limestone, and argillite are common in the Quesnel Highland and Cariboo Mountains and have silt loam, loam, and sandy loam textures. Quartzite and basaltic volcanic rocks are scattered throughout the area. Finer-textured soils may be calcareous in areas with limestone bedrock.

Glacial till (morainal) deposits are more common in the Monashee Mountains and Shuswap Highland, while blocky talus deposits are relatively common in the Selkirk and Purcell Mountains. Large areas of exposed bedrock and very shallow soils are common, particularly in the northern Monashee, Selkirk, and Purcell Mountains. In the Quesnel Highland and Cariboo Mountains, morainal materials form the dominant soil parent material. Steep slopes are dominated by colluvium. Thin soils and exposed bedrock are locally common.

Wildlife Habitat

The ESSFwcw provides critical habitat and connectivity for listed **mountain caribou** populations**.** Intact forest stands comprised of large, old trees with high densities of arboreal lichens that are located away from roads and other disturbances are key components of mountain caribou winter range.

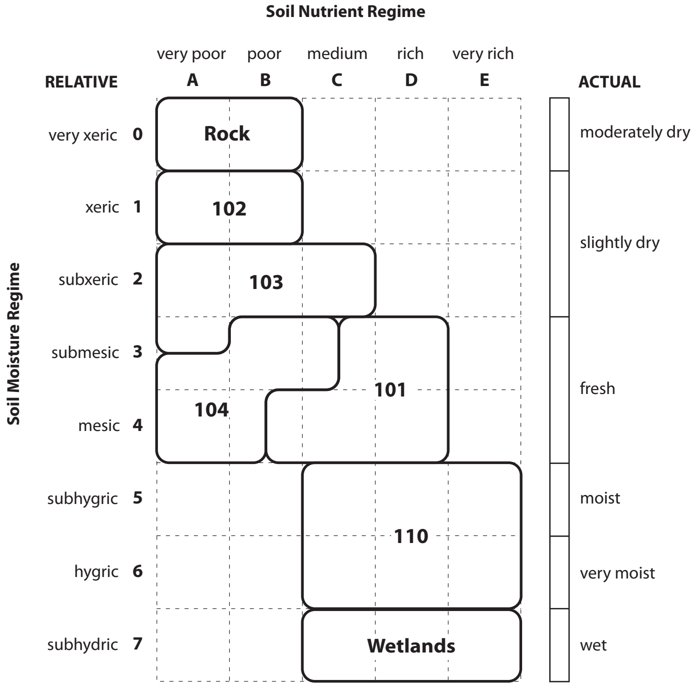
Wide-ranging carnivore species, including **wolverine** and **grizzly bear**, are known to occur in the ESSFwcw. Bears target early seral lush vegetation in spring (most often associated with avalanche tracks and moist meadows) and feed on abundant huckleberries throughout the late summer. **Rocky escape terrain** within the ESSFwcw is important habitat for mountain goats. Small lakes, wetlands, and wet forests in the ESSFwcw provide breeding habitat for other at-risk species, such as **western toad** and **magnum mantleslug**. A diversity of listed vascular and non-vascular plant species associated with subalpine wet forests and wetland/riparian habitats has been confirmed in the ESSFwcw, and **whitebark pine** is scattered on drier sites, especially in the southern part of this unit.

Olive-sided flycatcher (an at-risk species) occurs and is known to breed in the ESSFwcw, along with more common bird species such as varied and hermit thrushes, mountain chickadee, fox sparrow, dark-eyed junco, yellow-rumped warbler, and gray jay.

Distinguishing the ESSFwcw from Adjacent Biogeoclimatic Units

In the **ESSFwc2**, **ESSFwc3,** **ESSFwc4**, most sites have:	- considerably higher tree productivity with fewer natural openings - no mountain-heathers or anemones - no partridge-foot (ESSFwc2 and wc3) or mountain sagewort (ESSFwc3), and less wood-rushes (ESSFwc4)
zonal sites have:	- more Se - oak fern, queen's cup, and/or foamflower (> 1% cover)
wet sites have:	- lady fern and/or oak fern
In the **ESSFwcp**, most sites have:	- patchy tree distribution with many non-forested areas - krummholz trees - more meadows, tundra, and heathlands
In the **ESSFwmw**, most sites have:	- occasional false azalea - less mountain-heather - more wood-rushes
dry sites have:	- more La and Pa
In the **ESSFdcw**, most sites have:	- grouseberry - less mountain-heather
dry sites have:	- more Pa and La
In the **ESSFvcw**, most sites have:	- Hm - less Se - more partridge-foot

Edatopic Grid



Site series

101	Bl – Rhododendron – Valerian
102	BlPa – Huckleberry – Clad lichen
103	Bl – Rhododendron – Wood-rush
104	Bl – Mountain-heather
110	Bl – Valerian – Hellebore – Globeflower

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects
- shallow soils

→
- SMR 1
- Bl (Se, Pa) stands
- exposed bedrock is prominent
- rock-mosses, abundant clad lichens, and/or haircap mosses present

→ **102**

→
- SMR 2 (3)
- Bl (Se) canopy
- steep, warm aspect
- moderately coarse to coarse soils

→ **103**

SLIGHTLY DRY to MESIC FORESTS
- mid slopes (usually) with deep soils

→
- SMR 3 (4)
- Bl, Se (La) stands
- moisture-shedding sites or coarse soils
- abundant mountain-heathers
- wood-rushes (ESSFwcw4) or partridge-foot (ESSFwcw2/wcw3)

→ **104**

→
- SMR 4 (3)
- Bl (Se) stands
- moderate slopes of cool/neutral aspects
- abundant Sitka valerian and mountain arnica

→ **101**

MOIST to WET FORESTS
- level, lower, and toe slopes
- seepage or mottles at depth

→
- SMR 5–6
- Se, Bl stands
- abundant arrow-leaved groundsel, globeflower, paintbrushes, and/or anemones

→ **110**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	Common name
Trees	*Abies lasiocarpa*	■■■■	■■■■	■■■■	■■■■	■■■■	subalpine fir
	Pinus albicaulis	■■■					whitebark pine
	Larix lyallii[a]			□□			subalpine larch
	Picea engelmannii	*	□□□	□□□	■■■	■■■	Engelmann spruce
Regen	*Abies lasiocarpa*	■■■	■■■	■■■■	■■■	■■■	subalpine fir
	Pinus albicaulis	■■					whitebark pine
Shrubs	*Vaccinium membranaceum*	■■■■	■■■■	■■■■	■■■■	□□□	black huckleberry
	Rhododendron albiflorum	■■■■	■■■■■	■■■	■■■■	□□	white-flowered rhododendron
Herbs	*Empetrum nigrum*[b]	□	*				crowberry
	Carex spp.	□					dry sedges
	Cassiope mertensiana	*	□□	■■■■	*		white mountain-heather
	Artemesia norvegica[b]	*	□□	■■■	□□	□□	mountain sagewort
	Luzula spp.		■■■	■■■	■■■	□□	wood-rushes
	Luetkea pectinate[c]		*	■■■	*		partridge-foot
	"mitreworts"[d]		□	□	■■	■■■	mitreworts
	Arnica latifolia		□	□	■■■■	□□□	mountain arnica
	Phyllodoce empetriformis		*	■■■	*	*	pink mountain-heather
	Vahlodea atropurpurea				■■	□□	mountain hairgrass
	Veratrum viride				■■	■■■	false hellebore
	Valeriana sitchensis				■■■■	■■■■	Sitka valerian
	Pedicularis bracteosa				□	□□	bracted lousewort
	Erigeron peregrinus				*	□□	subalpine daisy
	Senecio triangularis					■■■	arrow-leaved groundsel
	Trollius albiflorus					□□□	globeflower
	Carex spp.					□□□	moist sedges[e]
	Parnassia fimbriata					□□	fringed grass-of-Parnassus

Layer	Scientific name	102	103	104	101	110	Common name
Moss layer	"leafy liverworts"[d]	■■■	■■■■	■■■■	■■■■	■■■	leafy liverworts
	Dicranum spp.	■■■	■■■■	■■■■	■■■	□□□	heron's-bill mosses
	Cladonia spp.	■■■	□	□□	□		clad lichens
	Racomitrium spp.	□□					rock-mosses
	Polytrichum spp.	□					haircap mosses
	Brachythecium spp.		*		■■■	□□□	ragged-mosses
	"leafy mosses"[d]					□□□	leafy mosses

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

[a] Primarily in the ESSFwcw4.
[b] Only in the ESSFwcw3.
[c] Primarily in the ESSFwcw2 and ESSFwcw3.
[d] Lists of grouped species are provided in Appendix 1.1.
[e] Mostly showy (*C. spectabilis*) and black alpine sedge (*C. nigricans*).

Environment Table[a]

Site series	102	103	104	101	110
No. of plots	4	32	39	39	12
SMR	1	2 (3)	3 (4)	4 (3)	5–6
SNR	B (A)	B–C (A)	B–C (A)	C (B, D)	C–D (E)
Slope position	UP CR	UP–MD, CR	MD (UP)	MD	LW (TO, MD)
Typical slope/ aspect	Warm/steep (moderate), very shallow soils	Warm/steep–moderately steep	Coarse/cool– neutral mid-slopes	Mid slope/neutral to cool	Lower slopes with moisture at depth
Common compensating conditions		Upper/neutral–cool; coarse crests	Mid-slope/warm aspect, moderately coarse soils	Coarse/lower; gentle/ warm	Perched water tables on mid slopes
Surficial materials	Cx/R, Dx	Cv, Mv (Mb, Cv)	Cb, Mb, Mv	Mb (Cb)	Mb, F (Cb)
Soil texture	SL (variable)	SL (LS, L, SiL)	SiL, L, SL	SiL, L, SL	SiL (L, SL)
Coarse fragment content	High–fragmental	Moderate–fragmental	Moderate (variable)	Moderate (variable)	Variable
Important features	Rock outcrops, blocky talus slopes with trees				Seepage or mottles within 50–75 cm; often associated with riparian areas

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

Bl – Rhododendron – Valerian **101**

General Description

SMR 4 (3). The 101 site series occurs on medium to moderately coarse-textured soils on mid slopes of neutral and cool aspects. Due to compensating factors, this site series is also common on upper slopes with deep soils and lower, receiving slopes with coarse-textured soils.

Bl dominates the tree layers, along with minor amounts of Se. **Black huckleberry** is abundant, while white-flowered rhododendron is typically present. **Mountain arnica** and **Sitka valerian** are abundant and characteristic. Low to moderate cover of mitreworts, wood-rushes, false hellebore, and/or mountain hairgrass is also common. **Ragged-mosses** are usually present along with **leafy liverworts** and heron's-bill mosses.

Differentiating from Other Site Series

Slightly drier sites (104) tend to have abundant mountain-heathers along with partridge-foot (104.2) and/or wood-rushes (104.1), and lack Sitka valerian. Slightly wetter sites (110) typically have higher forb cover, and contain more arrow-leaved groundsel, globeflower, subalpine daisy, false hellebore, and other herb species.

Variability

Wood-rushes are more abundant and dominant in the ESSFwcw4, while partridge-foot often occurs with low cover (< 3%) in the ESSFwcw2. Minor cover of mountain sagewort is common in the ESSFwcw3.

Management Issues

Timber harvesting is not recommended due to high snow cover, short growing seasons, and low tree productivity in regenerating stands. Where harvesting is undertaken, vegetation competition may be a concern. Avalanching and snowpress are likely on steep slopes.

102 BlPa – Huckleberry – Clad lichen

General Description

SMR 1. 102 forests occur on rocky sites with very shallow soils and abundant exposed talus and/or bedrock. Sites are often a complex of very shallow soils and bare (or moss-covered) rock.

Bl is typically dominant; **Pa** is widely distributed and usually occurs as scattered stems. Understorey vegetation varies, but **black huckleberry**, **white-flowered rhododendron**, heron's-bill mosses, **haircap mosses**, **clad lichens**, and **rock-mosses** are usually present. Herbs are very sparse or restricted to small patches of deeper soils among the rocks, and include wood-rushes, mountain-heathers, and very minor amounts of other species.

Differentiating from Other Site Series

The 102 is the driest forested site series recognized in the ESSFwcw. Drier sites include non-forested rock outcrops (Ro) and talus (Rt) slopes with < 10% tree cover in the stand. In areas with extensive cold-air pooling, krummholz (Sk) types can occur (see Section 6.7), particularly where productivity is very low and trees rarely exceed 10 m in height. Slightly moister sites (103) lack abundant (bed)rock at the surface and tend to occur on steep, warm aspects with coarse and/or shallow soils. Moister sites also have more developed herb communities.

Variability

Crowberry may be present in the ESSFwcw3. Plant species vary within sites based on soil depth in small microsites; moister species may occasionally occur in deeper pockets of soil.

Management Issues

This site series is not recommended for timber harvesting due to limitations in available soil for tree regeneration and growth and low tree productivity. These sites may provide habitats for rare and at-risk plant species (e.g., Pa).

Bl – Rhododendron – Wood-rush **103**

General Description

SMR 2 (3). The 103 site series occupies mid to upper, steep, warm slopes with shallow, coarse-textured soils. It also occurs on shallow crests and dry, shedding sites on neutral aspects. Soils are usually well to rapidly drained, with moderate to very high coarse fragment content. They are typically derived from colluvial materials on steep slopes but may be from morainal or glaciofluvial materials, particularly on crests.

Bl is the most common tree species, although Se is often present with low cover. **White-flowered rhododendron** and **black huckleberry** are widespread. Understorey forbs are typically sparse; **wood-rushes** are usually present, often with very small amounts of **arnicas**, mountain-heathers, and, in the northern half of the ESSFwcw, partridge-foot. **Leafy liverworts** and **heron's-bill mosses** dominate the moss layer.

Differentiating from Other Site Series

Slightly drier forested site series (102) are characterized by prominent bedrock or talus. Slightly moister sites (104) have abundant mountain-heathers.

Variability

Herb cover is often low; minor amounts of mountain-heathers may occur (< 3%) along with very low cover (< 1%) of a variety of herb species that are common in the ESSF and/or parkland (e.g., foamflower, valerian, western pasqueflower [*Anemone occidentalis*], grasses).

Management Issues

Timber harvesting is not recommended due to high snow cover, short growing seasons, and low tree productivity in regenerating stands. Where harvesting is undertaken, vegetation competition may be a concern. Avalanching and snowpress are likely on steep slopes.

104 Bl – Mountain-heather

General Description

SMR 3 (4). 104 forests occur on submesic sites, including those on shedding, cool to neutral sites with deep, coarse soils, and on gentle to moderate mid slopes of warm aspects. Soils are usually deep, well to rapidly drained, with moderately high to fragmental coarse fragment content and Mor humus forms. Orthic Humo-Ferric Podzols with sandy loam to silt loam textures are typical, depending on the parent materials.

Bl dominates the tree canopy. Se is usually present but with minor cover. **Black huckleberry** is usually abundant in the shrub layer, while white-flowered rhododendron cover is typically sparse to low. In the herb layer, **white mountain-heather** is abundant and **wood-rushes** are typically present in small to moderate amounts. Where the ESSFwcw occurs above the ESSFwc2 or wc3, **partridge-foot** is also common with high cover. Above the ESSFwc3, **mountain sagewort** often occurs. Moss cover is usually high and is dominated by **leafy liverworts** and **heron's-bill mosses**.

Differentiating from Other Site Series

Slightly drier sites (103) occur on warmer aspects and have little to no mountain-heathers, while slightly moister sites (101) have more diverse and abundant herbs, including more mountain arnica and Sitka valerian.

Variability

104 sites are most common on cool and neutral aspects where snow accumulation is high, but can occur on gentle to moderate warm aspects. White mountain-heather is consistently present, but pink mountain-heather cover is variable. Hitchcock's wood-rush (*Luzula hitchcockii*) is more common at the southern extent of the ESSFwcw, while small-flowered wood-rush (*L. parviflora)* is typical in the northern two-thirds. The 104 has been split into three variations for users who require additional information:

104.1 Bl – Mountain-heather – Wood-rush
with abundant wood-rushes and little to no partridge-foot
104.2 Bl – Mountain-heather – Partridge-foot
with abundant partridge-foot
104.3 Bl – Mountain-heather – Mountain sagewort
with abundant mountain sagewort; often with partridge-foot

Management Issues

Timber harvesting is not recommended due to high snow cover, short growing season, and low tree productivity in regenerating stands. Avalanching and snowpress are often concerns on steep slopes.

Bl – Valerian – Hellebore – Globeflower 110

General Description

SMR 5-6. 110 sites occur on **lower and toe slopes**, along **riparian areas**, and on **moisture-receiving sites**, including slight **depressions** and **level areas** adjacent to lakes, ponds, and wetlands. **Mottles** or **seepage** are usually present within **50 cm** of the soil surface. Soils are often Gleyed Humo-Ferric Podzols. Soil textures are variable, ranging from silt loam to sandy loam.

Bl and **Se** are common in the overstorey, with **arrow-leaved groundsel**, **Sitka valerian**, and/or false hellebore dominating the understorey. White-flowered rhododendron, black huckleberry, **bracted lousewort**, arnicas, **sedges** (mostly showy sedge and black alpine sedge), and miterworts are also common, along with variable cover of western pasqueflower, subalpine daisy, and paintbrushes (*Castilleja* spp.). **Ragged-mosses, leafy liverworts**, heron's-bill mosses, and **leafy mosses** are common in the moss layer.

Differentiating from Other Site Series

Slightly drier sites (101) lack seepage and have less herb cover and diversity, with less **arrow-leaved groundsel** and other forbs. Wetter sites tend to support non-forested wetland (Wf or Wa) or subalpine meadow (Am) communities.

Variability

Mountain sagewort (ESSFwcw3) and partridge-foot (ESSFwcw2) may be present. Herbaceous species diversity can be high, with a number of sedge species, rushes (*Juncus* spp.), and typical ESSF moist species, such as globeflower, willowherbs (*Epillobium* spp.), leatherleaf saxifrage (*Leptarrhena pyrolifolia*), and/or subalpine buttercup (*Ranunculus eschscholtzii*).

Management Issues

Timber harvesting is not recommended due to high snow cover, short growing season, cold-air drainage, frost pockets, and low tree productivity in regenerating stands. Where harvesting is undertaken, vegetation competition may be a serious concern. Due to moist soils, compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed.

Other Ecosystems

The following ecosystems occur within the ESSFwcw; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

In upper-elevation climates, the most common wetland types are fens (Wf), alpine wetlands (Wa), and swamps (Ws). Wetlands are described in Section 6.2.

Avalanche features

Due to the mountainous terrain and high snowpack of the ESSFwcw, avalanche features are very common, including herb meadow (Vh), shrub thicket (Vs), and treed (Vt) avalanche ecosystems. Section 6.5 describes avalanche ecosystems.

Rock outcrops and talus slopes

Rock outcrop (Ro) and talus (Rt) ecosystems are common in the ESSFwcw and frequently occur in complexes with the driest forested ecosystems. Detailed descriptions are provided in Section 6.6.

Subalpine shrub ecosystems

The Subalpine Shrub group includes two classes: krummholz (Sk) and shrub carr/shrubland (Sc) ecosystems. Although more common in the parkland, a number of krummholz ecosystem types with short, stunted tree growth commonly occur in the woodland, particularly in areas with cold air, including cool, north-facing basins and areas near high-elevation lakes. Classification of these units is currently in progress.

Shrub carr ecosystems (Sc), as described in *Wetlands of British Columbia* (MacKenzie and Moran 2004), occur on sites with moist, cold mineral soils that are prone to cold air and frost. Shrublands (also Sc) occur on drier sites and include black huckleberry and white-flowered rhododendron shrub fields. An overview of subalpine shrub ecosystems is included with other high-elevation ecosystems in Section 6.7.

Alpine ecosystems

In areas of cold air and/or subdued terrain, the woodland contains non-forested ecosystems that more commonly occur in the alpine and parkland. These include meadow (Am), tundra (At), and health (Ah) as well as late snowmelt (As) and fellfield (Af) ecosystems. Classification of these units is currently in progress. Section 6.7 provides an overview of high-elevation ecosystems, including the Alpine group and classes.

ESSFwh2
Saint Mary Wet Hot
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwh2 occurs as a transition between the ICH and ESSF in the central Purcell Mountains. On the west side, it occupies mid elevations in all of the creek valleys that flow into Kootenay Lake between Akokli and Howser Creeks, and occurs above the ICHmw2 except in isolated areas in Crawford and Glacier Creeks where it occurs above the ICHwk1. In the eastern Purcell Mountains, it occurs in the St. Mary, Dewar, White, Redding, and Meachen Valleys, where it is found above the ICHdm; in the St. Mary West Fork it occurs above the ICHmw2. Throughout its range, the ESSFwh2 occurs below the ESSFwm2. To the south, it is replaced by the ESSFwm4, and to the north by the ESSFwh1. Small areas of ESSFwh2 occur at the upper reaches of Jumbo, Toby, Dutch, and Findlay Creeks between the ESSFwm2 and MSdk.

Distribution of the ESSFwh2

Elevation Range

The ESSFwh2 typically forms a 150–200 m band between 1500 and 1700 m elevation on cool aspects, 1575 and 1750 m on neutral aspects, and 1650 and 1825 m on warm aspects. At the northern extent of its range (north of Carney Creek), the ESSFwh2 occurs approximately 100–150 m lower, at both its lower and upper extents. The ESSFwh2 occurs in the valley bottoms in the upper reaches of most drainages, often at lower than typical elevations due to the influence of cool air. In these areas, elevations drop to as low as 1350 m, with the ESSFwh2 covering an elevation band as wide as 300–400 m.

Climate[1]

The ESSFwh2 is located in the Moist climate subregion and is characterized by cool to warm, moist summers and cool, moist winters with moderate to heavy snowfall and a deep snowpack that typically persists from November through to April or early May. Rain-on-snow events occur most years but are infrequent within a given winter. The ESSFwh2 is slightly drier than the ESSFwh1 and ESSFwh3. Growing-season moisture deficits occur on subxeric and drier sites and may occur on submesic sites in dry, hot summers.

Forest and Vegetation Characteristics

The ESSFwh2 is a highly productive ICH–ESSF transition. Se, Hw, and Bl are common on **zonal sites**, along with sparse to moderate cover of false azalea, white-flowered rhododendron, black huckleberry, foamflower, five-leaved bramble, and queen's cup, and small to moderate amounts of oak fern. Fd, Lw, Pl, and Hw commonly occur with Bl and Se on **submesic and drier sites**, where falsebox and huckleberry are common. **Moist to wet sites** often contain mixtures of Se and Bl with occasionally abundant Hw and varying amounts of Cw, particularly in the understorey. Throughout the ESSFwh2, species more common to the ICH, such as foamflower, oak fern, and queen's cup, mix with ESSF species, such as arrow-leaved groundsel, Canby's lovage, mitreworts, and false hellebore. Dense Sitka alder (*Alnus viridis* ssp. *sinuata*) often grows along roadsides.

Although a mixture of Se, Bl, and typical ICH species characterize the ESSFwh2, stands of almost pure Hw or Hw and Cw occasionally occur within a landscape matrix otherwise dominated by typical ESSF tree species. Cw and Hw are more common as codominants of stands in the lower portions of the ESSFwh2, and are often restricted to the shrub and suppressed tree layer at higher elevations, closer to the ESSFwm2. Hw is also less abundant at the eastern extent of the ESSFwh2. While the presence of Cw, Hw, Lw, and Fd differentiate the ESSFwh2 from the ESSFwm2, stands of pure Se and Bl also frequently occur in the ESSFwh2.

[1] See Section 4.2 for more information on climate variables.

Disturbance

Old forests are relatively common in the ESSFwh2 where stand-replacing disturbances are infrequent. **Fires** are the dominant stand-replacing natural disturbance in the ESSFwh2, but **gap dynamics** caused by windthrow, insects, and pathogens are a widespread influence. Mixed-severity burns are uncommon and are usually limited to warm-aspect sites on slopes that extend to lower elevations; large Fd, Lw, and Cw are commonly found as legacies from previous fires.

Where Pl is abundant, such as extensive warm-aspect slopes along the north and south arms of Kootenay Lake and in the St. Mary drainages, **mountain pine beetle** has created large disturbances. Gall rusts also affect growth of Pl. Endemic levels of western balsam bark beetle can create small openings that drive regeneration and multi-aged stands. Spruce bark beetles are known to inflict high mortality on isolated stands, particularly following fire or blowdown, or where slash retention is high after harvest, while Douglas-fir bark beetles can cause high mortality on dry, warm-aspect sites where Fd is abundant. **Armillaria root rot** also creates small gaps in mature stands and can be a major impediment to regeneration of all species, particularly Fd, Lw, and Hw.

The combination of deep snowpacks and steep terrain results in widespread avalanche tracks and a high risk of snowpress on regenerating stands on steep slopes.

Soils, Geology, and Landforms

The Purcell Mountains originally formed as the western coast of North America in the Mesoproterozoic eon (up to 1.5 billion years ago). Continental drift and subsequent metamorphic processes have created complex geological history in this area. Common bedrock types in the ESSFwh2 include quartzite, sandstone, argillite, conglomerate, and granodiorites with interspersed mudstone, siltstone, shale, limestone, marble, and calcareous sedimentary rocks. Colluvium and morainal materials are most common. Soils on colluvium and morainal material are derived primarily from fine- to medium-grained bedrock and have loam or silt loam to sandy loam textures. Fluvial fans, floodplains, and glaciolacustrine deposits are uncommon.

Wildlife Habitat

The ESSFwh2 provides important wildlife habitat within and adjacent to the regionally important and remote Purcell Wilderness Conservancy Provincial Park, one of the largest intact ecosystems in southeastern British Columbia. The unit also provides wildlife habitat connectivity south to Kianuko

Provincial Park. Key wildlife species include wide-ranging carnivores such as **grizzly bear** and **wolverine**, as well as **Rocky Mountain elk**, **mule deer**, **white-tailed deer**, **moose**, and **mountain goat**. **Mountain caribou** winter range and management areas are located on the west slope of the Purcell Mountains in the upper reaches of Tam O'Shanter Creek south to Sanca Creek, and on the east slope of the Purcells in the upper Skookumchuck Creek and St. Mary River drainages.

The ESSFwh2 has high habitat potential for **wolverine**, and key habitats for **mountain goat** occur near steep, rocky escape terrain. **Grizzly bears** forage in vegetated avalanche chutes during spring and on abundant huckleberries throughout the summer. Small lakes and wetlands are common within this unit and provide breeding habitat for at-risk **western toad**. The at-risk **vivid dancer dragonfly** breeds in association with springs or streams in this unit.

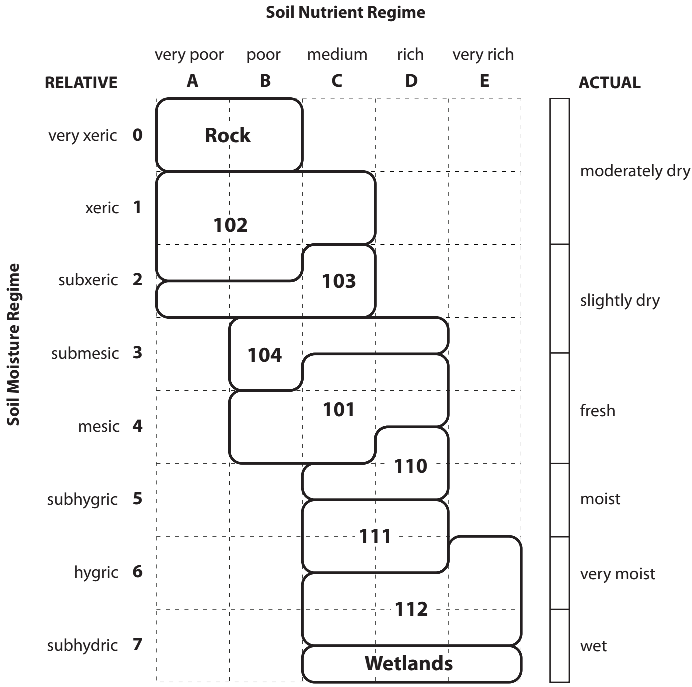
The ESSFwh2 contains **remnant sites with significant old growth** and associated habitat characteristics that are important to **small mammals**, **cavity-nesting birds**, and **furbearers**. Retaining large patches with veteran and large wildlife trees (with cavities/hollows, broken tops, large dead limbs), downed hollow logs, coarse woody debris, and large root balls is vital to sustaining old-growth–dependent species in managed stands.

Small twistedstalk
Streptopus streptopoides

Distinguishing the ESSFwh2 from Adjacent Biogeoclimatic Units

In the **ESSFwm2**, most sites have:	- no Cw, Hw, Fd, or Lw - more white-flowered rhododendron
zonal sites have:	- more arnica, wood-rushes, false hellebore, Sitka valerian, and/or mitreworts
dry sites have:	- less herbaceous species diversity; more shrub cover
wet sites have:	- more Canby's lovage, arrow-leaved groundsel, globeflower, false hellebore, and Sitka valerian
In the **ESSFwm4**, most sites have:	- more false azalea - more grouseberry/low bilberry
zonal sites have:	- more arnica, ragged-moss - less queen's cup, foamflower
dry sites have:	- considerably more Pl, grouseberry/low bilberry, bear-grass
wet sites have:	- less oak fern, lady fern, devil's club, five-leaved bramble
In the **ICHdm**, most sites have:	- Fd, Lw, Cw, Hw, Pw, Bg dominant in the overstorey - less Sxw and Bl - no white-flowered rhododendron; less false azalea and black huckleberry
zonal sites have:	- more Fd, Lw, Cw, Hw, Pl, and yew - no oak fern or five-leaved bramble
dry sites have:	- pinegrass, Oregon-grape, and/or snowberry - little to no Sxw or Bl
wet sites have:	- no false hellebore or Sitka valerian
In the **ICHmw2**, most sites have:	- Fd, Lw, Cw, Hw, Pw dominant in the overstorey - considerably less Sxw and Bl - no white-flowered rhododendron or false azalea (except on sites with cold-air influence)
zonal sites have:	- little to no oak fern; more twinflower and/or bunchberry
dry sites have:	- pinegrass, Oregon-grape, saskatoon, birch-leaved spirea, soopolallie, and/or snowberry - little to no Sxw or Bl
wet sites have:	- more devil's club - no false hellebore or Canby's lovage (except cold-air sites)

Edatopic Grid



Site series

101	BlHw – Rhododendron – Foamflower
102	Bl – Huckleberry – Rock-moss
103	Bl – Huckleberry – Falsebox
104	BlHw – Huckleberry – Pipecleaner moss
110	BlSe – Azalea – Oak fern
111	Se – Devil's club – Lady fern
112	SeBl – Horsetail – Canby's lovage

Site Series Flowchart

VERY DRY to DRY FORESTS

- warm aspects
- shallow soils

→
- SMR 1 (2)
- Bl (Se, Pl, Pa) stands
- exposed (bed)rock is prominent
- stonecrops, round-leaved alumroot, juniper, and/or rock ferns
- rock-mosses, clad lichens, and/or haircap mosses

→ **102**

→
- SMR 2
- Pl, Fd, Bl, Se, (Lw) canopy
- steep, warm aspect; shallow and/or coarse soils
- abundant black huckleberry and falsebox
- little to no rhododendron or false azalea

→ **103**

SLIGHTLY DRY to MESIC FORESTS

- mid slopes (usually) with deep soils
- rhododendron, black huckleberry, and pipecleaner moss

→
- SMR 3
- Bl, Se, Hw stands
- no oak fern, twistedstalk, or five-leaved bramble
- sparse foamflower (< 1%)

→ **104**

→
- SMR 4 (3)
- Se, Bl, Hw (Cw) stands
- abundant foamflower and queen's cup; twistedstalks present
- < 7% oak fern

→ **101**

MOIST to WET FORESTS

- level, lower, and toe slopes
- seepage or mottles
- often associated with riparian areas

→
- SMR 5 (4)
- Se, Bl (Hw, Cw) stands
- oak fern > 10% cover
- abundant foamflower, five-leaved bramble, spiny wood fern, and/or queen's cup
- lady fern and/or devil's club < 3%

→ **110**

→
- SMR 5 (6)
- Se, Bl stands
- seepage or mottles within top 30–50 cm
- abundant devil's club, thimbleberry, lady fern, and/or spiny wood fern

→ **111**

→
- SMR 6 (7)
- Se, Bl
- horsetails abundant (> 10%)
- arrow-leaved groundsel, Canby's lovage, and/or bluejoint > 3% each

→ **112**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Trees	*Pinus albicaulis*	□□□							whitebark pine
	Picea engelmannii	■■■	■■■	■■■■	■■■■	■■■■	■■■■	■■■■	Engelmann spruce
	Abies lasiocarpa	■■	□□□	■■■■	■■■	■■■	■■■	■■■	subalpine fir
	Pinus contorta	□□	□□□□						lodgepole pine
	Tsuga heterophylla	*	*	□□□□	□□□□	*			western hemlock
	Pseudotsuga menziesii		□□						Douglas-fir
Regen	*Abies lasiocarpa*	■■■	■■■	■■■	■■■	■■■	■■	■■■	subalpine fir
	Tsuga heterophylla	□□	*	■■■	□□□	*	*	*	western hemlock
	Pinus albicaulis	□□							whitebark pine
	Picea engelmannii	□	*	*	□	*	■■	■■	Engelmann spruce
	Thuja plicata			□□	*	*	□□		western redcedar
Shrubs	*Menziesia ferruginea*	□□□	□□	■■■	■■■	■■■■	■■■	■■■	false azalea
	Vaccinium membranaceum	■■■	■■■■	■■■■	■■■■	■■■	■■	■■	black huckleberry
	Paxistima myrsinites	□□□	■■■	□□	*				falsebox
	Rhododendron albiflorum	□□	□□□	■■■	■■■	□□□			white-flowered rhododendron
	Spiraea betulifolia	□□	□						birch-leaved spirea
	Juniperus communis	□□							common juniper
	Shepherdia canadensis	□□							soopolallie
	Ribes lacustre				□	□□	■	■■	black gooseberry
	Oplopanax horridus						■■■■		devil's club
	Rubus parviflorus						■■■		thimbleberry
	Lonicera involucrata							■■	black twinberry
Herbs	*Hieracium albiflorum*	□	□□						white hawkweed
	Vaccinium scoparium/ myrtillus	□	*						grouseberry/low bilberry
	Heuchera cylindrica	□							round-leaved alumroot
	Sedum spp.	□							stonecrops

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Herbs	*Chimaphila umbellata*		□						prince's pine
	Orthilia secunda		□□	■■	■■				one-sided wintergreen
	Clintonia uniflora			■■	■■■	■■■	■■■	□	queen's cup
	Tiarella trifoliata var. *unifoliata*			□	■■■	■■■■	■■■	■■■	one-leaved foamflower
	Rubus pedatus				■■■	□□□	□□	■■■	five-leaved bramble
	Gymnocarpium dryopteris				■■	■■■■■	■■■■	□□□	oak fern
	Streptopus streptopoides				□□				small twistedstalk
	Streptopus amplexifolius				□	■	■■	■■	clasping twistedstalk
	Dryopteris expansa					■■■	■■■	*	spiny wood fern
	Pectiantia brewerii					■	■■	■	Brewer's mitrewort
	Veratrum viride					□□	■■■	■	false hellebore
	Athyrium filix-femina					□	■■■	■■	lady fern
	Senecio triangularis							■■■	arrow-leaved groundsel
	Calamagrostis canadensis							■■■	bluejoint reedgrass
	Equisetum spp.							■■■■■	horsetails
	Ligusticum canbyi							■■	Canby's lovage
Moss layer	*Dicranum* spp.	□□□□	□□□	■■■	■■■	□□			heron's-bill mosses
	"leafy liverworts"[a]	□□□□	*	■■	■■■	*	□	□□□	leafy liverworts
	Polytrichum spp.	□□□							haircap mosses
	Racomitrium spp.	□□□							rock-mosses
	Pleurozium schreberi	□□		*	■■■	*	*	*	red-stemmed feathermoss
	Cladonia spp.	■■	□						clad lichens
	Rhytidiopsis robusta		■■■	■■■■	■■■	□□□	*		pipecleaner moss
	Brachythecium spp.		□□□	*	■■■	■■■	■■■	□□	ragged-mosses
	"leafy mosses"[a]					■■■	■■■	■■■	leafy mosses
	Sphagnum spp.							■■■	peat-mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site series	102	103	104	101	110	111	112
No. of plots	2	8	16	20	19	7	7
SMR	1 (2)	2	3	4 (3)	5 (4)	5 (6)	6 (7)
SNR	A–B	B–C	C (B)	C (B, D)	C–D	C–D	D (C, E)
Slope position	UP, CR	MD–UP (CR)	MD (LW, UP)	MD (LW)	LW (MD)	LW (MD, TO)	TO, LV
Typical slope/ aspect	Steep–moderately steep/warm	Steep/warm	Moderate/ warm	Moderate/ neutral (cool)	Gentle/cool (warm)	Gentle–moderate	Gentle–level
Common compensating conditions		Shallow crests; neutral aspects with high sun exposure	Upper/cool; shallow, coarse/ neutral	Lower/coarse; gentle/warm	Mid-slope receiving	Mid-slope receiving; moderately coarse toe slopes	
Surficial materials	Cx/R, Mx/R, Dx	Cv, Cb (Mv)	Mb (C)	Mb (Cb)	Mb, Cb (F)	Mb (Fb, Cb)	Fb (Ov, Lb)
Soil texture	SL, FSL, SiL	SL	SL (L, SiL)	SiL, FSL, SL, L	SiL, L, SL	L, SiL, SL, (FSL, SiCL)	FSL, SiL, CL, SL, L
Coarse fragment content	High–fragmental	Moderately high–high	Moderate–high	Moderate–high	Moderate–moderately high	Moderately high–high	Low
Important features	(Bed)rock is prominent and abundant	Insolation			Mottles at depth	Seepage or mottles 30–50 cm from surface	Water table near surface; can have thin organic veneers; cold air is common

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

BlHw – Rhododendron – Foamflower 101

General Description

SMR 4 (3). 101 forests typically occur on **mid slopes** of **neutral to cool aspects**. Due to compensating factors, this site series also occurs on lower slopes of warm aspects with extensive shading from adjacent mountains or with coarse soils. Soils are typically Humo-Ferric Podzols or Dystric Brunisols with Hemimor humus forms, and are well- to moderately well-drained with silt loam, fine sandy loam, or sandy loam soil textures.

Se, **Bl**, **Hw**, and occasionally **Cw** are the dominant tree species in both the overstorey and understorey. **White-flowered rhododendron**, **black huckleberry**, and **false azalea** comprise most of the shrub layer. Herb layers are often variable in cover, with considerable **foamflower**, **five-leaved bramble**, and **queen's cup** and frequent low cover of **oak fern** (< 5% cover). **Pipecleaner moss** typically occurs with moderate amounts of ragged-mosses, heron's-bill mosses, leafy liverworts, and red-stemmed feathermoss.

Differentiating from Other Site Series

Slightly drier sites (104) tend to have sparse herb cover, and lack five-leaved bramble, oak fern, twistedstalks, and (usually) foamflower. Slightly wetter sites typically have higher oak fern cover (> 10%) and contain false hellebore, mitreworts, lady fern, spiny wood fern, and/or leafy mosses (mostly *Rhizomnium* spp.). Wetter sites are moisture-receiving, with seepage indicated by mottles at depth.

Variability

Hw cover can be highly variable, and typically ranges from scattered in the understorey (typically at higher elevations) to codominant in the overstorey (especially at lower elevations). Old-growth Hw-leading stands can occur within the ESSFwh2. These stands look very similar to ICH forests but occur within a landscape matrix that otherwise resembles the ESSFwh2 with abundant Se, Bl, and/or white-flowered rhododendron. Although it may seem odd to have Hw forests in the ESSF, these old-growth forests may have initiated under different climatic conditions or disturbance histories and may not regenerate to Hw if harvested or burned.

Management Issues

These sites have high productivity for the ESSF and few limiting factors for tree growth. Sites are amenable to the growth of a wide variety of species, and species diversity should be fostered. Brush competition can be a concern in regenerating stands. Snow creep and avalanching can result in damage to regenerating trees on steeper slopes.

102 Bl – Huckleberry – Rock-moss

General Description

SMR 1 (2). 102 forests occur on warm-aspect sites with **abundant bedrock or talus** where total tree cover is 10% or greater in the overstorey. Soils are variable but shallow within any given stand, and comprise a mixture of bare rock and thin veneers. Soil textures vary considerably based on parent materials. Where granodiorites are the dominant rock type, soils are typically sandy loams; where finer rock types predominate, soils have silty loam or clay loam textures. The occurrence of this site series is very dependent on soil depth and often occurs as a mosaic with rock outcrops and the 103 site series in areas of variable soil depth.

Tree cover is typically comprised of **sparse Bl** and **Se**; **Pa** can be common, along with Hw and Pl. Huckleberry and falsebox are common shrubs, along with occasional dry-site species such as **junipers**. Herbs are usually sparse, with small amounts of white hawkweed, **stonecrops**, and saxifrages (*Saxifraga* spp.). Mosses are abundant, particularly heron's-bill mosses, **rock-mosses**, and haircap mosses, as well as **leafy liverworts** and **clad lichens**.

Differentiating from Other Site Series

The 102 is the driest forested site series recognized in the ESSFwh2. Drier sites include non-forested rock outcrops (Ro) and talus (Rt) slopes with < 10% tree cover in the stand. Slightly moister sites (103) lack abundant (bed)rock at the surface and tend to occur on steep, warm aspects with coarse and/or shallow soils. Moister sites also have small amounts of one-sided wintergreen, violets (*Viola* spp.), and/or prince's pine, more pipe-cleaner moss and ragged-mosses, and less haircap mosses, rock-mosses, and clad lichens.

Variability

Plant species vary within sites based on soil depth in small microsites; occasionally, moister species may occur in deeper pockets of soil. Cw and Hw may occur but typically in the B layer or as trees with stunted growth. White-flowered rhododendron is often absent on these very dry sites.

Management Issues

This site series is not recommended for timber harvesting due to limitations in available soil and soil moisture for tree regeneration and growth.

Bl – Huckleberry – Falsebox 103

General Description

SMR 2. 103 forests occur on **steep, warm, mid to upper slopes** with **shallow or coarse-textured soils** and on shallow crests with high solar insolation. Soils are usually derived from colluvial deposits due to steep slopes but may be morainal or glaciofluvial, particularly on crests. Dystric Brunisols are common.

Fd and **Pl** are often dominant or codominant with Se, Bl, and **Lw**. Bl is abundant in the regeneration layer. White-flowered rhododendron and false azalea are often sparse or absent, with **black huckleberry**, **falsebox**, Utah honeysuckle (*Lonicera utahensis*), and small amounts of birch-leaved spirea dominating the shrub layer. Understorey herb cover is typically sparse, with small amounts of prince's pine, white hawkweed, *Arnica* species, and one-sided wintergreen. Mosses are variable, with pipecleaner moss, ragged-mosses, and/or heron's-bill mosses most common.

Differentiating from Other Site Series

Slightly drier forested site series (102) are characterized by prominent bedrock or talus and abundant rock-mosses. Slightly moister sites (104) occur where soils are deeper, and on less steep slopes and/or cooler aspects. Submesic and mesic sites typically have more Hw, have little to no Fd or Lw, and contain queen's cup, foamflower, and/or five-leaved bramble.

These stands often resemble forests on similar sites in the ICH (e.g., ICHmw2/103). Although both stand types are Fd, Lw, and Pl dominated, ICH sites have higher cover of Douglas maple, birch-leaved spirea, and pinegrass, and lack Bl and Se. Fd is typical in the understorey of similar sites in the ICH but is usually replaced by Bl in the ESSFwh2.

Variability

Amounts of Fd, Lw, and Pl vary. Earlier seral stands often have more Pl. Bear-grass occurs from the southern to the northern extent of the ESSFwh2 but is inconsistently present in this site series. Black huckleberry cover is usually high (> 25%) but declines in stands with denser tree cover.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered. Where Pl is abundant, mountain pine beetle susceptibility is exacerbated by droughty conditions. Regeneration issues may be encountered due to growing-season moisture deficits. Snow creep and avalanching may cause damage to regeneration on steep slopes in winter, while soil erosion can be a concern on steep slopes during the growing season.

104 BlHw – Huckleberry – Pipecleaner moss

General Description

SMR 3. 104 forests typically occur on moderately steep slopes on the **mid-slope position of warm aspects** with medium-textured, deep soils. Due to compensating factors, these sites also occur on shallow neutral or cool aspects and lower slopes with coarse-textured soils. Soils are typically moderately well-drained Orthic Humo-Ferric Podzols or Eluviated Dystric Brunisols with silt loam to sandy loam textures. Coarse fragment content is typically moderate to high.

Se, **Bl**, and **Hw** dominate the tree layer, with abundant Bl, sparse Se, and variable Hw and Cw in the regeneration layer. **White-flowered rhododendron**, **black huckleberry**, and **false azalea** are the primary shrubs, with lesser amounts of falsebox and Utah honeysuckle. Herb cover is varied but usually low, with small amounts of queen's cup, one-sided wintergreen, foamflower, violets, and rattlesnake-plantain (*Goodyera oblongifolia*). Mosses vary, with pipecleaner moss typically abundant along with heron's-bill mosses and minor amounts of leafy liverworts.

Differentiating from Other Site Series

Slightly drier sites tend to have more Fd, Lw, and Pl. White-flowered rhododendron and false azalea are also less common and abundant, while queen's cup and foamflower are typically absent or very sparse on drier sites. Slightly moister sites (101) have more queen's cup, foamflower, five-leaved bramble, and/or oak fern.

Variability

White-flowered rhododendron may be sparse or absent at lower elevations where the ESSFwh2 transitions to the ICH. Black huckleberry can range from dominant (> 30% cover) to sparse but is usually present. Hw is usually present and can also range from dominant to sparse. Sites with high cover of Hw can have very sparse understorey species cover. Old-growth stands of almost pure Hw, with minor cover of white-flowered rhododendron, Cw, Se, and Bl, occasionally occur within the ESSFwh2. These forests have many ICH characteristics but fit with the ESSFwh2 where they occur in a landscape matrix with abundant Se and Bl.

Management Issues

This site series has high productivity for the ESSF and few limiting factors for tree growth. It is amenable to the growth of a wide variety of species, and species diversity should be fostered. Snow creep and avalanching may cause damage to regeneration on steeper slopes.

BlSe – Azalea – Oak fern **110**

General Description

SMR 5 (4). 110 forests typically occur on **receiving sites on lower slopes** where seepage is present either seasonally or at depth. Mottles are usually present within the top 50–75 cm. Soils are often Gleyed Dystric Brunisols or Humo-Ferric Podzols, although Sombric and Eutric Brunisols also occur. Soil textures are variable, ranging from silt loam to sandy loam. Humus forms are primarily Hemimors and Mormoders. Sites are often adjacent to or associated with **riparian** features.

Se, **Bl**, and often **Hw** and/or **Cw** are typical in the overstorey and regeneration layers. **False azalea** and black huckleberry are the dominant shrubs, along with variable white-flowered rhododendron and **black gooseberry**. The herb layer is typically rich and diverse with **oak fern**, **spiny wood fern**, **foamflower**, and queen's cup consistently present. Five-leaved bramble, false hellebore, Brewer's mitrewort, clasping twistedstalk, and minor amounts of lady fern (< 3%) are common. **Leafy mosses** (primarily *Rhizomnium nudum*) and **ragged-mosses**, along with variable presence of **pipecleaner moss**, are common in the moss layer.

Differentiating from Other Site Series

Slightly drier sites (101) lack seepage, have much less oak fern (< 10%) and leafy mosses, more pipecleaner and heron's-bill mosses, and typically lack spiny wood fern, mitreworts, and/or false hellebore. Slightly wetter sites have seepage within the top 25–75 cm, and high cover of lady fern and/or devil's club (> 10%). This site series is similar to the ICHmw2/112, but those forests occur in valley bottoms of landscapes with hillsides dominated by ICH species, such as Cw, Hw, Fd, and Lw, with minimal Se and Bl and no white-flowered rhododendron.

Variability

Hw and Cw presence and abundance can be variable. Minor amounts of devil's club or lady fern may occur (< 3%). Ferns and queen's cup are more common in the lower half of the ESSFwh2, while false hellebore is more common at upper elevations where Canby's lovage may occur.

Management Issues

This site series has high productivity for vegetation growth. This supports rapid tree growth, but vegetation competition often causes significant regeneration concerns. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Sites frequently provide travel corridors in steep terrain and forage for wildlife.

111 Se – Devil's club – Lady fern

General Description

SMR 5 (6). 111 forests occur on **lower and toe slopes with seasonal seepage** within the upper 50–75 cm of the soil profile. Sites are generally adjacent to or associated with riparian areas. Surficial materials are typically fluvial or morainal with sandy loam or silt loam soil textures, often with moderate to high coarse fragment content. Soils are frequently Gleyed Dystric Brunisols and Gleyed Humo-Ferric Podzols.

Se is usually the dominant tree, although **Hw**, **Bl**, and **Cw** can be abundant in the overstorey and are often (co)dominant in the regeneration layers. **Devil's club**, **thimbleberry**, and/or **lady fern** are common indicator species. **Oak fern**, **spiny wood fern**, and small amounts of **false hellebore** frequently occur. False azalea may be present with low cover, but white-flowered rhododendron is typically absent. Leafy mosses and ragged-mosses are common and can be abundant.

Differentiating from Other Site Series

Slightly drier sites (110) lack abundant lady fern and/or devil's club (< 3%), and have seepage deeper in the soil profile (> 50 cm). Wetter sites (112) have abundant horsetails, as well as moderate cover of Canby's lovage, arrow-leaved groundsel, and peat-mosses. Cw and Hw are less common on the wetter 112 sites.

Variability

Colder 111 sites have more Se, Bl, and white-flowered rhododendron, and less Hw and Cw. The herb and moss layers are very diverse, with a number of infrequently occurring species. Although devil's club and lady fern typically occur together, on some sites devil's club is sparse to absent, while lady fern and spiny wood fern are dominant (> 20% cover).

Management Issues

Tree productivity is high on these sites, and vegetation competition may be a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Sites frequently provide travel corridors in steep terrain and forage for wildlife.

SeBl – Horsetail – Canby's lovage 112

General Description

SMR 6 (7). 112 forests are uncommon in the ESSFwh2. They occur on **level sites** and **gentle toe slopes** with **seepage or a high water table within the top 30 cm** of the soil profile. Sites are associated with **riparian** areas and frequently have **water at the surface**, either as slow-moving streams or groundwater seepage. Soils are typically poorly drained Gleysols derived from fluvial or lacustrine materials and frequently have a thick Ah layer or a thin organic veneer and prominent mottles. Soil texture can be variable, ranging from clay loam to silt and sandy loam. **Cold-air pooling** is common.

Stands are typically **Se**-dominant with **Bl** frequently in the overstorey and understorey. Hw may be present, most commonly in the understorey. Shrub cover is variable, with **false azalea** commonly found with smaller amounts of black huckleberry, **black twinberry**, and/or black gooseberry. **Horsetails**—mostly common (*Equisetum arvense*)—are present and usually dominant, with moderate cover of **arrow-leaved groundsel**, **Canby's lovage**, violets, and **bluejoint reedgrass**. **Peat-mosses**, **leafy mosses** (mostly *Rhizomnium* spp.), **ragged-mosses**, leafy liverworts, glow moss (*Aulacomnium palustre*), and bent-leaf moss (*Rhytidiadelphus squarrosus*) are typical of the abundant and varied moss layer.

Differentiating from Other Site Series

The 112 is the wettest forested site series described. Slightly drier sites (111) have abundant lady fern and/or devil's club and little to no horsetail. Wetter sites include non-forested wetlands (see Section 6.2).

Variability

These sites often occur in complexes with wetlands or as small strips along stream or lake floodplains. Sites are often mounded, with trees and drier indicator species growing on elevated sites and wetter indicator species such as peat-mosses and sedges growing in hollows. Some sites may lack horsetail but exhibit other very wet indicators (e.g., leatherleaf saxifrage).

The 112 site series is typically riparian-associated. It is usually a high bench flood site, but can be a treed swamp. Users who require additional information can use phases to reflect this variability:

> **112a** for riparian flood sites
> **112b** for the swamp phase with a thick organic veneer and very poor drainage (Ws08.2) (see Section 6.2)

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Cold air and frost may limit seedling regeneration. Where harvesting occurs, competition from herbaceous brush can be a concern in regenerating stands. Windthrow hazard may be a concern in areas adjacent to harvesting due to shallow rooting.

Other Ecosystems

The following ecosystems occur in the ESSFwh2; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

In the ESSFwh2, wetlands are uncommon and generally occur at the upper end of valleys along the valley floor or in areas of subdued terrain. Fens (Wf), marshes (Wm), and swamps (Ws) all occur. Wetland ecosystems are described in Section 6.2.

Avalanche features

Avalanche paths are common in the steep, snowy mountains of the ESSFwh2 and provide important habitat and landscape diversity. A range of types occurs, including herbaceous (Vh), shrubby (Vs), and treed (Vt) avalanche ecosystems. Descriptions are provided in Section 6.5.

Rock outcrops and talus slopes

Numerous rock outcrop (Ro) and talus (Rt) ecosystems occur in the ESSFwh2 and are often found with the driest forested ecosystems. Descriptions are provided in Section 6.6.

ESSFwm2
Purcell Wet Mild
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwm2 occurs in the Purcell Mountains between the ESSFwh2 and the ESSFwmw from Akokli Creek in the south to Howser Creek in the north, and in the St. Mary drainages, including the West Fork, Dewar, White, Redding, and Meachen Creek valleys. To the south, it is replaced by the ESSFwm4, and to the north by the ESSFwc4. The ESSFdk1 occurs to the east of the St. Mary River and on the east slopes of the Purcell Mountains. Small areas of ESSFwm2 occur at the upper ends of Jumbo, Toby, Dutch, and Findlay Creeks adjacent to the ESSFdk2.

Distribution of the ESSFwm2

Elevation Range

In the southern half of its extent, the ESSFwm2 occurs between 1700 and 2000 m on cool aspects and between 1800 and 2050 m on warm aspects. In the northern half, it occurs between 1600 and 1950 m on cool aspects and between 1700 and 2000 m on warm aspects. On the east side of the Purcells, upper elevations can be as high as 2100 m on cool aspects and 2150 m on warm aspects.

Climate[1]

Located in the Moist climate subregion, the ESSFwm2 is characterized by cool, moist summers and cold, moist to wet winters with a deep snowpack that typically persists from November through May. Rain-on-snow events occur during most winters but are very infrequent. Growing-season moisture deficits are uncommon on all but the driest sites.

Forest and Vegetation Characteristics

Bl and Se are the dominant tree species in the ESSFwm2. Pl also occurs, particularly in earlier seral stands on warm aspects and in areas closer to the ESSFwm4, ESSFdk1, or ESSFdk2. Pa often occurs on drier, rocky sites, while La can be common on blocky talus and other rocky sites, particularly on cool aspects and on cold-air sites. Cw, Hw, Lw, and Fd are uncommon. Both white-flowered rhododendron and false azalea are common across most sites in the ESSFwm2, along with abundant black huckleberry. **Zonal sites** characteristically have abundant Bl, Se, foamflower, and arnica, and can have minor amounts of false hellebore, wood-rushes, and/or oak fern. Sparse understorey herb communities typify **drier sites**, while abundant and diverse herb communities are characteristic on **wetter sites** where oak fern, Canby's lovage, arrow-leaved groundsel, globeflower, and false hellebore are common. Bear-grass can be present on drier sites but is not consistent.

Tree productivity is moderate in the ESSFwm2 and is intermediate between the productive ESSFwh2 at lower elevations and the mostly non-productive ESSFwmw at higher elevations. Cold air, frost, shorter growing seasons, and a deep snowpack limit tree regeneration and growth.

Disturbance

Old forests are common in the ESSFwm2 where stand-replacing disturbances are infrequent. **Fires** are the dominant broad-scale natural disturbance, although **mountain pine beetle** has had significant impacts in localized areas with high Pl, particularly in the St. Mary drainage and the east shore of Kootenay Lake. **Small-scale forest gap dynamics** caused by

[1] See Section 4.2 for more information on climate variables.

windthrow, insects, and pathogens are important for creating stand structural complexity between stand-replacing fires. Endemic levels of **western balsam bark beetle** are key drivers of regeneration and multi-aged stands. Spruce bark beetles are known to inflict high mortality, particularly following fire or blowdown, or where slash retention is high after harvest. White pine blister rust and, more recently, mountain pine beetle have had devastating effects on whitebark pine. The combination of deep snowpacks and steep terrain result in widespread avalanche tracks and high risk of snowpress in regenerating stands on steep slopes. Extensive areas of provincial parks in the ESSFwm2 and difficult access have limited the area harvested.

Soils, Geology, and Landforms

The Purcell Mountains originally formed as the western coast of North America in the Mesoproterozoic eon (up to 1.5 billion years ago). Continental drift and subsequent metamorphic processes have created complex geological history in this area. Common bedrock types in the ESSFwm2 include quartzite and granodiorite, along with sandstone, argillite, and conglomerate. Mudstone, siltstone, shale, limestone, marble, and calcareous sedimentary rocks are commonly interspersed, particularly at the northern extent of the ESSFwm2. Colluvial materials and glacial till are the most common parent materials and generally have loam or silt loam to sandy loam surface textures. Rock outcrops are widespread in association with ridge crests and shallow soils.

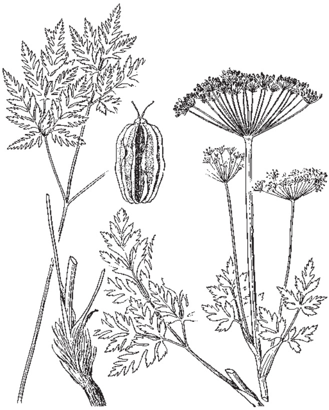
Wildlife Habitat

The ESSFwm2 provides important wildlife habitat within and adjacent to the regionally important Purcell Wilderness Conservancy Provincial Park, one of the largest intact ecosystems in southeastern British Columbia. The unit also provides wildlife habitat connectivity south to Kianuko Provincial Park. Key wildlife species in this area include wide-ranging carnivores such as **grizzly bear**, **black bear**, **wolverine**, **lynx**, **wolf**, and all **ungulate species** found in the Kootenay region except bighorn sheep.

Mountain caribou winter range and management areas occur on the west slope of the Purcell Mountains in the upper reaches of Tam O'Shanter Creek south to Sanca Creek, and on the east slope of the Purcells in the upper Skookumchuck Creek and St. Mary River drainages.

Key **mountain goat** habitat occurs near steep, rocky escape terrain. Vegetated avalanche chutes along with abundant huckleberries provide forage for **grizzly bears**. Small lakes and wetlands are moderately common within the ESSFwm2 and represent lush feeding areas and breeding habitat for the

western toad, a declining species. The at-risk **olive-sided flycatcher** breeds in the ESSFwm2, and more common bird species include hermit, Swainson's and varied thrushes, Wilson's warbler, and fox sparrow.



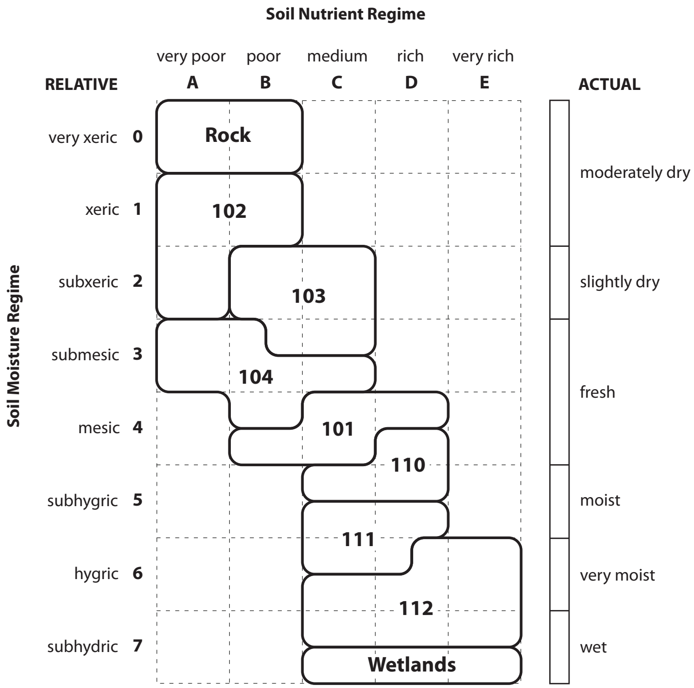
Canby's lovage
Ligusticum canbyi

Fringed grass-of-Parnassus
Parnassia fimbriata

Distinguishing the ESSFwm2 from Adjacent Biogeoclimatic Units

In the **ESSFwh2**, most sites have:	- Cw, Hw, Fd, or Lw - less white-flowered rhododendron
zonal sites have:	- less arnica, wood-rushes, false hellebore, Sitka valerian, and/or mitreworts
dry sites have:	- more herbaceous species diversity; less shrub cover
wet sites have:	- less Canby's lovage, arrow-leaved groundsel, globeflower, false hellebore, and Sitka valerian
In the **ESSFwm4**, most sites have:	- more Pl - Lw, Fd, Cw, and/or Hw (at lower elevations) - grouseberry/low bilberry
zonal sites have:	- no oak fern - minor bear-grass
dry sites have:	- considerably more Pl, grouseberry/low bilberry, bear-grass
wet sites have:	- less oak fern and five-leaved bramble
In the **ESSFwc4**, most sites have:	- no false azalea - less Sitka valerian
zonal sites have:	- more oak fern
dry sites have:	- more wood-rushes and foamflower
wet sites have:	- less globeflower
In the **ESSFwmw**, most sites have:	- no false azalea - small amounts of mountain-heather - more wood-rushes
dry sites have:	- La and more Pa

Edatopic Grid



Site series

101 Bl – Rhododendron – Azalea – Foamflower
102 BlPa – Huckleberry – Clad lichen
103 Bl – Azalea – Rhododendron
104 Bl – Rhododendron – Huckleberry – Heron's-bill moss
110 BlSe – Azalea – Oak fern
111 Bl – Arrow-leaved groundsel – Canby's lovage
112 SeBl – Horsetail – Canby's lovage

Site Series Flowchart

VERY DRY to DRY FORESTS

- warm aspects with shallow soils

→
- SMR 1 (2)
- Bl (Se, Pa, La) stands
- exposed (bed)rock is prominent
- saxifrages and/or juniper
- rock-mosses and/or haircap mosses; abundant clad lichens

→ **102**

→
- SMR 2 (3)
- Bl (Se, Pl) canopy
- steep, warm aspect
- abundant false azalea
- may have bear-grass

→ **103**

SLIGHTLY DRY to MESIC FORESTS

- mid slopes with deep soils
- neutral to cool slopes

→
- SMR 3 (2)
- Bl, Se stands
- shrubby with abundant rhododendron and huckleberry
- lacks false azalea
- little to no foamflower, arnicas, false hellebore (< 1%)

→ **104**

→
- SMR 4 (3)
- Se, Bl stands
- abundant foamflower and arnicas
- < 7% oak fern
- minor false hellebore (< 3%)

→ **101**

MOIST to WET FORESTS

- level, lower and toe slopes
- seepage or mottles
- often associated with riparian areas

→
- SMR 5 (4)
- Se, Bl stands
- seepage at depth (> 75 cm)
- foamflower, false hellebore, foamflower abundant
- oak fern > 10% cover

→ **110**

→
- SMR 6 (5)
- Se, Bl stands
- arrow-leaved groundsel, globeflower, and/or false hellebore abundant
- lacks horsetails, peat-moss, leatherleaf saxifrage

→ **111**

→
- SMR 6 (7)
- Se, Bl stands
- horsetails abundant (> 10%)
- leatherleaf saxifrage, bluejoint reedgrass, or sedges
- peat-mosses, glow moss, or sickle-moss

→ **112**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Trees	*Abies lasiocarpa*	■■■■	■■■■	■■■■	■■■■	■■■	■■■	■■■	subalpine fir
	Picea engelmannii	■■■	■■■	■■■	■■■■	■■■■	■■■■	■■■■	Engelmann spruce
Regen	*Abies lasiocarpa*	■■■	■■■	■■■	■■■	■■■	■■■	■■■	subalpine fir
	Picea engelmannii	■■	□	*	■■	■■	■■■	■■	Engelmann spruce
	Pinus albicaulis	■■		□					whitebark pine
Shrubs	*Vaccinium membranaceum*	■■■■	■■■■	■■■■■	■■■■	■■■■	■■	■■	black huckleberry
	Rhododendron albiflorum	□□□	□□□	■■■■	■■■■	■■■	*	■■■	white-flowered rhododendron
	Menziesia ferruginea	■	■■■■		■■■■	■■■		■■■	false azalea
	Paxistima myrsinites		■■						falsebox
Herbs	*Xerophyllum tenax*	□□	□□□						bear-grass
	Saxifraga ferruginea	□							Alaska saxifrage
	Arnica spp.		□□		■■■	□□□	■■■	■■■	arnicas
	Luzula spp.			□	□□	□□	□		wood-rushes
	Tiarella trifoliata var. *unifoliata*				■■■	■■■■	■■■	■■	one-leaved foamflower
	Veratrum viride				■■	■■■	■■■	□□□	false hellebore
	Pectiantia brewerii				□□	■■	■■	■	Brewer's mitrewort
	Streptopus amplexifolius				□	■	□	□□	clasping twistedstalk
	Gymnocarpium dryopteris				*	■■■■			oak fern
	Valeriana sitchensis				*	*	□□□	*	Sitka valerian
	Senecio triangularis					□	■■■	■■■	arrow-leaved groundsel
	Trollius albiflorus						■■■■	■■■■	globeflower
	Ligusticum canbyi						■■■	■■■	Canby's lovage
	Erigeron peregrinus						■■■		subalpine daisy
	Equisetum spp.						□□	■■■■	horsetails
	Parnassia fimbriata						■■	□	fringed grass-of-Parnassus

Layer	Scientific Name	102	103	104	101	110	111	112	Common Name
Herbs	*Pedicularis bracteosa*						■■	□	bracted lousewort
	Leptarrhena pyrolifolia							■■■	leatherleaf saxifrage
	Calamagrostis canadensis							□□	bluejoint reedgrass
	Carex nigricans							■■	black alpine sedge
Moss layer	*Dicranum* spp.	■■■■	■■■	■■■■	■■■	■■	■■		heron's-bill mosses
	"leafy liverworts"[a]	■■■	□□□	■■■■	■■■	■■■	■■■	□	leafy liverworts
	Cladonia spp.	■■■	□	■					clad lichens
	Racomitrum spp.	■■■							rock mosses
	Polytrichum spp.	□□							haircap mosses
	Brachythecium spp.	*	■■■	■■	■■■■	■■■■	■■■■	□□□	ragged-mosses
	Rhytidiopsis robusta		□□□	□	□□□	□□	□□		pipecleaner moss
	"leafy mosses"[a]				□□	□□□	■■■	■■■■	leafy mosses
	Sanionia uncinata						*	■■	sickle-moss
	Aulacomnium palustre							■■■	glow moss
	Sphagnum spp.							□□	peat-mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site series	102	103	104	101	110	111	112
No. of plots	4	14	10	25	16	4	7
SMR	1 (2)	2 – 3	3 (2)	4 (3)	5 (4)	5 (6)	6 (7)
SNR	A–B	B (C)	B (A, C)	B–C	C–D (B)	D (C)	D
Slope position	UP, CR (MD)	MD–UP	MD–UP	MD	LW–TO (MD)	TO (LV)	LW (TO, MD)
Typical slope/ aspect	Steep/warm	Steep/ warm	Moderately steep/ neutral mid slopes; moderately steep/ cool upper slopes	Moderate–moderately steep/ cool–neutral	Gentle–moderate	Level–gentle/ aspect variable	Level–gentle/ aspect variable
Common compensating conditions	Mid-slopes/ fragmental soils		Gentle/cool crests	Lower slopes/ coarse soils; gentle/warm aspects	Mid-slope moisture-receiving sites		
Surficial materials	Cx, Mx/R, Cv	Cb (Mb, Cv)	Cb, Mb (Cv,Mv)	Mb (Cb)	Mb, Cb (F)	F (Mb)	Ox/F, Ox/Mb, F (Ov/Lb)
Soil texture	SL, FSL (SiL)	SL (SiL, L, LS)	SL (Sil, L, LS)	FSL, SL (SiL, L)	SL, SiL (SCL, LS, L)	SL (LS, L, SiL)	SiL (SL, SiCL)
Coarse fragment content	High–fragmental	Moderately high–fragmental	Moderately high–fragmental	Moderate–moderately high	Moderate–high	Moderate–fragmental	Low–moderate; often increasing with depth
Important features	Rock outcrops, talus slopes, very shallow soils	Insolation	Usually cool to neutral aspect		Seepage or mottles within 1 m of surface	Seepage within 30–60 cm of the surface	Water table in upper 30 cm

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

Bl – Rhododendron – Azalea – Foamflower 101

General Description

SMR 4 (3). 101 forests typically occur on **mid slopes** of **neutral to cool aspects**. Due to compensating factors, this site series also occurs on lower slopes of warm aspects with extensive shading from adjacent mountains or with coarse soils. Soils are typically Orthic Humo-Ferric Podzols or Orthic Dystric Brunisols with Hemimor humus forms, and are well- to moderately well-drained with loamy (FSL, SL, L, or SiL) soil textures.

Bl is typically abundant, along with **Se**, in both the overstorey and understorey. **White-flowered rhododendron**, **black huckleberry**, and **false azalea** characterize the shrub layer. **Foamflower** and **arnicas** are usually present with moderate cover (~5–15%). Other herbaceous species include minor cover of false hellebore, violets (*Viola* spp.), wood-rushes, Brewer's mitrewort, and clasping twistedstalk. Five-leaved bramble and oak fern frequently occur with low cover, particularly in the lower half of the ESSFwm2. **Ragged-mosses**, **leafy liverworts**, and **heron's-bill mosses** are usually abundant, along with minor cover of leafy mosses and pipe-cleaner moss.

Differentiating from Other Site Series

Slightly drier sites (104) tend to have sparse herb cover, lacking foamflower, false azalea, and mitreworts; Pl may be present in younger stands on drier sites. Slightly wetter sites (110) typically have higher oak fern cover (> 10%), and contain more false hellebore, Brewer's mitrewort, and foamflower.

Variability

Upper elevations within the ESSFwm2 tend to have more white-flowered rhododendron and less false azalea, more arnica and less foamflower, and more false hellebore. Oak fern may be present in small amounts (typically < 7%), particularly at lower elevations.

Management Issues

Snow creep and avalanching can result in damage to regenerating trees on steeper slopes. High cover of ericaceous shrubs can create brush problems for conifer regeneration.

102 BlPa – Huckleberry – Clad lichen

General Description

SMR 1 (2). 102 forests occur on warm-aspect sites with **abundant bedrock or talus** where total tree cover is 10% or greater in the overstorey. Soils are variable but shallow within any given stand, and comprise a mixture of bare rock and thin veneers. Soil textures vary considerably based on parent materials. Where granodiorites are the dominant rock type, soil textures are typically sandy loam; where finer rock types predominate, soils have silt loam or loam textures. The occurrence of this site series is very dependent on soil depth and often occurs as a mosaic with rock outcrops and the 103 site series in areas of variable soil depth.

Bl mixes with **Se**, **Pa**, and occasionally **La** (at upper elevations), with Bl dominant in the subcanopy tree layers. **Black huckleberry** is typically the dominant shrub, although **white-flowered rhododendron** and **false azalea** may be present. Understorey herbs vary but are usually present in low abundance. Rock-associated species such as **saxifrages** generally occur, along with small amounts of herb species that are common to the ESSF, such as wood-rushes and arnicas; bear-grass may be present on some sites. Mosses are typically abundant and distinctive, with **rock-mosses**, **heron's-bill mosses**, **clad lichens**, haircap mosses, and leafy liverworts most common.

Differentiating from Other Site Series

The 102 is the driest forested site series recognized in the ESSFwm2. Drier sites include non-forested rock outcrops (Ro) and talus (Rt) with < 10% tree cover in the stand. Slightly moister sites (103) lack abundant (bed)rock at the surface and tend to occur on steep, warm aspects with coarse and/or shallow soils. Moister sites also have more pipecleaner moss and ragged-mosses, and less haircap mosses, rock-mosses, and clad lichens.

Variability

Plant species vary within sites based on soil depth in small microsites; occasionally, moister species may occur in deeper pockets of soil. This site series does not include La-dominated sites that occur on blocky talus sites where cold air pools; those are described as Rt21 (see Section 6.6).

Management Issues

This site series is not recommended for timber harvesting due to limitations in available soil for tree regeneration and growth. These sites may provide habitats for rare and at-risk plant species (e.g., Pa).

Bl – Azalea – Rhododendron 103

General Description

SMR 2 (3). 103 forests occur on **steep, warm, mid- to upper slope positions** with **shallow or coarse-textured soils** and on shallow crests with insolation. These forests occasionally occur on neutral aspects with extensive sun exposure or with very coarse soils. Soils are usually well- to rapidly drained with moderate to very high coarse fragment content. They are typically derived from colluvial materials on steep slopes but may be from morainal or glaciofluvial materials, particularly on crests. Dystric Brunisols are common with Hemimor humus forms.

Bl is usually abundant in the overstorey and understorey, with moderate **Se** in the overstorey; Pa occasionally occurs at low densities. **False azalea** and **black huckleberry** have abundant cover, while white-flowered rhododendron varies from sparse to moderate cover. Minor **falsebox** is common (< 5%). Understorey herbs are typically sparse, with small amounts of arnicas, **white hawkweed**, violets, and **one-sided wintergreen**. **Bear-grass** can be abundant but is not consistently present. The variable moss layer typically includes ragged-mosses, heron's-bill mosses, leafy liverworts, and pipecleaner moss.

Differentiating from Other Site Series

Slightly drier forested site series (102) are characterized by prominent bedrock or talus and abundant rock-mosses. Slightly moister sites (104) occur on cooler aspects and typically have little or no false azalea or falsebox.

Variability

Early- and mid-seral stands often have more Pl. Bear-grass occurs from the southern to the northern extent of the ESSFwm2, typically with low to moderate cover (< 10%) but occurs inconsistently on this site series.

Management Issues

Where Pl is abundant, mountain pine beetle susceptibility is exacerbated by droughty conditions. Regeneration issues may be encountered due to growing-season moisture deficits. On steep slopes, avalanching and snow press are often concerns in winter, while soil erosion can be a concern during the growing season.

104 Bl – Rhododendron – Huckleberry – Heron's-bill moss

General Description

SMR 3 (2). 104 forests typically occur on **moderately steep and steep, mid- to upper-slope positions on cool to neutral aspects**. Soils are usually deep, well to rapidly drained, with moderately high to fragmental coarse fragment contents and moderately thick Hemimor humus forms. Orthic Humo-Ferric Podzols and Eluviated Dystric Brunisols with sandy loam to silt loam textures are typical.

Bl is usually abundant in the overstorey and understorey, with moderate **Se** in the overstorey. Minor Pa can occur. Shrub cover is typically high, with abundant **white-flowered rhododendron** and **black huckleberry**, but false azalea is usually sparse or absent. Understorey herbs are sparse, with small (< 1%) amounts of one-sided wintergreen, wood-rushes, violets, and arnicas. Moss cover is typically high, usually with extensive coverage of **leafy liverworts** and **heron's-bill mosses**.

Differentiating from Other Site Series

As a site characterized by cool aspects and coarse soils, the 104 is differentiated by sparse understorey herbs and an abundant moss layer, particularly with heron's-bill mosses and leafy liverworts. Slightly drier sites (103) occur on warmer aspects and have more false azalea, falsebox, bear-grass, and/or pipecleaner moss, while slightly moister sites (101) have more diverse and abundant herbs, including foamflower, more arnicas, and minor cover of mitreworts, clasping twistedstalk, and false hellebore.

Variability

Sites with higher shrub cover tend to have lower understorey herb cover. Pl may be present in mid- and early-seral stands.

Management Issues

On steep slopes, avalanching and snowpress are often concerns in winter, while soil erosion can be a concern during the growing season.

BlSe – Azalea – Oak fern 110

General Description

SMR 5 (4). 110 forests typically occur on **receiving sites on lower slope positions** and mid-slope sites where seepage is present at depth. **Mottles** are usually present within the top **75–100 cm** but may be faint. Soils are often Gleyed Dystric Brunisols or Humo-Ferric Podzols. Soil textures are variable, ranging from silt loam to sandy loam. Sites are typically adjacent to or associated with **riparian** features.

Tree cover is typically characterized by **Se** dominant in the overstorey, along with **Bl** in both the overstorey and understorey. False azalea, black huckleberry, and white-flowered rhododendron are common. Herb cover is moderately diverse and abundant, with key species including **oak fern**, **foamflower**, and **false hellebore.** Brewer's mitrewort, wood-rushes, five-leaved bramble, stiff club-moss (*Lycopodium annotinum*), clasping twistedstalk, and arnicas may be present in minor amounts. **Ragged-mosses** often dominate the moss layer, although leafy liverworts and leafy mosses are also common.

Differentiating from Other Site Series

Slightly drier sites (101) lack seepage, have much less oak fern (< 7%), false hellebore, and leafy mosses, and have lower shrub cover and more pipe-cleaner and heron's-bill mosses. On slightly wetter sites (111), seepage occurs closer to the soil surface (within 25–75 cm), and herb cover is very lush with abundant arrow-leaved groundsel, globeflower, Canby's lovage, and/or subalpine daisy.

Variability

White-flowered rhododendron cover varies from moderate to absent. Minor cover of typically wetter species such as arrow-leaved groundsel, globeflower, and Canby's lovage may occur but plant communities are dominated by oak fern and foamflower.

Management Issues

Competition from brush is often a concern in regenerating stands. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Sites frequently provide travel corridors in steep terrain and forage for wildlife.

111 Bl – Arrow-leaved groundsel – Canby's lovage

General Description

SMR 5 (6). The 111 site series is uncommon in the ESSFwm2. It occurs on **gentle** (< 15%) **lower and toe slope positions with seepage** within the upper 30–75 cm of the soil profile. Sites are usually associated with **riparian areas**. Given that much of the ESSFwm2 occurs in steep terrain, 111 sites are more commonly found close to wetlands and lakes where gentle terrain occurs. Surficial materials are typically fluvial or morainal with sandy loam or silt loam soil textures, often with moderate to high coarse fragment content. Soils are frequently Gleyed Dystric Brunisols or Orthic Humic Gleysols on sites where occasional flooding occurs.

Se is usually the dominant tree, with **Bl** abundant in the regeneration layer and codominant in the overstorey. Stands are often open canopied with abundant and diverse herb cover and sparse shrubs. The **well-developed herb layer** is characterized by moderate to high cover of **globeflower**, **false hellebore**, **arrow-leaved groundsel**, **Canby's lovage**, **subalpine daisy**, and **Sitka valerian**. Ragged-mosses, leafy liverworts, heron's-bill mosses, and **leafy mosses** are common.

Differentiating from Other Site Series

Drier sites(110) lack abundant (> 20% combined cover) arrow-leaved groundsel, Canby's lovage, and globeflower, and have seepage deeper in the soil profile (> 50 cm). Wetter sites (112) are dominated by horsetails, with moderate cover of peat-mosses and glow moss, and small amounts of sedges and/or leatherleaf saxifrage.

Variability

Minor cover of horsetails may be present (< 3%) on 111 sites. The herb and moss layers are very diverse, with a number of infrequently occurring species.

Management Issues

Competition from brush is often a concern in regenerating stands. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. The water table may rise once trees are removed.

SeBl – Horsetail – Canby's lovage **112**

General Description

SMR 6 (7). 112 forests are uncommon in the ESSFwm2. They occur on **level sites**, **gentle toe slopes**, and **depressions** with **mottles or the water table within the top 30 cm** of the soil profile. Sites are associated with **riparian** areas and frequently have **water at the surface**, either as groundwater seepage or slow-moving streams. Soils are typically poorly drained Gleysols derived from fluvial or lacustrine materials and frequently have a thick Ah layer or a thin organic veneer and prominent mottles or gleying. Soil texture can be variable, ranging from clay loam to silt and sandy loam. **Cold-air pooling** is common.

Stands have an open canopy of **Se** with **Bl**. Understoreys have abundant and diverse herb cover with **horsetails** (mostly common [*Equisetum arvense*]), **globeflower**, **leatherleaf saxifrage**, and **sedges** dominant, along with arrow-leaved groundsel and Canby's lovage. **Glow moss**, **peat-mosses**, **sickle-moss**, and abundant leafy mosses are typical in the variable moss layer.

Differentiating from Other Site Series

The 112 is the wettest forested site series described. Slightly drier sites (111) have abundant globeflower, false hellebore, arrow-leaved groundsel, Canby's lovage, and/or subalpine daisy and little to no horsetail. Wetter sites include non-forested wetlands (see Section 6.2 for wetland descriptions).

Variability

These sites often occur in complexes with wetlands or as small strips along stream or lake floodplains. High plant diversity is common. Sites are often mounded, with trees and drier indicator species (e.g. arnicas and five-leaved bramble) growing on elevated sites and wetter indicator species (e.g., peat-mosses, sedges, leatherleaf saxifrage, small willowherbs [*Epilobium* spp.], and thallose liverworts) growing in hollows. Horsetails are generally present but may not be dominant on all sites, especially where other very wet indicators are present.

The 112 site series is typically riparian-associated. It is usually a high bench flood site, but can be a treed swamp. Users who require additional information can use phases to reflect this variability:

112a for riparian flood sites

112b for the swamp phase with a thick organic veneer and very poor drainage (Ws08.2) (see Section 6.2)

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, competition from herbaceous brush can be a concern in regenerating stands. Cold air and frost may limit regeneration.

Other Ecosystems

The following ecosystems occur within the ESSFwm2; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

The most common wetland types are fens (Wf), although marshes (Wm) and swamps (Ws), and, at upper elevations, alpine wetlands (Wa) also occur. Wetland ecosystems are described in Section 6.2.

Avalanche features

Avalanche paths are common in the steep snowy mountains of the ESSFwm2 and include herb meadow (Vh), shrub thicket (Vs), and treed (Vt) avalanche ecosystems. Section 6.5 describes these ecosystems in detail.

Rock outcrops and talus slopes

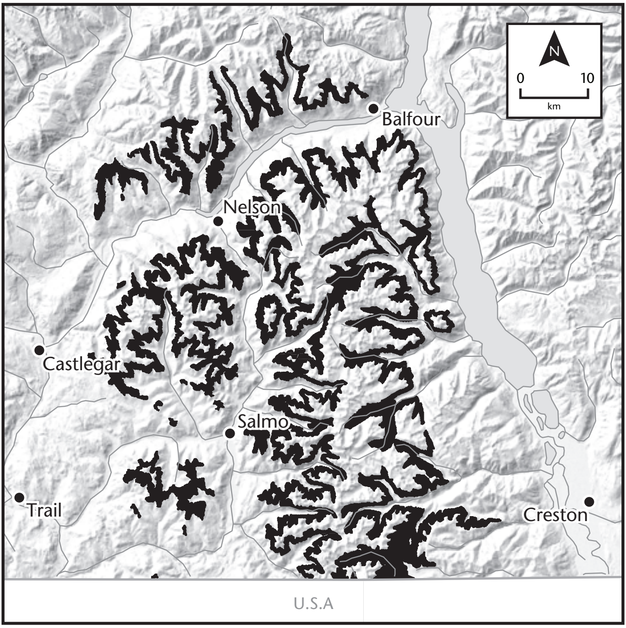
Several rock outcrop (Ro) and talus (Rt) ecosystems occur in the ESSFwm2. Descriptions are provided in Section 6.6.

ESSFwh3
Salmo Wet Hot
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwh3 occurs as an extensive transition between the ICHmw4 and ESSFwm3 in the south Selkirk Mountains from north of the west arm of Kootenay Lake to the U.S. border, and from the Slocan and Columbia Rivers to the south arm of Kootenay Lake. The ESSFwh3 abuts the ESSFwh1 at the divide between Six Mile Lakes and Lemon Creek and between Sproule and Pedro Creeks. The ESSFwh3 does not occur south of Cultus Creek and east of Jersey Creek to the U.S. border where it is replaced by the ESSFwm4.

Distribution of the ESSFwh3



Elevation Range

The ESSFwh3 typically occurs between 1450 and 1725 m on cool aspects, 1450 and 1750 m on neutral aspects, and 1500 and 1775 m on warm aspects. In the southwest portion of its range, the upper and lower boundaries are approximately 50–75 m higher. Due to an abundance of cold-air drainage, the ESSFwh3 occupies valley bottoms at lower than typical elevations in the Upper Priest, Monk, and Nun drainages west of Boundary Lake. In the upper portions of all drainages, the ESSFwh3 occurs at valley bottom, often at lower than typical elevations due to the influence of cool air.

Climate[1]

The ESSFwh3 occurs in the Moist climate subregion and is characterized by cool to warm, moist summers and cool, wet winters with heavy snowfall and a deep snowpack. The contrast between warm summers and wet, snowy winters is a key driver of plant communities. Snow cover usually begins in November and extends through to April or early May. Rain-on-snow events occur during most winters but are infrequent within a given winter. Growing-season moisture deficits occur on subxeric and drier sites and may occur on submesic sites in dry, hot summers.

Forest and Vegetation Characteristics

The ESSFwh3 is a highly productive ESSF–ICH transition. Bl, Se, Hw, and Cw are common on **zonal sites**, along with sparse to moderate cover of white-flowered rhododendron, black huckleberry, Utah honeysuckle, foamflower, five-leaved bramble, and queen's cup. Small to moderate amounts of oak fern frequently occur on zonal sites. Bear-grass is often abundant on **submesic and drier sites**. On dry, warm aspects, Fd, Lw, and Pl dominate the overstorey, while Bl, black huckleberry, and falsebox occupy the understorey. **Moist to wet sites** often contain mixtures of Se and Bl, with occasionally abundant Hw and varying amounts of Cw in the overstorey (except where cold air limits Cw and Hw).

Throughout the ESSFwh3, ICH species such as foamflower, oak fern, and queen's cup mix with ESSF species such as Sitka valerian, mitreworts, and false hellebore. Tall bluebells (*Mertensia paniculata*) and heart-leaved spring beauty (*Claytonia cordata*) often occur along streams, avalanche run-out zones, and other wet areas in the ESSFwh3. Dense Sitka alder (*Alnus viridis* ssp. *sinuata*) is common along roadsides.

Although a mixture of Se, Bl, and typical "ICH" tree species characterizes the ESSFwh3, stands of almost pure Hw or mixed Hw and Cw occasionally occur within a landscape matrix otherwise dominated by typical ESSFwh3 forests. Cw and Hw are more common as codominants of stands in the

[1] See Section 4.2 for more information on climate variables.

lower portions of the ESSFwh3, and are often restricted to the shrub and suppressed tree layer at higher elevations, closer to the ESSFwm3. Similarly, while the presence of Cw, Hw, Lw, and Fd differentiates the ESSFwh3 from the ESSFwm3, stands of pure Se and Bl also occur in the ESSFwh3.

Disturbance

Fires are the dominant stand-replacing natural disturbance in the ESSFwh3. Old forests are common in the ESSFwh3 where stand-replacing disturbances occur infrequently within a landscape matrix of mixed-severity disturbances. Moderate-severity fires occur more frequently in areas that are topographically connected to lower-elevation slopes—for example, long, continuous, warm-aspect slopes above ICH areas with more frequent fire. Large Fd, Lw, and Cw are commonly found as legacies from previous fires. Where Pl is abundant, such as the West Arm Provincial Park, the western slopes of the Bonnington Range, and along the south arm of Kootenay Lake, **mountain pine beetle** has created large disturbances. Gall rusts also affect Pl regeneration, while spruce weevil can be a growth impediment in regenerating Se stands.

Small-scale forest gap dynamics caused by windthrow, insects, and pathogens are important for creating stand structural complexity between stand-replacing fires. Endemic levels of western balsam bark beetle can create small openings that drive regeneration and multi-aged stands. Spruce bark beetles are known to inflict high mortality on isolated stands, particularly following fire or blowdown, or where slash retention is high after harvest. Douglas-fir bark beetles can cause high mortality on dry, warm-aspect sites where Fd is abundant. **Armillaria root rot** also creates small gaps in mature stands and can be a major impediment to tree regeneration, particularly Fd, Lw, and Hw.

Soils, Geology, and Landforms

Complex geological history characterizes the south Selkirk Mountains. Throughout much of the ESSFwh3, soils are derived primarily from coarse-grained granodiorite and granitic intrusive rocks. Other common rock types are quartzite and quartz in the Nelson Range, and basaltic volcanic rocks in the Bonnington Range and areas south. Fine-grained mudstone, siltstone, shale, limestone, slate, and argillite are commonly interspersed as mineral-rich areas.

Most soils have sandy loam textures with moderate coarse fragment content and are derived from colluvium or till (morainal materials). Glaciofluvial soils occur in some of the upper creek valleys and are gravelly with sandy loam to sandy surface textures. Soils typically become coarser (e.g., loamy sand) at depth. Seepage is common on mid to toe slopes, and organic soils are uncommon and often restricted to wet depressions. Fluvial fan and floodplain deposits are uncommon.

Wildlife Habitat

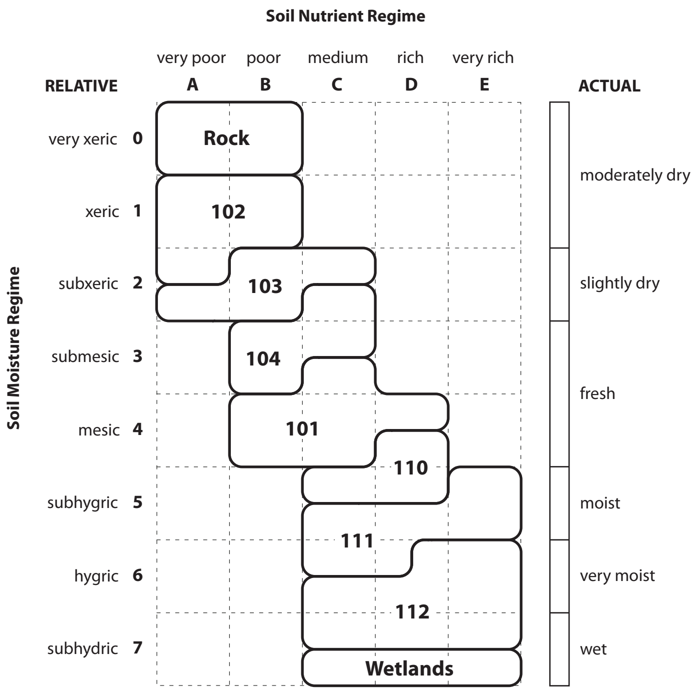
The highly productive ESSFwh3 is important for a number of wide-ranging flagship wildlife species. Black huckleberry production is abundant in the ESSFwh3, which provides important late-summer habitat for **grizzly bears** and **black bears**. Avalanche run-out zones also offer critical feeding grounds for bears in spring, and are key foraging areas for **wolverine**, which also use these areas (as well as large talus rubble areas) for winter denning and rearing kits. Other furbearers, such as **Canada lynx**, **American marten**, and **weasel** species, use this unit seasonally.

Older forests with lichen-loaded trees provide critical forage and winter range for **mountain caribou**. Small wetlands provide breeding and overwintering areas for **western toad**, and rocky substrates are important habitats for a range of species, including at-risk **red-tailed chipmunk**. Warm-aspect Fd stands provide important **Ungulate Winter Range habitat**. Large Fd, Lw, and Cw commonly occur as remnants from previous fires, and, along with large-diameter wildlife trees, large hollow logs, coarse woody debris, and root balls, provide critical habitat elements for a diversity of **cavity-nesting**, **denning**, and **roosting species**. Many of these species are insectivorous and function in the biological control of forest insects (e.g., **woodpeckers**; **nuthatch**, **chickadee**, **and creeper species**; **Vaux's swift; Pacific/winter wren**), and some members of this guild are at-risk species (**olive-sided flycatcher, little brown myotis, barn swallow**). Hermit thrush, varied thrush, warbling vireo, yellow-rumped warbler, and MacGillivray's warbler are common bird species in the ESSFwh3.

Distinguishing the ESSFwh3 from Adjacent Biogeoclimatic Units

In the **ICHmw4**, most sites have:	- more Hw, Cw, Pw, and falsebox - less white-flowered rhododendron
zonal sites have:	- less oak fern
dry sites have:	- less bear-grass - more Fd, Lw, Douglas maple, saskatoon, and prince's pine
wet sites have:	-less Sxw, Bl, and white-flowered rhododendron, except on cold-air sites - more devil's club
In the **ESSFwh1**, most sites have**:**	- less pipecleaner moss - more bunchberry and red-stemmed feathermoss
zonal sites have:	- more oak fern
dry sites have:	- no bear-grass or pinegrass - less Pl, Lw, and birch-leaved spirea
wet sites have:	- less false azalea - more Sitka valerian
In the **ESSFwm3**, most sites have:	- no Hw, Cw, Fd, or Lw - more wood-rushes, ragged-mosses, small leafy liverworts, and heron's-bill moss - less pipecleaner moss
zonal sites have:	- more arnica and mitrewort
dry sites have:	- more Pa and white-flowered rhododendron - less Pl
wet sites have:	- more globeflower, subalpine daisy, Sitka valerian, Canby's lovage, false hellebore, and arrow-leaved groundsel - less oak fern, lady fern, and devil's club; restricted to lower elevations where present
In the **ESSFwm4**, most sites have:	- more false azalea - some Cw, Hw, Fd, and Lw in the lower 1/3 of the zone
zonal sites have:	- more arnica and ragged-moss - less queen's cup and foamflower
dry sites have:	- more Pl and grouseberry/low bilberry
wet sites have:	- less oak fern, lady fern, devil's club, and five-leaved bramble

Edatopic Grid



Site series

101 BlHw – Rhododendron – Foamflower
102 BlFd – Bear-grass – Rock-moss
103 BlPl – Huckleberry – Bear-grass
104 Bl – Rhododendron – Bear-grass – Pipecleaner moss
110 Bl – Rhododendron – Oak fern
111 Se – Devil's club – Lady fern
112 SeBl – Horsetail – Canby's lovage

Site Series Flowchart

VERY DRY to DRY FORESTS

- warm aspects
- shallow soils

- SMR 1 (2)
- Fd (Pl, Lw) stands
- exposed rock is prominent
- saskatoon, birch-leaved spirea, falsebox, black huckleberry, and/or bear-grass are present
- rock-mosses, clad lichens, and/or haircap mosses are present

→ **102**

- SMR 2 (3)
- Pl, Fd, Bl, Se, (Lw) canopy
- steep, warm aspect; shallow and/or coarse soils
- black huckleberry; falsebox, birch-leaved spirea, and/or bear-grass are abundant
- rhododendron and false azalea are usually sparse or absent

→ **103**

SLIGHTLY DRY to MESIC FORESTS

- mid slopes (usually) with deep soils

- SMR 3 (2)
- Bl, Se(Hw) stands
- bear-grass is usually abundant
- moderate cover falsebox
- sparse foamflower (< 4% cover)

→ **104**

- SMR 4 (3)
- Se, Bl, Hw (Cw) stands
- abundant foamflower and queen's cup
- < 7% oak fern cover
- < 1% bear-grass cover

→ **101**

MOIST to WET FORESTS

- level, lower, and toe slopes
- seepage or mottles
- often associated with riparian areas

- SMR 5 (4)
- Se, Hw, Bl (Cw) stands
- oak fern > 10% cover; foamflower, five-leaved bramble, and/or queen's cup are abundant
- leafy mosses and/or pipecleaner moss moderate cover
- lady fern and/or devil's club < 3% cover

→ **110**

- SMR 5–6
- Se, Bl, Hw (Cw) stands
- seepage or mottles within top 30–50 cm
- abundant devil's club, lady fern, and/or spiny wood fern

→ **111**

- SMR 6 (7)
- horsetail is abundant (> 10% cover)
- arrow-leaved groundsel, Canby's lovage, clasping twistedstalk, and/or globeflower > 3% cover each
- queen's cup is sparse or absent

→ **112**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Trees	*Picea engelmannii*	□□	■■■	■■■	■■■■	■■■■	■■■■	■■■■	Engelmann spruce
	Abies lasiocarpa	■■	■■■	■■■■	■■■	■■■	■■■	■■	subalpine fir
	Pseudotsuga menziesii	■■■	□□□□						Douglas-fir
	Larix occidentalis	■■■	□□□						western larch
	Pinus contorta	□□	■■■■	*					lodgepole pine
	Tsuga heterophylla			□□□	□□□□	□□□□	■■■■	□□	western hemlock
	Thuja plicata				*	*	*		western redcedar
Regen	*Abies lasiocarpa*	■■	■■■	■■■	■■	■■■	□□	■■■	subalpine fir
	Picea engelmannii	□	□	□	□	■■	*	■■	Engelmann spruce
	Tsuga heterophylla		*	□□	□□	■■■	■■■	■■	western hemlock
Shrubs	*Vaccinium membranaceum*	■■■■	■■■■	■■■■	■■■■	■■■■	■■■	■■	black huckleberry
	Rhododendron albiflorum	*	*	■■■■	■■■■	■■■	□□	□□□	rhododendron
	Menziesia ferruginea				*	□□□	*	□□□	false azalea
	Paxistima myrsinites	■■■	■■■	■■	*				falsebox
	Spiraea betulifolia	■■■	□□						birch-leaved spirea
	Lonicera utahensis	■■	■■	■■	■■	■■	□	■■	Utah honeysuckle
	Amelanchier alnifolia	■■							saskatoon
	Lonicera involucrata							■■	black twinberry
	Oplopanax horridus						■■■■		devil's club

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Herbs	*Xerophyllum tenax*	■■■■	■■■■	■■■■	*				bear-grass
	Antennaria spp.	□□							pussytoes
	Hieracium albiflorum	■	■■						white hawkweed
	Clintonia uniflora		□□	□□	■■■	■■■	■■■		queen's cup
	Tiarella trifoliata var. *unifoliata*			■■	■■■	■■■	■■■■	■■	one-leaved foamflower
	Rubus pedatus				□□□	■■■	□□	■■	five-leaved bramble
	Gymnocarpium dryopteris				□□	■■■■	■■■■	■■■	oak fern
	Streptopus amplexifolius				□	■	■■	■■■	clasping twistedstalk
	Pectiantia brewerii					□□	■■■	■■	Brewer's mitrewort
	Veratrum viride					■■	■■	*	false hellebore
	Athyrium filix-femina					□	■■■■■		lady fern
	Ligusticum canbyi					□	*	■■■	Canby's lovage
	Dryopteris expansa						□□□		spiny wood fern
	Senecio triangularis							■■■	arrow-leaved groundsel
	Equisetum spp.							■■■■	horsetails
	Trollius albiflorus							■■	globeflower
Moss layer	*Racomitrium* spp.	■■■■							rock-mosses
	Polytrichum spp.	■■■	□□						haircap mosses
	Rhytidiopsis robusta	■■	■■■	■■■■	■■■■	□□□	*		pipecleaner moss
	Dicranum spp.	■■	□□□	*	□□□	*			heron's-bill mosses
	Cladonia spp.	■■	*						clad lichens
	Brachythecium spp.	□	■■■	□□□	□□□	■■■	□□□	■■■	ragged-mosses
	"leafy mosses"[a]				*	□□□	■■■■	■■■■	leafy mosses
	Rhytidiadelphus squarrosus							■■■■	bent-leaf moss
	Sphagnum spp.							■■■	peat-mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site series	102	103	104	101	110	111	112
No. of plots	4	9	33	27	32	20	4
SMR	1 (2)	2 (3)	3 (2)	4 (3)	5 (4)	5-6	6 (7)
SNR	A-B	C (A-B)	C (B)	C (B-D)	C-D	D (C,E)	D-E
Slope position	UP-MD (CR)	UP-MD (CR)	MD (LW, UP)	MD	LW (MD, TO)	LW, TO	TO, LV
Typical slope/ aspect	Moderately steep/warm, shallow	Steep/warm; shallow/coarse	Moderate/ warm	Moderate/ neutral (cool)	Gentle/cool (warm)	Gentle to moderate	Gentle to level
Common compensating conditions		Gentle crests	Upper/cool; shallow/ neutral	Lower/coarse; gentle/warm	Mid-slope receiving; coarse toe slopes	Lower/ receiving	
Surficial materials	Cv/R, Cx/R, Mx/R	Cv, Cb (Mv)	M (C)	M (Cb)	M, F	M, F (C)	F (M, Ox)
Soil texture	SL	SL	SL (L, SiL)	SiL, FSL, SL (L)	SiL, L, SL	SL, SiL	SL, SiL, CL
Coarse fragment content	High	High (fragmental)	Moderate (high)	Moderate	Moderate (low)	Moderate	Low; increasing with depth
Important features	(Bed)rock is prominent and abundant	Insolation			Seepage or mottles at 50–100 cm	Seepage within the upper 50 cm	Water table at or near the surface; may have thin organic veneer; cold air

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

BlHw – Rhododendron – Foamflower 101

General Description

SMR 4 (3). 101 forests typically occur on **mid slopes** with **neutral to cool aspects**. Because of compensating factors, they also occur on lower slope positions on warm-aspect sites with coarse soils. Soils are typically Humo-Ferric Podzols or Dystric Brunisols with Hemimor humus form and well- to moderately well-drained silt loam, fine sandy loam, or sandy loam surface textures.

Se, **Bl**, **Hw**, and occasionally **Cw** are the dominant tree species in both the overstorey and understorey. **White-flowered rhododendron** and **black huckleberry** comprise most of the shrub cover, with lesser amounts of Utah honeysuckle and (often) small amounts of falsebox and/or false azalea. Herb layers are often variable in cover, with considerable **foamflower** and **queen's cup**, moderate cover of five-leaved bramble, and frequent low cover of **oak fern** (< 1 to ~5% cover). Small amounts of bear-grass (one or two plants), one-sided wintergreen, and violets are common. **Pipecleaner moss** is the most abundant moss, and typically occurs with moderate amounts of ragged-mosses and heron's-bill mosses.

Differentiating from Other Site Series

Drier sites (104) tend to have abundant bear-grass and falsebox, and lack five-leaved bramble, oak fern, and leafy mosses. Wetter sites typically have higher oak fern cover (> 5%), contain false hellebore, Brewer's mitrewort, lady fern, and/or moderate cover of false azalea, and have more leafy mosses and less pipecleaner moss.

Variability

Oak fern is sporadically present; bear-grass can occur. Old-growth Hw-leading stands are common within the ESSFwh3. These stands look very similar to ICH forests but occur within a landscape matrix that otherwise resembles the ESSFwh3 with abundant Se, Bl, and/or white-flowered rhododendron. Although it may seem odd to have an Hw forest in the ESSF, these old-growth forests may have initiated under different climatic conditions or disturbance histories and may not regenerate to Hw if harvested or burned.

Management Issues

These sites have high productivity for the ESSF and few limiting factors for tree growth. Snow creep and avalanching can result in damage to regenerating trees on steeper slopes. Sites are amenable to the growth of a wide variety of species, and species diversity should be fostered.

102 BlFd – Bear-grass – Rock-moss

General Description

SMR 1 (2). 102 forests occur on warm-aspect sites with **abundant bedrock or talus** where total tree cover is 10% or greater in the overstorey. Soils are variable but shallow within any given stand, and comprise a mixture of bedrock exposures and thin veneers. Granodiorite is the dominant rock type in the ESSFwh3, and soils are usually sandy loams. The occurrence of this site series is very dependent on soil depth and often occurs as a mosaic with the 103 site series in areas of variable soil depth.

Stands are usually open with moderate to low cover of shrubs, herbs, and mosses. **Fd**, **Lw**, and/or **Pl** are typically present with lesser amounts of Se and Bl. **Black huckleberry**, **birch-leaved spirea**, **falsebox**, and **saskatoon** are the most abundant shrubs, often with small amounts of mountain-ash (*Sorbus* spp.), willows (*Salix* spp.), and/or white-flowered rhododendron. **Bear-grass** is usually abundant with **white hawkweed**, **pinegrass**, **dry sedges**, **fescues**, and/or **pussytoes** in the herb layer. Mosses are variable, with abundant **rock-mosses** and moderate to low cover of haircap mosses, pipecleaner moss, heron's-bill mosses, ragged-mosses, pelt lichens, and clad lichens.

Differentiating from Other Site Series

The 102 is the driest forested site series recognized in the ESSFwh3. Drier sites include non-forested rock outcrops (Ro) and talus (Rt) slopes with < 10% tree cover in the stand. Slightly moister sites (103) lack abundant (bed)rock at the surface and tend to occur on steep, warm aspects with coarse and/or shallow soils. Moister sites also have small amounts of queen's cup, Sitka alder, one-sided wintergreen (*Orthilia secunda*), violets, and/or prince's pine, more ragged-mosses, and less birch-leaved spirea, saskatoon, dry sedges, haircap mosses, and clad lichens. Hw and Cw are often present on moister sites.

Variability

All sites included in the 102 occur on warm aspects and crests; very rocky sites on cool aspects are usually 104 or are not described.

Management Issues

This site series is not recommended for timber harvesting due to limitations in available soil and soil moisture for tree regeneration and growth.

BlPl – Huckleberry – Bear-grass 103

General Description

SMR 2 (3). 103 forests occur on **steep, warm, mid to upper slopes** with **shallow or coarse-textured soils** and on shallow crests with insolation. Soils are usually colluvial due to steep slopes but may be morainal or glaciofluvial, particularly on crests. Dystric Brunisols are common.

Fd and **Lw** are often dominant or codominant with **Pl**, Se, and Bl. White-flowered rhododendron and false azalea are typically sparse or absent, with **black huckleberry**, **falsebox**, Utah honeysuckle, Bl, and small amounts of mountain-ash dominating the shrub layer. **Bear-grass** is usually the dominant herb but may be sparse or absent. **White hawkweed**, one-sided wintergreen, and prince's pine may be present. Pipecleaner moss, ragged-mosses, and/or heron's-bill moss comprise the sparse moss layer.

Differentiating from Other Site Series

The 103 differs from drier forested site series (102) due to the lack (or sparseness) of exposed bedrock and/or blocky talus. The 103 also tends to have small amounts of queen's cup and other moister species, and lacks significant amounts of rock-mosses and saskatoon. Moister sites (104) have little to no Fd and Lw and often contain Hw or Cw. Foamflower, white-flowered rhododendron, and pipecleaner moss are also more abundant.

These stands often resemble forests on similar sites in the ICHmw4. Although both are Fd, Lw, and sometimes Pl dominated, ICHmw4 sites have higher Douglas maple, birch-leaved spirea, thimbleberry, and pinegrass cover, less bear-grass, and no Bl and Se. Fd is typical in the regeneration layer in the ICHmw4 to Bl in the ESSFwh3.

Variability

Amounts of Fd, Lw, and Pl vary. Pl-leading stands often have higher shrub cover and lower bear-grass cover. Some sites without bear-grass may occur; these sites are characterized by a herb-poor understorey and little to no white-flowered rhododendron or false azalea.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered. Where Pl is abundant, mountain pine beetle susceptibility is exacerbated by droughty conditions. Regeneration issues may be encountered due to growing-season moisture deficits. Snow creep and avalanching may cause damage to regeneration on steep slopes in winter, while soil erosion can be a concern on steep slopes during the growing season.

104 Bl – Rhododendron – Bear-grass – Pipecleaner moss

General Description

SMR 3 (2). 104 forests typically occur on **mid-slopes of warm aspects** with medium-textured, deep soils. Due to compensating factors, these sites also occur on shallow neutral or cool aspects and lower slopes with coarse-textured soils. Soils are typically moderately well- to well-drained Dystric Brunisols or weak Humo-Ferric Podzols with sandy loam textures. Moderately thick (3–6 cm) Hemimors typify humus forms.

Bl, **Se**, and often **Hw** dominate the tree layer, with abundant Bl, sparse Se, and variable Hw in the regeneration layer. **White-flowered** r**hododendron** and **black huckleberry** are the principal shrubs, with lesser amounts of falsebox, Utah honeysuckle, and mountain-ash. **Bear-grass** is usually the dominant herb with 10–25 % cover but can be sparse or absent.

Differentiating from Other Site Series

Drier sites (103) tend to have more Fd, Lw, and Pl, although Pl is moderately common in younger seral stages of the 104. White-flowered rhododendron and foamflower are typically absent or sparse on drier sites. Moister sites (101) have little to no bear-grass and more queen's cup and foamflower, and often have small to moderate amounts of five-leaved bramble and/or oak fern. Hw and Cw are usually more abundant on moister sites.

Variability

Pl is common on early to mid-seral stands where it can be the leading species in mixed-species stands with Se, Bl, and Hw. Sites with high cover of Hw can have very sparse understorey species cover. Bear-grass is typically dominant but occasionally sparse or absent. Users who require additional detail can refer to site variations as:

104.1 Bl – Rhododendron – Bear-grass – Pipecleaner moss
bear-grass sites (> 10% cover)

104.2 Bl – Rhododendron – Pipecleaner moss
non–bear-grass sites (absent or < 10% cover)

Bear-grass sites tend to have less foamflower, queen's cup, Hw, pipecleaner moss, and shrub cover.

Management Issues

This site series has high productivity for the ESSF and few limiting factors for tree growth. It is amenable to the growth of a wide variety of species, and species diversity should be fostered. Snow creep and avalanching may cause damage to regeneration on steeper slopes.

Bl – Rhododendron – Oak fern 110

General Description

SMR 5 (4). 110 forests typically occur on **receiving sites on lower slopes** where seepage is present at depth. Mottles are usually present within the top 100 cm but may be faint. Soils are often Gleyed Dystric Brunisols or Humo-Ferric Podzols, although Sombric and Eutric Brunisols also occur. Soil textures are variable, ranging from silt loam to sandy loam. Humus forms are frequently Hemimors or Mormoders. Sites are typically upland but may be associated with seasonal or small streams and other riparian features.

Se, **Bl**, **Hw**, and occasionally **Cw** are common in the overstorey. **Black huckleberry**, **white-flowered rhododendron**, and **false azalea** are the dominant shrubs, with Bl, Se, and Hw common in the regeneration layer. The herb layer is typically rich and diverse with species such as **oak fern**, **foamflower**, **queen's cup**, **five-leaved bramble**, **false hellebore**, and **clasping twistedstalk** consistently occurring with a range of other less prominent species, including small amounts (< 1% cover) of lady fern and/or Canby's lovage. **Leafy mosses** (primarily *Rhizomnium nudum*), **ragged-mosses**, and **pipecleaner moss** comprise most of the moss layer.

Differentiating from Other Site Series

Drier sites (101) lack seepage within the top 100 cm of the soil, have less oak fern (< 5% cover) and leafy mosses and more pipecleaner and heron's-bill moss, and typically lack false hellebore. Wetter sites (111) have seepage or a water table within the top 25–50 cm, and high cover (> 20% cover) of lady fern and/or devil's club.

Variability

Sites with more cold-air influences can have little to no Cw and Hw and more Se, Bl, and white-flowered rhododendron. ESSFwh3/110 sites are similar to cold-air sites in the ICHmw4, but the ICHmw4/111 occurs in valley bottoms of landscapes with hillsides dominated by ICH species (Cw, Hw, Fd, Lw) with minimal Se, Bl, and white-flowered rhododendron.

Management Issues

Tree productivity is high on these sites, and vegetation competetion may be a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Sites frequently provide travel corridors in steep terrain and forage for wildlife.

111 Se – Devil's club – Lady fern

General Description

SMR 5–6. 111 forests occur on **lower and toe slopes with seasonal seepage or a high water table** within the upper 25–50 cm of the soil profile and occasionally near the surface. Sites are usually associated with **riparian areas**. Surficial materials are typically fluvial or morainal with sandy loam or silt loam textures and moderate coarse fragment content. Soils are frequently Gleysols or Gleyed Humo-Ferric Podzols.

Se, **Hw**, **Bl**, and occasionally **Cw** typify the overstorey, with Hw and lesser amounts of Bl, Cw, or Sx in the understorey. **Devil's club** is usually abundant (> 10% cover), with small amounts of black huckleberry and sparse white-flowered rhododendron and/or false azalea. The abundant and rich herb layer is dominated by **lady fern**, **oak fern**, **foamflower**, **violets**, **mitreworts**, **false hellebore**, and occasionally spiny wood fern. **Leafy mosses** (mostly *Rhizomnium nudum, R. magnifolium, and R. glabrescens*) and **ragged-mosses** are common in the variable moss layer.

Differentiating from Other Site Series

Drier sites (110) lack abundant (> 20%) lady fern and/or devil's club, and have seepage deeper in the soil profile (> 50 cm). Wetter sites (112) have horsetails, as well as moderate cover of Canby's lovage, arrow-leaved groundsel, and peat-mosses, and small amounts of rein orchids and/or leatherleaf saxifrage. Cw and Hw are less common on the wetter 112 sites.

Variability

Colder sites have more Se, Bl, and white-flowered rhododendron, and less Hw and Cw. Although devil's club and lady fern typically occur together, on some sites, devil's club is sparse to absent, while lady fern is predominant (> 20% cover). The herb and moss layers are very diverse with a number of infrequently occurring species.

Management Issues

Tree productivity is high on these sites, and vegetation competetion may be a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Sites frequently provide travel corridors in steep terrain and forage for wildlife.

SeBl – Horsetail – Canby's lovage **112**

General Description

SMR 6 (7). 112 forests are uncommon in the ESSFwh3. They occur on **level sites** and **gentle toe slopes with seepage or water table** at or near the soil surface (within 30 cm). Stands are often adjacent to streams and frequently have considerable cold-air drainage. Soils are typically Gleysols with thick Ah layers and prominent mottles. Soil texture can be variable, ranging from silt loam to sandy loam.

Stands can be open or clumpy and are **Se**-dominated with occasional **Bl** and/or **Hw**. Shrub cover is variable, with minor cover of **white-flowered rhododendron** and/or **false azalea**, and smaller amounts of black twinberry, oval-leaved blueberry (*Vaccinium ovalifolium*), or black gooseberry (*Ribes lacustre*). **Common horsetail** (*Equisetum arvense*) is present and usually a dominant species with **Canby's lovage**, **arrow-leaved groundsel**, **oak fern**, **clasping twistedstalk**, and smaller amounts of globeflower, leather-leaf saxifrage, rein orchids, tall bluebells (*Mertensia paniculata*), or mitreworts. **Peat-mosses**, **leafy mosses**, **ragged-mosses**, and **bent-leaf moss** are typical of the abundant moss cover.

Differentiating from Other Site Series

The 112 is the wettest forested site series described. Drier sites (111) have abundant lady fern and/or devil's club and little to no horsetail. Wetter sites include non-forested wetlands (see Section 6.2).

Variability

These sites often occur with wetlands or as small strips along floodplains. Sites are usually mounded, with trees and drier indicator species (e.g., false-box or pipecleaner moss) growing on elevated sites, and wetter indicator species (e.g., peat-mosses and sedges) growing in hollows. Some sites may lack horsetail but exhibit other very wet indicators (e.g., leatherleaf saxifrage).

The 112 site series is typically riparian-associated. It is usually a high bench flood site, but can be a treed swamp. Users who require additional information can use phases to reflect this variability:

112a for riparian flood sites

112b for the swamp phase with a thick organic veneer and very poor drainage (Ws08.2) (see Section 6.2)

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, competition from herbaceous brush can be a concern in regenerating stands. Cold air and frost may also limit seedling regeneration. Windthrow hazard may be a concern in areas adjacent to harvesting because of shallow rooting.

Other Ecosystems

The following ecosystems occur within the ESSFwh3; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

Wetlands are uncommon in the ESSFwh3, and tend to occur along the valley floor and in areas of subdued terrain. Fens (Wf), marshes (Wm), and swamps (Ws) occur. Wetland ecosystems are described in Section 6.2.

Grasslands and brushlands

Grasslands (Gg) and brushlands (Gb) are extremely uncommon in the ESSFwh3 and are limited to the driest, warmest sites. Grassland and brushland communities have been observed in the southern Bonnington Range. Section 6.4 provides descriptions of grassland and brushland ecosystems.

Avalanche features

Avalanche paths are common in the ESSFwh3, and a range of types occurs, including herbaceous (Vh), shrubby (Vs), and treed (Vt) ecosystems. Descriptions of avalanche ecosystems are provided in Section 6.5.

Rock outcrops and talus slopes

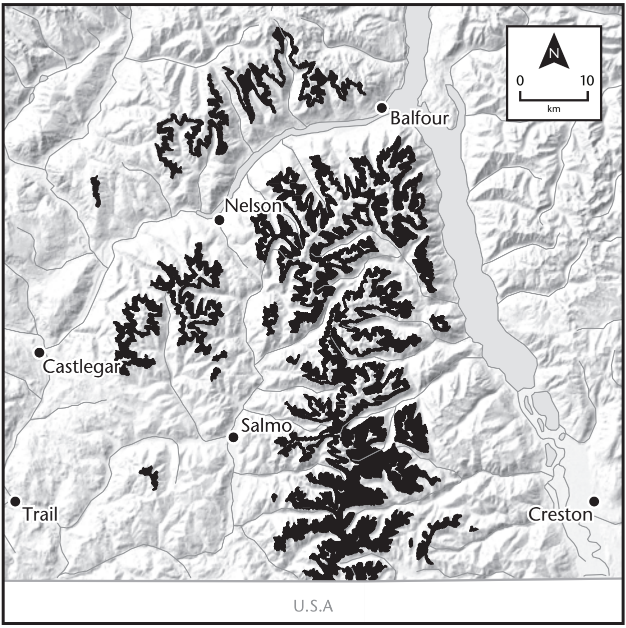
Numerous rock outcrop (Ro) and talus (Rt) ecosystems occur in the ESSFwh3 and are often found with the driest forested ecosystems. Descriptions are provided in Section 6.6.

ESSFwm3
Ymir Wet Mild
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwm3 occurs at upper montane elevations in the south Selkirk Mountains from north of the west arm of Kootenay Lake to the U.S. border and from the Slocan and Columbia Rivers to the south arm of Kootenay Lake north and west of Cultus and Next/Jersey Creeks. In the Cultus, Jersey, Next, Corn, Dodge, and Summit drainages, the ESSFwm3 is replaced by the ESSFwm4. Throughout its range, the ESSFwm3 occurs between the ESSFwh3 and the ESSFwmw. The ESSFwm3 abuts the ESSFwc4 along the divide north of the west arm of Kootenay Lake.

Distribution of the ESSFwm3



Elevation Range

Lower elevation limits are typically 1725 m on cool aspects, 1750 m on neutral aspects, and 1775 m on warm aspects. In the south Salmo River, Stagleap Creek, Mount Kelly, and Stott Peak areas, the lower elevation limits are approximately 25–50 m higher on all aspects. Upper elevation limits are 1950 m on all aspects at the northern extent, and range from 2050 m on cool aspects to 2070 on neutral aspects, and 2100 on warm aspects in the southern and eastern extent.

Climate[1]

The ESSFwm3 is located in the Moist climate subregion and is characterized by cool, wet winters with heavy snowfall and a very deep winter snowpack that typically persists from November through May or early June. Summers are moderately cool and moist to wet; high rainfall is common in June, but precipitation is much lower in July and August. Rain-on-snow events occur during most winters but are infrequent. Growing-season moisture deficits are uncommon on all but the driest sites.

Forest and Vegetation Characteristics

Se and Bl are the primary species in the ESSFwm3, with minor Pl and Pa on drier sites, and La in blocky talus slopes with cold air. Stands are typically more open than forests at lower elevations. Cw, Hw, Fd, and Lw are typically absent but can occur incidentally at low densities, usually in the understorey. Bl is moderately abundant (usually < 10% cover) in the regeneration layer in most stands, often with small amounts of Se, especially on moister sites. Abundant white-flowered rhododendron and black huckleberry, with sparse Utah honeysuckle (*Lonicera utahensis*) and mountain-ash (*Sorbus* spp.) are characteristic across most site series. Although understorey herbs and bryophytes can be variable, wood-rushes (mostly *Luzula hitchcockii* but also *L. parviflora*), bracted lousewort, and ragged-mosses are typically present on **most sites**. Bear-grass, leafy liverworts, heron's-bill mosses, and occasionally grouseberry or low bilberry dominate **drier types**; bear-grass is usually present at low densities across mesic to wet sites. Foamflower, arnicas, Brewer's mitrewort, and false hellebore typify **mesic and wetter sites**, while Sitka valerian, Canby's lovage, arrow-leaved groundsel, globeflower, and leafy mosses are consistently present on the **wettest sites**.

Tree productivity is moderate in the ESSFwm3 and is intermediate between the productive ESSFwh3 at lower elevations and the mostly nonproductive ESSFwmw at higher elevations. Cold air, frost, shorter growing seasons, and a deep snowpack limit tree regeneration and growth. In upper

[1] See Section 4.2 for more information on climate variables.

portions of the ESSFwm3, wood-rushes are usually more common, and Pa may be present at low densities.

Disturbance

Old forests are common in the ESSFwm3 where stand-replacing disturbances occur infrequently. **Fires** are the dominant stand-replacing natural disturbance. **Forest gap dynamics**, caused by tree mortality from windthrow, insects, and pathogens, are important for creating stand structural complexity between stand-replacing fires. The combination of deep snowpack and steep terrain results in widespread avalanche tracks. Snowpress also affects tree regeneration on moderately steep to steep slopes.

Where Pl is abundant, such as the West Arm Provincial Park, the western slopes of the Bonnington Range, and along the south arm of Kootenay Lake, **mountain pine beetle** has created large disturbances. Spruce bark beetles are known to inflict high mortality, particularly following fire or blowdown, or where slash retention is high after harvest. White pine blister rust and, more recently, mountain pine beetle have had devastating effects on whitebark pine. **Western balsam bark beetle** creates a steady supply of small canopy gaps that play an important role in stand dynamics.

Soils, Geology, and Landforms

Complex geological history characterizes the south Selkirk Mountains. Throughout much of the ESSFwm3, soils are derived primarily from coarse-grained granodiorite that originates from the Nelson Batholith. Morainal soils typically have sandy loam textures with moderate coarse fragment content, and they dominate much of the area. Andesites, phyllites, and schists are interspersed as mineral-rich areas, particularly in the Bonnington and Nelson Ranges. Granite and quartzite are common in the older rock formations that occur east of Kootenay Pass. Soils are often thinner in the ESSFwm3 than those at lower elevations, and coarse, rocky soils are common.

The ESSFwm3 is characterized by steep mountainous terrain with few areas of level or subdued terrain. Valleys and surficial geology have been shaped by extensive glacial history. Numerous drainages and sub-drainages flow into the south and west arms of Kootenay Lake, the Columbia River, and the Pend d'Oreille River.

Wildlife Habitat

Older forests in the ESSFwm3 provide important habitat for several **old-forest–dependent species** and critical winter range for the South Selkirk **mountain caribou** herd. In addition to having heavy lichen loads, these older forests have high structural diversity, with an abundance of large veteran trees, wildlife trees, large hollow logs, coarse woody debris, root balls, insect host trees, and a lush and diverse herb and/or shrub layer. Retaining forest patches with these habitat elements is necessary to maintain populations of **wildlife tree users** (e.g., **boreal owl**, **northern hawk owl**, **northern goshawk**, **American marten**, **red squirrel**, **pileated woodpecker**). Many of these species are insectivorous (e.g., **little brown myotis**, **olive-sided flycatcher**, **red-breasted nuthatch**, **mountain chickadee**) and play an important role in the biological control of bark and wood-boring beetles. Some species (e.g., **red-tailed chipmunk**) disperse mycorrhizal fungi and thereby improve plant nutrient uptake, while others disperse seeds (e.g., **Clark's nutcracker** is the main dispersal agent of **Pa** seeds).

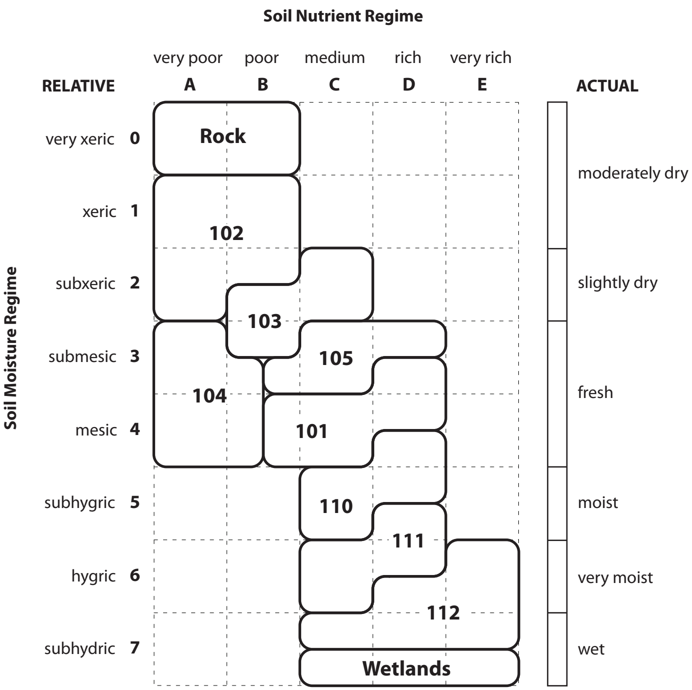
Small mountain wetlands in the ESSFwm3 are important breeding and overwintering sites for **western toad**, and provide lush feeding sites for **grizzly bears**. Avalanche paths and berry-producing sites are also critical for grizzly bears. **Wolverines** likely occur in the ESSFwm3 year-round. The listed **magnum mantleslug** and some **at-risk vascular plants** associated with wet forests occur in this unit. Common bird species include yellow-rumped warbler, dark-eyed junco, hermit thrush, varied thrush, and pine siskin.

Tall bluebells
Mertensia paniculata var. borealis

Distinguishing the ESSFwm3 from Adjacent Biogeoclimatic Units

In the **ESSFwh3**, most sites have:	- more Hw and Cw in the overstorey, mixed with Se and Bl - less wood-rushes, ragged-moss, small leafy liverworts, and heron's-bill moss - more pipecleaner moss
zonal sites have:	- less arnica and mitrewort - some oak fern
dry sites have:	- less Pa and white-flowered rhododendron - more Pl, Lw, and Fd
wet sites have:	- less globeflower, subalpine daisy, Sitka valerian, Canby's lovage, false hellebore, and arrow-leaved groundsel - more oak fern, lady fern, and devil's club
In the **ESSFwm4**, most sites have:	- more false azalea - less wood-rushes
zonal sites have:	- more bear-grass, grouseberry, and low bilberry - less mitrewort, false hellebore, and leafy liverworts
dry sites have:	- more Pl, Fd, Lw, and Cw at lower elevations - more grouseberry and/or low bilberry
wet sites have:	- less Sitka valerian, meadowrue, and ragged-mosses
In the **ESSFwc4**, most sites have:	- more Sitka valerian, oak fern, and five-leaved bramble - less false azalea and wood-rushes
dry sites have:	- no bear-grass - less Pl
In the **ESSFwmw**, most sites have:	- mountain-heathers - lower tree productivity with more openings - more wood-rushes
zonal sites have:	- more anemones, Sitka valerian, arnicas, and leafy liverworts - less Se
dry sites have:	- Pa and La - no bear-grass
wet sites have:	- no oak fern or queen's cup

Edatopic Grid



Site series

101 Bl – Rhododendron – Azalea – Foamflower
102 Bl – Huckleberry – Bear-grass
103 BlSe – Rhododendron – Bear-grass
104 Bl – Rhododendron – Huckleberry – Heron's-bill moss
105 BlSe – Rhododendron – Bear-grass
110 Bl – Rhododendron – Foamflower – Arnica
111 Bl – Arrow-leaved groundsel – Canby's lovage
112 SeBl – Horsetail – Canby's lovage

Site Series Flowchart

VERY DRY to DRY FORESTS

- warm aspects
- shallow, coarse soils

→
- SMR 1–2
- Bl (Se, Pl, Pa) stands
- exposed rock is prominent
- rhododendron is sparse (< 10%) or absent
- rock-mosses, clad lichens, and/or haircap mosses present

→ **102**

→
- SMR 2 (3)
- Bl (Se, Pa, Pl) canopy
- steep, warm aspect; shallow and/or coarse soils
- abundant bear-grass (> 15%)

→ **103**

SLIGHTLY DRY to MESIC FORESTS

- mid slopes (usually) with deep soils

→
- SMR 3 (4)
- Bl (Se) stands
- cool, steep sites with coarse-textured soils
- sparse to absent herb cover (< 3%)
- abundant shrub cover (> 50%)
- high moss and liverwort cover (> 50%)

→ **104**

→
- SMR 3
- Bl, Se stands
- bear-grass usually with moderate to low cover (3–15%)
- arnica usually present

→ **105**

→
- SMR 4 (3)
- Bl, Se stands
- arnica, mitrewort, wood-rush, and/or foamflower (3–7%)
- oak fern, arrow-leaved groundsel, and leafy mosses sparse to absent (< 1%)
- < 1% beargrass

→ **101**

MOIST to WET FORESTS

- level, lower, and toe slopes
- seepage or mottles
- often associated with riparian areas

→
- SMR 5 (4)
- Se, Bl stands
- lower slopes and receiving sites
- Sitka valerian and/or hellebore, typically < 7% each
- globeflower absent or very sparse
- oak fern and leafy mosses may be present with low to moderate cover

→ **110**

→
- SMR 6 (5)
- Se, Bl stands
- abundant hellebore (> 7%),
- moderate to abundant Sitka valerian, Canby's lovage, globeflower, and/or arrow-leaved groundsel

→ **111**

→
- SMR 6 (7)
- Se (Bl) stands
- usually associated with floodplains and riparian areas
- water table at or near the surface
- horsetail, sedges, and/or leatherleaf saxifrage > 3% each

→ **112**

Vegetation Table

Layer	Scientific name	102	103	104	105	101	110	111	112	Common name
Trees	*Abies lasiocarpa*	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■	subalpine fir
	Picea engelmannii	*	■■■	■■■	■■■■	■■■	■■■■	■■■■	■■■■	Engelmann spruce
Regen	*Abies lasiocarpa*	■■■	■■■	■■■	■■■	■■■	■■■	■■■	■■■	subalpine fir
	Picea engelmannii	□	□□	■	*	■■	□□	■	■■	Engelmann spruce
	Pinus albicaulis	□								whitebark pine
Shrubs	*Vaccinium membranaceum*	■■■■	■■■■	■■■■■	■■■■	■■■■	■■■■	■■■■	■■■	black huckleberry
	Rhododendron albiflorum	□□□	■■■■	■■■■■	■■■■■	■■■■■	■■■■	■■■	■■■■	white-flowered rhododendron
	Sorbus spp.	*	□	■	□					mountain-ash
	Ribes lacustre						■	□	■	black gooseberry
Herbs	*Xerophyllum tenax*	■■■	■■■■■		■■■	□	□	*	□	bear-grass
	Luzula spp.	■■■	*	□	■■	■■■	□□	■■	□	wood-rushes
	Carex rossii	□								Ross' sedge
	Orthilia secunda		□		□					one-sided wintergreen
	Arnica latifolia				■■■	■■■	■■■	■■■	■■■	mountain arnica
	Pedicularis bracteosa				□	*	*	□	■	bracted lousewort

Layer	Scientific name	102	103	104	105	101	110	111	112	Common name
Herbs	*Tiarella trifoliata* var. *unifoliata*					■■■	■■■	■■■	■■	one-leaved foamflower
	Pectiantia breweri					■■	■■	■■■	■■	Brewer's mitrewort
	Veratrum viride					□□	■■■	■■■■	■■■	false hellebore
	Ligusticum canbyi					□	□□	■■■	■■■	Canby's lovage
	Clintonia uniflora						■■■			queen's cup
	Gymnocarpium dryopteris						■■■			oak fern
	Senecio triangularis						□□	■■■	■	arrow-leaved groundsel
	Valeriana sitchensis						□	■■■		Sitka valerian
	Streptopus amplexifolius						■	■	■■■	clasping twistedstalk
	Erigeron peregrinus						*	□□		subalpine daisy
	Trollius albiflorus							□□□	■■■	globeflower
	Carex spp.								■■■	sedges
	Equisetum spp.								■■■	horsetails
	Leptarrhena pyrolifolia								■■■	leatherleaf saxifrage
	Platanthera spp.								□	rein orchids
Moss layer	*Dicranum* spp.	■■■	□□□	■■■■	□□	*				heron's-bill mosses
	Polytrichum spp.	■■	*							haircap mosses
	Racomitrium spp.	□								rock-mosses
	Brachythecium spp.	*	■■■	*	■■■	■■■	■■■■	■■■■	□□	ragged-mosses
	Cladonia spp.	*	□		□					clad lichens
	Rhytidiopsis robusta		□□□	□□□	*	*				pipecleaner moss
	"leafy liverworts"[a]		*	■■■■■	□□	□□□	*			leafy liverworts
	"leafy mosses"[a]						*	■■■	■■■■■	leafy mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and > 1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site series	102	103	104	105	101	110	111	112
No. of plots	6	23	7	13	20	12	20	2
SMR	1–2	2 (3)	3 (4)	3	4 (3)	5 (4)	6 (5)	6 (7)
SNR	B (A)	B–C	B (A)	B–C	C (B)	C–D	D (C)	D (E)
Slope position	CR–UP	MD–UP	MD–UP	MD	MD	LW (TO, MD)	TO (LW, LV)	LW, TO, LV
Typical slope/ aspect	Steep (moderate)/ warm	Steep/warm	Steep/cool	Moderate/ warm	Moderate/ cool– neutral	Moderate/ lower	Gentle (level)	Gentle–level
Common compensating conditions	Dry, rocky ridgetops			Lower/coarse; upper/cool		Mid-slope receiving; coarse- textured toe slopes		
Surficial materials	Cx/R	Cv (Cb, M)	Cb (Mb)	Cb, Mb	M (C)	M (FG)	M (F, L)	Ov, M, F
Soil texture	SL (FSL)	SL	SL (LS)	SL	SL (SiL, FSL)	SL, SiL (FSL, L)	SiL (SL, L, SiCL)	SiL, SiCL
Coarse fragment content	High–fragmental	High–fragmental	High (moderate–fragmental)	Moderate–high	Moderate (variable)	Moderate–high	Low; occasionally high	Low–moderate (increasing with depth)
Important features	May have thin veneers in portions of sites	Occurs only on steep, warm aspects	Occurs only on cool aspects			Seepage or mottles at depth (50–75 cm)	Mottles within 30–50 cm; seepage common	Water table at or near surface

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

Bl – Rhododendron – Azalea – Foamflower 101

General Description

SMR 4 (3). 101 forests typically occur on moderate- to moderately steep **mid slopes** of **neutral to cool aspects**. Due to compensating factors, these forests also occur on lower slopes either with coarse-textured soils or on warm aspects. Soils are usually moderately well to well drained with sandy loam or occasionally silt loam textures and are derived from morainal or, less frequently, colluvial or glaciofluvial materials. Coarse fragments generally comprise less than 35% of the soil but may be higher where soils are finer textured or in lower slope positions. Mor humus forms are typical.

Bl is usually the main tree species in the overstorey and understorey, with moderate amounts of **Se**. Shrub cover is typically high, with both **white-flowered rhododendron** and **black huckleberry**. **Mountain arnica**, **wood-rushes**, **foamflower**, or **Brewer's mitrewort** can dominate the herb layer, although in most stands, they occur together with low to moderate cover (3–7% each) and with smaller amounts of violets, bear-grass (< 3%), and/or false hellebore. Moss cover is typically low (~10%) but can be moderate (> 25%) to high (up to 50%), with **ragged-mosses** as the most frequently occurring and abundant species, followed by **leafy liverworts** and **heron's-bill mosses**.

Differentiating from Other Site Series

Drier sites (105) have considerably less foamflower, violets, and mitreworts, typically lack or have sparse occurrences of Canby's lovage and false hellebore, have higher bear-grass cover (> 3%) and/or grouseberry and low bilberry. Cool-aspect sites on coarse soils (104) have high shrub cover with very sparse herbs. Moister sites (110) typically have a combination of false hellebore, Sitka valerian, arrow-leaved groundsel, and/or oak fern, as well as leafy mosses, black gooseberry, more Se, and less white-flowered rhododendron.

Variability

Hw or Cw may be present incidentally and at very low densities, particularly at lower elevations transitioning to the ESSFwh3. At upper elevations, mesic sites tend to have more wood-rushes. False azalea can occur but is uncommon.

Management Issues

Snow creep and avalanching can result in damage to regenerating trees on steeper slopes. High cover of ericaceous shrubs can create brush problems for conifer regeneration.

102 Bl – Huckleberry – Bear-grass

General Description

SMR 1–2. 102 forests occur on **dry sites** with **very shallow soils and exposed bedrock**. They typically occur on upper slopes on warm aspects or on crests. Soils have rapidly drained sandy loam textures with high coarse fragments and thin Mor humus forms. Bedrock is primarily granodiorite.

Bl is the main tree species in both the overstorey and understorey, with occasional Se and Pa. Shrub cover varies, although **black huckleberry** is typically most abundant, with lesser amounts of white-flowered rhododendron. **Bear-grass** or **wood-rushes** are the most common herbs, although low cover of a variety of plants such as fireweed, dry sedges, mountain arnica, and bracted lousewort may also occur along with small amounts of Utah honeysuckle and mountain-ash.

Differentiating from Other Site Series

Drier sites include non-forested rock outcrops (Ro) and rock talus (Rt) with < 10% tree cover. On slightly moister sites (103), exposed rock is sparse to absent, while Se, white-flowered rhododendron, and bear-grass are more abundant. The ESSFwm3/102 site series does not include the La-dominated sites, which typically occur on blocky talus in cold air basins, often associated with small mountain lakes (Rt21; see Section 6.6).

Variability

Vegetation varies due to changes in soil depth, rock type, and amount of exposed bedrock. Rock plants such as *Sedum* species, saxifrages (*Saxifraga* spp.), or *Sellaginella* species, as well as glacier lily (*Erythronium grandiflorum*) or oval-leaved penstemon (*Penstemon ellipticus*) are often present in small amounts. At upper elevations, Pa is more common, and small amounts of La may be present. At mid to lower elevations, Pl may occur with or without Pa. Blocky talus sites can be included in the 102 but frequently lack some of the herb species that are more common on forested rock outcrop sites.

Management Issues

This site series is not recommended for timber harvesting due to limitations in soil availability for tree regeneration. These sites may provide habitats for rare and at-risk plant species (e.g., Pa).

BlSe – Rhododendron – Bear-grass **103**

General Description

SMR 2 (3). 103 sites occur on **steep, warm aspects**, primarily on mid to upper slopes with well- to rapidly drained soils. Because of compensating factors, these sites can also occur on very coarse soils on mid to lower slope positions or on dry, rocky ridgetops. Soils are typically deep but can be veneers over bedrock. Dystric and Eutric Brunisols are most common with sandy loam textures and high coarse fragments.

Bl is the main tree species but **Se** is common and Pa and Pl may be scattered at low densities. Understoreys are characterized by high cover of **white-flowered rhododendron**, **black huckleberry**, and **bear-grass**. Low cover of other herbs, and variable moss cover with ragged-mosses, heron's-bill mosses, and occasionally pipecleaner moss and clad lichens are common. Falsebox, Utah honeysuckle, and mountain-ash are often present at low densities.

Differentiating from Other Site Series

Drier sites (102) have extensive exposed bedrock or talus and less Se, white-flowered rhododendron, and bear-grass. Steep, cool-aspect sites (104) have a dense moss layer, usually dominated by leafy liverworts, and extensive white-flowered rhododendron and/or black huckleberry. Moister sites (105) do not occur on steep, warm aspects, and they have more Se, white-flowered rhododendron, and arnica.

Variability

Pl can be abundant, particularly in earlier seral stages. Pa is common at low densities at upper elevations or in areas with cold-air influences. Bear-grass is almost always present but varies from moderate cover (~15%) to very high cover (> 50%).

Management Issues

Snow creep and avalanching may cause damage to regeneration on steep slopes in winter, while soil erosion can be a concern on steep slopes during the growing season. Regeneration issues may be encountered due to growing-season moisture deficits, particularly in dry years. Where Pl is abundant, mountain pine beetle can cause significant mortality.

104 Bl – Rhododendron – Huckleberry – Heron's-bill moss

General Description

SMR 3 (4). 104 forests occur on **cool**, **steep** sites with **coarse** or shallow soils, and are characterized by **high moss** and **shrub cover**, and sparse or poorly developed herb cover. Soils are typically sandy loams with high coarse fragment content and Mor humus forms. Colluvial slopes are common.

Bl is abundant in the overstorey and understorey, with lesser amounts of Se. **White-flowered rhododendron** is consistently dominant (> 40% cover), with abundant **black huckleberry** (~25% cover). **Leafy liverworts** (mostly common [*Barbilophozia lycopodiodes*] but also mountain [*Neoorthocaulis floekeri*]) are abundant and dominate the moss layer along with heron's-bill mosses and pipecleaner moss. Understorey herbs are sparse to absent, with an average total cover of less than 2%.

Differentiating from Other Site Series

ESSFwm3/104 forests differ from both drier (103) and moister/richer (105, 101) sites by their high leafy liverwort and shrub cover coupled with low herb cover. Although the 105 has soil moisture conditions that are similar to this site, 104 forests are restricted to steep, cool, submesic sites, often with poor nutrients. 103 forests occur on warm aspects, while 105 forests occur on a range of submesic sites except steep, cool slopes with coarse soils. 105 forests typically have more abundant herb cover with bear-grass, wood-rushes, and/or mountain arnica, and less leafy liverworts. 101 sites have less moss cover and more herb cover, including moderate cover of foamflower, mountain arnica, Brewer's mitrewort, and/or false hellebore.

Variability

104 forests are most common at upper elevations in the ESSFwm3 but can occur across the elevation range. Pipecleaner moss is more common at lower elevations, while mountain leafy liverwort is more abundant at upper elevations. Trace amounts of foamflower, Brewer's mitrewort, one-sided wintergreen, and/or grouseberry/low bilberry may be present.

Management Issues

Snow creep and avalanching may cause damage to regeneration on steep slopes. High cover of ericaceous shrubs may result in problems for conifer regeneration.

BlSe – Rhododendron – Bear-grass **105**

General Description

SMR 3. 105 forests occur primarily on **mid slopes** of **warm aspects** with moderate to coarse-textured soils. Due to compensating factors, they also occur on cool-aspect upper slopes and on very coarse-textured lower slopes. Soils are usually well-drained Orthic Humo-Ferric Podzols with sandy loam or silt loam textures and moderate to high coarse fragments.

Bl and **Se** characterize the overstorey, with Bl, **white-flowered rhododendron**, **black huckleberry**, and small amounts of mountain-ash, Se, and/or Utah honeysuckle in the understorey. Small to moderate amounts of **bear-grass** (typically < 10%), **mountain arnica**, and/or **wood-rushes** are common, along with low cover (< 1%) of bracted lousewort, one-sided wintergreen, Brewer's mitrewort, Sitka valerian, and/or grouseberry/low bilberry. Ragged-mosses, heron's-bill mosses, and leafy liverworts are common in the sparse to moderate moss layer.

Differentiating from Other Site Series

Drier sites (103) have less Se, white-flowered rhododendron, wood-rushes, and leafy liverworts and more bear-grass (typically > 10%), and they occur on steep, warm aspects with shallow or coarse soils. The 104 occurs on steep, coarse, **cool** aspect sites with similar soil moisture conditions, but is characterized by high (> 50%) white-flowered rhododendron and leafy liverwort cover, with sparse to absent herbs. Mesic sites (101) have moderate cover (up to 10%) of foamflower, mountain arnica, Brewer's mitrewort, and wood-rush, and/or low cover (< 3%) of false hellebore, Canby's lovage, or bear-grass.

Variability

Pl may occur at low densities in earlier seral stages. Where bear-grass cover is low, grouseberry/low bilberry cover is often higher. Foamflower and Sitka valerian are often present at low densities.

Management Issues

Snow creep and avalanching may cause damage to regeneration on steep slopes in winter, while soil erosion can be a concern on steep slopes during the growing season. High cover of ericaceous shrubs may result in problems for conifer regeneration.

110 Bl – Rhododendron – Foamflower – Arnica

General Description

SMR 5 (4). 110 forests generally occur on **receiving** sites in **lower slope** positions. Due to compensating factors, these sites also occur on subhygric mid slopes with seasonal seepage and toe slopes with medium-coarse to coarse-textured soils. Soils are often derived from glaciofluvial, morainal, and less frequently colluvial materials, and are usually Gleyed Brunisols or Gleyed Humo-Ferric Podzols. **Mottles** are usually visible within the top 50–75 cm of the soil profile.

Se and **Bl** dominate the overstorey, while Bl is typical in the lower tree and shrub layers. **Black huckleberry**, **white-flowered rhododendron**, and occasionally false azalea are abundant in the shrub layer. The herb layer typically contains a combination of **false hellebore**, **queen's cup**, **foamflower**, and/or **oak fern**. Small amounts of lady fern, western meadowrue, clasping twistedstalk, Sitka valerian, black gooseberry, and/or bear-grass may be present. The variable moss layer consists of ragged-mosses with smaller amounts of leafy mosses.

Differentiating from Other Site Series

Drier sites (101) lack seasonal seepage or mottles and have more white-flowered rhododendron (> 30%), wood-rushes, heron's-bill mosses, and leafy liverworts; have less false hellebore, Sitka valerian, and black gooseberry; and typically lack oak fern, clasping twistedstalk, and arrow-leaved groundsel. Wetter sites (111) have less white-flowered rhododendron and black huckleberry, and more false hellebore, Canby's lovage, Sitka valerian, arrow-leaved groundsel, and globeflower.

Variability

Oak fern is more common and abundant at lower elevations in the ESSFwm3; at higher elevations, Sitka valerian and mountain arnica replace oak fern.

Management Issues

Competition from brush is often a concern in regenerating stands. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Sites frequently provide travel corridors in steep terrain and forage for wildlife.

Bl – Arrow-leaved groundsel – Canby's lovage 111

General Description

SMR 6 (5). 111 forests occur on gentle to level **toe** and **lower slopes**, frequently in **riparian** areas of wetlands, lakes, or streams, or near meadows or openings. Soils are often Gleysols or Gleyed Brunisols with **mottles near the surface** and growing-season seepage or the water table in the top 50–75 cm. Moderately thick to thick Ah layers (5–25 cm) are common, with Moder and Mormoder humus forms.

Se and **Bl** occur in the canopies of these open forests, with Bl more abundant than Se in the shrub and small tree layers. Stands tend to have low to moderate shrub cover, typically with black huckleberry and white-flowered rhododendron (~15% cover for each), and trace to small amounts of black gooseberry and/or Utah honeysuckle. The herb layer is very lush and often highly diverse, usually with moderate to high cover (> 10%) of **false hellebore**. Other common and abundant herbs are **arrow-leaved groundsel**, **Canby's lovage**, **globeflower**, **Brewer's mitrewort**, and **Sitka valerian**. Small amounts of violets (*Viola* spp.), foamflower, small willowherbs (*Epilobium* spp.), and/or subalpine daisy are usually present. Mosses can be variable, with leafy mosses, ragged-mosses, and sickle-moss (*Sanionia uncinata*) common.

Differentiating from Other Site Series

Drier sites (110) tend to have more (> 15%) white-flowered rhododendron and black huckleberry, less false hellebore and arrow-leaved groundsel, and often contain oak fern, particularly at lower elevations. Wetter sites (112) occur in similar positions in the landscape but have thicker organic horizons, seepage at or near the surface, and contain abundant horsetails and/or leatherleaf saxifrage.

Variability

111 forests often occur in level to gentle areas adjacent to stream or lake riparian areas. Where stands are more open, false hellebore and arrow-leaved groundsel are most abundant.

Management Issues

Competition from brush and herbs is often a concern in regenerating stands. Cold air and frost may limit seedling regeneration. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. The water table may rise once trees are removed.

112 SeBl – Horsetail – Canby's lovage

General Description

SMR 6 (7). 112 forests are uncommon in the ESSFwm3. They occur on **level to gentle slopes in riparian areas** where **drainage is poor** and the **water table** is at or near the surface throughout the growing season. A thin **organic veneer** or thick humus layer is common.

Se typically dominates the overstorey with moderate to equivalent amounts of Bl. Stands are usually open with sparse shrubs and abundant herbs and mosses. White-flowered rhododendron, black huckleberry, false azalea, Bl, and Se characterize the shrub layer. Diversity of herbs is high, with **horsetail** (mostly common [*Equisetum arvense*]), **leatherleaf saxifrage**, false hellebore, Canby's lovage, clasping twistedstalk, globeflower, starworts (*Stellaria* spp.), willowherbs, rein orchids, and/or sedges typical. Leafy mosses (mostly large leaf [*Rhizomnium magnifolium*]), sickle-moss, and thalose liverworts are common.

Differentiating from Other Site Series

The 112 is the wettest forested site series in the ESSFwm3. Horsetails, leatherleaf saxifrage, abundant leafy mosses, and moderate to low false hellebore cover distinguish the 112 from drier sites (111). Wetter sites tend to be sparsely treed or non-treed wetlands.

Variability

Variability in species composition is high on these sites due to microsite variation. Naturally mounded sites are common, with trees and drier indicator species often on elevated sites, and wetter indicator species, such as sedges, moisture-associated mosses, horsetails, and leatherleaf saxifrage, in depressions where the water table is at or close to the surface. Some sites may lack horsetail but exhibit other very wet indicators.

The 112 site series is typically riparian-associated. It is usually a high bench flood site, but can be a treed swamp. Users who require additional information can use phases to reflect this variability:

112a for riparian flood sites

112b for the swamp phase with a thick organic veneer and very poor drainage (Ws08.2) (see Section 6.2)

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, competition from herbaceous brush can be a concern in regenerating stands. Cold air and frost may limit seedling regeneration.

False azalea
Menziesia ferruginea

White-flowered rhododendron
Rhododendron albiflorum

Other Ecosystems

The following ecosystems occur within the ESSFwm3; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands
Wetlands are uncommon in the steep, high-elevation, mountainous terrain of the ESSFwm3. The most common wetland types are fens (Wf), although marshes (Wm), swamps (Ws) and, at higher elevations, alpine wetlands (Wa) occur infrequently. Wetland ecosystems are described in Section 6.2.

Grasslands and brushlands
Grassland (Gg) and brushland (Gb) communities have been observed in the southern Bonnington Range, but are extremely uncommon in the ESSFwm3 and are limited to the driest, warmest sites. Section 6.4 provides descriptions of grassland and brushland ecosystems.

Avalanche features
High snowfall and steep mountainous terrain make avalanche paths very common in the ESSFwm3. A number of herb (Vh), shrub (Vs), and (Vt) avalanche ecosystems occur. Section 6.5 describes these ecosystems in detail.

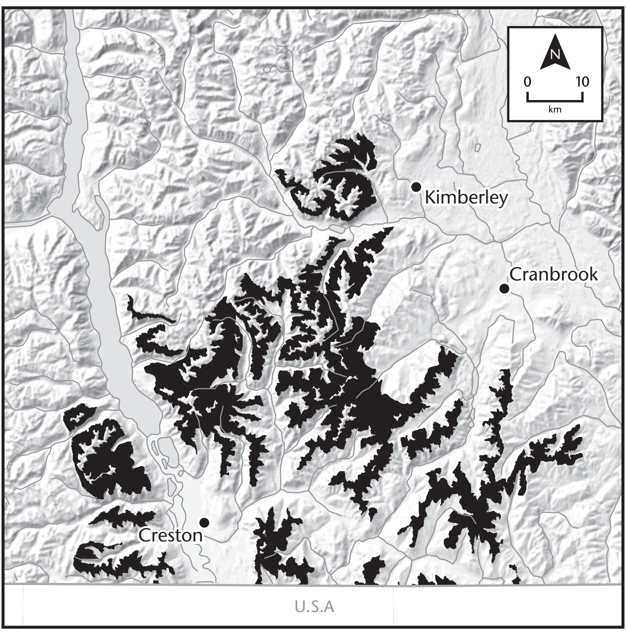
Rock outcrops and talus slopes
Numerous rock outcrop (Ro) and talus (Rt) ecosystems occur in the ESSFwm3 and are commonly found with the driest forested ecosystems. Descriptions of rock ecosystems are provided in Section 6.6.

ESSFwm4
Yahk Wet Mild
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwm4 occurs in the southern Purcell Mountains from Akokli Creek in the west to Matthew Creek, Moyie Mountain, and Yahk Mountain in the east, including the Moyie and Goat Rivers, as well as Hawkins, Freeman, Kid, Hellroaring, and Arrow Creeks. It also occurs in the south Selkirk Mountains, from Cultus Creek south to the U.S. border, including Next, Summit, and Corn Creeks. The ESSFwm4 occurs above the ICHdm and below the ESSFwmw, except in the south Selkirk Mountains, where it occurs above the ICHmw4. At similar elevations, it borders the ESSFwh2 and ESSFwm2 in the Purcell Mountains, the ESSFwh3 and ESSFwm3 in the south Selkirks, and the ESSFdk1 at its eastern extent. Terrain is more subdued in the ESSFwm4, and, in many areas, the ESSFwm4 extends to the tops of the mountains and hilltops.

Distribution of the ESSFwm4



Elevation Range

The ESSFwm4 borders the ICHdm in the south Purcell Mountains between 1575 and 1600 m on cool aspects and from 1600 to 1625 m on warm aspects. In the south Selkirk Mountains, the lower boundary with the ICHmw4 is from 1500 to 1550 m on cool aspects and from 1550 to 1650 m on warm aspects. At upper elevations, the boundary with the ESSFwmw ranges from 2000 to 2050 m on cool aspects and from 2050 to 2100 m on warm aspects.

Climate[1]

The ESSFwm4 is located in the Moist climate subregion, at the transition to the Dry climate subregion of the East Kootenay. It is characterized by cool, dry to moist summers, and cold, moist winters with a deep snowpack. Rain-on-snow events occur during most winters, particularly in the lower third of the unit, but are infrequent. The ESSFwm4 is drier than the ESSFwm1, ESSFwm2, ESSFwm3, and ESSFwc4. Growing-season moisture deficits can occur on subxeric and drier sites.

Forest and Vegetation Characteristics

The vegetation patterns of the ESSFwm4 are largely a result of lower-elevation mountains and relatively subdued terrain as compared to the remainder of the area covered by this field guide. At upper elevations above the ESSFwm4, woodland is moderately uncommon, parkland is extremely limited, and alpine areas are absent.

Bl, Se, and Pl are the dominant tree species, although Pa often occurs on drier, rocky sites at upper elevations and La is common on the coldest sites. Unlike similar ESSF subzones in the region, the ESSFwm4 is not bordered by an ICH/ESSF transitional unit at lower elevations. Hw, Cw, Fd, and Lw are often present throughout the full elevation range of the ESSFwm4 but tend to be more abundant in the lower third of the unit. At upper elevations, these tree species are either scattered and uncommon or restricted to the understorey. Both white-flowered rhododendron and false azalea are common across most sites in the ESSFwm4, along with black huckleberry. **Zonal sites** characteristically have abundant Bl, foamflower, and arnica, and may have minor amounts of bear-grass and grouseberry/low bilberry. Pl, bear-grass, and grouseberry/low bilberry typify **drier sites**. Oak fern, Canby's lovage, arrow-leaved groundsel, and false hellebore are common on **wetter sites**. Pl is common across mesic and submesic sites in early to mid-seral stages.

Avalanche tracks are uncommon throughout the ESSFwm4. Dry grasslands (Gg) and brushlands (Gb) occur infrequently and provide important plant diversity and wildlife habitat.

[1] See Section 4.2 for more information on climate variables.

Disturbance

Relatively frequent **fires** have left a range of stand ages across the landscape. Mature forests (140–250 years old) are common, but old growth (> 250 years) is uncommon, likely due to a combination of fires and extensive **timber harvesting**. Moderately long intervals usually occur between stand-replacing fires, although mixed-severity fires are known to occur, particularly at lower elevations (< 1750 m) on warm aspects and on slopes connected to areas of the ICH with higher fire frequency (Greene 2010). Snow avalanching is uncommon due to the relatively subdued terrain and lower-elevation mountains.

Mountain pine beetle has been a significant disturbance agent throughout much of the ESSFwm4, especially on drier than mesic sites where Pl is abundant. **Small-scale forest gap dynamics**, created by windthrow, insects, and pathogens, are widespread and important for creating structural complexity between stand-replacing fires. Endemic levels of **western balsam bark beetle** are key drivers of regeneration and multi-aged stands. **Spruce bark beetles** are known to inflict high mortality, particularly following fire or blowdown, or where slash retention is high after harvest. **White pine blister rust** and, more recently, mountain pine beetle have had devastating effects on whitebark pine. Armillaria root rot can affect Fd, Lw, and Hw at lower elevations in the ESSFwm4.

Soils, Geology, and Landforms

Soils are derived primarily from fine-grained metasedimentary rocks: argillite, sandstones, mudstones, conglomerate, and quartzite. Granodiorite intrusive rocks are also common, especially at the south end of Kootenay Lake. Colluvial soils with high coarse fragment content are widespread, along with morainal deposits. Soils on colluvium and morainal deposits typically have silt loam to sandy loam textures. Morainal soils may also be calcareous, grading to sandy or silty clay loam at depth or coarser sandy loam to loamy sand with increasing coarse fragments at depth. Glaciofluvial soils occur in some upper creek valleys and are gravelly with sandy loam to sand textures. Fluvial fans, floodplains, and glaciolacustrine deposits are uncommon.

Wildlife Habitat

The ESSFwm4 provides important late-seral habitat for threatened **mountain caribou** from the South Selkirk and South Purcell sub-populations. Large old trees, wildlife trees with cavities, hollow logs, coarse woody debris, and associated root balls are important habitat elements for a diversity of wildlife tree users (e.g., **three-toed and hairy woodpeckers**, **boreal and**

mountain chickadees, **red-breasted nuthatch**, **olive-sided flycatcher**, **American marten, little brown myotis, barn swallow**). Many of these species are insectivorous and assist in biological control of forest insects.

Wide-ranging carnivores such as **wolverine**, **lynx**, **wolf**, and **other furbearers** use the ESSFwm4 year-round. **Grizzly bears** feed extensively on berry-producing shrubs, particularly huckleberries, throughout summer. **Mule deer**, **moose**, **Rocky Mountain elk**, and **bighorn sheep** use the ESSFwm4 as summer range.

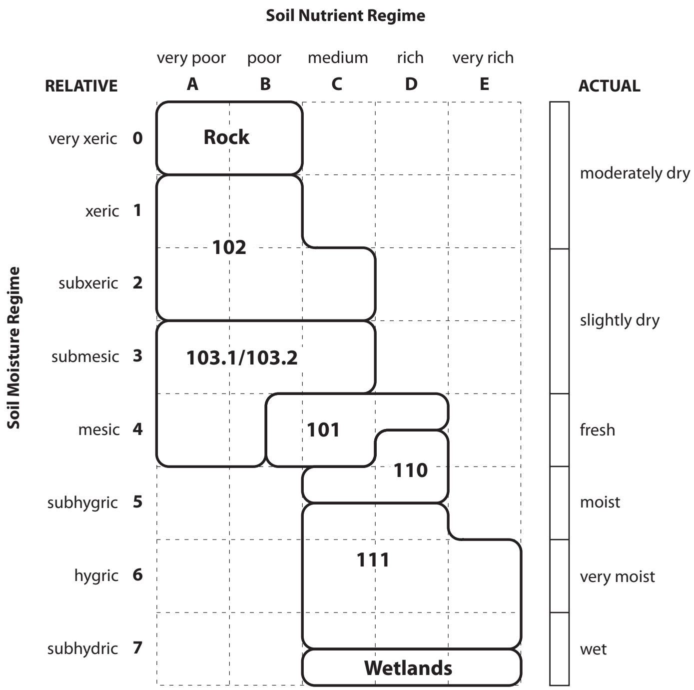
Wetland and riparian habitats are used by at-risk **western toads**, and **Rocky Mountain tailed frogs** breed in clear, cold, swift streams with coarse substrates. Rock outcrops and talus are important breeding habitats for species-at-risk, such as **red-tailed chipmunk** and **black swift.** The ESSFwm4 supports several at-risk vascular plant species**,** including endangered **Pa**, which relies on **Clark's nutcracker** for seed dispersal. Ruby-crowned kinglet, yellow-rumped warbler, Townsend's warbler, dark-eyed junco, and hermit thrush are common bird species.

Distinguishing the ESSFwm4 from Adjacent Biogeoclimatic Units

In the **ICHdm**, most sites have:	- minor Se, Bl (not dominant across the landscape) - no rhododendron and very little false azalea, except on wet sites with cold-air influence - less bear-grass and grouseberry/low bilberry
zonal sites have:	- Hw and Cw dominant or codominant - Lw, Pw, Pl, western yew, twinflower, prince's pine, pipecleaner moss, and red-stemmed feathermoss - no grouseberry/low bilberry or wood-rushes
dry sites have:	- Fd dominant in the canopy - birch-leaved spirea, pinegrass, twinflower, and prince's pine
wet sites have:	- more oak fern, baneberry, five-leaved bramble, and leafy mosses - devil's club and lady fern - little to no arrow-leaved groundsel and Canby's lovage
In the **ESSFwh2**, most sites have:	- more Cw, Hw, Fd, and Lw - less arnica
zonal sites have:	- more foamflower, oak fern, five-leaved bramble, and queen's cup
dry sites have:	- less white-flowered rhododendron, grouseberry/low bilberry, and bear-grass - more falsebox
wet sites have:	- more oak fern, lady fern, spiny wood fern, and devil's club

In the **ESSFwm2**, most sites have:	- less Pl - little to no grouseberry/low bilberry - no Lw, Fd, Hw, or Cw - more leafy liverworts
zonal sites have:	- no bear-grass
wet sites have:	- more oak fern, globeflower, and false hellebore
In the **ESSFwh3**, most sites have:	- less false azalea - more Cw, Hw, Fd, and Lw
zonal sites have:	- more foamflower, oak fern, and queen's cup
dry sites have:	- less white-flowered rhododendron; more falsebox
wet sites have:	- more oak fern, lady fern, and devil's club
In the **ESSFwm3**, most sites have:	- less Pl and false azalea - more wood-rushes - little to no grouseberry/low bilberry - no Lw, Fd, Hw, or Cw
zonal sites have:	- little to no bear-grass - more mitrewort, false hellebore, and leafy liverworts
wet sites have:	- more Sitka valerian and false hellebore
In the **ESSFwmw**, most sites have:	- no false azalea - small amounts of mountain-heather - more wood-rushes
dry sites have:	- La and more Pa
In the **ESSFdk1**, most sites have:	- no Hw or Cw - less foamflower, Bl, huckleberry, and white-flowered rhododendron
dry sites have:	- more pinegrass
wet sites have:	- no oak fern, lady fern, or devil's club

Edatopic Grid



Site series

101 Bl – Rhododendron – Azalea – Foamflower

102 BlPl – Low bilberry – Bear-grass

103.1 Bl – Azalea – Low bilberry

103.2 Bl – Azalea – Bear-grass

110 BlSe – Azalea – Oak fern

111 Bl – Arrow-leaved groundsel – Canby's lovage

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects
- shallow, coarse soils

→
- SMR 2 (1)
- Pl (Se, Pa, Bl) canopy
- exposed bedrock may or may not be prominent
- false azalea and rhododendron are sparse or absent (< 10% cover)

→ **102**

SLIGHTLY DRY to MESIC FORESTS
- mid slopes (usually) with deep soils

→
- SMR 3 (4)
- Bl, Se (Pl) stands
- low bilberry/ grouseberry abundant
- foamflower, arnica, and mitreworts sparse or absent

→
- little to no bear-grass (< 5% cover)

→ **103.1**

→
- high bear-grass (> 5% cover)

→ **103.2**

→
- SMR 4 (3)
- Bl, Se stands
- moderate arnica , foamflower, and woodrushes (3–7% cover)
- oak fern, arrow-leaved groundsel, and leafy mosses sparse to absent
- < 3% cover of bear-grass and low bilberry/grouseberry

→ **101**

MOIST to WET FORESTS
- level, lower and toe slopes
- seepage or mottles
- often associated with riparian areas

→
- SMR 5 (4)
- Se, Bl stands
- lower slopes and receiving sites
- oak fern, black gooseberry, and leafy mosses with low to moderate cover (2–7%)

→ **110**

→
- SMR 6 (5,7)
- Se, Bl stands
- abundant false hellebore, Canby's lovage, globeflower, and/or arrow-leaved groundsel

→ **111**

Vegetation Table

Layer	Scientific name	102	103.1	103.2	101	110	111	Common name
Trees	*Pinus contorta*	■■■■	□□□	□□□				lodgepole pine
	Abies lasiocarpa	■■■■	■■■■	■■■■	■■■■	■■■■	■■■	subalpine fir
	Picea engelmannii	□□	■■■	■■■■	■■■■	■■■■	■■■■	Engelmann spruce
Regen	*Abies lasiocarpa*	■■■	□□□	■■■	■■■	■■■	■■■	subalpine fir
	Picea engelmannii		□□	□□	□	■	■■■	Engelmann spruce
Shrubs	*Vaccinium membranaceum*	■■■	■■■	■■■■	■■■■	■■■	■■	black huckleberry
	Spiraea betulifolia	■■						birch-leaved spirea
	Paxistima myrsinites	□						falsebox
	Menziesia ferruginea		■■■■	■■■■	■■■■	■■■■■	■■■	false azalea
	Rhododendron albiflorum		■■■■	■■■	■■■■	■■	■■	white-flowered rhododendron
	Ribes lacustre					■■	■■	black gooseberry
	Lonicera involucrata						□□	black twinberry
Herbs	*Vaccinium scoparium/ myrtillus*	■■■■	■■■■	■■■	□□	*		grouseberry/low bilberry
	Xerophyllum tenax	□□□□	*	■■■■■	*			bear-grass
	Hieracium albiflorum	■						white hawkweed
	Arnica spp.	*	□□	*	■■■	■■■	□□	arnicas
	Tiarella trifoliata var. *unifoliata*				■■	■■■	□□	one-leaved foamflower
	Luzula spp.				□□			wood-rushes
	Veratrum viride				□	■■	■■■	false hellebore
	Mitella spp.				□	□□	■■	mitreworts
	Clintonia uniflora				*	□□□		queen's cup
	Gymnocarpium dryopteris					■■■		oak fern
	Senecio triangularis					■	■■■■	arrow-leaved groundsel
	Ligusticum canbyi					■	■■■	Canby's lovage

Layer	Scientific name	102	103.1	103.2	101	110	111	Common name
Herbs	*Thalictrum occidentale*					*	▪▪▪	western meadowrue
	Symphyotrichum foliaceus						▪▪	leafy aster
	Equisetum spp.						▪▪	horsetails
	Trollius albiflorus						▪▪	globeflower
Moss layer	*Cladonia* spp.	▪▪	*					clad lichens
	Rhytidiopsis robusta	▪	■■■■	▪▪▪	*			pipecleaner moss
	Brachythecium spp.		▪▪▪	■■■	■■■	■■■	*	ragged-mosses
	Dicranum spp.		■■■	▪	▪			heron's-bill mosses
	Barbilophozia spp.		▪▪	*	▪			leafy liverworts
	"leafy mosses"[a]					▪▪	▪▪	leafy mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots ▪ 50–70% of plots

Environment Table[a]

Site series	102	103.1 / 103.2	101	110	111
No. of plots	12	33	18	10	11
SMR	2 (1)	3 (4)	4 (3)	5 (4)	6 (5,7)
SNR	A–C	A–C	B–D	C–D	C–E
Slope position	UP–CR (MD)	MD–UP	MD	LW (MD, TO)	TO, LV
Typical slope/ aspect	Steep/warm; gentle crests	Moderately steep/neutral–warm	Moderate/ neutral–cool	Gentle–moderate/ cool (warm)	Level–gentle
Common compensating conditions	Fragmental, mid-slopes/ warm	Coarse, upper/ cool; very coarse/lower	Lower/coarse; gentle/warm	Mid-slope receiving	
Surficial materials	Cv/R, Mv/R (Cb, FG)	Mb, Cb, FG	M (C)	Mb (Fv/Mb)	F, Ov/F (Ov/L)
Soil texture	SL, LS	SL (LS)	SL, SiL	SL, SiL (SiCL, LS)	SL, SiL
Coarse fragment content	High	Moderately high–high	Low–moderately high	Low–moderately high	Variable, often increasing with depth
Important features	Coarse or shallow soils; bedrock can be common			Mottles at depth	Water table near surface

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

Bl – Rhododendron – Azalea – Foamflower 101

General Description

SMR 4 (3). 101 sites occur on **mid slopes of cool and neutral aspects** with **medium-textured soils**. Due to compensating factors, they also occur on lower slopes with moderately coarse-textured soils and occasionally on gently sloped warm aspects. Deep morainal deposits are common. Soils are typically well- to moderately well-drained Dystric Brunisols or Orthic Humo-Ferric Podzols, with sandy loam textures and Mor humus forms.

Se and **Bl** typify the overstorey, while **false azalea**, **white-flowered rhododendron**, and **black huckleberry** dominate the understorey shrub layer. **Arnica**, **foamflower**, and small amounts of bear-grass and/or grouseberry/low bilberry are typical in the herb layer.

Differentiating from Other Site Series

Slightly drier sites (103) tend to be dominated by bear-grass and/or grouseberry and low bilberry, and are more common on warm aspects or cooler sites with coarse soils. Moister sites have oak fern, black gooseberry (110), and/or moist species, such as Canby's lovage and arrow-leaved groundsel (111).

Variability

Minor cover of Cw, Hw, and Lw is common in this unit in the lower third of the ESSFwm4/101. Pl can be a common part of the species mixture in seral stands, although it is rarely dominant on these sites.

Management Issues

This site series has high productivity for the ESSF and few limiting factors for tree growth. It is amenable to the growth of a wide variety of species, and species diversity should be fostered.

102 BlPl – Low bilberry – Bear-grass

General Description

SMR 2 (1). The 102 site series typically occurs on **steep, warm, upper slopes with shallow and/or coarse-textured soils**. It also occurs on **dry crests** and on forested sites with **extensive exposed bedrock**, although these sites are uncommon in the ESSFwm4. Soils are usually rapidly drained Eutric or Dystric Brunisols with sandy soil textures (sandy loam or loamy sand) and are derived mainly from colluvium, although kame terraces and coarse-textured morainal materials are also common. Coarse fragment content is usually high (often fragmental), and humus forms are typically a thin Mor.

Pl dominates the overstorey along with **Bl**. At upper elevations, **La** and **Pa** may occur. At lower elevations, **Lw** and **Fd** can be present. Se occurs occasionally. **Black huckleberry** is the dominant shrub, with minor amounts of **birch-leaved spirea** common. White-flowered rhododendron and false azalea are typically sparse or absent. **Grouseberry/low bilberry** are typically abundant, while bear-grass cover ranges from abundant to absent. **White hawkweed** is usually present in minor amounts.

Differentiating from Other Site Series

The 102 is the driest forested site series recognized in the ESSFwm4. Drier sites include non-forested rock outcrops and talus slopes with < 10% tree cover. Slightly moister sites (103) have deeper soils, and usually have abundant white-flowered rhododendron and/or false azalea and a well-developed moss layer.

Variability

The 102 can occur on dry sites with abundant exposed bedrock. In most other biogeoclimatic units, a separate site series is identified. Users who require additional information can refer to site phases as:

102a for sites with prominent exposed bedrock (xeric phase)

102b for sites on shallow and/or coarse soils (subxeric phase)

White-flowered Rhododendron and false azalea may be absent at lower elevations close to the ICH.

Management Issues

Bedrock-dominated sites (102a) are not recommended for timber harvesting due to limitations in available soil and soil moisture for tree regeneration and growth; caution should be used to ensure regeneration success on warm, shallow, coarse sites (102b). Snow creep and avalanching may cause damage to tree regeneration on steep slopes in winter, while soil erosion can be a concern on steep slopes during the growing season.

Bl – Azalea – Low bilberry 103 / 103.1
Bl – Azalea – Bear-grass 103.2

General Description

SMR 3 (4). 103 forests occur on medium- to moderately coarse-textured soils on mid slopes of **warm aspects** and on **shallow or coarse-textured soils** on **cool to neutral aspects**. Due to compensating factors, this site series also occurs on upper slopes on warm aspects with deep soils and on lower slopes with either shallow or very coarse-textured soils. Soils are typically Orthic Humo-Ferric Podzols or Eluviated Dystric Brunisols with sandy loam or loamy sand textures and Mor humus forms.

Key species are **white-flowered rhododendron**, **false azalea**, and **grouseberry/low bilberry**. **Bl** and **Se** are typically the dominant species, although **Pl** is common and Lw or small amounts of Hw often occur at lower elevations. **Bear-grass** is abundant in the 103.2 variation (see below).

Differentiating from Other Site Series

Slightly drier sites (102) occur on steep, warm aspects with coarse and/or shallow soils and typically lack false azalea and white-flowered rhododendron. Slightly moister sites (101) are not dominated by Pl, grouseberry/low bilberry, or bear-grass, and have more foamflower and arnica.

Variability

This site series has been further subdivided into two variations:

103.1 Bl – Azalea – Low bilberry
has little to no bear-grass

103.2 Bl – Azalea – Bear-grass
has abundant bear-grass (> 5% cover)

Arnica, pipecleaner moss, and heron's-bill mosses are more common in the 103.1 (grouseberry/low bilberry) variation. The 103.2 variation is more common on glaciofluvial parent materials, including mid-slope kame terraces.

Management Issues

This site is amenable to the growth of several tree species, and diversity should be fostered. Snow creep and avalanching may cause damage to tree regeneration on steep slopes in winter, while soil erosion can be a concern on steep slopes during the growing season.

110 **BlSe – Azalea – Oak fern**

General Description

SMR 5 (4). The 110 occurs on **lower slopes** with **seasonal seepage** at depth (50–75 cm below the soil surface), and is occasionally found on mid-slope seepage sites. Surficial materials are typically morainal, or fluvial veneers over morainal materials on sites that are in **riparian** areas. Soils are primarily Gleysols or Gleyed Dystric Brunisols with loamy textures (silt loam or sandy loam).

Se and **Bl** are common in the overstorey. **Black huckleberry** and **false azalea** are usually abundant in the understorey, along with minor amounts of **black gooseberry** and white-flowered rhododendron. The herb layer is diverse, with small amounts of many species, including **oak fern**, **arnica**, **foamflower**, **false hellebore**, **queen's cup**, and **mitreworts**. The moss layer is variable, with ragged-mosses and leafy mosses characteristic.

Differentiating from Other Site Series

On slightly drier sites (101), oak fern, mitreworts, and black gooseberry are typically absent. Moister sites (111) have abundant arrow-leaved groundsel, false hellebore, and Canby's lovage, along with horsetails and/or globeflower.

Variability

Queen's cup, oak fern, foamflower, and black gooseberry are more common and abundant in the 110 in the lower two-thirds of the ESSFwm4, while arrow-leaved groundsel, false hellebore, Canby's lovage, and Sitka valerian are more abundant at upper elevations. Heart-leaved arnica (*Arnica cordifolia*) is common at lower elevations, while mountain arnica (*A. latifolia*) is more typical at upper elevations.

Management Issues

This site series has high productivity for vegetation, particularly in the lower half of the ESSFwm4. This supports more rapid tree growth, but vegetation competition may create brush concerns for regenerating trees. Due to moist soils, compaction and rutting are potential harvesting hazards and sites should be harvested when soils are dry or frozen. Sites frequently provide travel corridors and forage for wildlife.

Bl – Arrow-leaved groundsel – Canby's lovage 111

General Description

SMR 6 (5,7). 111 sites occur on toe slopes, in depressions, and along riparian areas where a **high water table** is present in the **upper 30 cm** of the soil profile throughout the growing season. Slopes are typically **gentle or level**. Parent materials are usually fluvial but can be lacustrine where stands are adjacent to small lakes. Soils are typically imperfectly to poorly drained Orthic Humic Gleysols, often with a thin organic veneer or thick humus form. Flooding can be rare to occasional.

Se and Bl are the dominant tree species found in frequently open canopies. Shrub cover tends to be variable, with false azalea, black gooseberry, and black twinflower common, along with small amounts of white-flowered rhododendron and black huckleberry. Understorey herbaceous species diversity is very high, with **arrow-leaved groundsel**, **Canby's lovage**, and **false hellebore** characteristically abundant, along with small amounts of numerous herbaceous species. **Horsetails** may be present but rarely dominate. Leafy mosses frequently occur, often with glow moss (*Aulacomnium palustre*) and occasionally with peat-mosses (*Sphagnum* spp.)

Differentiating from Other Site Series

Slightly drier sites (110) have less arrow-leaved groundsel, Canby's lovage, and false hellebore, more arnica and oak fern, and higher shrub cover. The 111 is the wettest forested site series described in the ESSFwm4; wetter sites are typically non-forested wetlands.

Variability

Minor oak fern and lady fern may be present at lower elevations that are transitional to the ICH. Sedges are common but typically occur with low cover. These sites often occur with non-forested wetlands or as narrow strips along floodplains and lake edges. Sites are typically mounded, with trees and drier indicator species, such as black huckleberry or arnicas, growing on elevated sites, and wetter indicator species, such as peat-mosses and horsetails, growing in hollows.

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where tree removal occurs, competition from herbaceous brush can be a concern in regenerating stands. Cold air and frost may also limit regeneration. Sites provide important forage for wildlife in landscapes where steep terrain is dominant.

Other Ecosystems

The following ecosystems occur within the ESSFwm4; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands
Fens (Wf), marshes (Wm), and swamps (Ws) occur in the ESSFwm4. At upper elevations of the ESSFwm4, alpine wetlands (Wa) also occur. Wetland descriptions are provided in Section 6.2.

Grasslands and brushlands
Grasslands (Gg) and brushlands (Gb) are uncommon in the ESSFwm4 and are limited to the driest, warmest sites. Section 6.4 provides descriptions of grassland and brushland ecosystems.

Avalanche features
Avalanche paths are uncommon in the ESSFwm4 relative to other ESSF units in the Columbia Mountains, largely due to more subdued terrain and smaller mountains. Herb (Vh), shrub (Vs), and treed (Vt) avalanche ecosystems occur, and are described in Section 6.5.

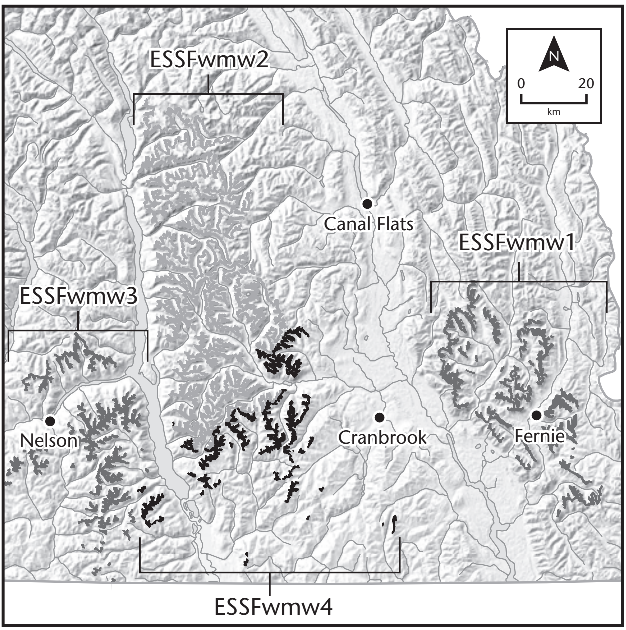
Rock outcrops and talus slopes
Numerous rock outcrop (Ro) and talus (Rt) ecosystems occur in the ESSFwm4 and are commonly found adjacent to the driest forested ecosystems. Descriptions are provided in Section 6.6.

ESSFwmw
Wet Mild Woodland
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwmw occurs at the uppermost forested elevations, where tree cover is consistently present, but productivity is reduced due to high snowpack, cold temperatures, frost, and shorter growing seasons. The ESSFwmw occurs below the ESSFwmp and above the wet mild variants of the ESSF: the ESSFwm1 in the Elk Ranges of the Rocky Mountains, the ESSFwm2 in the central Purcells, the ESSFwm3 in the south Selkirks, and the ESSFwm4 in the south Purcells. To the north and west, the ESSFwmw is bordered by the ESSFwcw; to the east, it is replaced by the ESSFdkw. Although the ESSFwmw is described in this guide as one biogeoclimatic unit, users who require additional information can separate the ESSFwmw based on the ESSFwm variants that occur below: ESSFwmw1, ESSFwmw2, ESSFwmw3, and ESSFwmw4.

Distribution of the ESSFwmw



Elevation Range

The ESSFwmw elevation range varies broadly from east to west and north to south. In the south Selkirks, the ESSFwmw3 extends from approximately 1950 to 2150 m on cool aspects and from 2000 to 2200 m on warm aspects. In the central Purcells, the elevation boundaries of the ESSFwmw2 typically extend from approximately 1950 to 2150 m on cool aspects and 2000–2200 m on warm aspects. In the south Purcells, parkland areas are limited, and the ESSFwmw4 typically occurs from 2050 m on cool aspects and 2100 m on warm aspects to mountain tops, except at the northern extent where its upper boundary with the ESSFwmp is 2200 m on cool aspects and 2250 m on warm aspects. In the Rockies, the ESSFwmw1 elevation varies widely from between 1900 and 2250 m on cool aspects and from between 2000 and 2350 m on warm aspects.

Climate[1]

The ESSFwmw is in the Moist climate subregion and is characterized by cold, wet summers and cold, moist to wet winters with heavy snow and a very deep snowpack that typically persists from October through June or early July; sheltered areas of late snowmelt persist into the summer. Growing-season moisture deficits are uncommon on all but the driest sites.

Forest and Vegetation Characteristics

Bl is the dominant tree species in the ESSFwmw, although Se is also common and is codominant on moister sites. Pa also occurs, particularly on drier sites. La is common throughout the ESSFwmw on drier sites, although it occasionally occurs on submesic and mesic sites. The ESSFwmw and ESSFwmp have one of the highest concentrations of La in the world, particularly in the Purcell Mountains.

The ESSFwmw covers a wide geographic range, extending almost 200 km from east to west and approximately 165 km from north to south. This results in high variability in vegetation. The driest areas are above the ESSFwm4. White-flowered rhododendron and black huckleberry are common across most forested sites in the ESSFwmw. **Zonal sites** have abundant Bl, black huckleberry, white-flowered rhododendron, wood-rushes, and Brewer's mitrewort. Grouseberry and low bilberry are common and abundant on **submesic** sites across the ESSFwmw, and frequently occur with high cover on mesic sites in the ESSFwmw4. Bear-grass commonly occurs on mesic and drier sites in the ESSFwmw3, and, to a lesser extent, the ESSFwmw1 and ESSFwmw2. Mountain-heathers often occur but at very low densities. **Wetter sites** have extensive and diverse herb communities characterized by

[1] See Section 4.2 for more information on climate variables.

arrow-leaved groundsel, globeflower, false hellebore, Brewer's mitrewort, Canby's lovage, Sitka valerian, and sedges.

The woodland is a transition between productive subalpine forests and non-forested high-elevation parkland and alpine ecosystems; as a result, higher-elevation non-forested ecosystem types are commonly scattered throughout the mostly forested ESSFwmw. Common types are small meadows (Am), late snowmelt patches on sheltered cool aspects (As), brushlands and grasslands (Gb and Gg; particularly above the ESSFwm3 and ESSFwm4), and krummholz (Sk) (see Section 6.7). The combination of steep terrain and a deep snowpack results in widespread avalanche tracks (see Section 6.5).

Tree productivity is relatively low across the ESSFwmw. Large-diameter Se are common, especially on mesic and wetter sites, but trees tend to have shorter heights (< 20 m at maturity), higher taper, and lower growth rates than trees at lower elevations in the ESSF. Cold air, frost, shorter growing seasons, and a deep snowpack limit tree regeneration and growth.

Disturbance

Old forests are common in the ESSFwmw where stand-replacing disturbances occur infrequently. Fires are the dominant broad-scale natural disturbance. **Small-scale forest gap dynamics** caused by windthrow, insects, and pathogens are the primary stand-replacing processes between fires. Endemic levels of **western balsam bark beetle** are key drivers of regeneration and multi-aged stands. Spruce beetle can occur but tends to have less of an impact than at lower elevations. White pine blister rust and, more recently, mountain pine beetle have had devastating effects on whitebark pine. Timber harvesting history is limited.

Soils, Geology, and Landforms

The broad distribution of the ESSFwmw covers a wide range of soil, geology, and landform types. In the Rocky Mountains, sedimentary rocks (limestone, slate, siltstone, and argillite) are common and frequently calcareous with high pH. Underlying geology is more complex in the Selkirk and Purcell Mountains, where coarse-grained intrusive materials, particularly granodiorites, mix with finer sedimentary and metasedimentary rocks, such as phyllite, schist, mudstone, siltstone, and argillite. Marble and quartz occur in the central Purcell Mountains. Rock outcrops and talus are common throughout.

Surface soil textures are most often sandy loam with loamy sand at depth in the south Selkirk Mountains, loam to sandy loam in the Purcell Mountains, and silt loam to loam in the Rocky Mountains. Calcareous soils are most common in the Rocky Mountains but occur in the Purcell Mountains, and are occasionally present in the south Selkirks Mountains.

Wildlife Habitat

This very large and widespread unit supports important habitats and provides vital connectivity for a diversity of wildlife species. The ESSFwmw provides critical habitat for endangered **mountain caribou** populations. Intact and undisturbed stands of large, old trees with heavy lichen loads are vital components of caribou winter range. Other ungulates, including **Rocky Mountain bighorn sheep**, **elk**, and **mule deer** forage in productive brushlands and windswept grasslands of the ESSFwmw during snow-free months, especially in the Purcell and Rocky Mountains. **Mountain goats** occur year-round, in association with abundant steep, rocky terrain.

The ESSFwmw is critically important for populations of wide-ranging carnivores such as **wolverine** and **grizzly bear**, which rely on productive habitats with abundant herbaceous vegetation (e.g., avalanche tracks, lush meadows, wetlands) for spring food. Bears feed extensively on huckleberries during the late summer. **Whitebark pine** is scattered on drier sites. **Clark's nutcracker** (the main seed disperser of Pa) removes the seeds from the cones and buries them at sites that can provide ideal conditions for germination, if left undetected.

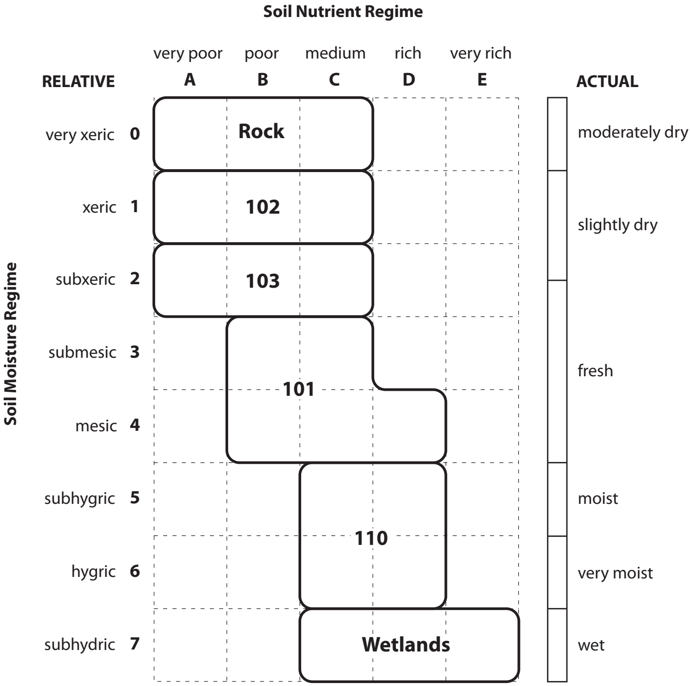
Several other at-risk species have been confirmed in the ESSFwmw. Burrowing mammals that potentially occur year-round in open habitats with friable soils include **least chipmunk** and **red-tailed chipmunk**. **Horned lark**, **Brewer's sparrow**, **olive-sided flycatcher**, and **gray-crowned rosy finch** are uncommon breeding bird species in forests and brushland and/or grassland patches of the ESSFwmw, and a variety of at-risk raptors can occur in this unit during migration (e.g., **broad-winged, Swainson's**, and **rough-legged hawks**; **peregrine** and **prairie falcons**). **Western toads** breed in small wetlands, and use forests and woodland patches with an abundance of cover, such as hollow logs, coarse woody debris, and brushy thickets.

Common birds associated with the ESSFwmw include hermit and varied thrushes, ruby-crowned kinglet, yellow-rumped warbler, dark-eyed junco, and Townsend's solitaire.

Distinguishing the ESSFwmw from Adjacent Biogeoclimatic Units

In the **ESSFwm1**, **ESSFwm2**, **ESSFwm3**, **ESSFwm4**, most sites have:	- considerably higher tree productivity with fewer natural openings - more false azalea - no mountain-heathers
zonal sites have:	- more arnica and foamflower
dry sites have:	- less Pa and/or La
wet sites have:	- more oak fern
In the **ESSFwcw**, most sites have:	- no false azalea - more mountain-heathers
dry sites have:	- less Pa and La
In the **ESSFdkw**, most sites have:	- less white-flowered rhododendron - no mountain-heathers - more grouseberry/low bilberry - less bear-grass
In the **ESSFwmp**, most sites have:	- large openings with non-forest ecosystems - shorter, stunted trees with clumpy distribution (krummholz) - more high-elevation species such as mountain-heathers, western pasqueflower, and paintbrushes

Edatopic Grid



Site series

101 Bl – Rhododendron – Wood-rush
102 BlLa – Heron's-bill moss
103 Bl(La) – Huckleberry – Grouseberry
110 Bl – Valerian – Hellebore – Globeflower

Site Series Flowchart

VERY DRY to DRY FORESTS • warm aspects • shallow soils	• SMR 1 • Bl (Se, Pa, La) stands • exposed bedrock prominent in stand • saxifrages, pussytoes, rock-mosses, and/or clad lichens	**102**
	• SMR 2 (3) • Bl (Se, Pl) canopy • steep, warm aspect • abundant grouseberry/low bilberry	**103**
SLIGHTLY DRY to MESIC FORESTS • mid slopes with deep soils	• SMR 3–4 • Bl (Se) stands • wood-rushes abundant • rhododendron and huckleberry abundant • minor grouseberry/low bilberry • little to no arrow-leaved groundsel, valerian, globeflower, or hellebore (< 3%)	**101**
MOIST to WET FORESTS • lower or toe slopes • seepage or mottles	• SMR 5–6 • Se, Bl stands • arrow-leaved groundsel, globeflower, false hellebore, and/or subalpine daisy abundant	**110**

Vegetation Table

Layer	Scientific name	102	103	101	110	Common name
Trees	*Abies lasiocarpa*	■■■	■■■■	■■■■	■■■■	subalpine fir
	Picea engelmannii	□□□	□□□	□□□	■■■■	Engelmann spruce
	Pinus albicaulis	□□□	□□□			whitebark pine
	Larix lyallii	□□□	*	*		subalpine larch
Regen	*Abies lasiocarpa*	■■■■	■■■■	■■■■	■■■	subalpine fir
	Picea engelmannii	□□	□	*	*	Engelmann spruce
	Pinus albicaulis	□□	■■			whitebark pine
Shrubs	*Vaccinium membranaceum*	□□□	■■■■	■■■■	■■■	black huckleberry
	Rhododendron albiflorum	□	■■■	■■■■	■■■	white-flowered rhododendron
Herbs	*Luzula* spp.	□□	■■■	■■■■	■■	wood-rushes
	Antennaria spp.	□□				pussytoes
	Arnica latifolia	□	□	□□	■■■	mountain arnica
	Phyllodoce spp.	□		□□		mountain-heathers
	Xerophyllum tenax	□		*		bear-grass
	Penstemon ellipticus	□				oval-leaved penstemon
	Vaccinium scoparium/myrtillus	*	■■■■	□□		grouseberry/low bilberry
	Pectiantia breweri			■	■■■	Brewer's mitrewort
	Carex nigricans				□□□	black alpine sedge
	Senecio triangularis				■■■	arrow-leaved groundsel
	Trollius albiflorus				■■■	globeflower
	Valeriana sitchensis				□□□	Sitka valerian
	Veratrum viride				■■■	false hellebore

Layer	Scientific name	102	103	101	110	Common name
Herbs	*Erigeron peregrinus*				□□	subalpine daisy
	Ligusticum canbyi				□□	Canby's lovage
	Pedicularis bracteosa				□□	bracted lousewort
	Thalictrum occidentale				□□	western meadowrue
	Viola spp.				■■	violets
	Parnassia fimbriata				□	fringed grass-of-Parnassus
Moss layer	*Dicranum* spp.	□□□	*	■■■		heron's-bill mosses
	Polytrichum spp.	□□□	□	■		haircap mosses
	Cladonia spp.	□□	■	*		clad lichens
	"leafy liverworts"[a]			□□□		leafy liverworts
	Brachythecium spp.		*	■■	□□□	ragged-mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site series	102	103	101	110
No. of plots	6	11	27	9
SMR	1	2 (3)	3–4	5–6
SNR	A–C	A–C	B–D	C–D
Slope position	UP–CR	UP–CR	MD	LW, TO, LV
Typical slope/ aspect	Steep–moderately steep/warm	Steep/warm	Moderately steep	Gentle, level (moderate)
Common compensating conditions		Neutral aspects with high sun exposure	Upper slope/ deep soils; lower slope/ coarse soils	Mid-slope receiving sites
Surficial materials	Cx/R, Mx/R, Dx	Cb, Mb (Cv, Mv)	Mb, Cb (Mv/R, Cv/R)	Mb, F (Cb, Lb)
Soil texture	FSL, SiL, SL	SL, L, SiL, FSL, LS	SL, Sil, FSL (LS, L)	SiL, SL, SiCL, FSL (L, LS)
Coarse fragment content	Moderate–fragmental	Moderate–fragmental	Variable	Variable; often sparse at surface
Important features	(Bed)rock is prominent and abundant	Insolation; coarse, shallow soils		Associated with riparian areas; often adjacent to wet depressions, ponds, or wetlands

[a] Codes and categories in Chapter 3. Keys for use in the field are in the appendices.

Bl – Rhododendron – Wood-rush 101

General Description

SMR 3–4. 101 forests occur on submesic to mesic sites on **mid slopes** with **deep, moderate to moderately coarse soils**. Due to compensating factors, this site series also occurs on lower slopes with coarse to very coarse soils and on upper soils with deep soils. Soils are typically Orthic Humo-Ferric Podzols with Hemimor humus forms, and are well to moderately well drained with loamy (FSL, SL, L, or SiL) soil textures.

Bl dominates the tree layers along with minor amounts of **Se**. Small amounts of La may be present. **Black huckleberry** and/or **white-flowered rhododendron** are typically abundant, along with **abundant wood-rushes** (primarily *Luzula hitchcockii;* also *L. parviflora* and *L. piperi*). Minor amounts of **mountain arnica**, **Brewer's mitrewort**, and **mountain-heathers** (< 3%) are typical. **Leafy liverworts** (especially mountain leafy liverwort [*Neoorthocaulis floerkei*]), **ragged-mosses**, and **heron's-bill mosses** are usually abundant.

Differentiating from Other Site Series

Drier sites (103) usually have abundant grouseberry and/or low bilberry and occur on subxeric sites, typically on warm aspects. Slightly wetter sites (110) have abundant herb cover with arrow-leaved groundsel, globeflower, false hellebore, subalpine daisy, Canby's lovage, and other forbs.

Variability

Grouseberry and/or low bilberry are often present in the ESSFwmw4 but are not typically the dominant herb on zonal sites. Bear-grass may be present, particularly in the ESSFwmw3 and ESSFwmw4. Wood-rushes are usually present, but cover may be low, particularly where bear-grass is present.

Management Issues

Timber harvesting is not recommended due to high snow cover, short growing seasons, and low tree productivity in regenerating stands. Where harvesting is undertaken, vegetation competition may be a concern. Avalanching and snowpress are likely on steep slopes.

102 **BlLa – Heron's-bill moss**

General Description

SMR 1. 102 forests occur on warm-aspect, rocky sites with **abundant bedrock or talus**. Soils are variable but shallow within any given stand, and comprise a mixture of bare rock and thin veneers. Soil textures vary considerably based on parent materials. Where granodiorites are the dominant rock type, soil texture is typically sandy loam; where finer rock types predominate, soils have silt loam or loam textures. The occurrence of this site series is very dependent on soil depth; the 102 often occurs as a mosaic with rock outcrops and the 103 site series in areas of variable soil depth.

Bl, **La**, **Pa**, and **Se** are common and comprise at least 10% total tree cover. **Black huckleberry** is the most common shrub, although **white-flowered rhododendron** may be present. Herb cover is usually sparse and variable, and typically includes minor cover (< 5%) of wood-rushes, **pussytoes**, **saxifrages**, **oval-leaved penstemon**, and mountain-heathers. Minor cover of mountain arnica, bear-grass, grouseberry, and/or low bilberry is common. Mosses are typically abundant and distinctive, with **heron's-bill mosses**, **clad lichens**, and **haircap mosses** most common.

Differentiating from Other Site Series

The 102 is the driest forested site series in the ESSFwmw. Drier sites include non-forested rock outcrops (Ro) and talus (Rt) with < 10% tree cover in the stand (see Section 6.6). Slightly moister sites (103) lack abundant (bed) rock at the surface, have more grouseberry and/or low bilberry, less moss cover, and lack species such as saxifrages and penstemons. La may be present on 102 sites, but a separate talus unit (Rt21) describes La-leading sites (see Section 6.6).

Variability

Plant species vary within sites based on soil depth in small microsites; moister species occasionally occur in deeper pockets of soil. Minor cover of bear-grass may occur, particularly in the ESSFwmw3 and ESSFwmw4. Calcareous rock outcrops may contain more diverse understorey species, including some that are more common at lower elevations.

Management Issues

This site series in not recommended for timber harvesting due to low productivity, short growing seasons, and limitations in available soil for tree regeneration and growth. These sites may provide habitats for rare and at-risk plant species (e.g., Pa).

Bl(La) – Huckleberry – Grouseberry 103

General Description

SMR 2 (3). 103 forests occur on **steep, warm, mid to upper slope positions** with **shallow or coarse-textured soils** and on **shallow crests** with insolation. These forests occasionally occur on neutral aspects with extensive sun exposure or on cooler aspects with very coarse soils. Soils are usually well to rapidly drained with moderate to very high coarse fragment content. They are typically derived from colluvial materials on steep slopes but may be from morainal or glaciofluvial materials, particularly on crests. Orthic Humo-Ferric Podzols and Eluviated Dystric Brunisols are common with Hemimor humus forms.

Bl is the most common overstorey and understorey tree species, although Se, Pa, and La may occur at low densities. **Grouseberry** and/or **low bilberry** are usually present and can be abundant along with **black huckleberry**, **white-flowered rhododendron**, **wood-rushes**, and minor amounts of mountain arnica. The moss layer is typically sparse and variable, with minor cover of clad lichens, haircap mosses, ragged-mosses, heron's-bill mosses, and leafy liverworts.

Differentiating from Other Site Series

Slightly drier forested site series (102) are characterized by prominent bedrock or talus and abundant rock-mosses. Slightly moister sites (101) occur on submesic to mesic sites and have more wood-rushes and less grouseberry/low bilberry.

Variability

Bear-grass may be present, particularly in the ESSFwmw3 and ESSFwmw4. La and Pa cover is usually minor (< 10%) and occurs on both warm- and cool-aspect sites.

Management Issues

Timber harvesting is not recommended due to high snow cover, short growing seasons, and low tree productivity in regenerating stands. Where harvesting is undertaken, soil erosion may be a concern on steep slopes. Avalanching and snowpress are likely on steep slopes.

110 Bl – Valerian – Hellebore – Globeflower

General Description

SMR 5–6. 110 sites occur on **gentle** (< 15%) **lower- and toe-slope positions with seepage or the water table** within the upper 30–75 cm of the soil profile. Sites are often adjacent to or associated with **riparian areas** and moisture-receiving sites, including slight depressions and level areas **adjacent to lakes**, **ponds**, **and wetlands**. Surficial materials are typically fluvial or morainal with sandy loam or silt loam soil textures. Soils are frequently Gleyed Dystric Brunisols or Orthic Cumulic Regosols on sites where occasional flooding occurs.

Bl and **Se** are common in the overstorey, with **arrow-leaved groundsel**, **Sitka valerian**, **false hellebore**, and/or **globeflower** dominating the understorey. White-flowered rhododendron, black huckleberry, wood-rushes, Canby's lovage, bracted lousewort, Brewer's miterwort, western meadowrue, and sedges, especially black alpine sedge, are also common. Paintbrushes (*Castilleja* spp.) and horsetails (*Equisetum* spp.) are often present. Ragged-mosses are typically present.

Differentiating from Other Site Series

Drier sites (101) lack abundant (> 20% combined cover) arrow-leaved groundsel, Canby's lovage, and globeflower, and other moist indicator herbs. Wetter sites tend to support non-forested wetland (Wf, Wa) or subalpine meadow (Am) communities (see Sections 6.2 and 6.7).

Variability

Total herb cover is always high, although dominance varies between arrow-leaved groundsel, false hellebore, globeflower, and Sitka valerian. Minor horsetail may be present (< 3% cover). The herb and moss layers are very diverse and highly variable, with a number of infrequently occurring species.

Management Issues

Timber harvesting is not recommended due to high snow cover, short growing seasons, and low tree productivity in regenerating stands. Where harvesting is undertaken, vegetation competition may be a serious concern. Due to moist soils, compaction and rutting are potential harvesting hazards.

Other Ecosystems

The following ecosystems occur within the ESSFwmw; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

In the high-elevation climate of the woodland, the most common wetland types are fens (Wf) and alpine wetlands (Wa). These are described in Section 6.2.

Grasslands and brushlands

Grasslands (Gg) and brushlands (Gb) are extremely uncommon in the ESSFwmw and are limited to the driest, warmest sites. They occur very infrequently in the southern Bonnington Range in the ESSFwmw3, the southern ESSFwmw4, and at the driest extent of the ESSFwmw1. They are unlikely to occur in the ESSFwmw2. Section 6.4 provides descriptions of grassland and brushland ecosystems.

Avalanche features

The combination of steep terrain and a deep snowpack results in widespread avalanche paths, particularly in the ESSFwmw1, ESSFwmw2, and ESSFwmw3. Herb (Vh), shrub (Vs), and treed (Vt) avalanche ecosystems are common. Section 6.5 describes avalanche ecosystems.

Rock outcrops and talus slopes

Rock outcrop (Ro) and talus (Rt) ecosystems are very common in the ESSFwmw. Descriptions of rock ecosystems are provided in Section 6.6.

Subalpine shrub ecosystems

The Subalpine Shrub group includes two classes: krummholz (Sk) and shrub carr/shrubland (Sc) ecosystems. Although they are more common in the parkland, a number of krummholz ecosystems occur in the woodland, particularly in areas with cold air such as north-facing basins and areas near high-elevation lakes. Classification of Sk units is currently in progress.

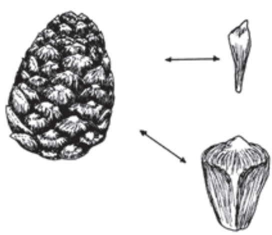
Shrub carr ecosystems (Sc-c), as described in *Wetlands of British Columbia* (MacKenzie and Moran 2004), occur on sites with moist, cold mineral soils that are prone to cold air and frost. Willows are the dominant shrub species. Shrublands (also Sc) occur on drier sites and include black huckleberry and white-flowered rhododendron shrub fields. Section 6.7 provides an overview of the Subalpine Shrub Class.

Alpine ecosystems

In areas of cold air and/or subdued terrain, the woodland can contain non-forested ecosystems that are more common in the alpine and parkland. They include meadows (Am), tundra (At), and health (Ah) as well as late snowmelt (As) and fellfield (Af) ecosystems. These units are currently being classified. Section 6.7 provides an overview of high-elevation ecosystems, including the Alpine Group and classes.

Subalpine larch
Larix lyallii

Whitebark pine
Pinus albicaulis



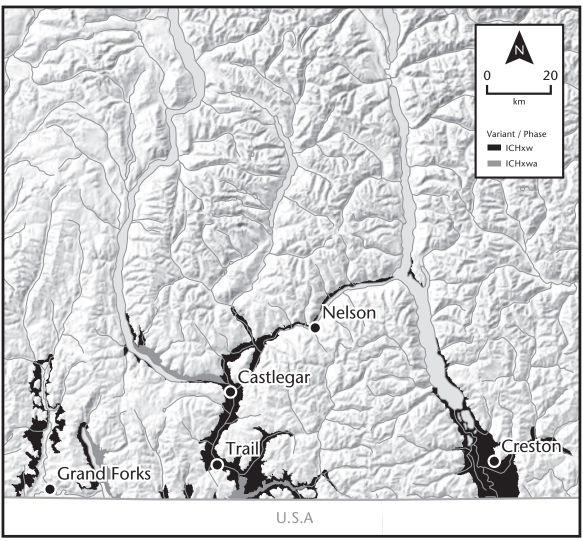
ICHxw
Very Dry Warm
Interior Cedar – Hemlock

Geographic Distribution

The ICHxw occurs at low elevations from the U.S. border north to Sunshine Creek on Lower Arrow Lake and to Boswell on the south arm of Kootenay Lake. It also occurs along the Kootenay River from Castlegar to Balfour and along the southern Slocan Valley to Passmore. In the west it occurs on the west side of Christina Lake and in the Granby Valley, and at its eastern extent, it occurs in the Moyie River valley from Creston to Kitchener.

The ICHxw occurs below the ICHdw1, and for most of its range, it occurs to valley bottom. Along Lower Arrow Lake, the Pend d'Oreille River, and Christina Lake, the ICHxw occurs adjacent to or above the ICHxwa, a warm-aspect phase that represents a hotter, drier area with similar mesic and moister sites (see p. 79). The ICHxw is a small biogeoclimatic unit in British Columbia; similar ecosystems are more abundant just south of the border in Washington and Idaho. Much of this subzone is occupied by private land.

Distribution of the ICHxw



Elevation Range

The ICHxw typically occurs at the lowest elevations at valley bottom or shore's edge, except where it occurs above the ICHxwa or IDF (in the Granby). On cool aspects, the upper elevation ranges from 600 to 800 m, on neutral aspects from 650 to 850 m, and on warm aspects from 700 to 900 m. In the Pend d'Oreille, upper elevations range from 1000 m on cool aspects to 1100 m on warm aspects; the upper elevations are lowest along the West Arm of Kootenay Lake.

Climate[1]

The ICHxw is transitional between the Dry and Moist climate subregions. It is characterized by very hot, very dry summers and mild, dry winters with low snowfall. Spring and fall are also dry and warm. The snowpack is moderately shallow and typically persists for a short duration in January and February. Winter rain-on-snow events are frequent and snow-free areas are common, particularly on warm-aspect sites. The ICHxw has the warmest winters of all biogeoclimatic units in southeast British Columbia. Growing-season moisture deficits typically occur on submesic and drier sites and on mesic sites in dry, hot years.

Forest and Vegetation Characteristics

The ICHxw is the driest Interior Cedar – Hemlock subzone and has many characteristics of the IDF, including abundant Fd, Py, and pinegrass. However, Cw, Bg, and Pw are also abundant, and Hw occurs occasionally on mesic sites and is common in wetter stands.

The ICHxw is characterized by high shrub cover; mallow ninebark, oceanspray, mock-orange (*Philadelphus lewisii*), snowberry, beaked hazelnut, Oregon-grape, and Douglas maple are common, both in forested ecosystems and brushlands (Gb; see section 6.4). Mature forests on **mesic sites** typically have a diverse mix of tree species, including Fd, Cw, Lw, Ep, Bg, Pw, and Pl. Hw may be present but is usually restricted to the understorey. **Drier sites** typically have Fd and Py, and have limited occurrences of other tree species. Tall shrubs are particularly common on these sites. **Moist sites** usually have abundant Hw and Cw, with variable amounts of Fd, Lw, Pl, Pw, Bg, Sxw, and Ep. Oak fern and lady fern occur with black huckleberry, western yew, foamflower, and wild ginger. The **wettest sites** are skunk cabbage and horsetail forests, but these are uncommon and, due to extensive valley-bottom disturbance, often occur only in early seral stages. Cottonwood floodplain forests are extensive along the major river valleys but have been reduced in extent due to urban and rural development and reservoir creation for hydroelectric power.

[1] See Section 4.2 for more information on climate variables.

Disturbance

Mixed-severity fire regimes characterize the ICHxw, although low-severity fires likely dominated warm aspects where widespread low-intensity underburns were common, particularly during years with warm, dry summers. Multiple fire scars in open Py and Fd stands provide ongoing evidence of these fires (Nesbitt 2010). First Nations burning was likely significant, particularly in areas along major waterways such as Lower Arrow Lake, the West Arm, and the Creston Valley (e.g., Quesnel and Pinnell 1998). Stand-replacing fires may have been more common on cool to neutral aspects.

Old-growth forests are currently rare due to **timber harvesting** and rural development. Historically, old growth would have consisted of widely spaced, large, old Py, Fd, and Lw on warm aspects, and large Cw and Hw stands in moist riparian areas. Since fire suppression, biotic and human disturbance are dominant features of this valley-bottom unit.

Bark beetles are important disturbance agents, particularly **Douglas-fir beetle**, which has significant impacts on warm-aspect sites with a high Fd component. M**ountain pine beetle** can also inflict high mortality where Pl is abundant. The fir engraver beetle affects Bg, and western pine beetle attacks Py, particularly in the Lower Arrow and Christina Lake areas. **Armillaria root rot** creates small gaps in mature stands and can be a major impediment to tree regeneration. Spruce budworm has had minor impacts on Fd thus far but has potential for expansion. **Birch decline**, due to a combination of insect, disease, and drought, has had devastating impacts on Ep, while **white pine blister rust** along with historic targeted harvesting has had a major impact on Pw. **Gall rusts** affect growth of Pl regeneration. **Animal damage** can also be extensive: bear damage to Cw and Lw plantations can be localized but severe.

Urban and rural development has had a major impact on ecosystems in the ICHxw. Almost 60% of the ICHxw occurs on private lands. With extensive development along the lowest-elevation areas, the wettest forested site series have been heavily affected, particularly the *CwSxw - Skunk cabbage* (113), *CwHw – Oak fern* (111), and *CwHw – Horsetail – Lady fern* (112). **Hydroelectric dams** in the Pend d'Oreille flooded considerable areas of these types of wet forests (MacKillop et al. 2008; Utzig and Schmidt 2011). Lakefront development also has ongoing impacts on foreshore environments. Forests in the lower Columbia Valley are recovering from **SO_2 smelter emissions**. **Invasive plant species** are widespread in this unit, particularly in early seral or drier forested and brushland sites, and include knapweeds (particularly spotted [*Centaurea stoebe* ssp. *micranthos*] and diffuse [*C. diffusa*]), sulphur cinquefoil (*Potentilla recta*), hawkweeds (*Hieracium* spp.), and scotch broom (*Cytisus scoparius*).

Soils, Geology, and Landforms

Granodiorite is the most common rock throughout the ICHxw, particularly along the Kootenay River and the West Arm of Kootenay Lake. Argillite, sandstone, and conglomerate are also common in the Creston area. In the Pend d'Oreille, basaltic volcanic rocks, mudstones, and siltstones can be found. Moderately rich volcanic rocks occur with fine-textured metasedimentary rocks in the Granby Valley. Calcareous materials also occur, particularly in the Creston Valley.

A wide variety of surficial materials occur, although coarse-textured, sorted, and unsorted glaciofluvial deposits are common and occur as terraces and kame deposits, particularly in larger valley-bottom areas. Rock outcrops, shallow colluvium, morainal materials, and fluvial deposits are also widespread. Agricultural areas are common across valley-bottom deposits of glaciofluvial and fluvial materials. Reservoir drawdown areas occupy large areas of the ICHxw in the Arrow and Pend d'Oreille Valleys.

As a result of widespread granodiorite rock and abundant glaciofluvial deposits, soils commonly have sandy loam or loamy sand textures. Thin, eolian cappings of silt or fine sand are common. Seepage is typically restricted to areas immediately adjacent to watercourses.

Wildlife Habitat

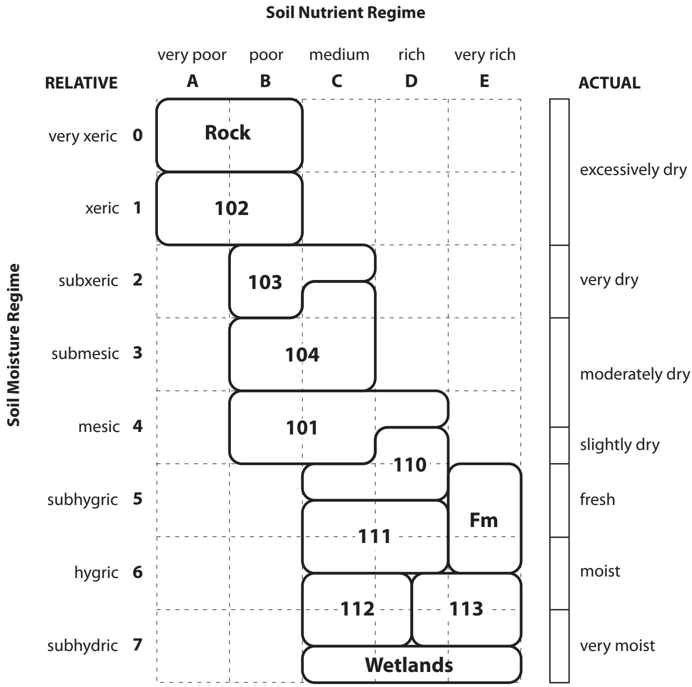
Very dry, warm conditions in the ICHxw support a mosaic of forest and brushland (shrub) communities. The unit covers a small area but provides habitat for a disproportionate number of **species at risk**. Many bird and mammal species in the ICHxw require wildlife trees for nesting, denning, and/or roosting. Examples include **Lewis's woodpecker**, **western screech-owl**, **great blue heron**, **little brown myotis**, and **fringed myotis**. Other at-risk species are associated with riparian and/or wetland habitats (e.g., **Coeur d'Alene salamander**, **northern leopard frog**, **western toad**, **painted turtle**, **American bittern**, **American avocet**, **western grebe**, **great blue heron**, **double-crested cormorant**, **sandhill crane**, **Forster's tern**, and **yellow-breasted chat**). Rock outcrops, talus, and/or cliffs are important breeding substrates for several at-risk reptiles (**western skink**, **northern rubber boa**, **North American racer**, **gopher snake**, and **western rattlesnake**), birds (**canyon wren**, **peregrine falcon**), and mammals (**Townsend's big-eared bat**, **little brown myotis**, **red-tailed chipmunk**). Open grassland and agricultural areas in the ICHxw are used by many species, including listed **northern pocket gopher**, **bobolink**, **long-billed curlew**, **short-eared owl**, **common nighthawk**, and **barn swallow**.

The ICHxw provides key winter ranges for **mule deer**, **white-tailed deer**, **Rocky Mountain elk**, and **bighorn sheep** and spring forage and connectivity for **grizzly bear**. American badgers were historically present, but are very uncommon. Extensive wetlands, riparian areas, and cottonwood floodplain forests in the Creston Valley and along the Kootenay/Columbia systems contribute to high species diversity; a significant number of raptors, waterfowl, shorebirds, other water birds, and furbearers breed, overwinter, or migrate through there. This unit has the **highest bird diversity in the region**, and common species include American robin, Swainson's thrush, dark-eyed junco, warbling vireo, and western tanager. A **very high diversity of at-risk vascular plant species** (i.e., > 20 species) are aggregated in the ICHxw/xwa.

Distinguishing the ICHxw from Adjacent Biogeoclimatic Units

In the **ICHxwa**, most sites have:	- less Cw, Ep, Pl, and queen's cup - more fairybells and oceanspray
submesic sites have:	- higher shrub cover, especially snowberry, oceanspray, and mallow ninebark - little to no Cw
dry sites have:	- more Py and bluebunch wheatgrass - less kinnikinick and falsebox
In the **ICHdw1**, most sites have:	- more prince's pine and twinflower - less snowberry
zonal sites have:	- Hw - more Cw, falsebox, twinflower, and queen's cup - less wild sarsasparilla and fairybells
submesic sites have:	- occasional Hw, especially in the understorey - more falsebox and Douglas maple
dry sites have:	- less mallow ninebark, oceanspray, mock-orange, and pinegrass
In the **IDFdm1** and **IDFdh**, most sites have:	- no Cw - more pinegrass and kinnikinnick - more grasslands
wet sites have:	- no Hw and less ferns
In the **ICHmk1**, most sites have:	- some Sxw and Bl - more Pl and falsebox - no oceanspray or mallow ninebark
zonal sites have:	- more Cw, Sxw, queen's cup, and bunchberry - more Douglas maple, alder, and black huckleberry - less wild sarsaparilla and fairybells
dry sites have:	- little to no mock-orange or bluebunch wheatgrass

Edatopic Grid



Site series

101	CwFd – Hazelnut – Sarsaparilla
102	FdPy – Oceanspray – Bluebunch wheatgrass
103	FdPy – Oregon-grape – Pinegrass
104	Fd(Py) – Douglas maple – Pinegrass
110	CwHw – Foamflower
111	CwHw – Oak fern
112	CwHw – Horsetail – Lady fern
113	CwSxw – Skunk cabbage
Fm01	Cottonwood – Snowberry – Rose[1]

[1] See Section 6.3 for descriptions.

Site Series Flowchart

Forest group	Site characteristics	Site series
VERY DRY to DRY FORESTS • warm aspects • shallow soils	• SMR 1 • open Fd, Py stands • exposed rock is prominent • bluebunch wheatgrass, rock ferns, and/or stonecrop • rock-mosses, clad lichens, and/or haircap mosses	102
	• SMR 2 • Fd, Py open canopy • steep, warm aspect; shallow and/or coarse soils • pinegrass often abundant • bluebunch wheatgrass often present	103
SLIGHTLY DRY to MESIC FORESTS • mid slopes (usually) with deep soils	• SMR 3 (2) • Fd stands; often some Py, Pl, or Lw • shrubby: snowberry, oceanspray, rose, and/or Douglas maple • < 10% pinegrass and/or showy aster • Cw, Hw absent or sparse	104
	• SMR 4 • mixed Fd, Cw, Lw stands • Bg, Pl, Ep, At common in earlier seral stands • beaked hazelnut, Douglas maple, and/ or falsebox • little to no mallow ninebark and oceanspray • abundant wild sarsaparilla and fairybells or twinflower and prince's pine	101
MOIST to WET FORESTS • lower or toe slopes • seepage or mottles	• SMR 5 (4) • Cw, Hw stands • black gooseberry and/or yew • foamflower and queen's cup abundant • < 1% lady fern, oak fern, or devil's club	110
	• SMR 5-6 • Cw, Hw stands • oak fern, lady fern, devil's club, and/or wild ginger	111
WET to VERY WET FORESTS • gentle or flat lower or toe slopes • water table present, often near the surface	• SMR 6 (7) • Cw, Hw (Sxw) stands • > 5% horsetail cover • < 3% oak fern and lady fern cover	112
	• SMR 6 (7) • Cw, Hw (Sxw) stands • > 5% skunk cabbage cover	113

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	113	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■	■■■■■	■■■■■	*	*			Douglas-fir
	Pinus ponderosa	■■■	■■■	*						ponderosa pine
	Larix occidentalis			*	□□□	□□□				western larch
	Thuja plicata				■■■■	■■■■	■■■■■	■■■■	■■■■	western redcedar
	Betula papyrifera				□□□	*	□□□			paper birch
	Abies grandis				□□□	*	*			grand fir
	Pinus monticola				*	□□				western white pine
	Tsuga heterophylla					□□□□	■■■■	□□□	■■■■	western hemlock
Regen	*Pseudotsuga menziesii*	■■■	■■■	*	□	*				Douglas-fir
	Thuja plicata				□□□	■■■■■	■■■	■■■	■■■	western redcedar
	Tsuga heterophylla				*	■■■■	□□□	■■	■■■■	western hemlock
Shrubs	*Physocarpus malvaceus*	■■	□□□	■■■						mallow ninebark
	Symphoricarpos albus	■■	■■■	■■■	□□	*	□			snowberry
	Mahonia spp.	■■	■■■	■■■	■■	■				Oregon-grape
	Amelanchier alnifolia	■■	■■	■■	■■	■■	□			saskatoon
	Spiraea betulifolia	■■	■■	■■	□					birch-leaved spirea
	Holodiscus discolor	□□	□□	■■■	*					oceanspray
	Rosa gymnocarpa	□	■■	■■■	■■	■	■			baldhip rose
	Acer glabrum			■■■	■■■	*	■■			Douglas maple
	Corylus cornuta				■■■	*	□□			beaked hazelnut
	Rubus parviflorus			*	□□	■■■	■■■	□□	□	thimbleberry
	Vaccinium membranaceum				*	□□				black huckleberry
	Taxus brevifolia					□□□	*	■■	■■	western yew
	Ribes lacustre					■	□□			black gooseberry
	Oplopanax horridus						□□□			devil's club

Layer	Scientific name	102	103	104	101	110	111	112	113	Common name
Herbs	*Pseudoroegneria spicata*	■■■	▨▨▨							bluebunch wheatgrass
	Calamagrostis rubescens	■■	■■■■	■■■	▨					pinegrass
	Festuca spp.	■■	▨	*						fescues
	Achillea millefolium	■■	■							yarrow
	Heuchera cylindrical	■■								round-leaved alumroot
	"rock ferns"[a]	■■								rock ferns
	Sedum spp.	▨	*							stonecrops
	Arctostaphylos uva-ursi	*	▨▨							kinnikinnick
	Arnica cordifolia	*	*	■■■						heart-leaved arnica
	Eurybia conspicua			▨▨						showy aster
	Prosartes spp.			■■	■■■	▨	■			fairybells
	Aralia nudicaulis			*	■■■	▨▨	■■■			wild sarsaparilla
	Linnaea borealis			*	■■■	■■	■■	■■■	■■	twinflower
	Chimaphila umbellata			*	■■■	▨▨	*			prince's pine
	Clintonia uniflora				■■	■■■	■■■	■■	■■	queen's cup
	Tiarella trifoliata var. *unifoliata*					■■■	■■■■			one-leaved foamflower
	Gymnocarpium dryopteris					*	■■■	▨▨	▨▨	oak fern
	Asarum caudatum						▨▨▨	▨▨	■■	wild ginger
	Athyrium filix-femina						■■	■■	■■■	lady fern
	Equisetum spp.						▨	■■■		horsetails
	Lysichiton americanus								■■■■■	skunk cabbage
Moss layer	*Polytrichum* spp.	■■■	■■	*		*				haircap mosses
	Racomitrium spp.	■■■								rock-mosses
	Peltigera spp.	■■	▨	■■	*					pelt lichens
	Cladonia spp.	■■	▨							clad lichens
	"leafy mosses"[a]					*	■■	■■■	■■■■■	leafy moss

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1%; ■■ 1–3%; ■■■ 3–10%; ■■■■ 10–25%; ■■■■■ > 25%; * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots; ▨ 50–70% of plots

Environment Table[a]

Site series	102	103	104	101	110	111	112	113
No. of plots	10	23	21	22	4	10	X[b]	X[b]
SMR	1	2	3 (2)	4	5 (4)	5-6	6 (7)	6 (7)
SNR	A–B	B–C	B–C	B–C	C–D	C–D	C–D	C–D
Slope position	UP–CR (MD)	MD–UP	MD	MD	LW, TO	TO (LV)	LV	LV
Typical slope/ aspect	Steep–moderately steep/warm	Steep/warm	Moderately steep–steep / warm	Moderate/ neutral (cool)	Gentle, level (moderate)	Gentle (moderate)	Level	Level
Common compensating conditions			Upper, shedding, cool aspects; occasionally coarse–very coarse, lower	Lower, coarse; gentle, warm	Mid-slope receiving sites; moderately coarse toe slopes			
Surficial materials	Cx/R, Mx/R, Dx/R	Cv, FG (Cb, Mv)	Mb, FG (Cb)	Mb (Cb, FG, F)	F, M, FG	F (M, FG)	F, Ov/F	Ov/F
Soil texture	SL (FSL, LS)	SL (LS, FSL)	SL, Sil (FSL, L, LS)	SL, FSL, L, SiL	SiL, SL, L	SL, FSL, LS (SiL)	SiL (SL, S)	SiL (SL, S)
Coarse fragment content	High–fragmental (moderate)	High–fragmental	Moderate–high (fragmental)	Low–moderate	Low–moderate	Moderate (variable)	Sparse–low; often increasing at depth	Sparse–low
Important features	(Bed)rock is prominent and abundant; soils shallow	Insolation; coarse or shallow soils common			Seasonal seepage at depth	Moisture within top 30–50 cm	Saturated soils, cold air drainage	Saturated soils

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.
[b] Limited data are available for older stands in the 112 and 113; descriptions provided here are based on plot data (vegetation, site, soils) from the same site associations in similar biogeoclimatic units.

CwFd – Hazelnut – Sarsaparilla 101

General Description

SMR 4. The 101 typically occurs on mid slopes of cool to neutral aspects. Due to compensating factors, this site also occurs on gentle or lower slopes of warm aspects with coarse soils. Surficial materials are typically morainal but can be colluvial or glaciofluvial, and may have a very thin eolian capping of volcanic-derived ash. Soils with silt loam to (fine) sandy loam textures are common, often becoming coarser at depth. Eutric and Dystric Brunisols are the dominant soil types.

A diverse mix of tree species is common, with **Fd** frequently found with **Cw**, Lw, Ep, Bg, Pw, and/or minor Pl. Shrub cover is often equally diverse, with **beaked hazelnut**, **Douglas maple**, Oregon-grape, saskatoon, and thimbleberry usually present. Understorey herbs typically include **fairybells**, **wild sarsaparilla**, queen's cup, **prince's pine**, and/or **twinflower**. Mosses and lichens are variable and usually sparse.

Differentiating from Other Site Series

Foamflower, oak fern, devil's club, and more Hw are present on moister sites (110), while drier sites (104) typically have pinegrass, Py, and more Fd, and frequently lack Cw.

Variability

Sites are highly variable with a broad range of tree species. Earlier seral stages often have higher broadleaf cover, including Ep and At. Understoreys in most mature stands are dominated by either fairybells (*Prosartes hookeri* and/or *P. trachycarpa*) and wild sarsaparilla, or prince's pine and twinflower, with minor amounts of the other species. Fd can be dominant, with minor Cw or Cw restricted to the understorey. Hw is typically absent but may occur at low densities in the understorey, particularly in areas transitional to the ICHdw1. Dull Oregon-grape (*Mahonia nervosa*) is common in the Pend d'Oreille, while tall Oregon-grape (*M. aquifolium*) is more typical elsewhere.

Management Issues

This site series is amenable to the growth of a wide variety of tree species, and diversity should be fostered. Invasive plant species can be a concern, particularly following disturbance. Brush competition from species such as thimbleberry and bracken fern (*Pteridium aquilinum*) can be high following overstorey removal.

102 FdPy – Oceanspray – Bluebunch wheatgrass

General Description

SMR 1. 102 forests occur on dry, steep slopes on warm aspects with **exposed bedrock** and very shallow soils, or on **blocky talus slopes** where rocks form the dominant substrate. Soils often vary in depth, with deeper pockets of soil interspersed among very thin veneers and exposed rock. Humus forms are usually very thin and dry. Stands often occur in larger complexes with open, non-forested rock outcrops or talus areas (with less than 10% total tree cover) and with 103 sites on deeper, coarse-textured soils.

Fd and/or **Py** are the dominant tree species. Shrub cover is typically moderate, with abundant mallow ninebark, oceanspray, mock-orange, saskatoon, Oregon-grape, and snowberry. **Bluebunch wheatgrass**, **round-leaved alumroot**, **pinegrass**, fescues, and **rock ferns** (particularly parsley fern [*Cryptogramma acrostichoides*] and western cliff fern [*Woodsia oregana*]) are common, although **stonecrops**, ***Selaginella* species**, and other rock outcrop species often occur with very low cover. Rock-mosses, haircap mosses, and clad lichens are typically abundant, along with varying amounts of electrified cat's-tail moss (*Rhytidiadelphus triquetrus*) and heron's-bill mosses (*Dicranum* spp.).

Differentiating from Other Site Series

These sites can be easily differentiated by the dominance of bedrock and/or blocky talus on the surface. Drier sites are non-treed (< 10% cover) rock outcrops, talus, or brushlands (e.g., Gb03). Slightly moister sites (103) occur with deeper soils, lack abundant exposed (bed)rock, and typically have less bluebunch wheatgrass and more pinegrass.

Variability

Plant communities on forested rock outcrops and talus sites can be highly variable, particularly due to slight changes in soil occurrence and depth; as a result, the 102 supports a high diversity of plant species. Common species that occur at low densities include silky lupine (*Lupinus sericeus*), poverty oatgrass (*Danthonia spicata*), junegrass (*Koeleria macrantha*), pussytoes (*Antennaria* spp.), and narrow-leaved collomia (*Collomia linearis*).

Management Issues

Not recommended for timber harvesting due to limitations in available soil and soil moisture for tree regeneration and growth. These sites are sensitive to disturbance and are susceptible to invasive plant species. Sites often contain rare or sensitive plant and animal species.

FdPy – Pinegrass 103

General Description

SMR 2. 103 forests occur on **steep, warm**, mid to upper slopes, typically with **coarse and/or shallow soils**. Soils are usually well- to rapidly drained Dystric or Eutric Brunisols with thin humus forms. Colluvial soils are typical. These sites frequently occur in a mosaic with 102 forests and non-forested rock outcrops or talus ecosystems (< 10% tree cover).

An open **Py** and **Fd** canopy is characteristic, with a dense, shrubby understorey of **birch-leaved spirea**, **Oregon-grape**, **snowberry**, **saskatoon**, **rose**, **mallow ninebark**, and **oceanspray**. **Pinegrass** is usually present along with minor amounts of bluebunch wheatgrass, yarrow, pussytoes, paintbrushes (*Castilleja* spp.), junegrass, desert-parsleys (*Lomatium* spp.), and wild strawberry (*Fragaria* spp.). Moss cover is generally sparse.

Differentiating from Other Site Series

Drier forested sites have extensive exposed bedrock and/or talus with more bluebunch wheatgrass and rock-associated species and less pinegrass. Slightly moister and/or richer sites have less Py, lack bluebunch wheatgrass, have more Douglas maple, and have either fairybells, showy aster, twinflower, prince's pine, and/or wild sarsaparilla.

Non-forested brushlands with < 10% tree cover (e.g., Gb03) also occur on dry, coarse sites on warm aspects and may be confused with seral broadleaf-dominated 103 sites. Presence of stumps or > 10% cover of Ep and At saplings can help differentiate.

Variability

Broadleaf-dominated stands are common on these sites, where Ep and At often dominate or form mixed stands of Fd, Py, Pl, and Lw with abundant understorey shrubs such as mallow ninebark, oceanspray, snowberry, and saskatoon. Broadleaf-dominated sites are the result of repeated, high-severity fires, and in many cases, show slow stand development. These sites can be coded as 103$B.[2]

Management Issues

Drought may limit tree growth and establishment. High brush cover can also cause regeneration problems. Warm-aspect sites provide important ungulate winter range due to lower snow depth and high forage availability. Invasive plant species are often widespread, especially after disturbance. Soil erosion can be a concern on steep slopes. Sites often contain at-risk or sensitive plant and animal species.

[2] See Section 2.3 for seral coding.

104 Fd(Py) – Douglas maple – Pinegrass

General Description

SMR 3 (2). 104 sites typically occur on moderately steep **mid slopes** on **warm aspects**. Due to compensating factors, this site unit also occurs on **upper, shedding** slopes on **cool to neutral** aspects and occasionally on lower slopes with coarse to very coarse soils. Stands typically occur on soils derived from morainal or glaciofluvial materials. Soils are usually Dystric or Eutric Brunisols with moderate to moderately high coarse fragments and sandy loam textures, and often become coarser at depth.

Fd dominates the tree layers, often with minor Py or Pl. Sites are typically shrubby with abundant **Douglas maple**, **snowberry**, **oceanspray**, **birch-leaved spirea**, **mallow ninebark**, **Oregon-grape**, **saskatoon**, and **baldhip rose**. **Pinegass** is usually present with moderate cover, and is found with fairybells, **showy aster**, twinflower, prince's pine, and/or wild sarsaparilla. Moss and lichen cover is usually sparse.

Differentiating from Other Site Series

Shrub cover is similar to drier sites, although slightly drier sites (103) typically have little to no Douglas maple and may have some bluebunch wheatgrass. Py is usually present and often more abundant on drier sites. Slightly moister sites (101) have Cw, Pw, Bg, Lw, and queen's cup and higher cover of one of more of the following: fairybells, twinflower, prince's pine, and/or wild sarsaparilla.

Variability

Seral stands often have higher amounts of Ep, At, or Pl; Lw may be present with minor cover in both seral and mature stands.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered. Soil erosion can be a concern on steep slopes. Invasive plant species can be a concern, particularly following disturbance. Warm-aspect sites provide important ungulate winter range due to lower snow depth and high forage availability. Drought may limit tree productivity and establishment during dry growing seasons. High brush cover can also cause regeneration problems.

CwHw – Foamflower 110

General Description

SMR 5 (4). 110 forests occur on **lower slopes** with **seasonal seepage at depth**. Sites are often a narrow band between mesic mid-slope conditions and hygric riparian areas. Mottles are usually present within the top 50 cm of the soil profile.

Cw and **Hw** are typically abundant in the overstorey and understorey, with moderate shrub cover of thimbleberry, western yew, and black gooseberry. **Queen's cup** and **foamflower** characterize the often sparse understorey.

Differentiating from Other Site Series

Drier sites (110) have Fd and/or Lw. The presence of foamflower and the absence or sparseness of oak fern, wild ginger, and lady fern differentiate the 110 from wetter (111) site series.

Variability

Due to extensive disturbance histories, many sites are currently in mid-seral stages with dense overstorey canopies and sparse understoreys with limited herbaceous species. This is particularly common where Hw overstoreys create dark, shaded conditions.

Management Issues

Tree productivity is high on these sites, and vegetation competition may be a concern. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. These sites are often associated with riparian management areas, and frequently provide travel corridors in steep terrain and forage for wildlife.

111 CwHw – Oak fern

General Description

SMR 5–6. 111 forests occur on **toe slopes** and **level** sites with **seepage** within the **top 30–50 cm** of the soil profile. Sites are typically gentle but can be moderately steep where available moisture is prominent. Gleysols and Gleyed Eutric Brunisols are common, with Moder humus forms. Sites are often associated with riparian areas that have rare flooding events. Soils are variable and can have moderately coarse sandy loam and loamy sand textures with moderate to high coarse fragment content.

Hw is usually present in the overstorey and/or understorey, along with **Cw**. Minor Ep, Bg, Pw, Act, and Fd may be present. Understorey herbs can be diverse, with **oak fern**, foamflower, **lady fern**, queen's cup, pathfinder (*Adenocaulon bicolor*), wild sarsaparilla, and sweet-scented bedstraw (*Galium triflorum*) commonly present. **Wild ginger** and **devil's club** may be present. Minor cover of leafy mosses is often present with ragged-mosses (*Brachythecium* spp.).

Differentiating from Other Site Series

Drier sites (110) lack oak fern, lady fern, devil's club, and wild ginger, while moister sites have abundant horsetails (112) and/or skunk cabbage (113).

Variability

Species cover may vary, particularly where sites have considerable microsite variation, with wetter species such as lady fern in depressions, and drier species such as mock-orange and saskatoon on elevated mounds.

Management Issues

Tree productivity is high on these sites, and vegetation competition may be a concern. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should occur when soils are dry or frozen. These sites are often associated with riparian management areas, and frequently provide travel corridors in steep terrain and forage for wildlife.

CwHw – Horsetail – Lady fern 112

General Description

SMR 6 (7). Old and mature 112 sites are very rare in the ICHxw. This site series occurs on gently sloping to level **riparian** areas with cool microsites. The water table is typically at or near the surface, within or immediately below a thin **organic veneer**. Soils are typically Orthic Humic Gleysols with repeated flooding and/or water retention in depressions. Microtopography is often hummocky, with trees establishing on elevated microsites.

Cw, Hw, Sxw, and Act typically comprise the overstorey, with low to moderate amounts (< 10% cover) of **horsetails** (*Equisetum arvense, E. pratense*) along with lady fern, oak fern, and sweet-scented bedstraw. Rattlesnake fern (*Botrypus virginianus*) is often present in minor amounts. Leafy mosses, particularly *Rhizomnium nudum*, *R. magnifolium*, and *Plagiomnium* spp., are also common.

Differentiating from Other Site Series

Slightly drier sites lack horsetail and have abundant oak fern, lady fern, and/or devil's club. The 112 site series occurs on similar sites to 113 (*CwSxw – Skunk cabbage*) forests. Horsetail sites are usually associated with minor to prominent cool air and have minimal to no skunk cabbage.

Variability

Most 112 sites occur as highly disturbed, early to mid-seral forests where species composition is highly variable. Horsetails are often sparse (2–5% cover), and site identification is based on the presence of a thin organic veneer, evidence of cold air, presence of the water table near the surface, and sparse cover (< 3%) of devil's club, lady fern, and oak fern (species typical of 111), coupled with a lack of skunk cabbage (found in 113).

Management Issues

Not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, competition from brush can be a concern in regenerating stands. Due to disturbance history and proximity to rural and urban development, invasive species are a significant concern.

113 CwSxw – Skunk cabbage

General Description

SMR 6 (7). Old and mature *CwSxw – Skunk cabbage* sites are very rare in the ICHxw. They occur on **level** to **gently sloping** areas, often associated with **riparian** areas. The **water table** typically occurs at or near the surface, within or immediately below an **organic veneer**. Soils are either organic or Orthic Humic Gleysols with water retention in riparian areas or depressions. Microtopography is often hummocky, with trees restricted to elevated microsites.

Cw, Hw, and Sxw are common in the overstorey. At, Act, and Ep may be present in earlier seral stages. Minor amounts of devil's club and lady fern may be present along with leafy mosses. The most obvious distinguishing species is the dominance of **skunk cabbage**.

Differentiating from Other Site Series

Although 113 forests occur on similar sites as the 112, 113 sites can easily be distinguished from other sites by the abundance of skunk cabbage. Wetter sites are non-forested wetlands that do not support extensive tree growth. Slightly drier sites (111) have more oak fern, lady fern, devil's club, and/or wild ginger, and lack skunk cabbage.

Variability

Due to widespread development in valley bottoms throughout the ICHxw, most occurrences are in heavily disturbed, early to mid-seral stages. Broadleaf species such as Act and Ep are common in younger stands. 113 sites can also be classified as *Ws10 Western redcedar – Spruce – Skunk cabbage* forested swamps. (See Section 6.2)

Management Issues

Not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, competition from brush can be a concern in regenerating stands. Due to disturbance history and proximity to rural and urban development, invasive species are a significant concern.

Other Ecosystems

The following ecosystems occur within the ICHxw; the most common site codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

Extensive wetlands occur in the ICHxw in the Creston Valley, while smaller wetland complexes occur in the Granby, Slocan, and Little Slocan Valleys. The most frequently occurring types are marshes (Wm), swamps (Ws), and shallow water (Ww). Fens (Wf) are very uncommon. Descriptions for these and other wetlands are provided in Section 6.2.

Cottonwood forests and other flood ecosystems

Cottonwood forests (Fm) are moderately uncommon in the ICHxw. Extensive cottonwood stands occur in the Creston Valley, while smaller cottonwood floodplain areas occur in the Granby, Slocan, and Little Slocan Valleys, and as narrow bands in riparian areas and at creek deltas. The most common cottonwood floodplain forest ecosystem is *Fm01 Cottonwood – Snowberry – Rose*. Alder and willow low bench floodplains (Fl) are uncommon. Flood ecosystems are described in Section 6.3.

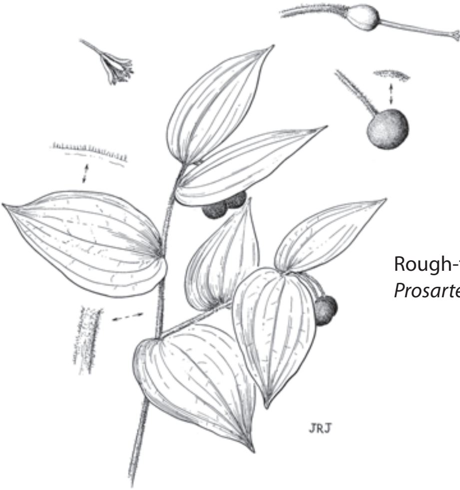
Grasslands and brushlands

Brushlands are common on warm-aspect, dry sites (*Gb03 Ninebark – Oceanspray – Bluebunch wheatgrass*) and occur on coarse-textured glaciofluvial terraces (*Gb06 Snowbrush – Poverty oatgrass*), primarily in the ICHxwa in the Lower Columbia Valley. *Gb05 Smooth sumac* brushlands are uncommon on warm, rubbly sites in the ICHxwa.

Grasslands (Gg) are very uncommon and are generally restricted to small (< 0.5 ha) openings, usually in a matrix of dry forests (102, 103), brushlands, and/or rock outcrops. Information about grassland and brushland ecosystems is provided in Section 6.4.

Rock outcrops and talus slopes

Rock outcrops (Ro) and talus (Rt) ecosystems are very common in the ICHxw. Rock ecosystems are described in Section 6.6.



Rough-fruited fairybells
Prosartes trachycarpa

Hooker's fairybells
Prosartes hookeri

ICHxwa
Very Dry Warm
Interior Cedar – Hemlock
Warm Phase

Interpreting a Biogeoclimatic Phase

Biogeoclimatic phases are used to represent areas where vegetation communities are controlled by climate processes at a finer scale than the typical subregional scale used for subzone/variant mapping. In this case, the ICHxwa represents extensive areas of warm-aspect sites where local conditions are hotter and drier than expected within the broader ICHxw. Soils are also frequently very shallow, with a disproportionate abundance of dry sites across the landscape, particularly in the Lower Arrow and Christina Lake areas. Historically, low-severity, frequent fires were extensive. Large Py and Fd with multiple fire scars are common across the landscape and open forest stand structure was more typical.

Much of the area now mapped as ICHxwa was previously mapped as IDF. Because of the extensive distribution of dry site series, the ICHxwa looks remarkably like an IDF subzone, although mesic sites support Cw, and both Cw and Hw grow on wet sites.

Geographic Distribution

The ICHxwa occurs at low elevations in the Pend d'Oreille Valley, on the east side of Christina Lake, and along the Lower Arrow Lakes from Broadwater to the Keenleyside Dam. The ICHxwa is mapped from valley bottom to the ICHdw1 except in the Pend d'Oreille where it occurs below the ICHxw. South of Christina Lake, it occurs above the IDFdh. Small, unmapped areas may occur within the ICHxw that more closely resemble the ICHxwa.

The ICHxwa is a very small biogeoclimatic unit in British Columbia; similar ecosystems are more abundant just south of the border in Washington and Idaho. Most of this subzone occurs on private land. The map of the ICHxw shows the distribution of both the ICHxwa and ICHxw (see page 69); no separate map is provided for the ICHxwa.

Elevation Range

Throughout most of its range, the ICHxwa occurs from valley bottom or shore's edge to 700–900 m on cool aspects, 750–950 m on neutral aspects, and 800–1000 m on warm aspects. On the east side of Christina Lake, it extends approximately 100 m higher on all aspects.

How to Classify Sites in the ICHxwa

The ICHxwa uses the same site series framework and numbers as the remainder of the ICHxw. Users can refer to the ICHxw for: a map showing its geographic distribution; descriptions of climate, disturbance, soils, geology, and wildlife habitat; a vegetation table; an environment table; and lists of non-forested ecosystems. To make site identification simpler in the field, specific tools for the ICHxwa are provided in this section, including an edatopic grid with a list of site series and a site series flowchart.

A summary table for the site series in the ICHxwa is provided on page 94. The table outlines typical site and vegetation characteristics in the ICHxwa and provides an overview of vegetation differences between the ICHxwa and ICHxw. To classify sites in the ICHxwa, users should record data with the ICHxwa phase (e.g., ICHxwa/103). Some management and conservation activities may differ between the ICHxw and ICHxwa.

Forest and Vegetation Characteristics

The ICHxwa represents extensive warm-aspect, low-elevation areas where vegetation has characteristics of both the ICH and IDF. Tree species diversity is high, with Fd, Py, Cw, Bg, Lw, Pl, Pw, Ep, At, and, on wetter sites, Act, Hw, and Sxw. Pinegrass is common on **drier** than mesic sites, while fairybells are common on **mesic** sites. In comparison to the ICHxw, the ICHxwa has considerably **more bluebunch wheatgrass and fescues** on dry sites, and **Cw is often restricted to subcanopy layers on mesic sites** where **Fd dominates**. Very few mesic and moister sites occur in the ICHxwa.

Other Significant Issues

Although similar to the ICHxw, the ICHxwa has a hotter, drier local climate and more open stands, particularly on drier sites with Fd and Py. Historically, **low-severity fires** on frequent return intervals were more common based on observations of fire-scarred trees. Fire suppression has shifted plant community composition due to forest ingrowth and encroachment and has likely affected diversity and abundance of many fire-adapted plants. Hot, dry conditions may lead to more frequent and **intense drought events** and insect or disease outbreaks linked to drought stress. **Hydroelectric dams** and associated infrastructure have impacted sites in the Pend d'Oreille and Lower Arrow Lakes, particularly wetter site series and non-forested types that are most common along valley-floor riparian areas. **Invasive plant species** are a significant threat to native plant communities.

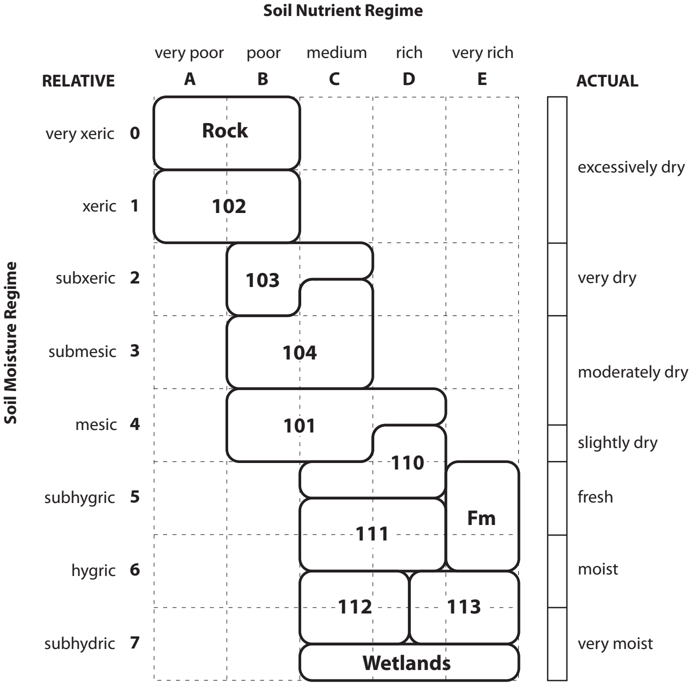
The ICHxwa provides important habitat for a large number of sensitive and at-risk species. (See the Wildlife Habitat section for the ICHxw.)

Diversity and densities of **reptiles** (e.g., rubber boas, racers, and skinks) and **birds** (e.g., common nighthawks) may be even higher in the ICHxwa than in the ICHxw.

Wild sarsaparilla
Aralia nudicaulis

Beaked hazelnut
Corylus cornuta

Edatopic Grid



Site series

101	CwFd – Hazelnut – Sarsaparilla
102	FdPy – Oceanspray – Bluebunch wheatgrass
103	FdPy – Oregon-grape – Pinegrass
104	Fd(Py) – Douglas maple – Pinegrass
110	CwHw – Foamflower
111	CwHw – Oak fern
112	CwHw – Horsetail – Lady fern
113	CwSxw – Skunk cabbage
Fm01	Cottonwood – Snowberry – Rose[1]

[1] See Section 6.3 for descriptions.

Site Series Flowchart

Forest group	Criteria	Site series
VERY DRY to DRY FORESTS • warm aspects • shallow soils	• SMR 1 • open Py (Fd) stands • exposed rock is prominent • bluebunch wheatgrass, rock ferns, and/or stonecrops • rock-mosses, clad lichens, and/or haircap mosses	**102**
	• SMR 2 • Fd, Py open canopy • steep, warm aspect; shallow and/or coarse soils • pinegrass; fescue and junegrass • bluebunch wheatgrass often abundant	**103**
SLIGHTLY DRY to MESIC FORESTS • mid slopes (usually) with deep soils	• SMR 3 (2) • Fd (Py) stands • high shrub cover: snowberry, mallow ninebark • pinegrass with minor cover (< 10%) • Cw, Hw absent or sparse	**104**
	• SMR 4 • mixed Fd (Cw) stands with Lw, Bg, Ep, At • Cw often restricted to the understorey • high shrub cover: beaked hazelnut and/or Douglas maple • fairybells and wild sarsaparilla common and abundant	**101**
MOIST to WET FORESTS • lower or toe slopes • seepage or mottles	• SMR 5 (4) • Cw (Hw) stands • black gooseberry and/or yew • foamflower and queen's cup abundant • < 1% lady fern, oak fern, and devil's club	**110**
	• SMR 5–6 • Cw, Hw stands • oak fern, lady fern, devil's club and/or wild ginger • mottles or seepage in the top 30–50 cm	**111**
WET to VERY WET FORESTS • gentle or flat, lower or toe slopes • water table present, often at or near the surface	• SMR 6 (7) • Cw, Hw (Sxw) stands • > 5% horsetail • < 3% oak fern and lady fern	**112**
	• SMR 6 (7) • Cw, Hw (Sxw) stands • > 5% skunk cabbage	**113**

Characteristics of the ICHxwa and Vegetation Differences between the ICHxw and ICHxwa

ICHxwa site series	Site characteristics[a]	Vegetation characteristics[b]	Differences between ICHxwa and ICHxw on similar sites
ICHxwa/101	**SMR 4.** Typically neutral or cool aspect, or gentle mid-slope positions (< 10%) on warm aspects; moderate-texture soils. Uncommon in the ICHxwa.	Fd (Cw) overstorey with **abundant shrubs**, including Douglas maple, beaked hazelnut, oceanspray, and minor amounts of mallow ninebark (especially near Christina Lake). Fairybells and wild sarsaparilla are usually abundant in the understorey.	The ICHxwa has less Pl, Ep, prince's pine, twinflower, and queen's cup and more fairybells than similar sites in the ICHxw; **Cw is often restricted to the B layer**.
ICHxwa/102	**SMR 1**. Exposed bedrock or talus are dominant features of the stand. Usually warm-aspect sites. Common in the ICHxwa.	**Py, Fd, bluebunch wheatgrass**, rock ferns, stonecrops, and rock-mosses are common. Trees are > 10% cover.	In the ICHxwa, there is **more Py** and **bluebunch wheatgrass** and often less Fd, and sites may have smooth sumac.
ICHxwa/103	**SMR 2**. Steep, warm, coarse and/or shallow sites. Very common in the ICHxwa.	**Fd, Py** overstorey with an often moderately shrubby understorey of snowberry and other shrubs. Oceanspray and mallow ninebark are more common around Christina Lake. **Pinegrass** is abundant, usually with moderate cover of bluebunch wheatgrass.	The ICHxwa often has more grasses—pinegrass, fescues, junegrass—than the ICHxw. **Bluebunch wheatgrass** is common. **Py** is more abundant.
ICHxwa/104	**SMR 3 (2)**. Moderate soils and slope on warm aspects; occasionally occurs on cool aspects on upper slope positions, shedding sites, or with coarse soils. Common in the ICHxwa.	**Fd-leading canopy**, often codominant with Py. Shrubby understorey with abundant mallow ninebark, snowberry, and oceanspray. Variable herb layer with pinegrass and minor cover of other herbs.	The ICHxwa has more snowberry, mallow ninebark, oceanspray, and showy aster and less beaked hazelnut, birch-leaved spirea, Douglas maple, arnica, and fairybells than similar sites in the ICHxw.
ICHxwa/110 **ICHxwa/111** **ICHxwa/112** **ICHxwa/113**		Data are pooled across both the ICHxw and ICHxwa; see ICHxw descriptions.	

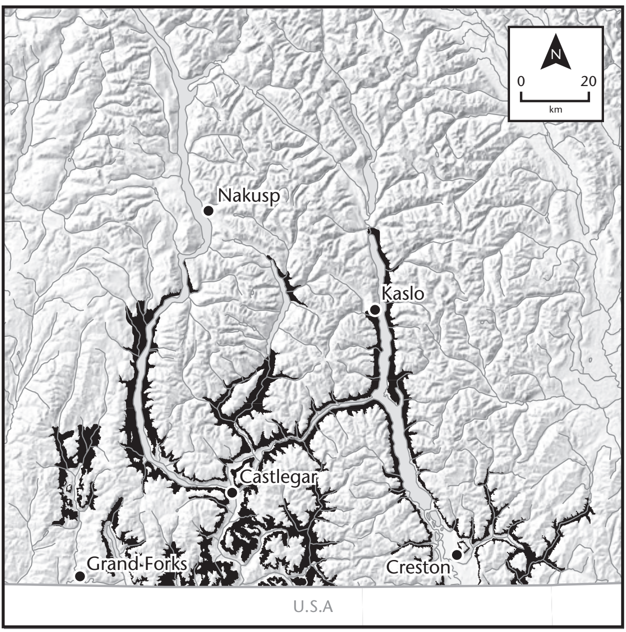
[a] For more information, refer to the site series descriptions for the ICHxw.
[b] Scientific names for all plant species are provided in the descriptions for the ICHxw.

ICHdw1
West Kootenay Dry Warm Interior Cedar – Hemlock

Geographic Distribution

The ICHdw1 occurs at lower elevations around Kootenay, Lower Arrow, and Christina Lakes, and in the Slocan, Salmo, Granby, Big Sheep, and Moyie River valleys and their tributaries. In much of the southern portion of its range, the ICHdw1 occurs above the ICHxw and ICHxwa; in the remainder, it occurs to the valley bottom. Upper elevations of the ICHdw1 are bordered by the ICHmw4 in the south Selkirk Mountains, the ICHdm east of Kootenay Lake, the ICHmw2 in the Slocan Valley and the north arm of Kootenay Lake, and the ICHmw5 along Christina and Lower Arrow Lakes and in the Granby Valley.

Distribution of the ICHdw1



Elevation Range

The ICHdw1 typically ranges from 600–800 m to approximately 1000–1225 m on cool aspects, from 650–850 m to 1150–1275 m on neutral aspects, and from 700–900 m to approximately 1200–1350 m on warm aspects. The higher limits tend to occur in the southern and eastern portions of the range.

Climate[1]

The ICHdw1 is located in the Moist climate subregion and is characterized by moist, warm springs; hot to very hot, dry summers; and mild, dry winters with a moderately shallow snowpack. Rain-on-snow events frequently occur. Snowpacks usually persist from January through March, although snow-free areas are common on warm-aspect sites. The ICHdw1 is relatively dry and warm compared to the remainder of the Moist climate region. Growing-season moisture deficits occur on submesic and drier sites, and occasionally on mesic sites in dry years.

Forest and Vegetation Characteristics

The ICHdw1 is a highly productive biogeoclimatic unit. Tree species diversity is very high, and mixes of Cw, Fd, Hw, Pl, Bg, Pw, Lw, Py, Ep, At, and Act are common. Bl and Sxw occur occasionally, particularly at upper limits of the variant, in areas with cold-air influence, and at both the eastern and western extremes where the ICHdw1 is nearer the MS and IDF.

The typical “Kootenay mix” on **zonal sites** consists of Fd, Cw, Hw, Lw, and frequently Bg, Pw, Pl, and Ep, with moderate amounts of falsebox, black huckleberry, Cw, and Hw in the shrub layer. Prince’s pine, queen’s cup, and twinflower are the most common and consistently occurring herb species on **mesic sites**, which have a sparse moss layer typified by pipecleaner moss. **Submesic sites** have a similar suite of tree species, with less Hw and more Pl, Lw, Ep, and Py. Py can be common and abundant on the **driest site** series, where Cw is uncommon and Hw is typically absent. Drier sites also tend to have abundant shrub cover with Douglas maple, birch-leaved spirea, Oregon-grape, baldhip rose, falsebox, and soopolallie. Cw and Hw dominate **wetter sites**, where high cover of oak fern, lady fern, and foamflower is common. Skunk cabbage and horsetail sites are uncommon and, due to extensive valley-bottom development, often occur in disturbed early seral stages where present.

Hw and Bg are less common at the eastern and western extents of the ICHdw1, where Pl and, to a limited extent, Sxw are more abundant. Bg is uncommon west of Arrow Lakes. Oceanspray and mallow ninebark are more

[1] See Section 4.2 for more information on climate variables.

common in the Granby/Burrell area of the ICHdw1 due to their overwhelming presence across that landscape.

Disturbance

Due to extensive disturbance history, old-growth forests are rare, and mature and younger stands dominate the landscape. The ICHdw1 has an extremely broad range of fire regimes. Historically, **mixed-severity fire** regimes occurred across the landscape, with fire return intervals ranging from low-intensity underburns on return intervals of less than 20 years to stand-replacing fires burning on 200-year intervals (Nesbit 2010). First Nations burning was common in localized areas. The **mining era** of the late 1800s and early 1900s involved widespread burning to clear land for easier prospecting and created extensive fire-origin stands, particularly in the Kootenay and Slocan Lakes areas (Quesnel and Pinnell 2000) and the Granby River valley. Timber harvesting has been extensive in more recent times.

Bark beetles are important disturbance agents, particularly **mountain pine beetle**, but also **Douglas-fir beetle**, especially on warm-aspect sites with high Fd. Fir engraver beetle affects Bg. **Armillaria root rot** creates small gaps in mature stands and can be a major impediment to tree regeneration. **Birch decline** due to a combination of insect, disease, and drought has had large impacts on Ep, while **white pine blister rust** along with historic targeted harvesting has had a major impact on Pw. **Gall rusts** affect growth of Pl regeneration. **Animal damage** can also be extensive: bear damage to Cw and Lw plantations can be localized but severe.

Urban and rural development have had a major impact on ecosystems in the ICHdw1. Approximately 30% of the ICHdw1 occurs on private lands, particularly in valley-bottom areas. **Hydroelectric dams** on the Kootenay and Columbia River systems **flooded** large areas of wet forest, wetland, and riparian cottonwood stands in the ICHdw1. In an assessment of habitat losses due to dams in the Columbia Basin, skunk cabbage, horsetail, devil's club, and cottonwood sites were found to be highly affected, with large areas and high proportions of the pre-dam areas lost to flooding (MacKillop et al. 2008; Utzig and Schmidt 2011). **Invasive plant species** are widespread in this unit, particularly in early seral or drier sites, and include knapweeds (particularly spotted [*Centaurea stoebe* ssp. *micranthos*] and diffuse [*C. diffusa*]), sulphur cinquefoil (*Potentilla recta*), and hawkweeds (*Hieracium* spp.).

Soils, Geology, and Landforms

A variety of rock types occur due to the wide geographic extent and varied geological history within the ICHdw1. Coarse-grained intrusive rocks such as granodiorite and granites are most common. Fine-grained rocks such as mudstone, siltstone, and shale are more common in the Monashee and Central Selkirk Ranges, along with metamorphic gneiss and basaltic volcanic materials. Medium-grained sandstones and coarse conglomerates are common in the Purcell Mountains.

Morainal materials with loamy to sandy loam textures are the dominant surficial materials, with similarly textured colluvium common on steeper (> 50%) slopes along valley walls. Glaciofluvial materials (kame and narrow terraces) are also common. Fine sandy loam–textured, volcanic ash–influenced eolian veneers of up to 40 cm are widespread. The coarse fragment content of these "ash caps" is variable due to differing degrees of soil mixing (perturbation).

Wildlife Habitat

Many species at risk occur in the ICHdw1. Forests dominated by Fd, Py, or deciduous species support breeding **Lewis's woodpecker**, **flammulated owl**, **western screech-owl**, and/or **fringed myotis**, all of which are wildlife tree–dependent. Rock outcrops, talus, and/or cliffs are important for at-risk reptiles (**western skink**, **northern rubber boa**, **North American racer**, **western rattlesnake**), birds (**canyon wren**, **peregrine falcon**), and mammals (**Townsend's big-eared bat**, **little brown myotis**, **red-tailed chipmunk**). Other species at risk use grassland or agricultural habitats: **American badger**, **prairie falcon**, **Swainson's hawk**, **short-eared owl**, **long-billed curlew**, **common nighthawk**, **bobolink**, and **barn swallow**. Common bird species include Swainson's thrush, American robin, warbling vireo, Hammond's flycatcher, and dark-eyed junco.

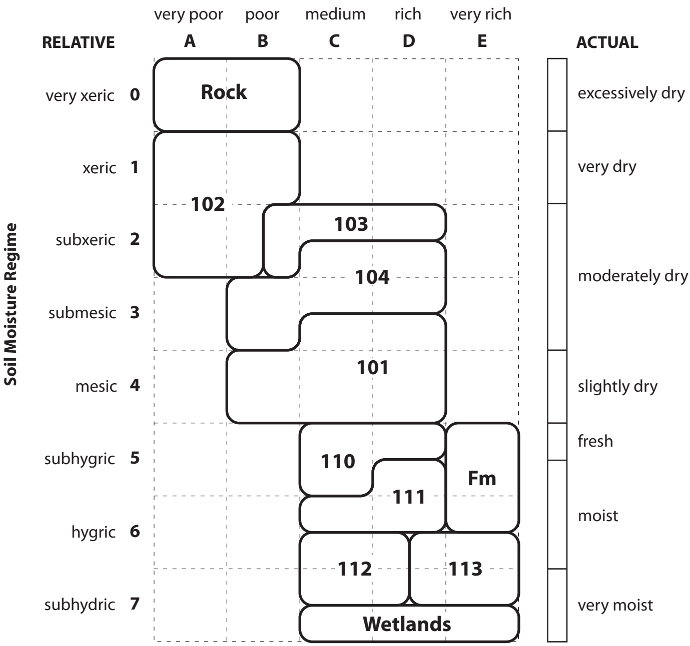
Key ungulate winter ranges and important foraging areas for **mule deer**, **white-tailed deer**, **Rocky Mountain elk**, and occasionally **bighorn sheep**, occur in the ICHdw1. Wide-ranging carnivores such as **cougar**, **black bear**, and **grizzly bear**, and various **furbearers** occur seasonally or year-round.

Riparian/wetland habitats on the lower Columbia, Slocan, Kootenay, Salmo, and Goat Rivers, and their tributaries are key breeding areas for regionally significant species (e.g., **osprey**, **bald eagle**, **harlequin duck**, **American mink**, **North American river otter**, **American beaver**) and for species at risk, including **Couer d'Alene salamander**, **blotched tiger salamander**, **western toad**, **painted turtle**, and **great blue heron**. Large water bodies (Kootenay, Lower Arrow, and Slocan Lakes) provide overwintering and staging areas, and remnant cottonwood stands are critical habitat for open and cavity-nesting, roosting and denning species.

Distinguishing the ICHdw1 from Adjacent Biogeoclimatic Units

In the **ICHxw**, most sites have:	- less Cw and Hw - more shrubs
zonal sites have:	- more Douglas maple, hazelnut, snowberry, Oregon-grape, and saskatoon - no Hw
dry sites have:	- more Py, mallow ninebark, oceanspray, mock-orange, bluebunch wheatgrass, and pinegrass
In the **ICHmw2**, most sites have:	- no Py or Bg - more moss
zonal sites have:	- foamflower - bunchberry, especially in northern and western areas - sparse Fd and Lw in mature/old stands
dry sites have:	- little or no oceanspray and mallow ninebark - less pinegrass
In the **ICHmw4**, most sites have:	- no Py - Bg restricted to lower elevations
zonal sites have:	- foamflower - sparse Fd and oak fern
dry sites have:	- frequent bear-grass - little or no oceanspray and mallow ninebark
In the **ICHmw5**, most sites have:	- no Py and Bg
zonal site have:	- less Fd - minor Sxw and Bl
dry sites have:	- little or no oceanspray and mallow ninebark -extensive Pl stands
In the **ICHdm**, most sites have:	- no Py - Bg restricted to lower elevations - fewer shrubs
zonal site have:	- minor Sxw and Bl - foamflower - less western yew
dry sites have:	- bear-grass and grouseberry/low bilberry - little or no mallow ninebark and oceanspray
wet sites have:	- Sxw, Bl, and false azalea

Edatopic Grid



Site series

101 CwFd – Prince's pine – Twinflower
102 FdPy – Pinegrass – Rock-moss
103 Fd(Py) – Douglas maple – Pinegrass
104 FdCw – Douglas maple – Prince's pine
110 CwHw – Oak fern
111 CwHw – Devil's club – Lady fern
112 CwHw – Horsetail – Lady fern
113 CwSxw – Skunk cabbage
Fm01 Cottonwood – Snowberry – Rose[1]

[1] See Section 6.3 for descriptions.

Site Series Flowchart

VERY DRY to DRY FORESTS • warm aspects • shallow soils	• SMR 1–2 • open Fd, Py stands • exposed rock is prominent • rock ferns, stonecrop, and pinegrass • rock-mosses, clad lichens, and/or haircap mosses	**102**
	• SMR 2 • Fd, Py open canopy • steep, warm aspect; shallow and/or coarse soils • shrubby with Douglas maple, birch-leaved spirea, Oregon-grape, falsebox, rose, and/or snowberry • pinegrass often abundant • Cw, Hw typically absent	**103**
SLIGHTLY DRY to MESIC FORESTS • mid slopes (usually) with deep soils	• SMR 3 (2) • mixed Fd, Lw, Pl, Cw stands • shrub-rich with abundant falsebox, Douglas maple, birch-leaved spirea, Oregon-grape, rose, soopolallie, and/or snowberry	**104**
	• SMR 4 (3) • mixed Cw, Hw, Fd, Lw stands • Pl, Ep, At also common in earlier seral stands • falsebox and huckleberry ~10% cover • abundant pipecleaner moss	**101**
MOIST to WET FORESTS • lower or toe slopes • seepage or mottles present	• SMR 5 • falsebox and yew • oak fern, queen's cup, and foamflower abundant • < 1% lady fern and/or devil's club	**110**
	• SMR 6 (5) • > 5% devil's club • > 5% lady fern	**111**
WET to VERY WET FORESTS • level or gentle lower or toe slopes • seepage or water table present, often near the surface	• SMR 6 (7) • Cw, Hw (Sxw) stands • > 5% horsetail cover • < 3% oak fern and lady fern cover	**112**
	• SMR 6 (7) • Cw, Hw (Sxw) stands • > 5% skunk cabbage cover	**113**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	113	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■■	■■■■	■■■■	*	*			Douglas-fir
	Pinus ponderosa	□□□	□□□							ponderosa pine
	Pinus contorta			□□□	*					lodgepole pine
	Thuja plicata			□□□	■■■■	■■■■■	■■■■■	■■■■	■■■■	western redcedar
	Larix occidentalis			□□□	□□□	*				western larch
	Abies grandis			*	□□	*				grand fir
	Tsuga heterophylla				□□□□	■■■■	□□□□	□□□	■■■■	western hemlock
	Picea engelmannii x *glauca*					□□	□□	□□		hybrid white spruce
Regen	*Pseudotsuga menziesii*	■■■	■■■	■■■	*					Douglas-fir
	Thuja plicata			□□□	■■■■	■■■■	■■■	■■■	■■■	western redcedar
	Tsuga heterophylla			*	■■■	■■■	□□	■■	■■■■	western hemlock
Shrubs	*Paxistima myrsinites*	■■■	■■■	■■■■	■■■	□□				falsebox
	Acer glabrum	■■■	■■■	■■■	□□	□				Douglas maple
	Spiraea betulifolia	■■■	■■■	■■						birch-leaved spirea
	Rosa gymnocarpa	■■	■■■	■■■	■■	■				baldhip rose
	Amelanchier alnifolia	■■	■■	■■	□	□				saskatoon
	Holodiscus discolor	■■	□□							oceanspray
	Philadelphus lewisii	□□								mock-orange
	Physocarpus malvaceus	□□								mallow ninebark
	Mahonia spp.	■	■■■	■■	□□					Oregon-grape
	Symphoricarpos albus	□	■■■	*						snowberry
	Shepherdia canadensis			□□						soopolallie
	Vaccinium membranaceum			□□	■■	■				black huckleberry
	Taxus brevifolia				*	■■■	□□	■■■	■	western yew
	Oplopanax horridus					□	■■■	*	*	devil's club

Layer	Scientific name	102	103	104	101	110	111	112	113	Common name
Herbs	*Calamagrostis rubescens*	■■■	■■■■	□□						pinegrass
	Prosartes spp.	□	□	□□	□□	□	□			fairybells
	Fragaria spp.	■	■■	□						strawberry
	Festuca spp.	■	□	*						fescues
	Achillea millefolium	■	□							yarrow
	Heuchera cylindrical	□								round-leaved alumroot
	"rock ferns"[a]	■								rock ferns
	Hieracium albiflorum		■■	□	*					white hawkweed
	Linnaea borealis			■■■■	■■■	■■	*	■■■	■■	twinflower
	Chimaphila umbellate			■■■	■■■	*			□	prince's pine
	Clintonia uniflora			□□	■■■	■■■	■■■	■■	■■	queen's cup
	Tiarella trifoliata var. *unifoliata*					■■■	■■■	■■■	■■■	one-leaved foamflower
	Gymnocarpium dryopteris					■■■	■■■■	□□	□□□	oak fern
	Athyrium filix-femina					■	■■■	■■	■■■	lady fern
	Streptopus amplexifolius					■	■	□□	■	clasping twistedstalk
	Osmorhiza berteroi					■	■	■	□	mountain sweet-cicely
	Trillium ovatum					□	□	*		western trillium
	Cornus canadensis					□	*	□□	□□	bunchberry
	Asarum caudatum						■■	□□	■■	wild ginger
	Equisetum spp.							■■■		horsetails
	Lysichiton americanus								■■■■■	skunk cabbage
Moss layer	*Pleurozium schreberi*	■■■		*	□□□	*				red-stemmed feathermoss
	Racomitrium spp.	■■■								rock-mosses
	Cladonia spp.	■	□							clad lichens
	Rhytidiopsis robusta			*	■■■■	*		□□	□□	pipecleaner moss
	"leafy mosses"[a]					■■■	■■■	■■■	■■■■■	leafy mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site series	102	103	104	101	110	111	112	113
No. of plots	6	20	65	40	12	20	5	X[b]
SMR	1 (2)	2	3 (2)	4 (3)	5	6 (5)	6 (7)	6 (7)
SNR	A–B	B–D	B–D	B–D	C–D	C–D	D (C–E)	D (C–E)
Slope position	UP, CR	UP, MD	MD (UP)	MD	LW (TO, MD)	LW (TO, LV)	TO, DP	TO, DP
Typical slope/ aspect	Mostly warm	Steep/warm	Moderate–moderately steep/warm	Moderate/ neutral–cool	Gentle (steep)	Gentle–level	Gentle, level	Gentle, level
Common compensating conditions			Upper/cool; lower/ coarse–very coarse	Lower, coarse/ warm; gentle/ warm	Mid-slope receiving	Steep cool, receiving		
Surficial materials	Cx/R or Mx/R (Cb)	Cv, Cb (FG, Mb)	Mb, FG (Cb)	Mb (Cb, FG)	F, Mb (FG)	F (Mb)	F, Ov/F	Ov/F
Soil texture	SL, SiL (FSL, LS)	SL (SiL, LS, FSL)	SL (L, LS, SiL)	SL (L, Sil, FSL)	SL (FSL, LS, SiL, S)	SL, LS (SiL, FSL, SiCL)	SiL (SL, S)	SiL (SL, S)
Coarse fragment content	High–fragmental	Moderate–high (fragmental)	Moderate–high	Moderate (variable)	Moderate (variable)	Low–moderate	Sparse–low; often increasing at depth	Sparse–low
Important features	Dominated by (bed)rock	Insolation; soils frequently shallow and/or coarse			Seepage or mottles within 50–75 cm	Seepage or mottles within 30–50 cm	Cold air; water table within 0–30 cm; organic veneer	Water table within 0–30 cm; organic veneer

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.
[b] Limited data are available for older stands in the ICHdw1 /113; descriptions provided here are based on plot data (vegetation, site, soils) from the same site association in similar biogeoclimatic units.

CwFd – Prince's pine – Twinflower **101**

General Description

SMR 4 (3). 101 forests typically occur on the mid-slope position of neutral to cool aspects. Due to compensating factors, these sites also occur on gentle, warm slopes, and on lower slopes of warm aspects where moisture receiving and shedding are approximately equal. Parent materials are typically morainal but can be colluvial or glaciofluvial and may have an eolian capping of volcanic-derived ash. Soils are typically sandy loam Dystric or Eutric Brunisols with variable coarse fragment content.

Tree species diversity is high throughout all seral stages. **Fd**, **Cw**, **Hw**, **Lw**, **Pw**, and **Bg** are common across stands of all ages, while Pl, Ep, and At are abundant in early to mid-seral stands. **Falsebox**, **black huckleberry**, **queen's cup**, **prince's pine**, and **twinflower** are typical in the floristically diverse understorey.

Differentiating from Other Site Series

Although tree species diversity is similar, slightly drier 104 sites usually lack Hw in the overstorey and have higher shrub cover and diversity, including more Oregon-grape, Douglas maple, snowberry, birch-leaved spirea, saskatoon, and/or soopolallie. Py is often present on drier sites. Regenerating Cw is often more abundant in 101 forests than in the 104. Wetter sites have less Fd and Lw, and more Cw and Hw, and contain oak fern, foamflower, and other seepage-site indicators.

Variability

Tree species composition on 101 sites is highly variable due to the broad range of suitable species. Earlier seral stages often have higher broadleaf cover, including Ep and At. At lower elevations, fairybells and wild sarsaparilla may be present at low densities, while minor (< 1% cover) foamflower is common at upper elevations or near the northern limits. Twinflower can have high cover in open stands. Western yew may be present. Denser stands, particularly on cool aspects, can have almost no understorey vegetation, particularly where Hw is abundant and subcanopy light is limited.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered. Brush competition can cause regeneration problems.

102 FdPy – Pinegrass – Rock-moss

General Description

SMR 1 (2). 102 forests occur on very dry, steep slopes on warm aspects with **exposed bedrock** and very shallow soils or on **blocky talus slopes** where rocks form the dominant substrate. Soils often vary in depth, with deeper pockets of soil interspersed among very thin veneers and exposed rock. Humus forms are usually thin and dry, if present. Stands often occur in larger complexes with open, non-forested rock outcrops or talus areas (with < 10% total tree cover) and with 103 sites on deeper, coarse-textured soils.

Fd and/or **Py** are the dominant tree species. Shrub cover is typically moderate but variable, often with tall shrubs such as **oceanspray** and **ninebark**. **Kinnikinnick** (*Arctostaphylos uva-ursi*), **round-leaved alumroot**, **pinegrass**, and rock ferns (mostly **parsley fern** [*Cryptogramma acrostichoides*], cliff ferns [*Woodsia* spp.], and fragile fern [*Crystopteris fragilis*]) are common. *Selaginella* species, stonecrops (*Sedum* spp.), and other **rock outcrop plants** often occur with very low cover. Mosses, including heron's-bill mosses, red-stemmed feathermoss, and **rock-mosses** often form a dense mat. Clad lichens and haircap mosses (*Polytrichum* spp.) frequently occur.

Differentiating from Other Site Series

These sites can be easily differentiated as the driest forested ecosystems in the ICHdw1. Drier sites tend to be non-treed (< 10% cover) rock outcrops or talus. 103 sites have deeper soils, lack abundant exposed (bed)rock, and have higher shrub and lower moss cover and diversity.

Variability

Pl is common in earlier seral stages and at higher elevations. Cw regeneration and other moister understorey species may occur in hollows or other microsites with moisture retention capability.

Management Issues

This site series is not recommended for timber harvesting due to limitations in available soil and soil moisture for tree regeneration and growth. It often contains at-risk or sensitive plant and animal species.

Fd(Py) – Douglas maple – Pinegrass 103

General Description

SMR 2. 103 forests occur on **steep**, **warm** mid to upper slopes with **shallow soils**. Soils are typically well- to rapidly drained Dystric or Eutric Brunisols with thin humus forms. Colluvial parent materials are typical. This site frequently occurs in a mosaic with 102 forests and non-forested rock outcrops or talus ecosystems (< 10% tree cover).

An open **Fd** and **Py** canopy is typical, with an understorey of diverse and abundant shrubs typified by **falsebox**, **Douglas maple**, **birch-leaved spirea**, **Oregon-grape**, **snowberry**, **saskatoon,** and **oceanspray**. **Pinegrass** is usually present along with minor amounts of wild strawberry, white hawkweed, and often kinnikinnick. The moss layer is generally sparse.

Differentiating from Other Site Series

Drier sites are dominated by exposed bedrock or talus, typically with abundant moss cover, including red-stemmed feathermoss, rock-mosses, haircap mosses, and heron's-bill mosses. Moister sites have higher tree species diversity with more Cw, Lw, Hw, and Pl, and less Py; pinegrass is sparse to absent, and twinflower, prince's pine, and queen's cup are common.

Variability

Broadleaf-dominated stands are common on these sites where Ep and At often dominate or form mixed stands with Fd, Py, Pl, and Lw; understorey shrubs such as mallow ninebark, oceanspray, snowberry, and Douglas maple can be abundant. Broadleaf-dominated sites are often the result of repeated, high-severity fires, and in many cases, show slow stand development processes. These sites can be coded as 103$B.[2]

Py is often less abundant at higher elevations where Pl or Lw may be present in minor amounts. Oceanspray and mallow ninebark can be abundant.

Management Issues

Drought may limit tree growth and establishment during drier than normal growing seasons. Soil erosion can be a concern on steep slopes. Sites provide important ungulate winter range due to lower snow depth and high forage availability. High brush cover can also cause regeneration problems. Invasive plant species can be a significant concern.

[2] See Section 2.3 for seral coding.

104 FdCw – Douglas maple – Prince's pine

General Description

SMR 3 (2). 104 sites occur across a range of **submesic** sites in the ICHdw1. They typically occur on moderate to moderately steep **mid slopes of warm aspects**, but due to compensating factors, they also occur on upper, shedding slopes of cool to neutral aspects with very coarse soils. Sites are typically derived from morainal or glaciofluvial materials. Soils are usually Dystric or Eutric Brunisols with moderate to moderately high coarse fragment content and sandy loam textures, which often become coarser at depth.

Tree species diversity is typically high, with abundant **Fd** mixed with **Lw**, **Pl**, and **Cw**. The shrub layer is also diverse, with high cover of **falsebox** and **Douglas maple**, and minor amounts of saskatoon, birch-leaved spirea, and/or Oregon-grape. Soopolallie, thimbleberry (*Rubus parviflorus*), and black huckleberry may be present. Pinegrass is sparse to absent, and **twinflower**, **prince's pine**, and **queen's cup** are common and often abundant. The moss layer is variable, with sparse cover of red-stemmed feathermoss and/or pipecleaner and heron's-bill mosses.

Differentiating from Other Site Series

Drier sites (103) have more Py and pinegrass, while Lw, Cw, and Pl are either sparse or absent. Moister sites (101) have less shrub cover, including less Douglas maple, and drier shrub species such as birch-leaved spirea, snowberry, saskatoon, and Oregon-grape are either sparse or absent. Moister sites also have more queen's cup and less twinflower, and Hw is present in the overstorey and/or understorey.

Variability

Tree species diversity is often high, and either Fd, Lw, or Pl can dominate, particularly in earlier seral stages. Py and/or Hw may be present in minor amounts. Ep and beaked hazelnut (*Corylus cornuta*) are common in seral stands. Understorey plants can also be diverse, although twinflower and prince's pine are typically prominent.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered. Warm-aspect sites can provide important ungulate winter range due to lower snow depth and high forage availability. Soil erosion can be a concern on steep slopes. Brush competition from shrubs and bracken fern (*Pteridium aquilinum*) can cause regeneration problems. Invasive plant species can be a significant concern.

CwHw – Oak fern **110**

General Description

SMR 5. 110 forests occur on **lower slopes** with **seasonal seepage at depth**. Sites are often a narrow band between mesic mid-slope conditions and hygric stream-side areas. Gleysols and gleyed Eutric Brunisols are common, with mottles within the top 75 cm of the soil profile.

Hw and **Cw** are the dominant trees in both the overstorey and understorey, although Pw, Bg, Fd, and Sxw often form minor components of the stand. Shrub cover is typically sparse, with minor black huckleberry, falsebox, and/or western yew. **Oak fern**, **foamflower**, and **queen's cup** typify the understorey, while **leafy mosses**, especially *Rhizomnium nudum* occur with pipecleaner moss and ragged-mosses. Minor amounts of lady fern and/or devil's club (< 1% cover) are often present.

Differentiating from Other Site Series

Drier sites (101) lack oak fern and foamflower; slightly drier sites are instead dominated by prince's pine and twinflower. Lady fern, wild ginger, and/or devil's club are present, with > 5% cover on wetter sites (111).

Variability

Following extensive fires within the past 100 years, these sites frequently occur as mid-seral stands with extremely sparse herb and moss cover. In these species-poor stands, site and soil conditions must be used to confirm site series classification; slope position, mottling, and/or seasonal seepage at depth are the most reliable indicators.

Management Issues

Tree productivity is high on these sites, and vegetation competition may be a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. These sites are often associated with riparian management areas, and frequently provide travel corridors in steep terrain and forage for wildlife.

111 CwHw – Devil's club – Lady fern

General Description

SMR 6 (5). 111 forests occur on **lower** and **toe slopes** with **seepage** or the **water table** at 30–50 cm below the soil surface. Sites are typically gently sloped but can be moderately steep where available moisture is prominent. Soils are typically Gleysols or Gleyed Eutric Brunisols. Stands are usually associated with **riparian** areas.

Tree cover is dominated by **Cw** and **Hw**, although minor amounts of Sxw and/or Act are common, particularly in riparian areas. **Devil's club** and/or **lady fern** are present with moderate to high cover (> 5% cover), along with oak fern, **wild ginger**, foamflower, queen's cup, and/or **sweet-scented bedstraw**. **Leafy mosses**, including *Rhizomnium nudum*, *R. magnifolium*, or *Plagiomnium* spp., are usually present and abundant.

Differentiating from Other Site Series

The presence of devil's club and/or lady fern, with > 5% cover of either, separates the 111 from most other ecosystems. Some wetter sites may have these species but can be distinguished by moderate to abundant horsetails (> 5% cover) and/or skunk cabbage.

Variability

111 stands can have either lady fern or devil's club. On some sites, particularly in dense stands, herb and shrub cover may be very sparse, and wild ginger and seepage within the upper 30–50 cm of the soil are more reliable indicators.

Management Issues

Tree productivity is high on these sites, and vegetation competition may be a concern. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. These sites are often associated with riparian management areas, and frequently provide travel corridors in steep terrain and forage for wildlife.

CwHw – Horsetail – Lady fern 112

General Description

SMR 6 (7). Old and mature *CwHw – Horsetail – Lady fern* forests are extremely uncommon in the ICHdw1. Where present, 112 forests occur on gently sloping to level **riparian** areas with **cool microclimates**. The water table occurs at or near the surface, within or immediately below a thin **organic veneer**. Soils are typically Orthic Humic Gleysols with repeated flooding and/or water retention in depressions. Microtopography is often hummocky, with trees restricted to establishing on elevated microsites.

Cw, Hw, Sxw, and Act typically comprise the overstorey, with low to moderate amounts (< 10% cover) of **horsetails** (*Equisetum arvense, E. pratense*) along with lady fern, oak fern, and sweet-scented bedstraw. Rattlesnake fern (*Botrypus virginianus*) is often present in minor amounts. Leafy mosses, particularly *Rhizomnium nudum*, *R. magnifolium*, and *Plagiomnium* spp., are also common.

Differentiating from Other Site Series

Drier sites (110 and 111) lack horsetails and have abundant oak fern, lady fern, and/or devil's club. The 112 site series occurs on sites similar to 113 stands, but horsetail sites are usually associated with minor to prominent cold-air pooling and have minimal to no skunk cabbage (< 3% cover).

Variability

Due to disturbances, most of these forests occur in earlier seral stands where vegetation can be highly variable. Weedy species are common, particularly in disturbed sites. Trees and species associated with drier sites often occur on elevated microsites with wetter species growing in depressions.

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, competition from brush can be a concern in regenerating stands. Due to disturbance history and proximity to rural and urban development, invasive plant species are a significant concern.

113 CwSxw – Skunk cabbage

General Description

SMR 6 (7). Old and mature *CwSxw – Skunk cabbage* sites are very rare in the ICHdw1. Where present, 113 sites occur on **level** areas or **gentle** slopes, often associated with **riparian** areas. The **water table** is typically at or near the surface, within or immediately below an **organic veneer**. Soils are either organic or Orthic Humic Gleysols with water retention in riparian areas or depressions. Microtopography is often hummocky, with trees restricted to elevated microsites.

Cw, Hw, and Sxw are common in the overstorey. At, Act, and Ep may be present in earlier seral stages. Minor amounts of devil's club and lady fern may be present along with leafy mosses. The most obvious distinguishing species is the dominance of **skunk cabbage**.

Differentiating from Other Site Series

Although they occur on similar sites as the 112, 113 sites can easily be distinguished from all other forested site series by the abundance of skunk cabbage. Wetter sites are non-forested wetlands. Slightly drier sites (111) have lady fern, devil's club, and/or wild ginger, and lack skunk cabbage.

Variability

Due to widespread development in valley bottoms throughout the ICHdw1, most occurrences are in heavily disturbed, earlier seral stages. Broadleaf species such as Act and Ep are common in younger stands. Weedy species such as wall lettuce (*Mycelis muralis*) can be common, particularly in disturbed sites. Trees and species associated with drier sites often occur on elevated microsites with wetter species growing in depressions. 113 sites can also be classified as *Ws10 Western redcedar – Spruce – Skunk cabbage* forested swamps (see Section 6.2).

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, competition from brush can be a concern in regenerating stands. Due to disturbance history and proximity to rural and urban development, invasive plant species are a significant concern.

Other Ecosystems

The following ecosystems occur within the ICHdw1; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

Wetlands are moderately common in the ICHdw1; they occur at the fringes of slow-moving streams and rivers, along lakeshore and pond margins, and in wet depressions in broad valley bottoms. The most frequently occurring types are marshes (Wm), swamps (Ws), and shallow water (Ww), although fens (Wf) also occur. Descriptions for these and other wetlands are provided in Section 6.2.

Cottonwood forests and other flood ecosystems

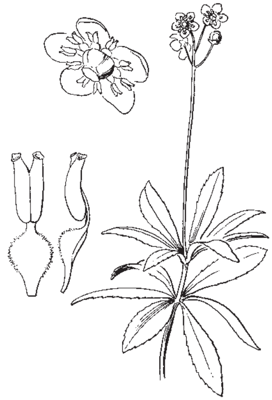
Cottonwood forests are relatively common in the ICHdw1, although significant areas were flooded for hydroelectric developments. Large areas remain in the Inonoaklin, Salmo, Moyie, and Granby Valleys, and at the north and south ends of Kootenay Lake. Smaller cottonwood complexes occur along floodplains, on river and stream deltas, and as narrow bands in riparian areas. Although the Fm02 and Fm04 occasionally occur, the most common cottonwood forest floodplain ecosystem is *Fm01 Cottonwood – Snowberry – Rose*. Low bench flood ecosystems (Fl), dominated by willow and alders, are common along stream and lake edges. Flood ecosystems are described in Section 6.3.

Grasslands and brushlands

Brushlands occur on steep, warm-aspect sites in the ICHdw1, although they are moderately uncommon. The most frequently occurring brushland type is *Gb03 Ninebark – Oceanspray – Bluebunch wheatgrass*. Grasslands (Gg11) are very uncommon and are usually restricted to small (< 0.5 ha) openings, typically in a matrix of dry forests (102, 103), brushlands, and/or rock outcrops. Information about grassland and brushland ecosystems is provided in Section 6.4.

Rock outcrops and talus slopes

Rock outcrops (Ro) and talus (Rt) ecosystems are very common in the ICHdw1. Rock ecosystems are described in Section 6.6.



Prince's pine
Chimaphila umbellata

One-sided wintergreen
Orthilia secunda

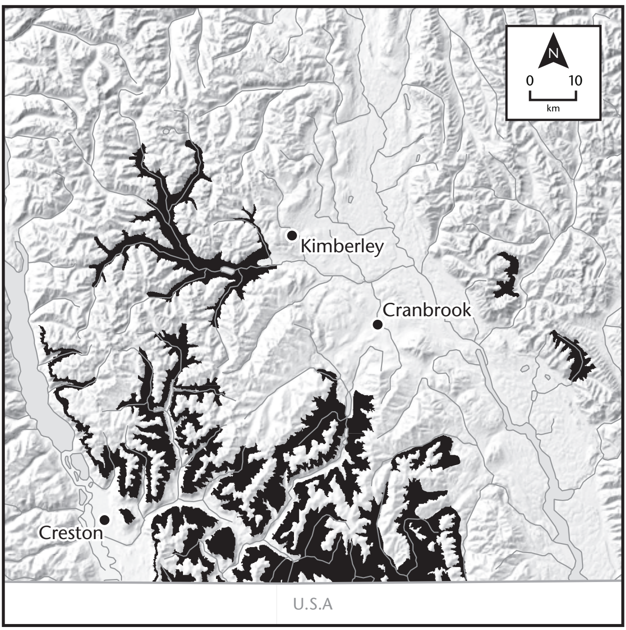
Wild ginger
Asarum caudatum

ICHdm
Dry Mild
Interior Cedar – Hemlock

Geographic Distribution

The ICHdm occurs in the southern Purcell Mountains, east of Kootenay Lake from Akokli Creek to Bloom Creek in the Yahk Range and in the St. Mary drainages from Redding Creek to Hellroaring and Matthew Creeks. A small area of ICHdm also occurs in the front ranges of the Rocky Mountains near the Bull River and along Sand Creek. The ICHdm typically occurs above the ICHdw1 and below the ESSFwm4. At the eastern extent of the range, in the Yahk, Gilnockie, and Teepee Creek drainages, it abuts the MSdw and occurs below the ESSFdk1. In the St. Mary drainages, the ICHdm occurs below the ESSFwh2.

Distribution of the ICHdm



Elevation Range

Where the ICHdm occurs at valley bottom, it is generally found up to 1500 m on cool aspects, 1550 m on neutral aspects, and 1650 m on warm aspects. Where it is found above the ICHdw1, it typically occurs from 1000 to 1575 m on cool aspects, from 150 to 1600 m on neutral aspects, and from 1300 to 1625 m on warm aspects.

Climate[1]

The ICHdm occurs in the Moist climate subregion and is characterized by warm, dry summers, moist springs, and cool, dry winters with a moderate snowpack that typically persists from December or January through to March or early April. The ICHdm climate is transitional between typical ICH and MS climates. It is cooler and moister than the ICHdw1, and cooler and drier than the ICHmw2 and ICHmw4. Growing-season moisture deficits can occur on subxeric and drier sites, and on submesic sites in dry years.

Forest and Vegetation Characteristics

The ICHdm occurs in a climatic transition from moister ICH forests to drier, cooler MS forests. As a result, diverse forests are common with Cw, Hw, Lw, Fd, Pl, Sxw, Bl, Pw, Ep, At, Act, and, at lower elevations, Bg. Shrub diversity is also high, with minor amounts of black huckleberry, falsebox, Utah honeysuckle, and false azalea common on most site types. **Mesic forests** are typically closed stands dominated by Lw, with variable mixtures of Hw, Cw, Pl, Bl, Cw, Sxw, and Fd. Climax Hw stands are uncommon. **Drier sites** typically have more Fd and Pl and lack Cw and Hw. Pinegrass is typically present, along with higher shrub cover that includes birch-leaved spirea, Oregon-grape, roses (baldhip [*Rosa gymnocarpa*] and prickly [*R. acicularis*]), and/or soopolallie. Cw and Hw dominate **wetter sites**, with Sxw and Bl abundant in stands controlled by **cold air**. Devil's club, oak fern, lady fern, and leafy mosses are prominent in the understorey of these wetter sites.

Cottonwood stands occur infrequently but are most abundant in valley-bottom locations in the Kid, Goat, Moyie, and St. Mary Rivers. Rock outcrop sites, avalanche run-out zones, and wetlands are also uncommon in the ICHdm.

Disturbance

Stand-replacing **fires** and mixed-severity fires were historically widespread in the ICHdm. Evidence of mixed-severity burns is most often found on warmer aspects and on slopes on all aspects that extend to lower elevations. Fire-scarred Fd, Lw, and occasionally Cw are common. As a result of **timber harvesting,** combined with both natural and human-caused fire

[1] See Section 4.2 for more information on climate variables.

(particularly during the mining era), old-growth forests are uncommon. The current landscape is dominated by early to mid-seral mixed coniferous stands. Prior to European settlement, old and mature forests would have been more common.

Bark beetles are important disturbance agents, particularly **mountain pine beetle**, but also spruce beetle following fire, blowdown, or where slash retention is high after harvest; Douglas-fir beetle is an important disturbance agent in isolated stands with high cover of Fd. **Armillaria root rot** also creates small gaps in mature stands and can be a major impediment to tree regeneration. **Birch decline**, due to a combination of factors, has had large impacts on Ep, while **white pine blister rust** has had a major impact on Pw. Western **gall rust** affects growth of Pl regeneration. Spruce weevil can impede growth in planted stands. **Animal damage** can be extensive in Pl and Lw plantations.

Soils, Geology, and Landforms

Dominant bedrock types include argillite, sandstones, conglomerate, and other fine-textured metasedimentary rocks. Quartzites and granodiorites are also common. Soils derived from morainal materials predominate, typically with sandy loam to fine sandy loam textures, but also with silt and loam textures. Glaciofluvial materials with gravelly or sandy textures are common. Thin (< 30 cm), silty or fine sandy eolian cappings are widespread in valley bottoms. Fluvial soils on floodplains and terraces along the St. Mary, Yahk, and Moyie Rivers and other main waterways have loamy to sandy surface textures and are gravelly at depth.

Wildlife Habitat

Important winter range for Rocky Mountain elk, mule deer, and moose occurs on south-facing slopes. Pockets of late-seral forest at higher elevations provide habitat connectivity for the threatened South Purcell **mountain caribou**. This unit is used by a range of cavity-dependent species (e.g., **black-capped**, **chestnut-backed**, and **mountain chickadees**; **pileated**, **three-toed**, **hairy**, **downy**, and **black-backed woodpeckers**; **red-naped sapsucker**, **red-breasted nuthatch**, **brown creeper**, **mountain bluebird**, **red squirrel**, **yellow pine chipmunk**). Most are **insectivorous species** that play an important role in the biological control of forest insects. Forest stands (often dominated by Lw) support suitable breeding habitat for at-risk **Williamson's sapsucker**, whereas uncommon mixed stands have breeding potential for listed **western screech-owl**. Maintaining **patches of mature and old forest structure** with large live and dead wildlife trees (with cavities, hollows, broken tops, and large horizontal limbs) is important for these species.

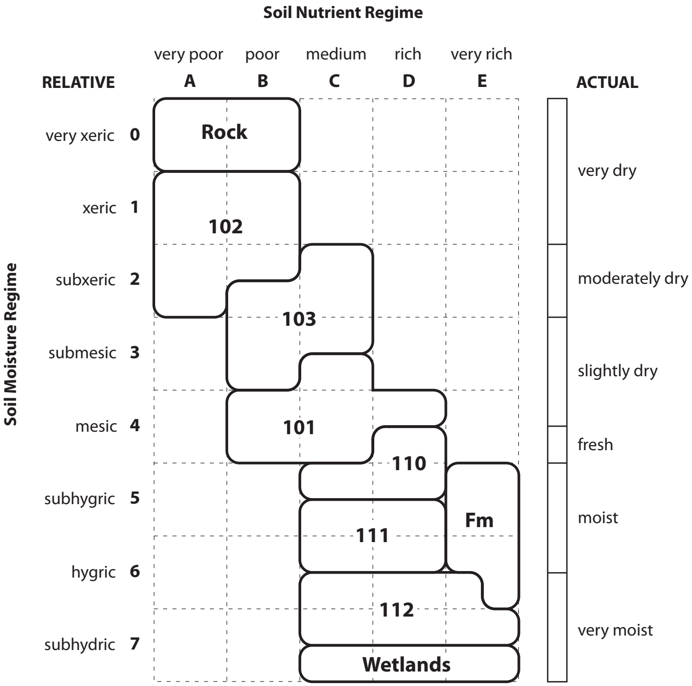
Rocky Mountain tailed frogs breed in clear, cold, swift streams with coarse substrate, mainly within the Yahk drainage of the ICHdm. **Wetland and riparian areas** are used for breeding and feeding by a variety of birds, mammals, and herptiles, such as at-risk **painted turtle**, **western toad**, **great blue heron**, and **little brown myotis**. Early seral openings and drier, open forests provide suitable habitat for endangered **American badger**, as well as at-risk **common nighthawk**, **barn swallow**, and **northern rubber boa**. Some of the more common bird species include Swainson's thrush, warbling vireo, yellow-rumped warbler, MacGillivray's warbler, and Cassin's vireo.

Distinguishing the ICHdm from Adjacent Biogeoclimatic Units

In the **ICHdw1**, most sites have:	- no false azalea, Sxw, Bl, or bear-grass - more falsebox
zonal sites have:	- little to no foamflower - less western yew
dry sites have:	- Py - more Cw, Douglas maple, tall Oregon-grape, saskatoon, and snowberry - no grouseberry and/or low bilberry - less Pl
In the **ICHmw2**, most sites have:	- less Sxw, Bl, and Pl - no false azalea - more bunchberry, red-stemmed feathermoss, and step moss
dry sites have:	- Douglas maple but lack Rocky Mountain juniper and choke cherry - no grouseberry/low bilberry - less pinegrass - more queen's cup and pipecleaner moss
In the **MSdw**, most sites have:	- more pinegrass, birch-leaved spirea, snowberry, and grouseberry/low bilberry - less foamflower and queen's cup
zonal sites have:	- more Sxw, Bl, Fd, and arnica
wet sites have:	- no oak fern, lady fern, and devil's club
In the **ESSFwh2**, most sites have:	- Se and Bl dominant or co-dominant in the canopy - more false azalea, white-flowered rhododendron, and black huckleberry - no grouseberry/low bilberry
zonal sites have:	- oak fern and five-leaved bramble - no Pl or Lw

dry sites have:	- less Fd - no snowberry, saskatoon, tall Oregon-grape, or rose
wet sites have:	- more false hellebore and mitrewort
In the **ESSFwm4**, most sites have:	- Se and Bl dominant or co-dominant in the canopy - Cw and Hw in small amounts at lower elevations - white-flowered rhododendron, false azalea, and more black huckleberry
zonal sites have:	- arnica, wood-rushes, minor grouseberry/low bilberry, and/or beargrass - no Lw, Pw, western yew, twinflower, prince's pine, pipecleaner moss, and red-stemmed feathermoss
dry sites have:	- no Fd, birch-leaved spirea, pinegrass, or bluebunch wheatgrass - less twinflower, prince's pine, and pipecleaner moss - more Pl and grouseberry/low bilberry
wet sites have:	- false hellebore, arrow-leaved groundsel, and Canby's lovage - little to no devil's club and lady fern
In the **ESSFdk1**, most sites have:	- Se and Bl dominant or co-dominant in the canopy - no Cw, Hw, or queen's cup - more Pl, false azalea, arnica, and grouseberry/low bilberry
wet sites have:	- false hellebore and arrow-leaved groundsel - no lady fern or devil's club

Edatopic Grid



Site series

101	HwCw – Queen's cup – Pipecleaner moss
102	Fd – Snowberry – Oregon-grape
103	Pl(Lw) – Pinegrass – Twinflower
110	CwHw – Oak fern
111	CwHw – Devil's club – Lady fern
112	SxwCw – Horsetail – Lady fern
Fm01	Cottonwood – Snowberry – Rose[1]
Fm02	Cottonwood – Spruce – Horsetail[1]

[1] See Section 6.3 for descriptions.

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects
- shallow, coarse soils

→
- SMR 1–2
- Fd (Lw, Pl) stands
- abundant shrubs, including snowberry, saskatoon, and Oregon-grape
- bluebunch wheatgrass, stonecrops, round-leaved alumroot, and/or rock ferns

→ **102**

→
- SMR 2–3
- Pl, Lw (Fd) stands
- mid slopes of warm aspects
- coarse or moisture-shedding sites on cool aspects
- pinegrass, twinflower, and/or grouseberry/low bilberry,
- bear-grass may be present with moderate to low cover (3–15%)

→ **103**

SLIGHTLY DRY to MESIC FORESTS
- gentle to moderately steep mid slopes (usually) with deep soils

→ (SMR 2–3 box above) → **103**

→
- SMR 4 (3)
- Hw, Cw, Lw, Fd, (Pl, Sxw, Bl) stands
- queen's cup and foamflower with low to moderate cover (< 5%)
- no oak fern or leafy mosses

→ **101**

MOIST to WET FORESTS
- level, lower and toe slopes
- seepage or mottles
- often associated with riparian areas

→
- SMR 5 (4)
- Cw, Hw (Sxw, Bl) stands
- oak fern, foamflower, and leafy mosses
- < 2% devil's club and lady fern

→ **110**

→
- SMR 6 (5)
- Cw, Hw (Sxw, Bl) stands
- abundant devil's club and lady fern (> 7% cover)

→ **111**

→
- SMR 6 (7)
- Sxw, Bl (Hw, Cw) stands
- horsetail, cow-parsnip, and/or Canby's lovage
- level or gentle sites with water table at or near the surface

→ **112**

Vegetation Table

Layer	Scientific name	102	103	101	110	111	112	Common name
Trees	*Pseudotsuga menziesii*	■■■■	□□	*				Douglas-fir
	Pinus contorta		■■■■	*				lodgepole pine
	Larix occidentalis		■■■	□□□	*			western larch
	Picea engelmannii x *glauca*		□□	□□□	■■■	■■■	■■■■	hybrid white spruce
	Abies lasiocarpa		*	□□□	□□□	■■■	□□□	subalpine fir
	Tsuga heterophylla			■■■■	■■■■	■■■		western hemlock
	Thuja plicata			■■■	■■■■	■■■■	*	western redcedar
Regen	*Pseudotsuga menziesii*	■■	*					Douglas-fir
	Abies lasiocarpa		□□			■■	■■■	subalpine fir
	Tsuga heterophylla		*	■■■	■■■	■■■	□□	western hemlock
	Picea engelmannii x *glauca*		*			□□	□□	hybrid white spruce
	Thuja plicata			□□□	■■■	■■■	□□	western redcedar
Shrubs	*Symphoricarpos albus*	■■■						common snowberry
	Amelanchier alnifolia	■■■						saskatoon
	Mahonia aquifolium	■■■						tall Oregon-grape
	Rosa spp.	■■■						roses
	Paxistima myrsinites	□□□	■■	■■	□			falsebox
	Spiraea betulifolia	□□	■■■					birch-leaved spirea
	Vaccinium membranaceum	□□	*	■■	■■	■	■■	black huckleberry
	Shepherdia canadensis		□□					soopolallie
	Menziesia ferruginea		*	■	■	■■	■■	false azalea
	Taxus brevifolia			□□□	*			western yew
	Oplopanax horridus					■■■■		devil's club
	Rubus parviflorus					□	■■■	thimbleberry
	Ribes lacustre					□	■■	black gooseberry
	Lonicera involucrata					□	■■	black twinberry

Layer	Scientific name	102	103	101	110	111	112	Common name
Herbs	*Calamagrostis rubescens*	■■■	■■■■					pinegrass
	Pseudoroegneria spicata	□□□						bluebunch wheatgrass
	Achillea millefolium	■						yarrow
	Heuchera cylindrica	■						round-leaved alumroot
	"rock ferns"[a]	□						mountain cliff fern
	Linnaea borealis		■■■	□□				twinflower
	Vaccinium scoparium/ myrtillus		■■■					grouseberry/low bilberry
	Chimaphila umbellata		■■	□□				prince's pine
	Tiarella trifoliata var. *unifoliata*			□□	■■■	■■■	■■	one-leaved foamflower
	Clintonia uniflora			■■	■■■	■■	■■	queen's cup
	Orthilia secunda			■	■■			one-sided wintergreen
	Goodyera oblongifolia			■	■			rattlesnake-plantain
	Gymnocarpium dryopteris				■■■	■■■	■■■	oak fern
	Rubus pedatus				□□	□□	□□	five-leaved bramble
	Streptopus amplexifolius				□	■■	■	clasping twistedstalk
	Athyrium filix-femina					■■■■	■■	lady fern
	Equisetum spp.						□□□	horsetails
	Heracleum maximum						□□	cow-parsnip
	Dryopteris expansa						□□	spiny wood fern
	"mitreworts"[a]						■■	mitreworts
	Thalictrum occidentale						■■	western meadowrue
	Ligusticum canbyi						□□	Canby's lovage
Moss layer	*Brachythecium* spp.	□□	*	*	□□	■■	□□	ragged-mosses
	Rhytidiopsis robusta		*	■■■	■■■■			pipecleaner moss
	Pleurozium schreberi			□□□	□□	*	□	red-stemmed feathermoss
	"leafy mosses"[a]				■■■	■■■	■■■■	leafy moss

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site Series	102	103	101	110	111	112
No. of plots	4	21	10	10	7	6
SMR	1–2	2–3	4 (3)	5 (4)	6 (5)	6 (7)
SNR	A–B	B–C	B–C (D)	C–D	D (C)	D (C)
Slope position	UP (MD, CR)	MD–UP	MD	LW, TO, LV	TO (LW)	LV (TO)
Typical slope/ aspect	Steep/warm	Moderate–steep/warm	Moderate/ neutral (cool)	Gentle–level (moderate)	Gentle	Level (gentle)
Common compensating conditions		Coarse and/ or moisture shedding, neutral–cool	Lower/coarse; gentle/warm	Mid-slope receiving sites; moderately coarse toe slopes		
Surficial materials	Cv/R or Cx/R	Mb (Cb, FG, Cv/R)	Mb (Cb, FG, LG)	Mb, Cb (F)	Fb (Mb, Ov)	Fb (Ov)
Soil texture	SL, L	L, SiL, SL (FSL, LS)	FSL, SL, SiL (LS, SiCL)	SL, SiL (FSL, LS, L)	SL, FSL, LS (SiCL)	FSL, SL (SiL)
Coarse fragment content	High	Moderate–high	Moderate–high	Moderate–high	Variable; often low near surface and fragmental at depth	Low; often increasing with depth
Important features	Insolated sites; soils are often fragmental			Seasonal seepage at depth (> 50 cm)	Seepage or water table 20–50 cm deep; frequently associated with riparian areas	Water table at or near the surface; cold air is common

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

HwCw – Queen's cup – Pipecleaner moss 101

General Description

SMR 4 (3). 101 forests typically occur on **mid slopes** of **cool to neutral aspects** with medium-textured soils. Due to compensating factors, this site series also occurs on gentle, warm slopes with medium- to fine-textured soils, and on lower slopes with coarse-textured soils. Typical soils are loamy to (fine) sandy loam textures with low to moderate coarse fragment content. Orthic Humo-Ferric Podzols and Dystric Brunisols derived from morainal blankets are common, although 101 sites occasionally occur on colluvium or glaciofluvial materials.

Tree species composition is diverse: **Hw** is usually present and often dominant, particularly in mature and older stands. **Lw**, Pw, **Cw**, Bl, Sxw, and sometimes Pl are usually part of the canopy, and typically more abundant in mature and younger stands. Hw and Cw regeneration is frequently abundant, with minor amounts of **falsebox**, **huckleberry**, and often **western yew**. Characteristic herb species are **prince's pine**, **queen's cup**, **twinflower**, and **foamflower**. Bear-grass is present on some sites. The moss layer is often well developed with abundant pipecleaner moss and often red-stemmed feathermoss, along with moderate amounts of heron's-bill mosses and ragged-mosses.

Differentiating from Other Site Series

Drier sites (103) have more Fd, Pl, and Lw, and typically contain soopolallie, birch-leaved spirea, pinegrass, and/or grouseberry/low bilberry, and abundant twinflower and prince's pine. Moister sites (110) have oak fern, lady fern, and/or devil's club, and typically lack Fd and Pl. Wetter sites occur in receiving sites and have mottles or seepage within the top 100 cm of the soil profile.

Variability

Mid-seral stands are very common across the landscape due to extensive historic disturbances. These younger stands typically contain a diverse mix of tree species, with higher Lw and Pl cover. Falsebox, black huckleberry, prince's pine, and twinflower are often more abundant in mid-seral stands. Earlier seral stands have less Hw and more Lw and Pl in the overstorey, and can have minor amounts of pinegrass. Bg may be present at lower elevations in areas transitional to the ICHdw1. Sparse understorey herbs and shrubs are common in older forests, particularly where Hw cover is high and understorey light levels are low.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered; forest productivity is high.

102 Fd – Snowberry – Tall Oregon-grape

General Description

SMR 1–2. 102 sites occur on **shallow** and/or **coarse**, **steep**, **insolated** warm-aspect slopes, often with fragmental soils or exposed bedrock. Humus forms, where present, are usually thin and dry. Soils are typically well- to rapidly drained Eutric or Dystric Brunisols. Coarse-textured colluvial blankets and veneers are common. Stands may occur in larger complexes with open, non-forested rock outcrops or talus areas (with < 10% total tree cover).

Fd is the dominant tree species, with occasional scattered **Lw**. Shrubs are abundant and typically include **saskatoon**, **Oregon-grape**, birch-leaved spirea, and rose. **Bluebunch wheatgrass** is often plentiful, typically with **pinegrass** and small amounts of dry-site species such as **round-leaved alumroot**, yarrow, and/or **rock ferns** (mostly mountain cliff fern).

Differentiating from Other Site Series

The 102 is the driest forested site series in the ICHdm. Drier sites are non-forested (< 10% tree cover) rock outcrops (Ro, Rt) or brushlands (Gb). Slightly moister sites (103) occur on deeper or more moderately textured soils, and tend to have less Fd and more Lw and Pl, along with more twinflower, prince's pine, and/or grouseberry/low bilberry.

Variability

Scattered Py may occur, particularly on the driest sites and in areas transitional to the ICHdw1. The 102 includes sites with abundant exposed bedrock—the amount affects the proportions of species that occur on rock or thin soil versus deeper soils. Users who require additional information can refer to site series phases:

102a for sites with prominent exposed bedrock (xeric phase)
102b for sites on shallow and/or coarse soils (subxeric phase)

Management Issues

Bedrock-dominated sites (102a) are not recommended for timber harvesting due to limitations in available soil and soil moisture for tree regeneration and growth; caution should be used to ensure regeneration success on warm, shallow, coarse sites (102b). Drought may limit tree productivity and cause mortality, especially during dry growing seasons. Erosion and compaction are high risks on steep slopes, particularly on soils with higher silt content.

Warm-aspect sites provide important ungulate winter range due to lower snow depth and higher forage availability. Both phases may provide habitat for at-risk or sensitive plant and animal species.

Pl(Lw) – Pinegrass – Twinflower **103**

General Description

SMR 2–3. 103 stands occur on **mid slopes of warm aspects** with medium- to moderately coarse soils. Due to compensating factors, this unit also occurs on **coarse or shedding sites** on **cool and neutral aspects**. Soils are typically well drained with sandy loam textures. Eutric or Dystric Brunisols are common with Mor or Moder humus forms.

Pl, **Lw**, and **Fd** are common tree species. Shrubs are typically moderate in cover with **birch-leaved spirea** and small amounts of falsebox. **Pinegrass**, **prince's pine**, **twinflower**, and **grouseberry/low bilberry** are characteristic herb species. **Bear-grass** (*Xerophyllum tenax*) is present on some sites, particularly in upper and colder areas of the subzone. Due to frequent disturbances, stands are usually young to mid seral.

Differentiating from Other Site Series

Drier sites (102) typically have abundant shrubs, including saskatoon, Oregon-grape, juniper, and/or choke cherry (*Prunus virginiana*), along with dry-site species such as alumroot, rock ferns, and/or bluebunch wheatgrass. These sites typically occur where sun exposure is high and/or soils are very coarse or shallow. Mesic (101) and moister sites have more abundant Cw and Hw. These sites also typically have more queen's cup, foamflower, and mosses, particularly pipecleaner moss and red-stemmed feathermoss.

Variability

Tree species diversity is high: earlier seral stands often have more Pl or Lw; Fd is variable but can be dominant; Sxw and Bl are more common at the eastern extent of the ICHdm, closer to the MSdw; Cw or Hw may be present in minor amounts, especially in the understorey. Pinegrass and grouseberry/low bilberry cover varies from absent to abundant (> 30% cover) across the 103.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered. Drought can be a concern during dry growing seasons. Warm-aspect sites provide important ungulate winter range due to lower snow depth and higher forage availability. Soil erosion can be a concern on steep slopes.

110 CwHw – Oak fern

General Description

SMR 5 (4). The 110 site series occurs on **subhygric receiving sites** with **seasonal seepage** and **moisture at depth**. Sites typically occur on lower slopes but can also occur on mid-slope seepage sites. Soils are typically imperfectly to moderately well-drained Dystric Brunisols with Mor humus forms. Mottles and seepage are often deep in the soil profile (> 50 cm). Sites are usually associated with riparian areas.

Hw, **Cw** , **Sxw**, and **Bl** form the tree canopy, with Hw and Cw co-dominating the moderate to sparse shrub layer. **Oak fern**, **foamflower**, **queen's cup**, and **five-leaved bramble** are characteristic in the herb layer. Mosses are often well developed with abundant pipecleaner moss and moderate cover of leafy mosses (primarily *Rhizomnium nudum*).

Differentiating from Other Site Series

Drier sites (101) lack oak fern and leafy mosses, and typically have more falsebox, prince's pine, twinflower, Lw, and Pl. Moister sites (111) have > 5% cover of devil's club and/or lady fern.

Variability

Oak fern cover can be highly variable on these sites, ranging from dominant to sparse (< 3%), although abundant foamflower (5–10% cover) is typically consistent. Minor cover of lady fern or devil's club may occur (< 2%), particularly in the St. Mary drainages.

Management Issues

Tree productivity is high on these sites, and vegetation competition may be a concern following harvest. Due to the presence of moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Frost may also limit regeneration, particularly in areas where cold air can pool. Sites frequently provide travel corridors in steep terrain and forage for wildlife.

CwHw – Devil's club – Lady fern 111

General Description

SMR 6 (5). The 111 site series occurs on **gentle toe and lower slope positions** with **seepage** or the **water table** in **the upper 20–50 cm**. Soil textures are typically coarser loamy sands and sandy loams but can include a finer-textured (silt or fine sand) component. Coarse fragment content is often low near the surface but commonly increases to fragmental (> 70% of the soil) at depth. Thick Moder and Mormoder humus forms or very thin organic veneers are common. Soils are typically Gleysols or Gleyed Brunisols derived from fluvial or glaciofluvial materials. Sites are usually associated with **riparian areas**. Flooding can be rare to occasional.

Cw occurs with Hw, Sxw, and/or Bl in both the overstorey and understorey. **Devil's club** and **lady fern** are present, along with oak fern, foamflower, and leafy mosses.

Differentiating from Other Site Series

Drier sites (110) have little to no devil's club and/or lady fern (< 3% of each), while wetter sites (112) have horsetails, cow-parsnip, and/or Canby's lovage, and typically have more thimbleberry, black twinberry, alder, or red-osier dogwood and no devil's club.

Variability

Devil's club is usually abundant; where sparse, lady fern tends to have high cover. Earlier seral stands can be dense with low light and fewer understorey herbs and shrubs, except in small canopy gaps.

Management Issues

Tree productivity is high on these sites. Vegetation competition may be a significant concern in regenerating stands. Due to the presence of moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Frost may also limit regeneration, particularly in areas where cold air can pool. Sites are often associated with riparian management areas. Large-diameter trees, coarse woody debris, and snags are common in old-growth stands and provide important habitat for primary and secondary cavity nesters, as well as overwintering sites for bears and small mammals. Sites frequently provide travel corridors in steep terrain and forage for wildlife.

112 SxwCw – Horsetail – Lady fern

General Description

SMR 6 (7). The 112 site series occurs on **moist to wet sites** with **cold air** exposure and is associated with **riparian areas** and **floodplains**. The **water table** is typically present near the soil surface or **within the upper 10–20 cm**. Sites are **level or gentle** (< 10% slope). Flooding is occasional to rare. Soils are typically Gleysols or Gleyed Brunisols derived from fluvial materials. Surface textures are primarily fine sandy loam to sandy loam with low coarse fragment content or increasing amounts at depth. Humus forms vary but are typically Moders or Mormoders.

Sxw and **Bl** dominate the overstorey and understorey, with lesser amounts of Hw and Cw. **Thimbleberry** is often abundant, with small amounts of **false azalea**, **black twinberry**, **alder** (both mountain [*Alnus incana*] and Sitka [*A. viridis* ssp. *sinuata*]), or **red-osier dogwood** (*Cornus stolonifera*). Herbs include a wide range of moist, cool indicators such as **cow-parsnip**, **Canby's lovage**, and **mitreworts**, often with small to moderate amounts of **horsetails**. Oak fern, lady fern, foamflower, and baneberry (*Actaea rubra*) are also commonly present. Leafy mosses are the dominant moss (typically *Plagiomnium* spp. and *Rhizomnium nudum*).

Differentiating from Other Site Series

The 112 is the wettest forested site series in the ICHdm and is associated with cold-air exposure in riparian areas. Slightly drier sites (111) have more Cw, Hw, devil's club, and lady fern, and lack horsetails, cow-parsnip, Canby's lovage, alder, and/or red-osier dogwood.

Variability

The 112 site series has highly variable vegetation due to the combined influence of cold air and moisture associated with riparian areas. Horsetail is usually present; where absent, cold-air indicators such as Canby's lovage, arrow-leaved groundsel (*Senecio triangularis*), and false hellebore usually occur.

Management Issues

Not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Cold air and frost may also limit regeneration. Sites are often associated with riparian management areas; windthrow hazard may be a concern in areas adjacent to harvesting due to shallow rooting. Where harvesting occurs, competition from shrubby and herbaceous brush can be a concern in regenerating stands.

Other Ecosystems

The following ecosystems occur within the ICHdm; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

Marshes (Wm) and swamps (Ws) are the most common wetland ecosystems in the ICHdm, although fens (Wf) also occur. The *Ws10 Western redcedar – Spruce – Skunk cabbage* forested swamp occurs very infrequently. Wetlands are described in detail in Section 6.2.

Cottonwood forests and other flood ecosystems

Cottonwood floodplain forests are moderately common in the ICHdm and occur primarily in and around the St. Mary River, Hawkins Creek, Moyie Lake, and other areas where the ICHdm occurs at valley bottom. The most common Fm site associations in the ICHdm are *Fm01 Cottonwood – Snowberry – Rose* and *Fm02 Cottonwood – Spruce – Dogwood*. More information on these and other flood ecosystems is provided in Section 6.3.

Brushlands (and grasslands)

Brushlands (Gb03) occasionally occur in the ICHdm on steep, warm-aspect sites with shallow, rubbly soils. Grasslands (Gg11) are uncommon and occur primarily in small (< 0.5 ha) openings. Section 6.4 provides more detailed descriptions of grassland and brushland ecosystems.

Avalanche features

Avalanche paths occur infrequently in the ICHdm and are generally in lower macroslope positions with start zones in the higher-elevation ESSF subzones. Herb (Vh) and shrub (Vs) types are most common. Treed (Vt) avalanche ecosystems are uncommon in the ICHdm. Descriptions of avalanche ecosystems are provided in Section 6.5.

Rock outcrops and talus slopes

A number of rock outcrop (Ro) and talus (Rt) ecosystems occur in the ICHdm and are commonly found adjacent to the driest forested ecosystems. Descriptions of rock ecosystems are provided in Section 6.6.

Rattlesnake-plantain
Goodyera oblongifolia

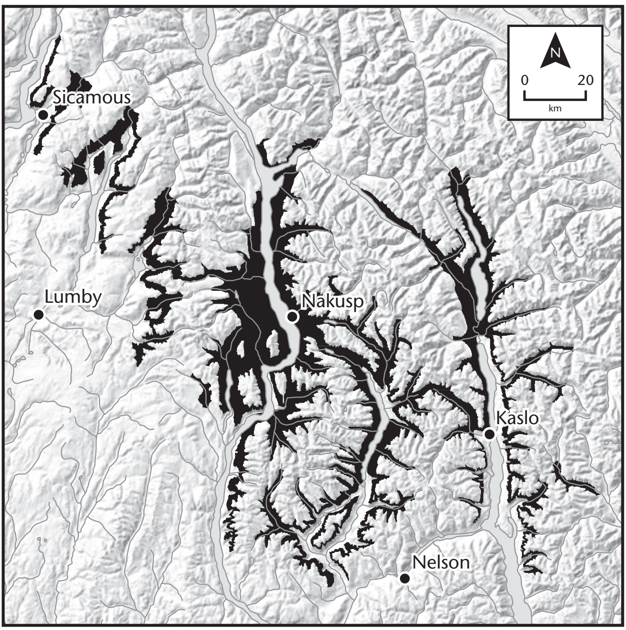
Queen's cup
Clintonia uniflora

ICHmw2
Slocan Moist Warm
Interior Cedar – Hemlock

Geographic Distribution

The ICHmw2 is one of the most extensive biogeoclimatic units in the Southern Interior. It ranges from Shuswap Lake in the west to the St. Mary Westfork in the east. It occurs from valley bottom to mid slopes along the Duncan, Slocan, Upper Arrow, and Whatshan Lakes, and above the ICHdw1 in the Lower Arrow and Little Slocan Lakes, and the north arm of Kootenay Lake. Around Mable, Sugar, Mara, and Shuswap Lakes, the ICHmw2 occurs above the ICHdw4. The ICHmw2 occurs below the ESSFwh1 or ICHwk1. At similar elevations, the ICHmw2 abuts the ICHmw3 (Upper Arrow Lakes and northern Shuswap area), the ICHmw4 (south Selkirk Mountains), ICHmw5 (Lower Arrow Lakes, southern Monashee Mountains, and Shuswap), and ICHdm (Purcell Mountains).

Distribution of the ICHmw2



Elevation Range

Where the ICHmw2 occurs at valley bottom, upper limits extend to 1150 to 1250 m on cool aspects, 1250–1400 m on neutral aspects, and 1250–1450 m on warm aspects. Where it occurs above the ICHdw1 or ICHdw4, it is found from 1050 to 1500 m on cool aspects, 1100–1500 m on neutral aspects, and 1150–1550 m on warm aspects.

Climate[1]

The ICHmw2 is located in the Moist climate subregion and is characterized by warm, moist summers and cool to mild, moist winters with moderate snowfall. Snowpacks are moderately deep and persist from December through March or April, although rain-on-snow events occur frequently. Persistent snowpack combined with a relatively mild climate prevents soils from freezing to any significant depth. Growing-season moisture deficits can occur on subxeric and drier sites, and on submesic sites in dry years.

Forest and Vegetation Characteristics

The ICHmw2 is a highly productive biogeoclimatic unit with high species diversity and excellent tree growth. Cw, Hw, Fd, and Lw are common and abundant, with varying amounts of Pw, Pl, Bl, Sxw, Ep, At, and Act forming complex mixes. Pl, Bl, and Sxw are often more common closer to the ICHmw5 (particularly in the Shuswap and Lower Arrow Lakes). Feathermosses are common throughout, although pipecleaner moss is often dominant in the southern and eastern areas. Old and mature **mesic sites** are typically Hw leading with codominant Cw, and minor Fd and Lw; earlier seral stands can have much higher Fd, Lw, At, and Ep cover. Foamflower, queen's cup, black huckleberry, Utah honeysuckle, and falsebox are typical. **Dry sites** are dominated by Fd and Lw, with abundant dry shrubs such as Oregon-grape, saskatoon, Douglas maple, and soopolallie; Pl may be present in small to moderate amounts, particularly in early seral stands. Species on **wet sites** range from oak fern, lady fern, and devil's club to horsetail or skunk cabbage with abundant Cw, Hw, and often Sxw.

Cottonwood floodplain ecosystems provide important habitat, particularly in the Duncan, Lardeau, and Shuswap drainages where extensive stands remain. Wetlands occur infrequently but provide important biodiversity. Dry, rocky slopes and rock outcrops are common, especially along the major lake valleys.

[1] See Section 4.2 for more information on climate variables.

Disturbance

Historically, **stand-replacing fires** predominated, but **mixed-severity fire** was also common, particularly on warmer aspects and on slopes that extend to lower elevations. Fire-scarred Fd, Lw, and occasionally Cw, are common. Old growth is currently uncommon due to timber harvesting and historic human-caused fires associated with European settlement (mining era) in the late 1800s and early 1900s. **Timber harvest** since the 1970s has also increased the proportion of early- to mid-seral stands.

Bark beetles are important disturbance agents, particularly **mountain pine beetle** in localized areas where Pl is abundant, and **Douglas-fir beetle** on warm-aspect sites with high Fd cover. **Armillaria root rot** also creates small gaps in mature stands and can be a major impediment to tree regeneration. **Birch decline** due to a combination of insect, disease, and drought has had devastating impacts on Ep, while **white pine blister rust** along with historic targeted harvesting has had a major impact on Pw. **Gall rusts** affect growth of Pl regeneration, while **foliar needle diseases** affect Pl (e.g., dothistroma) and Lw (blight and needle cast). Spruce weevil can be a growth impediment in planted stands. **Animal damage** can also be extensive: bear damage to Cw and Lw plantations can be localized but severe. Cattle can have an impact on plantations where range tenures occur.

Hydroelectric dams on the Kootenay and Columbia River systems flooded large areas of wetlands, cottonwood stands, and wet forests (devil's club, skunk cabbage, and horsetail dominated ecosystems) in the ICHmw2, particularly in the Upper Arrow and Duncan reservoirs where these ecosystems were historically much more common (MacKillop et al. 2008; Utzig and Schmidt 2011).

Soils, Geology, and Landforms

The wide geographic range of the ICHmw2 covers an area of highly varied geology. In general, coarse intrusive materials (granodiorite and granite) are common in the central Selkirk Mountains, along with fine- to medium-grained metasedimentary rocks (slate, siltstone, argillite) and limestones. Coarse- to medium-grained sedimentary rocks (quartz, sandstones) are common in the Purcell Mountains, and gneiss and granitics are dominant in the Monashee Mountains.

Morainal blankets and veneers are the most common surficial material on gentle to steep slopes, while rubbly colluvium occurs on steep terrain. Thin, eolian-influenced cappings of fine sandy loam materials are also widespread. Some of this is derived from volcanic ash. Over much of the area, sandy loam soil textures occur near the surface and become coarser with depth. In the central Selkirks, finer-textured parent materials frequently lead to soils with a significant silt or clay component. Shallow soils interspersed with exposed bedrock are common along the valley walls of the Kootenay, Slocan, and Arrow Lakes, while glaciofluvial soils of coarse, gravelly, or sandy deposits are more common at lower elevations and as kame terraces along valley walls. Reservoir drawdown areas occupy large areas of the ICHmw2 in the Arrow and Duncan Valleys.

Wildlife Habitat

The productive and diverse forests of the ICHmw2 support abundant and diverse wildlife. **Mountain caribou** use the ICHmw2 seasonally (in early winter before the snowpack has deepened and consolidated), as do **wolverine**. **Grizzly bears**, **black bears**, **moose**, **mule deer**, and **Rocky Mountain elk** forage in early seral habitats. Rocky Mountain elk also overwinter on warmer aspects in this unit.

The ICHmw2 provides abundant habitat for mature and old-forest–dependent species, including various **cavity-nesting, roosting, and denning birds and mammals**. Patches of large live and dead trees with cavities, hollow logs, coarse woody debris, and thickets should be retained to maintain these guilds. They include a diversity of insectivorous species as well as several species at risk: **Lewis's woodpecker**, **olive-sided flycatcher**, **fringed myotis**, and **little brown myotis**. Additional listed species are associated with rocky habitats (**rubber boa**, **Townsend's big-eared bat**, **peregrine falcon**) or agricultural areas (**barn swallow**, **bobolink**, **common nighthawk**). Many species in the ICHmw2 breed in riparian and/or wetland habitats, or use them as staging or stopover areas on migration. Listed examples include **Coeur d'Alene salamander**, **western toad**, **painted turtle**, **great blue heron**, and **sandhill crane**.

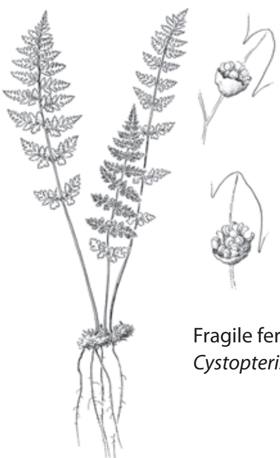
Cottonwood floodplains, such as those found in the Duncan, Lardeau, and Shuswap drainages, where **Kokanee salmon** and/or **Gerrard rainbow trout** spawn, represent highly productive ecosystems that help sustain a diversity of fish-eating birds and mammals seasonally or year-round. Examples include **grizzly bear**, **osprey**, **bald eagle**, **American mink**, **North American river otter**, and a variety of waterfowl and shorebird species. Several listed vascular plant species and a few listed invertebrates are found in the ICHmw2. Some of the more common bird species include Swainson's thrush, American robin, Hammond's flycatcher, warbling vireo, and MacGillivray's warbler.

Distinguishing the ICHmw2 from Adjacent Biogeoclimatic Units

In the **ICHdw1**, most sites have:	- Bg, particularly in earlier seral stands - more Fd
zonal sites have:	- more prince's pine and twinflower - no foamflower
dry sites have:	- Py - more pinegrass, kinnikinnick, and tall shrubs, especially oceanspray and mallow ninebark
wet sites have:	- less Sxw and no Bl
In the **ICHdw4**, most sites have:	- more Fd, Pl, and Ep - more seral stands and less old-growth forests - more step moss and electrified cat's-tail moss
zonal sites have:	- more prince's pine and twinflower - less foamflower
dry sites have:	- more pinegrass - oceanspray, beaked hazelnut, and/or orange honeysuckle
wet sites have:	- less devil's club and lady fern
In the **ICHdm**, most sites have:	- less feathermoss - more Pl
zonal sites have:	- less bunchberry - occasional Sxw and Bl
dry sites have:	- bear-grass and/or grouseberry/low bilberry
wet sites have:	- less oval-leaved blueberry
In the **ICHmw4**, most sites have:	- more pipecleaner moss - less bunchberry
zonal sites have:	-no red-stemmed feathermoss or step moss
dry sites have:	- bear-grass
In the **ICHmw5**, most sites have:	- more Lw and Pl - less step moss, knight's plume, and feathermoss
zonal sites have:	- minor but frequent Sxw and Bl - more prince's pine and twinflower

(*Continued*)

In the **ICHmw3**, most sites have:	- no Lw - more Pw - less Utah honeysuckle - occasional red huckleberry
In the **ICHwk1,** most sites have:	-more Sxw, Bl, and bunchberry
zonal sites have:	- more oak fern and forbs
dry sites have:	- less Fd - no pinegrass - more queen's cup
wet sites have:	- more oval-leaved blueberry and devil's club
In the **ESSFwh1,** most sites have:	- white-flowered rhododendron - dominant Se and Bl stands - less Cw, Hw
zonal sites have:	- more oak fern, five-leaved bramble
dry sites have:	- Bl (often in the regen layer) - no common juniper and pinegrass - less Lw, Fd, saskatoon, Oregon-grape, and soopolallie
wet sites have:	- less devil's club - Sitka valerian



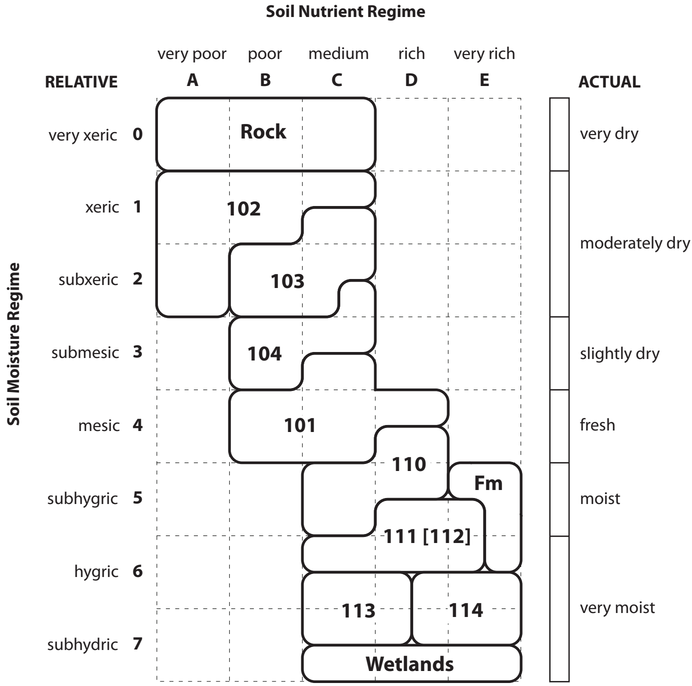
Fragile fern
Cystopteris fragilis

Mountain cliff fern
Woodsia scopulina

Western cliff fern
Woodsia oregana

Parsley fern
Cryptogramma acrostichoides

Edatopic Grid



Site series

101	HwCw – Falsebox – Feathermoss
102	Fd(Pl) – Falsebox – Pinegrass
103	Fd – Douglas maple – Falsebox
104	FdCw – Falsebox – Prince's pine
110	CwHw – Oak fern
111	CwHw – Devil's club – Lady fern
112	Sxw(Hw) – Huckleberry – Oak fern
113	CwHw – Horsetail – Lady fern
114	CwSxw – Skunk cabbage
Fm01	Cottonwood – Snowberry – Rose[1]
Fm02	Cottonwood – Spruce – Horsetail[1]
Fm04	Cottonwood – Western redcedar – Dogwood – Lady fern[1]

[1] See section 6.3 for descriptions

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects
- shallow, coarse soils

→
- SMR 1 (2)
- Fd, (Pl) stands
- exposed rock is prominent
- sedums, saxifrages, pinegrass, and/or rock ferns
- rock-mosses, clad lichens, and/or haircap mosses

→ **102**

→
- SMR 2 (1)
- Fd (Pl, Lw) canopy
- steep, warm aspect; shallow and/or coarse soils
- Douglas maple, Oregon-grape, birch-leaved spirea
- minor cover of pinegrass, prince's pine and/or twinflower

→ **103**

SLIGHTLY DRY to MESIC FORESTS
- mid slopes (usually) with deep soils

→
- SMR 3 (2)
- Fd, Cw, Lw, Hw (Pl) stands
- abundant falsebox, prince's pine, and/or twinflower (5–30% cover)
- < 2% foamflower and bunchberry

→ **104**

→
- SMR 4 (3)
- Hw, Cw stands
- moderate cover of falsebox, black huckleberry (1–7%)
- no Douglas maple, soopolallie, birch-leaved spirea
- low to moderate cover of foamflower and bunchberry (< 10%)

→ **101**

MOIST to WET FORESTS
- lower or toe slopes
- seepage or mottles

→
- SMR 5 (4)
- CwHw stands
- abundant oak fern
- devil's club and lady fern sparse or absent (< 3% cover each)

→ **110**

→
- SMR 5 (6)
- Cw, Hw stands
- abundant devil's club and/or lady fern

→ **111**

→
- SMR 5 (6)
- cold-air influence
- Sxw, Bl (Cw, Hw) stands
- rhododendron, devil's club, ferns

→ **112**

WET to VERY WET FORESTS
- gentle to level riparian and floodplain areas
- seepage at or near the surface

→
- SMR 6 (7)
- Cw, Hw (Sxw, Bl) stands
- abundant horsetail

→ **113**

→
- SMR 6 (7)
- Cw, Hw (Sxw, Bl) stands
- abundant skunk cabbage

→ **114**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	113	114	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■	■■■■	*						Douglas-fir
	Pinus contorta	□□□	*								lodgepole pine
	Thuja plicata		*	■■■■	■■■■	■■■■■	■■■■■	*	■■■■	■■■■■	western redcedar
	Larix occidentalis		*	□□□	*						western larch
	Tsuga heterophylla			□□□□	■■■■■	■■■■■	■■■■	■■■	■■■■	■■■■	western hemlock
	Picea engelmannii x *glauca*					*	□□□	■■■■	□□	□□	hybrid white spruce
	Abies lasiocarpa							■■■■			subalpine fir
Regen	*Pseudotsuga menziesii*	■■■	■■	□□							Douglas-fir
	Thuja plicata	□□	*	■■■	■■■	■■■	■■■	■■■	□□□	■■■■	western redcedar
	Tsuga heterophylla	*		□□□	■■■■	■■■	■■■	■■■	□□□	■■■■	western hemlock
	Abies lasiocarpa							■■			subalpine fir
Shrubs	*Paxistima myrsinites*	■■■	■■■	■■■■	■■						falsebox
	Spiraea betulifolia	□□	■■■	□							birch-leaved spirea
	Amelanchier alnifolia	■■	■■	□							saskatoon
	Rosa gymnocarpa	□	■■	□□							baldhip rose
	Acer glabrum	□	■■■	□							Douglas maple
	Vaccinium membranaceum	*	□□	■■■	■■	□□	□	■■	*	■	black huckleberry
	Mahonia aquifolium	*	■■	□							tall Oregon-grape
	Shepherdia canadensis		□□	□□□							soopolallie
	Rubus parviflorus		*			*	□□	□□□	*	■	thimbleberry
	Taxus brevifolia				□□	□□	□□		*	■■■■	western yew
	Vaccinium ovalifolium					□□	□□	■■■	□□	■■	oval-leaved blueberry
	Oplopanax horridus					■■	■■■■	■■	□□	■■■■	devil's club
	Ribes lacustre						□	■■	*	■■	black gooseberry
	Rhododendron albiflorum							■■■			white-flowered rhododendron
	Cornus stolonifera								□□□	□	red-osier dogwood

Layer	Scientific name	102	103	104	101	110	111	112	113	114	Common name
Herbs	*Calamagrostis rubescens*	■■■	□□□								pinegrass
	Fragaria spp.	■■	□								strawberry
	"rock ferns"[a]	■									rock ferns
	Chimaphila umbellata	*	■■	■■■	□						prince's pine
	Linnaea borealis	*	*	■■■	■■	*	*			■	twinflower
	Hieracium albiflorum		□	□							white hawkweed
	Clintonia uniflora			□□□	■■	■■■	■■■	■■■		■■■	queen's cup
	Gaultheria ovatifolia			□□							western tea-berry
	Pteridium aquilinum			□□							bracken fern
	Cornus canadensis				□□	□□	*	*	*	■■■	bunchberry
	Tiarella trifoliata var. *unifoliata*				■■	■■■	■■■■	■■■■	■■	■■■	one-leaved foamflower
	Gymnocarpium dryopteris					■■■■	■■■■	■■■■	*	■■■■	oak fern
	Rubus pedatus					□□□	□□□	■■■■■		□□	five-leaved bramble
	Athyrium filix-femina					□	■■■■	□□□	■■■■	■■■■	lady fern
	Dryopteris expansa					□	■■■	■	□□		spiny wood fern
	Valeriana sitchensis							■■			Sitka valerian
	Equisetum spp.								■■■■■	■■■	horsetails
	Lysichiton americanus								*	■■■■■	skunk cabbage
Moss layer	*Pleurozium schreberi*	□□□□	□□□	■■■■	■■■■	□□□	*	*		■■■	red-stemmed feathermoss
	Dicranum spp.	■■■	*	*	□□			□□		*	heron's-bill moss
	Racomitrium spp.	□□□									rock-mosses
	Peltigera spp.	■■	□□	□□							pelt lichens
	Rhytidiopsis robusta			□□□□	■■■	□□□□	□□	■■■■			pipecleaner moss
	Hylocomium splendens			□□□	□□□□	*				■■■	step moss
	"leafy mosses"[a]					□□	■■■■	□□	*	■■■■■	leafy moss

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site Series	102	103	104	101	110	111	112	113	114
No. of plots	7	16	26	20	21	28	4	3	4
SMR	1 (2)	2 (1)	3 (2)	4 (3)	5 (4)	5 (6)	5 (6)	6 (7)	6 (7)
SNR	A–B (C)	B–C	C (B)	C (B, D)	C–D	D (C, E)	D (C, E)	D (C)	D (C, E)
Slope position	UP, CR (MD)	MD, UP (CR)	MD (LW, UP)	MD	LW (MD)	LW, TO, LV	LW, TO, LV	LV, TO	LV (DP)
Typical slope/ aspect	Steep–moderately steep/ warm–neutral	Steep/warm	Moderate/ warm	Moderate/ neutral (cool)	Gentle to moderate slopes/cool (warm)	Gentle–moderate	Gentle–moderate	Gentle–level	Gentle–level
Common compensating conditions		Shallow crests; neutral aspects in large valleys with high sun exposure	Upper/cool; shallow or coarse on neutral or lower	Lower/ coarse; gentle/ warm	Mid-slope receiving	Mid-slope receiving sites; moderately coarse toe slopes	Mid-slope receiving sites; moderately coarse toe slopes		
Surficial materials	Cx/R, Dx/R	Cv, Cb (Mv)	Mb (Cb, FG)	Mb (Cb, FG)	Mb, Cb (F)	F (Mb, Cb)	F (Mb, Cb)	F, Ox/F, Ox/L	Ov/F, Ov/L (Ob)
Soil texture	SL, L, FSL	SL (LS)	SL (LS, L, SiL)	L, SL, FSL, SiL	L, SL (SiL, LS)	L, SiL, SL, (LS, SiCL)	L, SiL, SL, (LS, SiCL)	FSL, SiL, CL, SL, L	SiL, CL, L
Coarse fragment Content	High–fragmental	High–fragmental	Moderate–high (fragmental)	Moderate	Low–moderate (high)	Moderate (variable)	Moderate (variable)	Low	Low
Important features	Exposed (bed)rock is prominent	Insolation; soils shallow and/or coarse			Mottles at depth (> 70 cm)	Seepage or mottles within top 30–50 cm	Cold air; Sxw, Bl leading; seepage within top 50 cm	Water table near surface; can have organic veneers and cold air	Water table near surface; organic veneer

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

HwCw – Falsebox – Feathermoss 101

General Description

SMR 4 (3). Typical conditions for 101 forests are **mid slopes** of **neutral to cool** aspects with **moderate-textured soils**. Due to compensating factors, this site series also occurs on gentle, warm slopes with moderate- to fine-textured soils, and on lower slopes with coarse-textured soils. Typical soil textures are loamy to (fine) sandy loam with low to moderate coarse fragments. Humo-Ferric Podzols and Dystric Brunisols derived from morainal blankets are common, although stands occasionally occur on colluvium or glaciofluvial materials.

Hw and **Cw** stands are often dense and frequently have a component of Fd, Lw, and/or Pw, especially in earlier seral stages. **Black huckleberry**, **falsebox**, and **western yew** are typical shrubs, while minor amounts of queen's cup, foamflower, twinflower, and bunchberry occupy the herb layer. Understoreys are often sparse, particularly where Hw creates abundant shade. Common mosses are red-stemmed feathermoss, pipecleaner moss, and step moss.

Differentiating from Other Site Series

Slightly drier sites (104) have more Fd, Pl, and Lw, and typically contain soopolallie, Douglas maple, birch-leaved spirea, and abundant twinflower and/or prince's pine. Moister sites (110) have oak fern, lady fern, and/or devil's club, with seasonal seepage or seepage at depth.

Variability

Bunchberry and feathermosses (step moss, red-stemmed, and knight's plume) are more common and abundant in the northern and western portions of the ICHmw2, while foamflower and pipecleaner moss are more typical in the Kootenay and Slocan Lake areas in the south and eastern portions. Stands can have low cover of understorey herbs and diverse tree species, which makes site series identification difficult. Low cover occurs in younger forests through to old growth and is often linked to low understorey light levels, particularly where Hw forms the canopy. Where limited species are present, users should rely on site and soil conditions for site series identification.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered; forest productivity is high. Brush competition can cause regeneration problems following overstorey removal.

102 Fd(Pl) – Falsebox – Pinegrass

General Description

SMR 1 (2). The 102 site series occurs on forested sites with **extensive exposed bedrock** and occasionally blocky talus. Soils often vary in depth, with deeper pockets of soil interspersed among very thin veneers and exposed rock. Humus forms are usually thin and dry, if present. Stands often occur in larger complexes with open, non-forested rock outcrops or talus areas (with < 10% total tree cover) and with 103 sites on deeper, coarse-textured soils.

Fd forms the open canopy, often with Pl, especially in earlier seral stands. The shrub layer can be variable but typically contains **falsebox**, **birch-leaved spirea**, **saskatoon**, snowberry (*Symphoricarpos albus*), and Fd regen. Cw and Hw may be present in minor amounts. **Pinegrass**, **rock ferns**, (including parsley fern [*Cryptogramma acrostichoides*], fragile fern [*Cystopteris fragilis*], cliff ferns [*Woodsia* spp.]), and wild strawberry are common, along with minor amounts of various rock outcrop species such as **stonecrops** (*Sedum* spp.) and **saxifrages** (e.g., *Saxifraga bronchialis*). Rock-mosses, pelt lichens, heron's-bill mosses, and clad lichens are typical in the extensive moss and lichen layer.

Differentiating from Other Site Series

The 102 is the driest forested site series; drier sites are non-forested (< 10% tree cover) rock outcrops (Ro), talus (Rt), or brushlands (Gb). Slightly moister sites (103) occur on warm aspects with shallow and/or coarse soils, and have increased shrub cover, including Douglas maple, birch-leaved spirea, and Oregon-grape, and minor cover of forest herbs such as prince's pine and twinflower.

Variability

Forested rock outcrop sites can be highly variable due to differences in the depth of soil pockets, bedrock geology, and sun exposure. Pl can be abundant, particularly in earlier seral stands, while Lw and Cw may be present. At lower elevations, stands may have oceanspray (*Holodiscus discolor*), mallow ninebark (*Physocarpus malvaceus*), and other tall shrubs, but unlike similar sites in the ICHdw1, lack Py. Common juniper (*Juniperus communis*) may be present.

Management Issues

This site series is not recommended for timber harvesting due to severe soil moisture limitations and little available soil for tree regeneration and growth.

Fd – Douglas maple – Falsebox 103

General Description

SMR 2 (1). 103 forests occur on **steep**, **warm**, **coarse**, and/or **shallow** slopes and **dry crests**. Soils are typically well- to rapidly drained Eutric or Dystric Brunisols with moderate to high coarse fragment content and thin humus forms. Colluvial blankets and veneers are common surficial materials.

The open canopy consists of **Fd**, usually with a minor **Lw**, **Pl**, or **Cw** component. At and Ep may be present in earlier seral stands. Shrubby understoreys of **falsebox**, **Douglas maple**, birch-leaved spirea, saskatoon, Oregon-grape, and baldhip rose are typical. Herb cover varies, with **pinegrass** varying from dominant to absent. Low cover of **prince's pine**, white hawkweed, and strawberry may occur.

Differentiating from Other Site Series

Drier forested sites (102) have extensive exposed rock with understorey species typical of rock outcrops—stonecrops, rock ferns, and rock-mosses. Moister sites (104) occur on deeper or less coarse-textured soils and tend to have Cw, Hw, and more Lw, along with more twinflower, prince's pine, queen's cup, and mosses. At higher elevations, similar sites in the ESSFwh1/103 tend to have Bl and Utah honeysuckle (*Lonicera utahensis*) in the understorey. At lower elevations in the ICHdw1 and ICHdw4, drier species such as oceanspray, mock-orange (*Philadelphus lewisii*), and western trumpet (*Lonicera ciliosa*) are usually present on equivalent sites.

Variability

The 103 site series can occur on open slopes on neutral aspects, particularly in broad, north–south trending valleys such as the Kootenay, Arrow, Slocan, and Duncan where sun exposure is high. Stands often have high cover of Lw or Fd. Minor cover of dryland shrubs such as oceanspray and mock-orange may be present in areas transitional to the ICHdw1.

Management Issues

Drought may limit tree productivity during dry growing seasons. Warm-aspect sites provide important ungulate winter range due to lower snow depth and higher forage availability. Soil erosion can be a concern on steep slopes. High brush cover can cause regeneration problems.

104 FdCw – Falsebox – Prince's pine

General Description

SMR 3 (2). 104 forests occur on steep to **moderately steep**, **warm-aspect** slopes with **deep**, well-drained soils. Due to compensating factors, the 104 also occurs on **upper**, **shedding** sites on **cool to neutral** aspects with higher coarse fragments and/or coarser soils. Orthic Dystric Brunisols and weakly developed Orthic Humo-Ferric Podzols are common with Mor or Moder humus forms.

Tree cover is highly variable and diverse, with **Fd**, **Cw**, **Hw**, and **Lw** common. Ep is often present in seral stands. **Black huckleberry** and **falsebox** characterize the shrub layer, although varying amounts of **soopolallie** and small amounts of birch-leaved spirea or baldhip rose are also common. Dense Hw and/or Cw regeneration may also occur. Understorey herb cover is often sparse, although **prince's pine** and **twinflower** can have moderate to high cover; queen's cup, bracken fern, and western tea-berry may occur. The moss layer is highly variable, with red-stemmed feathermoss, pipecleaner moss, and step moss most abundant.

Differentiating from Other Site Series

Slightly drier site series (103) are typically dominated by Fd and/or Lw with limited Cw and Hw in the understorey, more Douglas maple and saskatoon, more pinegrass, and less twinflower, prince's pine, and queen's cup. Slightly moister sites (101) have less Fd, Lw, and Pl, more Hw, and lack drier shrubs such as Douglas maple, birch-leaved spirea, and soopolallie; herbs are foamflower and/or bunchberry, not twinflower and prince's pine.

Variability

Step moss and red-stemmed feathermoss are more abundant in the northern and western areas of the ICHmw2, while pipecleaner moss is dominant in the southern and eastern areas. Cool-aspect sites tend to have higher moss cover, particularly feathermosses. Stands can have very sparse understoreys, especially where Hw is abundant in the canopy. Twinflower can be very abundant, particularly on coarser-textured glaciofluvial sites and in earlier seral stands where Pl is abundant.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered. High brush competition from bracken fern and thimbleberry can cause regeneration problems following overstorey removal. Soil erosion can be a concern on steep slopes. Drought may limit tree productivity during drier than normal years.

CwHw – Oak fern 110

General Description

SMR 5 (4). 110 forests occur on **receiving sites** with **moisture at depth**. They are typically found on **lower slopes** but also occur on middle slopes with water-restricting layers that maintain seepage at depth. Stands are usually associated with riparian areas. Soils are typically Gleysols or Gleyed Brunisols derived from morainal or fluvial materials. Soil texture can be variable, with coarser sandy loam and loamy sand on lower and toe slope positions and finer silt loam and loam soils on gentle, moisture-retaining mid-slope sites. **Mottles** are typically present at depth (within the upper 70–100 cm of the soil).

Cw, **Hw** canopies are common, with moderate to abundant **oak fern**, **foamflower**, queen's cup, and five-leaved bramble in the understorey. Minor amounts of devil's club (< 3% cover) and oval-leaved blueberry typically occur. Leafy mosses, red-stemmed feathermoss, and pipecleaner moss are usually present.

Differentiating from Other Site Series

On drier sites (101), oak fern is sparse to absent (< 1% cover), and Fd and Lw are often present. On moister sites (111), lady fern and/or devil's club are abundant (> 5% cover of one or both). The 112 differs due to the presence of cold air, which leads to stand dominance by Sxw and Bl and the presence of false azalea and/or white-flowered rhododendron.

Variability

Minor cover of lady fern, spiny wood fern, or devil's club may occur (< 2%).

Management Issues

Tree productivity is high on these sites, and vegetation competition is often a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Sites frequently provide travel corridors in steep terrain and forage for wildlife. Large-diameter trees, coarse woody debris, and snags are common in old-growth stands and provide important habitat for primary and secondary cavity nesters, as well as overwintering sites for bears and small mammals.

111 CwHw – Devil's club – Lady fern

General Description

SMR 5 (6). 111 forests occur on **receiving sites** on lower and toe slope positions with poor to imperfect drainage. **Mottles** are usually prominent, and **seepage** is typically present within the **top 30–50 cm** of the soil profile. Soils tend towards Gleysols, gleyed Brunisols, or, where flooding is common, Gleyed Cumulic Humic Regosols with multiple buried horizons. Sites are typically associated with riparian areas.

Old-growth stands of high productivity **Cw** and **Hw** are common. **Devil's club** and/or **lady fern** and **spiny wood fern** typify the understorey. Minor amounts of Sxw or Bl may be present. Other common species include abundant oak fern, queen's cup, and foamflower. Leafy mosses are common and often occur with ragged-mosses.

Differentiating from Other Site Series

Abundant devil's club and/or lady fern (> 5% cover) distinguish this site from drier site series (110) where oak fern and/or foamflower dominate and lady fern is sparse to absent. Wetter sites are characterized by skunk cabbage (114) or horsetails (113), and occur on level to gentle areas where seepage is at or near the surface. The 112 differs due to the presence of cold air, with Sxw, Bl false azalea and/or white-flowered rhododendron.

Variability

Lady fern can occur with high cover where devil's club is sparse to absent. Users who require additional information can refer to site series variations:

111.1 CwHw – Devil's club – Lady fern
sites with abundant devil's club

111.2 CwHw – Lady fern – Oak fern
sparse devil's club (< 5% cover) and abundant lady fern and spiny wood fern (> 25% combined cover)

Hummocky terrain is common in these forests, with trees on elevated microsites and wetter understorey species in depressions.

Management Issues

Tree productivity is high on these sites, and vegetation competition is often a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Sites are often associated with riparian management areas. Large-diameter trees, coarse woody debris, and snags are common in old-growth stands and provide important habitat.

Sxw(Hw) – Huckleberry – Oak fern **112**

General Description

SMR 5 (6). 112 sites occur on level, toe, and lower slope positions in **moisture-receiving** areas with **cold air. Seepage or the water table** are present **within 30–50 cm** of the soil surface. These sites typically occur near the upper ends of valleys where ESSF-like influences extend along valley bottoms, with ICH tree species dominating valley sidewalls. Soils usually have silt loam or sandy loam textures, and, due to an association with riparian areas, are typically derived from fluvial deposits.

Sxw and **Bl** are the dominant tree species; Hw, and occasionally Cw, may be present in minor amounts. Common understorey species include black huckleberry, oak fern, foamflower, five-leaved bramble, and ragged-mosses. Minor amounts of devil's club, oval-leaved blueberry, and clasping twisted stalk (*Streptopus amplexifolius*) are common. White-flowered rhododendron, Sitka alder (*Alnus viridis* ssp. *sinuata*), and twinberry (*Lonicera involucrata*) may be present.

Differentiating from Other Site Series

112 sites occupy similar slope positions and site conditions as the 111 but occur only where cold air and frost pockets are dominating factors. They are easily differentiated due to the dominance of Sxw and Bl in the tree and regeneration layers. Wetter sites may also be affected by cold air but are typically characterized by horsetails and have seepage or a water table close to the surface. Minor Sxw or Bl may be present in 110 or 111 stands naturally, or plantations may have high Sxw cover. In these cases, the abundance of both cold air and Sxw and Bl can be used to differentiate these sites from other site series.

Where Sxw, Bl, white-flowered rhododendron, and other characteristically ESSF species dominate at upper elevations of the ICHmw2, the stand is likely transitional to the ESSF and should be managed as such.

Variability

Cw and Hw cover varies in these stands but is never dominant. White-flowered rhododendron and other characteristically ESSF species such as false hellebore (*Veratrum viride*), false azalea, cow-parsnip (*Heracleum maximum*), or Sitka valerian may be present.

Management Issues

Frost damage and higher snowpack may affect regeneration. Due to the presence of moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. These sites are often associated with riparian management areas.

113 CwHw – Horsetail – Lady fern

General Description

SMR 6 (7). 113 forests are uncommon in the ICHmw2. They occur on **level** or very gentle toe slopes in **receiving** areas where **moisture is close to the surface**. They are usually associated with **cold air** and **riparian** areas. Thin **organic veneers** are common over moderately coarse soils with silt loam to sandy loam textures. Flooding is rare to occasional.

Abundant **horsetails** (> 10% cover) occur with a **Cw**, **Hw** understorey, often with **Sxw**. Lady fern may be abundant; devil's club and **red-osier dogwood** are often present.

Differentiating from Other Site Series

CwHw – Horsetail – Lady fern sites differ from the 112 site series by the prominence of horsetails and the availability of seepage at or near the surface. 114 forests have abundant skunk cabbage and usually thicker organic veneers. Wetter sites are typically non-forested wetlands that do not support tree growth.

Variability

Minor cover of skunk cabbage is common (< 5%) where horsetails are abundant. The 113 and 114 ecosystems can occur in complexes, often with non-forested wetland or riparian communities. Thimbleberry may be abundant.

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, competition from herbaceous brush can be a concern in regenerating stands. Cold air and frost may limit regeneration.

General Description

SMR 6 (7). 114 forests are uncommon in the ICHmw2. They occur on **moist**, **receiving** sites on level, toe, and depression sites. Soils are typically derived from **fluvial** materials and are capped with a **thick organic veneer** or **thin organic blanket**. Seepage or the water table are usually present at or near the surface.

Cw and **Hw** usually dominate the canopy along with minor amounts of Sxw and Bl. **Skunk cabbage** is always present with moderate to high cover (> 10%) along with high cover of lady fern.

Differentiating from Other Site Series

114 forests are easily differentiated by the abundance of skunk cabbage. 112 forests occur on slightly drier sites and are characterized by abundant Sxw and Bl, cold air, and express ESSF-like characteristics within an ICH landscape. 113 forests have abundant horsetail and lack skunk cabbage (< 5% cover). Wetter sites are non-forested wetlands.

Variability

These stands can be highly diverse, with a number of moisture-associated herbs such as small willow-herbs (*Epilobium* spp.), rattlesnake fern (*Botrypus virginianus*), wild ginger (*Asarum caudatum*), rein orchids (*Platanthera* spp.), and sedges (*Carex* spp.); lady fern is often abundant. The moss layer is also variable, with peat-mosses (*Sphagnum* spp.), silk mosses (*Plagiothecium* spp.), and thallose liverworts (e.g., *Marchantia* spp.) common. Earlier seral stages may have Act, Ep, or At and alders. Drier species such as bunchberry, twinflower, and feathermosses may occur on mounded areas, particularly around the bases of trees. 114 sites can also be classified as *Ws10 Western redcedar – Spruce – Skunk cabbage* forested swamps (see Section 6.2).

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where tree removal occurs, competition from herbaceous brush is usually a concern in regenerating stands. Cold air and frost may limit regeneration.

Other Ecosystems

The following ecosystems occur within the ICHmw2; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

Due to the extensive geographic area covered by the ICHmw2, a number of wetland ecosystems occur. The most common wetland types in the ICHmw2 are marshes (Wm), swamps (Ws), and shallow water (Ww) types, although fens (Wf) can be common. Wetlands are described in Section 6.2.

Cottonwood forests and other flood ecosystems

Cottonwood floodplain forests are relatively common in the ICHmw2, although significant areas were flooded for hydroelectric developments. Large areas remain in the Duncan and Lardeau Valleys and the upper Shuswap River north of Sugar Lake. Smaller cottonwood complexes occur along floodplains and river and stream deltas, and as narrow bands in riparian areas. The most common cottonwood floodplain types are *Fm01 Cottonwood – Snowberry – Rose*, *Fm02 Cottonwood – Spruce – Horsetail*, and *Fm04 Cottonwood – Western redcedar – Lady fern*. The Fm01 occurs in the climatically driest areas of the ICHmw2, while the Fm04 occurs in the climatically wettest areas and the Fm02 occurs on colder floodplain sites. Alder and willow low bench floodplains (Fl) also occur. Section 6.3 provides descriptions of flood ecosystems.

Brushlands and grasslands

Brushlands (Gb) and grasslands (Gg) are very uncommon in the ICHmw2, occasionally occurring on steep, warm-aspect, exposed sites. Section 6.4 provides descriptions of grassland and brushland ecosystems.

Avalanche features

Avalanche paths occur infrequently in the ICHmw2, and are generally at the bottom of large slopes with start zones in the higher-elevation ESSF subzones. Herb (Vh) and shrub (Vs) types are most common. Descriptions of avalanche ecosystems are provided in Section 6.5.

Rock outcrops and talus slopes

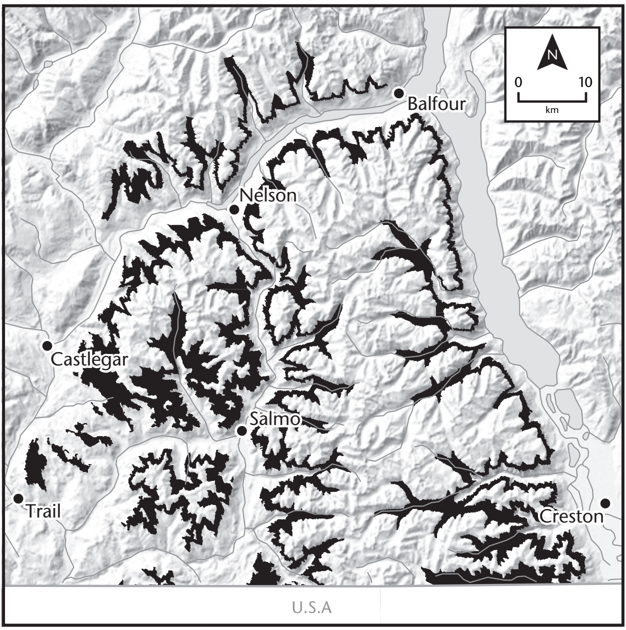
A number of rock outcrop (Ro) and talus (Rt) ecosystems occur in the ICHmw2 and are commonly found adjacent to the driest forested ecosystems. Descriptions of rock ecosystems are provided in Section 6.6.

ICHmw4
Ymir Moist Warm
Interior Cedar – Hemlock

Geographic Distribution

The ICHmw4 occurs at mid elevations in the south Selkirk Mountains. It is bounded by the Columbia and Slocan Rivers to the west, the height of land in the West Arm's Kokanee Range to the north, and the west shores of Kootenay Lake to the east. The ICHmw4 occurs between the ICHdw1 at lower elevations and the ESSFwh3 at higher elevations, except in the southeast portion of its range, from Cultus Creek south to Dodge Creek, where the ICHmw4 occurs below the ESSFwm4. The ICHmw4 abuts the ICHmw2 to the north.

Distribution of the ICHmw4



Elevation Range

The ICHmw4 ranges from 1070 to 1530 m on cool aspects, 1150–1575 m on neutral aspects, and 1275–1600 m on warm aspects. Both lower and upper limits of the ICHmw4 tend to occur at slightly higher elevations across the southern half of its extent.

Climate[1]

The ICHmw4 is located in the Moist climate subregion and is characterized by warm, moist summer and autumn seasons, wet springs, and cool to mild, moist winters with moderate snowfall. Snowpacks are moderately deep and persist from December through March or early April, although rain-on-snow events are frequent. Persistent snowpack combined with a relatively mild climate prevents soils from freezing to any significant depth. Growing-season moisture deficits can occur on subxeric and drier sites, and on submesic sites in dry years.

Forest and Vegetation Characteristics

Tree diversity and productivity are high in the ICHmw4. Climax **zonal sites** are characterized by stands of Hw and Cw, often with sparse understoreys of black huckleberry, falsebox, foamflower, queen's cup, and pipecleaner moss. Mid-seral stands occur frequently, and include Fd, Lw, Hw, and Cw, with occasional Pl and Pw. Bg occurs at lower elevations where the ICHmw4 is close to the ICHdw1, while Sxw and Bl occur where the ICHmw4 transitions to the ESSF and in areas with cold air. **Drier sites** have higher Fd, Lw, and Pl cover and may lack Cw and Hw in the overstorey of mature forests. Birch-leaved spirea, saskatoon, common juniper, pinegrass, bear-grass, and kinnikinnick are common in the understorey. **Moist to wet sites** are Cw and Hw dominated and typically lack Fd, Lw, and Pl; understoreys vary from oak fern to lady fern and devil's club, to horsetail. Ep and At are often abundant in early seral stands on dry to moist sites, and often remain as remnants in mature forests. Cottonwood floodplain forests are uncommon and are limited to small riparian areas along the bottoms of relatively steep valleys.

Disturbance

Fire, insects, and pathogens are the primary agents of disturbance. Historically, **stand-replacing fires** were important at the landscape scale, while **mixed-severity fires** were common. Low-severity fires were more common on warmer aspects and on slopes that extend to lower elevations (Nesbit 2010). Fire-scarred trees are common across the range of historic fire severities, with veteran Fd, Lw, and occasionally Cw common post-fire (Quesnel and Pinnell 1997; MacKillop 2003). Old growth is currently uncommon

[1] See Section 4.2 for more information on climate variables.

due to timber harvesting and historic human-caused fires associated with European settlement (mining era) in the late 1800s and early 1900s. Abundant timber harvesting since the 1970s has also increased the amount of early seral forest, while fire suppression has been effective in reducing the occurrence of fire across the landscape (Nesbit 2010).

Mountain pine beetle and **Douglas-fir beetle** are key disturbance factors. **Birch decline** due to a variety of factors, including insect, disease, and drought, is a more recent phenomenon and has had large impacts on Ep. **Armillaria root rot** creates small gaps in mature stands and can be a major impediment to tree regeneration. **White pine blister rust**, along with historic targeted harvesting, has had a major impact on Pw. **Gall rusts** affect growth of Pl regeneration, while **foliar needle diseases** affect Pl and Lw (blight and needle cast). **Animal damage** can also be extensive: bear damage to Cw and Lw plantations can be localized but severe.

Soils, Geology, and Landforms

Complex geological history characterizes the south Selkirk Mountains. Throughout much of the ICHmw4, soils are derived primarily from coarse-grained granodiorite rocks from the Nelson Batholith. Soils derived from morainal parent materials dominate much of the area and usually have sandy loam surface textures with moderate coarse fragments. Soils often become coarser at depth with loamy sand textures and higher coarse fragment content. Andesites, phylites, and schists derived from fine sedimentary parent materials are interspersed as mineral-rich areas, particularly in the Bonnington and Nelson ranges. Granite and quartzite are common in the older rock formations east of Kootenay Pass.

Wildlife Habitat

The ICHmw4 provides productive habitat for a range of wildlife species, including several flagship species. **Mountain caribou** use this unit in early winter before snowpacks have deepened and firmed up on subalpine winter ranges. Both **grizzly bears** and **black bears** forage on huckleberries in early seral habitats. **Wolverine** may use a variety of seral stages seasonally, along with **other furbearers**. **Rocky Mountain elk**, **bighorn sheep** and **mule deer** forage in the ICHmw4 and overwinter on warmer aspects with shallower snowpacks.

A variety of **cavity-nesting**, **roosting**, **and denning bird and mammal species** rely heavily on mature and old stands in the ICHmw4. Abundant structural diversity is provided by veteran trees (especially Fd, Lw, and Cw) that have survived previous severe fires, and by wildlife trees, coarse woody debris, and thickets. Patches of wildlife trees retained in harvested openings can help sustain these guilds, many of which are insectivorous and contribute to the biological control of bark and wood-boring beetles. Species at risk in this guild include **olive-sided flycatcher**, **little brown myotis**, **and barn swallow.** Swainson's thrush, warbling vireo, and Townsend's, MacGillivray's, and yellow-rumped warblers are some of the more common bird species.

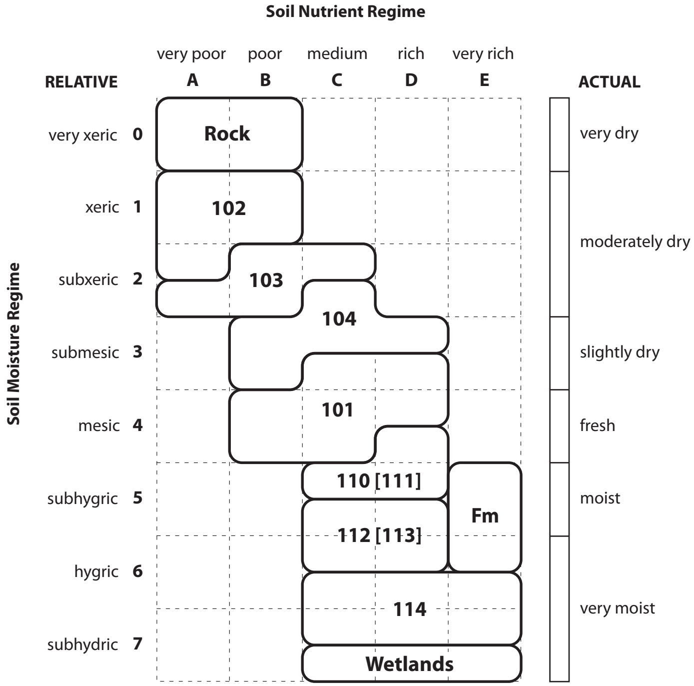
Wetlands and riparian areas are scattered but provide important breeding habitats for species such as **western toad** and **sandhill crane**. **Peregrine falcon** and **red-tailed chipmunk** are species at risk that are associated with rocks, talus, or cliffs in the ICHmw4.

Bear-grass
Xerophyllum tenax

Distinguishing the ICHmw4 from Adjacent Biogeoclimatic Units

In the **ICHdw1**, most sites have:	- Bg, particularly in earlier seral stands - no Bl - fewer old-growth forests
zonal sites have:	- more Fd - no oak fern or foamflower
dry sites have:	- Py, oceanspray, mock-orange, mallow ninebark
wet sites have:	- no Bl or five-leaved bramble
In the **ICHmw2**, most sites have:	- more bunchberry - more feathermosses
dry sites have:	- no bear-grass
In the **ESSFwh3**, most sites have:	- dominant or codominant Se and Bl - more white-flowered rhododendron and/or false azalea - less Cw and Hw
dry sites have:	- more bear-grass - Bl in the understorey - less Fd and Lw - less Douglas maple and prince's pine
wet sites have:	- more Canby's lovage - less twinflower
In the **ESSFwm4**, most sites have:	- dominant or codominant Se and Bl - white-flowered rhododendron and/or false azalea
zonal sites have:	- arnica and woodrushes
dry sites have:	- Bl in the understorey - less Fd and Lw - more grouseberry and/or low bilberry and bear-grass
wet sites have:	- more hellebore

Edatopic Grid



Site series

101 HwCw – Falsebox
102 FdPl – Juniper – Kinnikinnick
103 Fd – Douglas maple – Falsebox
104 FdCw – Falsebox – Prince's pine
110 CwHw – Oak fern
111 Sxw(Hw) – Huckleberry – Oak fern
112 CwHw – Devil's club – Lady fern
113 SxwBl – Devil's club – Lady fern
114 SxwCw – Horsetail – Lady fern
Fm01 Cottonwood – Snowberry – Rose[1]
Fm04 Cottonwood – Western redcedar – Dogwood – Lady fern[1]

[1] See Section 6.3 for descriptions.

Site Series Flowchart

VERY DRY to DRY FORESTS • warm aspects • shallow soils	• SMR 1 (2) • open Fd, Pl stands • exposed bedrock or talus prominent in stand • juniper, kinnikinnick, parsley fern, stonecrop, and fescues • rock-mosses, clad lichens, haircap mosses	102
	• SMR 2 • Fd, Lw (Pl) open canopy • steep, warm aspect; shallow and/or coarse soils • shrub rich: Douglas maple, birch-leaved spirea, and/or thimbleberry • Cw, Hw sparse or absent	103
SLIGHTLY DRY to MESIC FORESTS • mid slopes (usually) with deep soils	• SMR 3 (2) • mixed Fd, Lw, Cw, Hw (Pl) stands • prince's pine and pipecleaner moss • bear-grass may be present	104
	• SMR 4 (3) • Hw, Cw stands • Fd, Lw, Pl, Ep, At can be common in younger stands • foamflower and pipecleaner moss	101
MOIST to WET FORESTS • lower or toe slopes • seepage or mottles	• SMR 5 (4) • Cw, Hw stands • oak fern and foamflower abundant • < 3% lady fern and/or devil's club	110
	• SMR 6 (5) • Cw, Hw stands • > 7% devil's club and/or lady fern cover	112
MOIST to WET FORESTS with COLD AIR • lower or toe slopes or level • seepage or mottles	• SMR 5 (4) • Sxw, Bl (Hw, Cw) stands • black huckleberry abundant • false azalea and/or rhododendron present • no devil's club	111
	• SMR 5–6 • Sxw, Bl (Hw, Cw) stands • devil's club abundant • black huckleberry sparse or absent	113
	• SMR 6 (7) • Sxw, Bl (Hw, Cw) stands • level or gentle sites with water table at or near surface • horsetail, lady fern (> 10% cover), arrow-leaved groundsel and/or Canby's lovage (> 2% cover)	114

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	113	114	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■	□□□							Douglas-fir
	Pinus contorta	■■■■	□□□	□□□							lodgepole pine
	Larix occidentalis	*	□□	□□□							western larch
	Abies lasiocarpa			*	*	*	■■■	*	■■■	□□□	subalpine fir
	Tsuga heterophylla			□□□	■■■■■	■■■■■	□□□	■■■■■	□□	□□□	western hemlock
	Thuja plicata			■■■■	■■■■	■■■■	*	■■■■	*	*	western redcedar
	Picea engelmannii x *glauca*			□□	*	*	■■■■	□□	■■■■■	■■■■	hybrid white spruce
Regen	*Pseudotsuga menziesii*	■■■	■■■								Douglas-fir
	Abies lasiocarpa		□□	□□	*	*	□□		□□	■■■	subalpine fir
	Thuja plicata		□	■■■	■■	■■	■■■	■■■	□□	■■■	western redcedar
	Tsuga heterophylla			□□□	■■■■	■■■	■■■	■■■	■■■	■■■	western hemlock
	Picea engelmannii x *glauca*						□		□□	■■	hybrid white spruce
Shrubs	*Vaccinium membranaceum*	■■■	□□□	■■■	■■■	■■	■■■■	□	■■	□	black huckleberry
	Paxistima myrsinites	■■■	■■■■	■■■	■■	□□	□				falsebox
	Spiraea betulifolia	□□□	■■■								birch-leaved spirea
	Amelanchier alnifolia	■■	■■								saskatoon
	Juniperus communis	■■									common juniper
	Acer glabrum		■■■	*		*		*			Douglas maple
	Taxus brevifolia				□□	□□	□□	□□		*	western yew
	Rubus parviflorus		■■■	□			□□		■■	□□	thimbleberry
	Mahonia aquifolium		□								tall Oregon-grape
	Oplopanax horridus					□	□	■■■■	■■■■		devil's club
	Menziesia ferruginea						□□□□		□□□	□□	false azalea
	Rhododendron albiflorum						□□				rhododendron
	Ribes lacustre						□		■■	□	black gooseberry

Layer	Scientific name	102	103	104	101	110	111	112	113	114	Common name
Herbs	*Calamagrostis rubescens*	■■■	□□								pinegrass
	Antennaria spp.	■■									pussytoes
	Arctostaphylos uva-ursi	■■									kinnikinnick
	Festuca spp.	□									fescues
	Cryptogramma acrostichoides	■									parsley fern
	Heuchera cylindrica	■									round-leaved alumroot
	Xerophyllum tenax	■		□□□							bear-grass
	Hieracium albiflorum	□	■								white hawkweed
	Clintonia uniflora		□□	□□	■■■	■■■	■■■	■■■	□□		queen's cup
	Linnaea borealis		*	□□□	□□	*					twinflower
	Chimaphila umbellata		□	■■							prince's pine
	Tiarella trifoliata var. *unifoliata*				■■	■■■	■■■	■■■■	■■■■	■■	one-leaved foamflower
	Gymnocarpium dryopteris				□	■■■■	■■■■	■■■■	■■■■	■■■	oak fern
	Rubus pedatus					□□	■■■	■■	■■	□	five-leaved bramble
	Athyrium filix-femina					■	■■	■■■■	■■■■■	■■■■	lady fern
	Streptopus amplexifolius						■■	■	■■	■■	clasping twistedstalk
	Dryopteris expansa						□	□□	■■■		spiny wood fern
	Pectiantia brewerii								□□□	■■	Brewer's mitrewort
	Senecio triangularis								■	□□□	arrow-leaved groundsel
	Equisetum spp.									■■■■■	horsetails
Moss layer	*Racomitrium* spp.	■■■									rock-mosses
	Polytricum spp.	■■									haircap mosses
	Cladonia spp.	■									clad lichens
	Brachythecium spp.	□	□□	*		*	■■■	■■■■	□□□	■■■	ragged-mosses
	Rhytidiopsis robusta		*	■■■■	■■■■	■■■■	□□	■■■			pipecleaner moss
	"leafy mosses"[a]					*	■■■■	■■■■	■■■■	■■■■	leafy mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Environment Table[a]

Site Series	102	103	104	101	110	111	112	113	114
No. of plots	3	10	17	19	19	6	22	3	5
SMR	1 (2)	2	3 (2)	4 (3)	5 (4)	5 (4)	5–6	5–6	6 (7)
SNR	A–B	A–B (C)	B–C	C (B,D)	C–D	C–D	C–D (E)	C-D (E)	D (C, E)
Slope position	MD–UP	UP–MD	MD (UP)	MD	LW (TO, MD)	LW (TO, MD)	TO (LW, MD)	TO (LW, MD)	LV (TO)
Typical slope/ aspect	Variable	Steep/ warm	Moderate/ warm	Moderate/ neutral (cool)	Gentle (steep)	Gentle/ neutral–warm	Gentle (level)	Gentle (level)	Level (gentle)
Common compensating conditions			Upper, cool; shallow, neutral	Lower, coarse; lower, warm; gentle, warm	Mid-slope receiving	Steep, cool, receiving			
Surficial materials	Cx/R, Mx/R	Cv (Cb)	M, C, FG	M (C FG)	M (C)	M (C)	F (M, C)	F (M, C)	Ov/F, F
Soil texture	SL	SL	SL	SL (FSL)	SL, SiL (FSL)	SL, SiL	SiL, SL	SiL, SL	SiL, FSL, SiCL
Coarse fragment Content	High (moderate)	High (fragmental)	Moderate–high	Moderate (high)	Moderate (low)	Low–moderate	Moderate–high; often increasing at depth	Moderate (high)	Low, often increasing at depth
Important features	Dominated by (bed)rock	Insolation			Mottles within 75 cm	Cold air; mottles within 75 cm	Seepage within 50–70 cm	Cold air; seepage within 50–70 cm	Water table at or near surface; cold air

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.

HwCw – Falsebox **101**

General Description

SMR 4 (3). The 101 site series occurs on **mid-slope** positions of **neutral to cool** aspects, or due to compensating factors, on lower slope positions or gentle slopes of warm aspects where moisture receiving and shedding are approximately equal. Surficial materials are typically morainal but can be colluvial or glaciofluvial; soils are typically sandy loam Dystric Brunisols.

Old and mature forests are dominated by **Hw** with abundant **Cw** and occasionally sparse Fd or Lw. Understorey vegetation is typically sparse to moderate in cover with scattered **falsebox**, **black huckleberry**, **foamflower**, **queen's cup**, and **pipecleaner moss**.

Differentiating from Other Site Series

The 101 differs from slightly drier sites (104) by the presence of small amounts of foamflower and the lack of bear-grass, birch-leaved spirea, Douglas maple, and prince's pine. Slightly wetter sites (110) usually have > 3% cover of oak fern, have more foamflower, and may contain devil's club.

Variability

Earlier seral stages often have a wider diversity of tree species, including some Fd, Lw, Ep, Pl, and occasionally Pw, or, at lower elevations, Bg or At. Sxw and Bl occur in higher abundance in areas with cold-air influences and where the ICHmw4 transitions to the ESSFwh3 or ESSFwm4. Understorey vegetation in young through mature and old stands is often very sparse; in these cases, users should rely on site and soil characteristics for site series identification and classification.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be fostered. Forest productivity is high. Brush competition can cause regeneration problems following overstorey removal.

102 FdPl – Juniper – Kinnikinnick

General Description

SMR 1 (2). 102 stands occur on dry sites with extensive **exposed bedrock** and occasionally on blocky talus slopes where rocks form the dominant substrate. Soils often vary in depth with very thin veneers, exposed rock, and small, deeper pockets of soil interspersed. Humus forms are usually thin and dry. Stands often occur in larger complexes with 103 forests, open, non-forested rock outcrops, or talus areas.

Fd is the dominant tree species, often with lesser amounts of Pl. Shrubs, including black huckleberry, falsebox, saskatoon, and **juniper** are typically dispersed among rocky areas with **round-leaved alumroot** and parsley fern. **Pinegrass** is usually present with small amounts of **kinnikinnick**, pussytoes, and/or dry sedges (*Carex* spp). **Rock-mosses**, **clad lichens**, pelt lichens (*Peltigera* spp.), and **haircap mosses** are typically present. *Selaginella* species, stonecrops (*Sedum* spp.), and other rock outcrop plants often occur with very low cover.

Differentiating from Other Site Series

The 102 is the driest forested site series in the ICHmw4 and can be differentiated from non-forested rock outcrop and talus units by the presence of 10% or greater tree cover in a stand. The 103, the next moister site, differs in that soils are deeper, and exposed bedrock is either very limited or absent. Slightly moister 103 sites typically lack parsley fern, kinnikinnick, juniper, rock-mosses, and haircap mosses.

Variability

At lower elevations, small amounts of oceanspray (*Holodiscus discolor*) or mallow ninebark (*Physocarpus malvaceus*) may be present. Earlier seral stages often have more Pl; Lw may be present in small amounts in early to late seral stands. Vegetation often varies within sites due to variability in soil depth to rock; extremely shallow areas may contain rock outcrop species, while deeper pockets of soil may support shrubs and trees.

Management Issues

This site series is not recommended for forest harvest due to limitations in available soil and soil moisture for tree regeneration and growth.

Fd – Douglas maple – Falsebox 103

General Description

SMR 2. 103 forests occur on **shallow**, **steep**, **warm** mid to upper slopes. Soils are typically **coarse-textured**, well- to rapidly drained Dystric Brunisols with thin humus forms. Since this unit occurs on steep slopes, soils are typically colluvial.

Forests are characterized by open stands of Fd and moderate to high shrub cover, often dominated by **Douglas maple**, **birch-leaved spirea**, and **falsebox**. Lw, Pl, saskatoon, Oregon-grape, thimbleberry, prince's pine, and/or queen's cup are often present in small to moderate amounts. Mosses and lichens are usually sparse.

Differentiating from Other Site Series

The 103 differs from drier sites in that exposed rock does not form the dominant substrate, and rock-mosses, haircap mosses, common juniper, parsley fern, and other rock outcrop–associated species are absent or very sparse. Moister sites (104) have Cw, Hw, and pipecleaner moss, as well as more prince's pine and queen's cup, and fewer shrubs.

Variability

Deciduous tree–dominated stands are common on 103 sites, where Ep and At either dominate or form mixed stands with Fd, Pl, and Lw. These sites are often the result of repeated, high-severity fires, and, in many cases, show slow stand development processes. Many of these areas appear to be in a near-perpetual deciduous state. Users who require additional information can refer to these using seral coding as ICHmw4/103$B.[2]

Dry, warm sites in the ESSFwh3 and lower elevations of the ESSFwm4 often resemble the ICHmw4/103 in that Fd, Lw, and Pl are usually dominant in the overstorey, although, in the ESSF, Bl is typically the dominant species in the regeneration layer and bear-grass is usually abundant.

Management Issues

Drought may limit tree growth and establishment, particularly in areas transitional to the ICHdw1. Soil erosion can be a concern on steep slopes. High brush cover can cause regeneration problems. Warm-aspect sites provide important ungulate winter range due to lower snow depth and higher forage availability.

[2] See Section 2.3 for seral coding.

104 FdCw – Falsebox – Prince's pine

General Description

SMR 3 (2). 104 forests typically occur on **mid slopes of warm aspects**. Due to compensating factors, these sites also occur on cool aspects on upper slope positions and on cool to neutral aspects on mid slopes with coarse-textured or shallow soils. Soils are usually Dystric Brunisols with sandy loam textures and Mor humus forms.

Tree species are often very mixed with **Cw**, **Fd**, **Hw**, **Lw**, and **Pl** in the overstorey and Cw and/or Hw in the understorey. Shrub cover is often low, with falsebox and black huckleberry as the main species. Understorey herbs include small amounts of **prince's pine**, **twinflower**, and, often, queen's cup. Although inconsistent in presence, **bear-grass** can be the dominant understorey species.

Differentiating from Other Site Series

Drier sites (103) also occur on warm aspects, but are steep and on shallow or coarse soils. Drier sites are generally shrubbier and usually contain pinegrass, saskatoon, Fd, and abundant Douglas maple in the understorey. Slightly moister, mesic (101) sites have foamflower and more Hw, and lack Pl (in mature stands).

Variability

The suite of species in the canopy is variable. Although not present on all sites, bear-grass can dominate. Sites without bear-grass tend to also lack Douglas maple and may have minor cover of low bilberry (*Vaccinium myrtillus*) or grouseberry (*V. scoparium*). Users who require additional information can refer to site variations as:

104.1 FdCw – Falsebox – Prince's pine
non–bear-grass sites (absent or < 10% cover)
104.2 FdCw – Falsebox – Prince's pine – Bear-grass
bear-grass–dominated sites (> 10% cover)

Earlier seral stages often contain At and Ep in conifer-dominated stands. Glaciofluvial soils tend to support higher Pl and twinflower cover. Cool-aspect, submesic sites may have higher moss cover and very few herbs.

Management Issues

Tree species diversity is high on these sites and should be maintained. High brush competition from species such as bracken fern and thimbleberry can cause regeneration problems following overstorey removal. Soil erosion can be a concern on steep slopes. Drought may limit tree productivity and establishment during drier than normal years.

CwHw – Oak fern 110

General Description

SMR 5 (4). 110 forests typically occur on steep, lower slope sites and gentle toe slopes, often with **seasonal seepage** within the top metre of soil. They are typically within or adjacent to riparian areas although they can also occur on mid-slope sites with seepage. Soils are usually Gleyed Brunisols or Gleyed Humo-Ferric Podzols with silt loam or fine sandy loam textures, a Mor humus form, and faint to prominent mottles.

Old-growth stands of high-productivity **Cw** and **Hw** are relatively common in this site series. **Oak fern** is the dominant understorey species with small amounts of black huckleberry and/or falsebox, queen's cup, and foamflower. Pipecleaner moss and leafy mosses (mostly *Rhizomnium nudum*) form a moderate cover on the forest floor. Small amounts (< 3% cover) of lady fern and devil's club may be present.

Differentiating from Other Site Series

The abundance of oak fern is the most obvious feature differentiating the 110 from drier (101) sites, although an increase in foamflower, the presence of moisture-associated leafy mosses, and faint to prominent soil mottles are also useful differentiating characteristics. Wetter sites (112) have high cover (> 5%) of lady fern and devil's club. The 111 differs due to the presence of cold air, which leads to Sxw and Bl dominance and the presence of false azalea and/or white-flowered rhododendron.

Variability

The amount of oak fern varies from approximately 5% to more than 30% cover; lady fern cover is typically very sparse but can be as high as 5%, particularly where devil's club is absent and forest conditions are transitional to the 112 site series.

Management Issues

Tree productivity is high on these sites and vegetation competition may be a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should occur when soils are dry or frozen. Large-diameter trees, logs, and snags are common in old-growth stands and provide important habitat for primary and secondary cavity nesters, as well as overwintering sites for bears and small mammals.

111 Sxw(Hw) – Huckleberry – Oak fern

General Description

SMR 5 (4). 111 forests occur on **moisture-receiving sites** with **cold-air** exposure, usually in riparian areas. Seasonal seepage is present at depth (within < 1 m), and mottles are usually present within the top 75 cm of soil. Soils are usually gleyed Brunisols or Podzols with loamy to sandy loam textures and moderate (30–50%) coarse fragment content.

Cold air leads to stands dominated by **Sxw** and **Bl** with lesser amounts of Hw and occasionally Cw. Understoreys usually contain **false azalea** and/or **white-flowered rhododendron** with abundant **black huckleberry**, **oak fern**, foamflower, five-leaved bramble, ragged-mosses, and leafy mosses. Small amounts of western trillium (*Trillium ovatum*), lady fern, twistedstalks (*Streptopus* spp.), violets (*Viola* spp.), and devil's club may be present.

Differentiating from Other Site Series

The 111 site series differs from the 110 due to the influences of cold air. This leads to conditions resembling the ESSF, such as an abundance of Sxw, Bl, white-flowered rhododendron, and/or false azalea. The 113 represents a wetter cold-air site series that has abundant devil's club and lady fern.

Variability

The 111 site series occurs in valley bottoms within the ICH. Although it resembles oak fern sites in the ESSFwh3 (110 site series), those forests occur at higher elevations and/or at the upper reaches of valleys where Cw, Hw, Fd, and Lw no longer dominate the landscape. The ICHmw4/111 site series does not occur on mid-slope positions transitional to the ESSF; while management may not differ considerably between these two units, those stands typically belong to the ESSFwh3/110 site series.

Management Issues

Cold air and frost may limit regeneration, particularly after clearcutting or heavy canopy removal. Tree productivity is high on these sites, and vegetation competition may be a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. These sites are often associated with riparian management areas.

CwHw – Devil's club – Lady fern 112

General Description

SMR 5–6. 112 forests occur on lower and toe slope positions in **receiving sites** with poor to imperfect drainage. Mottles are usually prominent, and seepage is typically present within the top 50 cm of the soil profile. Soils are Gleysols, Gleyed Brunisols, or, where flooding is common, Gleyed Orthic Humic Regosols with multiple buried horizons. Sites are usually associated with **riparian** areas.

Old-growth Cw, Hw stands are relatively common. **Devil's club** and **lady fern** are usually abundant, while black huckleberry and falsebox may be present at very low densities. The moss layer has moderate to high cover and is comprised primarily of ragged-mosses, **leafy mosses** (often *Rhizomnium magnifolium*), and lesser amounts of pipecleaner moss.

Differentiating from Other Site Series

The 112 site series differs from drier site series (110) due to the abundant cover of devil's club and/or lady fern (> 10%, combined). The 113 describes sites with cold air on a similar moisture regime; these sites occur in valley bottoms dominated by Sxw and Bl, with ICH species on adjacent hillsides. Wetter sites (114) also have Sxw but are characterized by abundant horsetail and moderate amounts of arrow-leaved groundsel and/or Canby's lovage (*Ligusticum canbyi*).

Variability

Hummocky terrain is common in these riparian-associated forests, with trees growing on elevated microsites and wetter understorey species growing in depressions. Stands occasionally have high cover (> 30%) of lady fern, but devil's club is sparse to absent. This is most common in transitional areas between the 110 and 112 or on sites with thin organic veneers (or a thick forest floor).

Management Issues

Tree productivity is high on these sites, and vegetation competition may be a concern following harvest. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. Large-diameter trees, coarse woody debris, and snags are common in old-growth stands and provide important habitat for primary and secondary cavity nesters, as well as overwintering sites for bears and small mammals. These sites are usually associated with riparian management areas.

113 SxwBl – Devil's club – Lady fern

General Description

SMR 5–6. 113 forests are uncommon and occur on receiving sites with **seasonal seepage or flooding** and **exposure to cold air**. They are usually associated with **riparian areas** and occur on lower or toe slopes, typically on cool aspects or sites lacking insolation. Soils are Gleysols or gleyed Brunisols and Podzols, usually with sandy loam textures.

Because of cold-air influences, **Sxw** and **Bl** dominate the overstorey and understorey. Hw and Cw are often codominant or secondary species. The shrub layer is typified by **devil's club**, **false azalea**, thimbleberry, and Hw. **Lady fern**, **oak fern**, spiny wood fern, and foamflower are common in the typically species-rich herb layer. Ragged-mosses and leafy mosses are typically present.

Differentiating from Other Site Series

The 113 occupies similar slope positions and sites as the 112 but is influenced by **cold air** and is dominated by **Sxw** and **Bl**. Drier sites with cold air (111) are also Sxw and Bl dominated but have sparse to no devil's club and lady fern (< 3% each). Wetter sites also commonly have cold-air influences, but horsetail is abundant. The 113 is very similar to the ESSFwh3/111 but differs primarily in terms of location: the ICHmw4/113 is restricted to cold-air valley bottoms with more typical ICH plant communities on hillslopes above. These sites often occur near the upper ends of valleys where ESSF-like influences extend only along valley bottoms.

Variability

113 sites often contain ESSF indicator species such as cow-parsnip (*Heracleum maximum*) and Sitka valerian (*Valeriana sitchensis*). Hummocky terrain is common, with trees growing on elevated microsites and wetter species growing in depressions. The amount of Sxw and Bl may vary, but sites are dominated by these species, with Cw or Hw forming secondary components of mature stands.

Management Issues

Cold air and frost may limit regeneration, particularly after clearcutting or heavy canopy removal. Tree productivity is high on these sites, and vegetation competition may be a concern. Due to moist soils, compaction and rutting are potential harvesting hazards; harvesting should take place when soils are dry or frozen. These sites are usually associated with riparian management areas.

SxwCw – Horsetail – Lady fern **114**

General Description

SMR 6 (7). 114 sites are uncommon on level to very gently sloping **fluvial or lacustrine plains** where the **water table is near the surface**. Soils are typically Gleysols or occasionally Gleyed Brunisols, and often contain a thin organic veneer (or thick forest floor). Cold-air drainage or pooling is usually present, leading to an overstorey with abundant **Sxw** and scattered to varying amounts of Bl, Hw, and Cw. Stands are associated with **riparian areas**.

Understoreys are often diverse, typically dominated by **horsetails** (common [*Equisteum arvense*], meadow [*E. pratense*], and wood [*E. sylvaticum*]), with **lady fern**, **oak fern**, arrow-leaved groundsel, and violets, as well as smaller amounts of Canby's lovage, foamflower, western trillium, small willowherbs (*Epilobium* spp.), mountain arnica (*Arnica latifolia*), clasping twistedstalk, sweet-scented bedstraw (*Galium triflorum*), bog orchids (*Platanthera* spp.), Brewer's miterwort, and tall bluebells (*Mertensia paniculata*).

Differentiating from Other Site Series

The 114 unit is the wettest coniferous site series recognized in the ICHmw4. Wetter sites tend to be non-forested wetlands. Cottonwood floodplain forests are uncommon in the ICHmw4. Slightly drier forested site series (112, 113) have devil's club and lack abundant horsetails.

Variability

Hummocky terrain is common in these forests, with trees growing on elevated microsites and wetter species growing in depressions. The amount of Cw and Hw in the overstorey varies widely from absent to codominant with Sxw and Bl. The herb layer is also typically variable with numerous species present, often in small amounts.

Management Issues

This site series is not recommended for harvesting due to sensitive soils, hydrology, and riparian function; compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, competition from herbaceous brush is usually a concern in regenerating stands. Cold air and frost may limit regeneration.

Other Ecosystems

The following ecosystems occur within the ICHmw4; the most common codes are listed under each realm/group. These, and other less common types, are described in detail in Chapter 6.

Wetlands

Wetlands are uncommon in the ICHmw4; they occur primarily along the shorelines of mountain lakes. Fens (Wf) and swamps (Ws) are the most common types, although marshes (Wm) and shallow water (Ww) ecosystems also occur. Detailed information on wetlands is provided in Section 6.2

Cottonwood forests and flood ecosystems

Cottonwood forests are uncommon in the ICHmw4, occurring in narrow bands of riparian areas and at the shore of lakes and ponds. The most common types are *Fm01 Cottonwood – Snowberry – Rose* and *Fm04 Cottonwood – Western redcedar – Dogwood – Lady fern*. Additional information on flood ecosystems, including low bench (Fl) flood ecosystems, is provided in Section 6.3.

Brushlands and grasslands

Brushlands (Gb) occasionally occur on steep, warm aspect sites with shallow, rubbly soils. Where present, they generally occur with seral At- or Ep-leading 103 forests where it can be difficult to distinguish between brushlands and shrub-stage broadleaf forests. Grasslands (Gg) are extremely uncommon in the ICHmw4. Section 6.4 provides descriptions of grassland and brushland ecosystems.

Avalanche features

Avalanche paths occur infrequently in the ICHmw4, and are generally at the bottom of large slopes with start zones in the higher-elevation ESSF subzones. Herb (Vh) and shrub (Vs) types are most common. Descriptions of avalanche ecosystems are provided in Section 6.5.

Rock outcrops and talus slopes

Rock outcrop (Ro) and talus (Rt) ecosystems are common in the ICHmw4. See Section 6.6 for descriptions of rock ecosystems.

6 BIOGEOCLIMATIC CLASSIFICATION OF NON-FORESTED AND RELATED ECOSYSTEMS

6.1 Introduction to Classification of Non-forested and Related Ecosystems

Non-forested and related ecosystems, including cottonwood floodplains and wetland-associated forests, are an important part of British Columbia's landscape and biological diversity. Plant community composition and vegetation structure of these ecosystems stand in contrast to the mostly coniferous-dominated forests that are typical across much of British Columbia. Non-forested habitats supply critical life history requirements for many plant and animal species.

The non-forest classification and coding approach was formalized within BEC through the publication of Technical Report 068: *Biogeoclimatic Ecosystem Classification of Non-forested Ecosystems in British Columbia* (MacKenzie 2012). Ecosystems covered by this classification occur across a range of environmental conditions, and include wetlands, avalanche, rock outcrop, grassland, and floodplain types. Non-forest, as referred to here, includes non-commercial cottonwood floodplain forests and wetland-associated forests that are part of the Wetland Realm or the Flood Group in the BEC site classification system (see Section 2.1.2).

At very broad scales, all ecosystems can be divided into Terrestrial, Freshwater, Marine, and Subterranean "core" realms, with Wetland, Estuarine, Intertidal, and Wedge realms in the interface between core realms (Figure 6.1.1). The BEC system addresses only the Terrestrial, Wetland, and coastal Estuarine realms at this time.

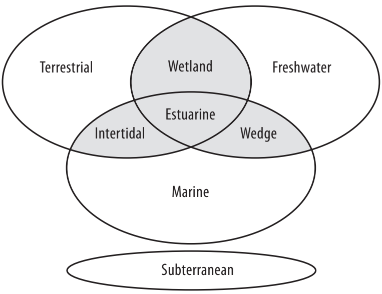


FIGURE 6.1.1 *Site (ecosystem) realms. Core realms are unshaded; interface realms are shaded grey. (Modified from Fraser et al. 1995.)*

As described in Chapter 2 (see Section 2.1 and Figure 2.2), the site classification component of BEC includes a hierarchy of broad to specific ecosystem groupings. At higher levels, ecosystems are grouped into site classes, groups, and realms on the basis of environmental limiting factors and broader vegetation attributes (e.g., wetlands, avalanche features, and grasslands). At finer levels of the hierarchy, specific plant communities form the basis of the classification (e.g., as site associations within the broader groupings). Figure 6.1.2 shows the site classification categories used in BEC; the broader levels that are described in the non-forest classification are outlined in grey (MacKenzie 2012).

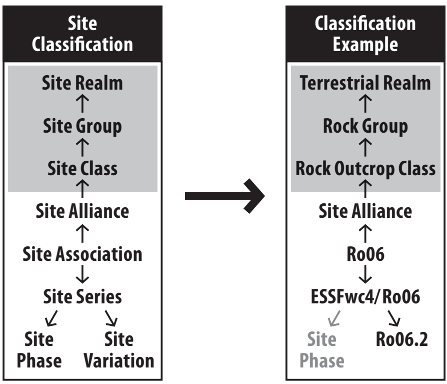


FIGURE 6.1.2 *Site classification framework (with broad-level site units used in non-forested classification highlighted in grey). This example shows the levels of classification for the Juniper – Kinnikinnick – Stonecrop – Sandwort variation of the Ro 06 rock outcrop.*

The following are some key principles of non-forested and related ecosystem classification:

- All forested units have the potential for > 10% tree cover at stand maturity; sites that support < 10% tree cover are considered non-forested in the BEC system.

- Some forested sites, such as forested wetlands and cottonwood-dominated mid bench floodplains, are included in the non-forest classification system because they are part of the Wetland Realm or Flood Group.
- Non-forested ecosystems typically occur where environmental factors preclude conifer forest development (e.g., snow cover, soil moisture limitations, repeated site disturbance, flooding).
- Determination of site groups is hierarchical: ecosystems that come first in the flowchart (Figure 6.1.3) override ecosystems with similar characteristics that are lower in the flowchart. For example, the Rock Group occurs above the Avalanche Group in the flowchart, so rock outcrops within an avalanche track are part of the Rock Group (Ro); there is no avalanche rock class.

The non-forest classification addresses two Wetland groups (peatland and mineral) and 10 Terrestrial groups. Each of these groups is further divided into a number of site classes (Table 6.1.1). Figure 6.1.3 is a flowchart of the site groups described for non-forested terrestrial classification and Table 6.1.1 provides a list of all site classes currently defined for ecosystems of British Columbia's interior. For many Terrestrial groups, the site class is the most detailed level of classification described to date. For example, the Hydrogenic Group is divided into Spring-seepage (Hs), Vernal pool (Hv), and Waterfall spray (Hw) classes; no further plant community classification has been formally identified for these types. Users can refer to Technical Report 068 (MacKenzie 2012) for additional information on site groups and site classes.

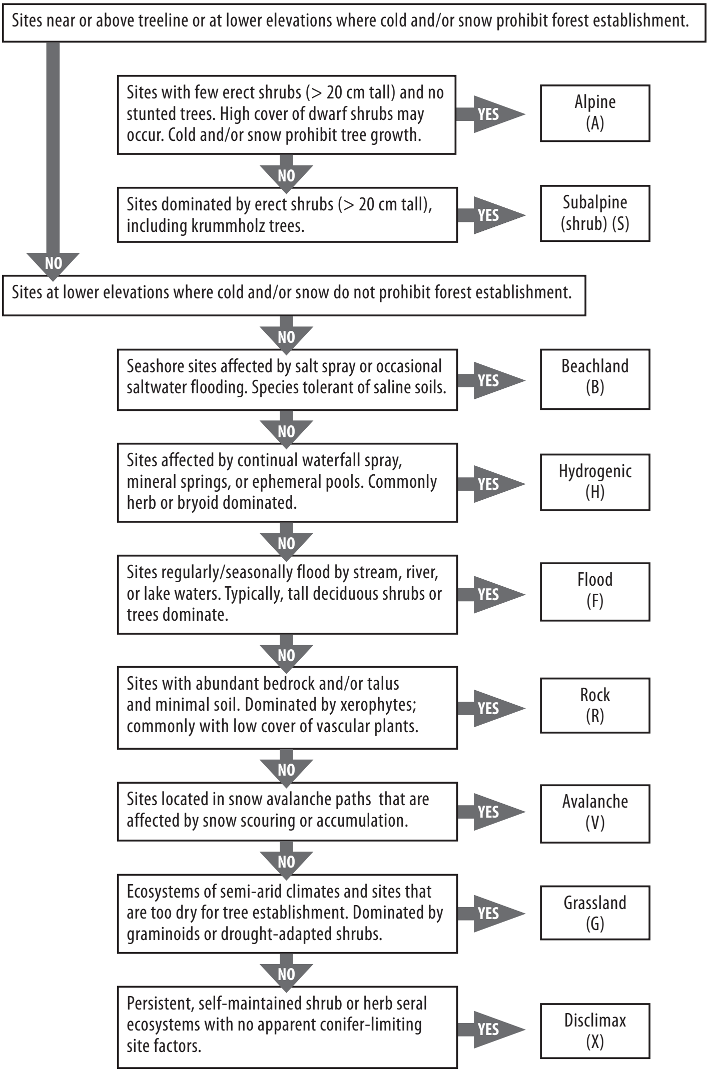


FIGURE 6.1.3 *Key to non-forested Terrestrial groups.*

TABLE 6.1.1 *Wetland and Terrestrial site groups, classes, and codes for non-forested ecosystems in British Columbia*

Site realm	Site group[a]	Site class	Code
Wetland Realm	***Peatland Group***	Bog[b]	Wb
		Fen	***Wf***
	Mineral Wetland Group	***Marsh***	***Wm***
		Swamp[b]	***Ws***
		Shallow water	Ww
		Alpine wetland	***Wa***
Terrestrial Group	***Alpine Group***	Zoogenic alpine	Az
		Alpine meadow	Am
		Alpine grassland	Ag
		Alpine heath	Ah
		Alpine nivation (Late snowbed)	As
		Alpine tundra	At
		Alpine fellfield[c]	Af
	Subalpine Shrub Group	Shrubland/Shrub carr[d]	Sc
		Krummholz	Sk
	Hydrogenic Group	Spring-seepage	Hs
		Vernal pool	Hv
		Waterfall spray	Hw
	Flood Group[e]	***Low bench***	***Fl***
		Middle bench (cottonwood)[b]	***Fm***
		Fringe	Ff
		Active channel	Fa
	Rock Group	***Rock outcrop***	***Ro***
		Rock talus	***Rt***
		Rock cliff	Rc
		Lava flow	Rl
		Dune	Rd
	Avalanche Group	***Avalanche herb meadow***	***Vh***
		Avalanche shrub thicket	***Vs***
		Avalanche treed	Vt
	Grassland Group	***Grassland***	***Gg***
		Shrub-steppe	Gs
		Brushland	***Gb***
		Alkaline/saline meadow	Ga
	Disclimax Group	Vegetation[f]	Xv
		Zoogenic	Xz
		Anthropogenic	Xa

[a] Bold and italics are used to identify site groups and codes for site classes that are described in detail in this field guide.
[b] Cottonwood forests (Fm) and some bog (Wb) and swamp (Ws) site associations can be forested.
[c] The Alpine Fellfield Class can be split into four subclasses: Rock (Af-r), Scree (Af-s), Felsenmeer (Af-n), and Fellfield (Af-f) .
[d] The Shrubland/Shrub-carr Class has two subclasses: Shrubland (Sc-b) and Shrub-carr (Sc-c).
[e] High bench floodplains (Fh) are dominated by conifers and are addressed through forested site series in Chapter 5.
[f] The Vegetation Class of the Disclimax Group has two subclasses: shrub-dominated ecosystems (Xv-s) and herb-dominated ecosystems (Xv-h).

Non-forested site association naming and coding

Wetland coding follows the standards outlined in Extension Note 106 (MacKenzie 2011) and Technical Report 068 (MacKenzie 2012). Each **site class** can have a number of **site associations** that are based on characteristic site, soil, and vegetation features. For non-forested ecosystems, site associations are given a four-character code using letters for the site group (e.g., V = avalanche) and site class (e.g., h = herbaceous) and numbers to subdivide units into site associations: the most common site association in each site class starts with 01 (e.g., Vh01) (Figure 6.1.4).

Each site association is assigned a name based on one to three of the most characteristic plant species in that association. The species are listed in order according to stratum, as follows: trees, shrubs, herbs, and mosses. If there is more than one species in the name per stratum, the species with the highest site dominance is listed first. Where trees are included in a non-forested ecosystem name, the full (common) name is spelled out for non-forested and related ecosystems instead of using the code (e.g., subalpine fir is used instead of Bl).

Site association coding for non-forested ecosystems can be used across biogeoclimatic units and may be presented with or without a BGC unit prefix (e.g., ESSFwc4/Vh01 or just Vh01). When presented with a biogeoclimatic unit, the combined coding represents a site series within that biogeoclimatic unit. Figure 6.1.4 provides an example of the nomenclature and coding for an avalanche herb meadow, including site association variations.

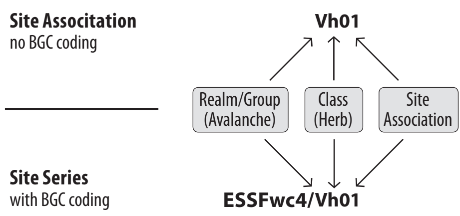


FIGURE 6.1.4 *Non-forest ecosystem nomenclature and coding (showing the Vh01 Cow parsnip – Fireweed – Nettle avalanche herb meadow site association as an example).*

Coding for disturbed non-forested ecosystems

Many non-forested sites have been disturbed in ways that affect vegetation communities, which may make these sites difficult to classify. For these situations, modifying symbols can be appended to non-forested codes to denote severely disturbed or seral states:

- "**$**" is used to denote seral[1] vegetation communities (e.g., Gg01$);
- "**!**" indicates an ecosystem now occupied by aggressive invasive species (e.g. Wm01!); and
- square brackets "[]" may be used to enclose and denote a specific disturbance type in conjunction with one of the above codes (e.g. Wm01$[B.d]).

Disturbance codes should be applied from those listed in the *Field Manual for Describing Terrestrial Ecosystems* (LMH 25: Site Description section) (Province of British Columbia 2010).[2] A selection of common disturbance types that apply to non-forest associations described in this guide is presented in Table 6.1.2. The list covers a wide range of disturbances, from beaver or hydroelectric dams to garbage disposal, recreation effects, waterhole development for livestock, and herbicide use, although additional codes can be found in LMH 25 (Province of British Columbia 2010).

Disturbance codes can be used as modifiers such that a *Water sedge – Beaked sedge* marsh that has been flooded by beaver dam activity is recorded as Wm01$[W.i]. Where it is difficult to determine the site association, the site group can be used with the disturbance modifiers. For example, an unknown/unclassified rock outcrop with an ATV trail built through it is recorded as Ro$[R.ec]. It is intended that these disturbance codes be applied only when a significant effect on natural vegetation is observed.

Note that where a disturbance type is an inherent, natural attribute of an ecosystem, it should not be recorded in the ecosystem unit. For example, terrain avalanching [T.a] is an expected disturbance for the Avalanche Group and water inundation [W.i] is inherent in the Flood Group. Disturbance codes are not needed to identify these natural, expected events.

1 Seral, in the context used here, includes sites that are rebounding from a stand-replacing disturbance (e.g., a brushland following wildfire) as well as those that are being changed through stand-altering processes (e.g., a weed-infested grassland or a livestock-impacted wetland).

2 The disturbance codes will not necessarily fit within government databases but are intended to provide an additional means of recording disturbed sites. If using LMH 25 and associated databases, the disturbance codes can be recorded in the disturbance fields instead of (or in addition to) the site series label.

TABLE 6.1.2 *Common disturbance codes used for non-forested ecosystems*[a]

B. Biotic effects
- b. beaver tree cutting
- d. domestic grazing/browsing (includes trampling)
- w. wildlife grazing/browsing
- v. invasive vegetation

S. Soil disturbance
- c. compaction

R. Recreation-related effects
- ec. constructed trail
- it. informal trail
- mb. mud bogging/rutting
- tr. trampling (temporary use)

D. Disposals
- g. domestic garbage disposal

M. Plant or site modification effects
- c. herbicide use
- g. seeded or planted to grasses (h for herbs; s for shrubs; t for trees)

L. Forest harvesting[b]
- l. land clearing (includes abandoned agriculture)
- c. clearcut system
- e. selection system
  - gr group selection
  - si single tree

W. Water-related effects
- i. inundation (including temporary inundation resulting from beaver activity)
- d. water table control (diking, damming)
- e. water-table depression (drought or extensive water extraction)

[a] A full list of disturbance codes is provided in LMH 25: Site Description section (Province of British Columbia 2010).
[b] Pertains to forested swamps and cottonwood middle bench floodplain ecosystems.

Aggressive invasive species

Aggressive invasive plant species can have a significant effect on ecosystems and can permanently alter the vegetation community. Unlike the disturbed ecosystems described above, plant communities will not recover without significant intervention (e.g., excavators). These are not natural ecosystems and this approach does not apply to other ecosystems with non-native species (e.g., cattle-damaged sites with thistles [*Cirsium arvense*]) where the vegetation could return to natural or semi-natural communities in the absence of continued disturbance.

Special coding is provided for a limited list of aggressive invasive species. The coding uses a number (specific to each species) following the "!" symbol (e.g., !.1 refers to reed canarygrass [*Phalaris arundinacea*] and !.2 refers to yellow iris [*Iris pseudacorus*], also known as yellow-flag iris). At this time, there are only five aggressive invasive types identified for species that occur in wetland and/or flood ecosystems (see page 347), but this coding could be applied to other aggressive invasive species and other site groups (e.g., Grasslands).[3]

[3] Aggressive invasive species codes are tracked on the BECWeb site. Any additional species will be listed there.

Non-forested ecosystems described in this guide

This field guide provides site-level classification tools and descriptions for the following non-forested and related ecosystems:

Section 6.2 Wetlands
Section 6.3 Flood Ecosystems and Cottonwood Forests
Section 6.4 Brushlands and Grasslands
Section 6.5 Avalanche Ecosystems
Section 6.6 Rock Outcrops and Talus
Section 6.7 High-elevation Ecosystems

The remaining site groups and classes are listed in Table 6.1.1 and are described in Technical Report 068 (MacKenzie 2012). Table 6.1.3 summarizes the environmental factors that determine non-forest conditions for each group described in this field guide. Figure 6.1.5 shows a schematic of the typical soil moisture and nutrient regimes of non-forested ecosystems within the south-central Columbia Mountains.

TABLE 6.1.3 *Environmental factors that promote non-forest conditions for realms/groups described in this field guide*

Realm/Group	**Environmental factors**
Wetland (Section 6.2)	Restricted to soils that are water-saturated for a sufficient length of time that excess water is the principal determinant of vegetation and soils development
Flood (Section 6.3)	Regular and prolonged flooding by stream and lake waters; includes cottonwood-dominated floodplains
Grassland (Brushlands) (Section 6.4)	Excessively droughty conditions caused by arid regional climates, intense solar influence, or very rapidly drained soils; frequent, repeated fires may occur
Avalanche (Section 6.5)	Destructive downslope movement of snow (avalanching)
Rock (Section 6.6)	Lack of a suitable rooting substrate: lack of soil, unstable talus, extreme geology
Alpine/Subalpine Shrub (Section 6.7)	Excessively cold and/or snowy conditions: sites above or near treeline; occasionally at lower elevations in extreme conditions

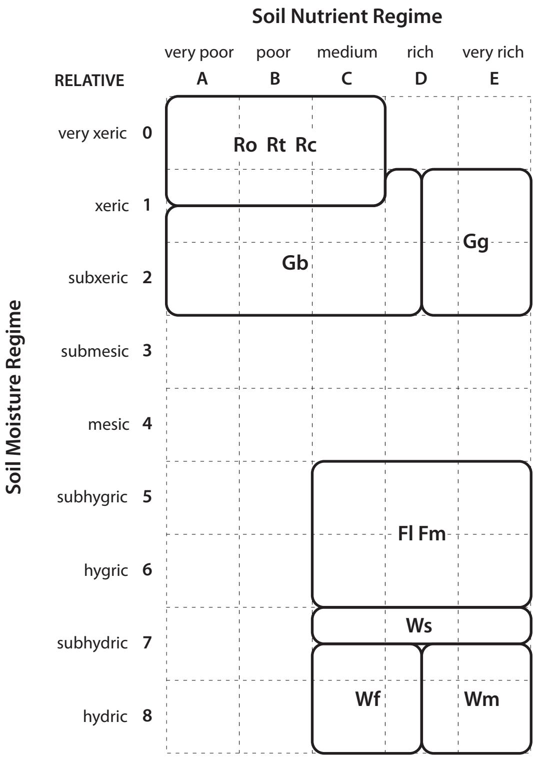


FIGURE 6.1.5 *Edatopic grid showing the typical relative soil moisture regime and soil nutrient regime of non-forested classes in the south-central Columbia Mountains.*

Using this field guide for non-forested and related ecosystem classification in the field

Several tools are provided for each of the site realms/groups, site classes, and site associations described in this guide. Each section includes an overview of the environmental factors, ecological significance, and general characteristics at the site realm/group level. For each site class, a table shows the expected distribution of each site association across the subzones/variants described in this guide, and flowcharts are provided to help differentiate between site associations at the specific site level. Vegetation tables and site unit descriptions provide additional information.

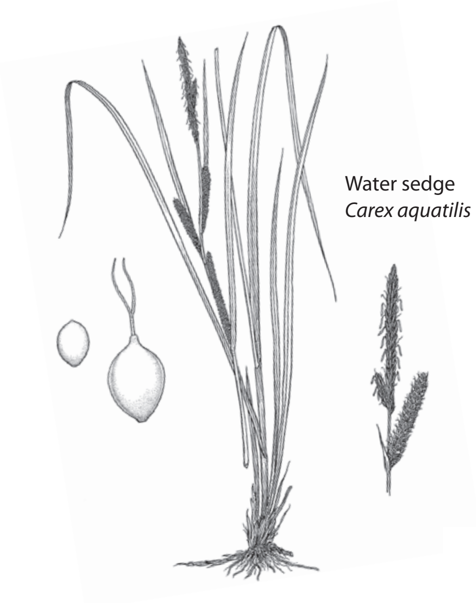
As described in Chapter 3, tree species are described in the text and flowcharts using the standard codes recognized in British Columbia (see Appendix 3.6). For all other species, where the scientific and common names are both provided in the vegetation table for a given site realm/group, the species is referred to in the text using the common name. Where a species is not included in a vegetation table for that site realm/group, the scientific name is provided in the text.

Non-forested classification follows a broader approach than that presented for forested site series. Site associations apply at a provincial scale and are not limited to a single biogeoclimatic subzone/variant. As such, data used in site association descriptions can be from outside of the field guide area. However, plot data used to characterize ecosystems described in this field guide have been limited to the southern interior of British Columbia, even where a site association may occur more broadly across the province. Because site associations are based on data drawn from broad geographic areas with highly variable climate, soils, elevations, and local vegetation patterns, users should not expect specific site locations to perfectly match the vegetation lists provided for the site association.

This guide does not include comprehensive lists or descriptions of all potential non-forested site associations in the study area. Site associations are described in this guide only for the site classes where sufficient information is available; additional undescribed site associations are likely to occur. Ecosystems that are more common in other regions or biogeoclimatic units are also likely to occur, particularly at the fringes of the biogeoclimatic units described in this guide (e.g., where the ICHdw1 is close to the IDF).

Additional resources for non-forested ecosystem classification include:

- *Wetlands of British Columbia* (MacKenzie and Moran 2004)
- Technical Report 068: *Biogeoclimatic Ecosystem Classification of Non-forested Ecosystems in British Columbia* (MacKenzie 2012)
- Extension Note 106: *New Coding Schemes for Biogeoclimatic Site Units* (MacKenzie 2011)
- The Ecology Program website: BECWeb
- Additional field guides for southern British Columbia



Water sedge
Carex aquatilis

Common cattail
Typha latifolia

6.2 Wetland Ecosystems

This section provides a brief overview of classification and identification of the most common wetland ecosystems in the south-central Columbia Mountains. Information has been adapted from the *Wetlands of British Columbia* field guide (MacKenzie and Moran 2004) and from new field data.

Ecological significance of wetlands

Wetlands are ecosystems in which the soils are saturated with water long enough that excess moisture and resulting low oxygen levels determine both vegetation and soil development. Wetlands include a broad range of ecosystems, from those permanently flooded by shallow water and dominated by aquatic plants to forested sites with very wet, poorly aerated soils. Wetlands occur in a variety of topographic positions, including in depressions or basins, on level areas or seepage slopes, in toe slope positions, at pond or lake edges, adjacent to streams and rivers, and in gullies. Soils belong mostly to the Organic or Gleysolic orders. Nutrient levels may be extremely poor, rich, or somewhere in between depending on water flow, dissolved mineral content, pH, and degree of decomposition of organic matter.

Wetlands have one or more of the following features, which reflect periodically or permanently saturated soils and anaerobic soil conditions:

- peaty organic horizons > 40 cm thick
- blue-grey gleying within 30 cm of the soil surface of non-sandy soils
- prominent mottles within 30 cm of the soil surface of sandy soils
- hydrogen sulphide (rotten egg smell) in the upper 30 cm of the soil
- vegetation that includes species adapted to waterlogged conditions

Although wetlands occupy a relatively small proportion of the provincial land base, they play an extremely important ecological role. Wetlands are important to many wildlife species, including large and small mammals, birds, amphibians, fish, and insects that depend on them as a source of food, water, and cover. Wetlands supply critical nesting habitat for waterfowl and other bird species, and provide rearing habitat for juvenile fish species. Due to their distinctive flora, wetlands have always had an ethnobotanical significance to First Nations people.

Wetlands also have hydrological significance. They contribute to water quality by filtering fine sediments and providing flood and erosion protection during storm events and spring snowmelt. They also provide a place for water storage and release, which is especially important in summer when the water supply may be limited. Knowledge and understanding of wetland function are essential to ensuring the longevity of these significant environments.

TABLE 6.2.1 *Wetland classes and their general features*

Group	Class	Code	Hydrology	Soil features	Vegetation	Comments
Peatland	Bog	Wb	Saturated organic soils with rooting depths above the permanent water table level; never flooded	Organic; poorly decomposed peat-mosses; acidic; nutrient poor; Fibrisols or Mesisols	Low and dwarf ericaceous shrubs, sedges; high moss cover, mostly peat-mosses	Very uncommon in southeast British Columbia
	Fen	Wf	Rooting zone within groundwater influence; water level near surface throughout the season	Organic; moderately decomposed sedges and brown mosses; nutrient medium; Mesisols	Non-ericaceous shrubs, sedges, reeds, grasses, forbs, brown mosses, or peat-mosses	Most common wetland class in the province, but absent from very warm, dry climates
Mineral wetland	Marsh	Wm	Shallowly flooded (0.1–2 m); water levels may fluctuate throughout the seasons	Mineral, but may be capped with a well-decomposed organic veneer; nutrient rich; Gleysols	Emergent sedges, reeds, grasses, or horsetails	Low plant species diversity; most common in warmer, drier, lower-elevation climates; > 10% emergent vegetation cover
	Swamp	Ws	Flowing or fluctuating water table; temporary flooding (0.1–1 m)	Mineral; often capped with a well-decomposed organic veneer; nutrient rich; Gleysols, Humic Regosols	Can be tall shrub or tree dominated; understorey of forbs and mosses	Transitional to upland ecosystems
	Shallow water	Ww	Permanently flooded; still or slow-moving water (0.5-5 m)	Aquatic substrates of sands, silts, clays, and/or organics	Rooted, submerged, and/or floating aquatic vegetation	Dominated by floating and submerged plants; frequently pond lilies
	Alpine wetland	Wa	Seeps and saturated flats	Mineral with limited peat formation	Dwarf willows, forbs, mosses; also black-sedge	High elevation; cold soils and climate

Wetlands were much more common throughout southeast British Columbia prior to the development of hydroelectric dams. Significant valley bottom wetland areas were flooded in the Duncan, Arrow, Revelstoke, Kinbasket, and Koocanusa Reservoirs (MacKillop et al. 2008; Utzig and Schmidt 2011). Urban and rural development, agriculture, and invasive plant species are also significant threats to wetland environments.

Naming and coding of wetlands

The BEC classification framework recognizes a separate site realm for wetlands, which occurs in the interface between the terrestrial and freshwater realms (see MacKenzie 2012). The Wetland realm is further divided into two "groups" and five "classes." Sites with deep, poorly decomposed organic peat accumulations are in the **Peatland Group,** which includes the bog and fen classes. The **Mineral Wetland Group** includes the marsh, swamp, and shallow water classes (Table 6.2.1). The wetland classes used are the same as those in the Canadian Wetland Classification System (NWWG 1988). Table 6.2.1 provides an overview and comparison of the hydrology, soil features, and vegetation of wetland classes.

Users who require less detailed information and broader-level classification may choose to describe wetlands at the class level rather than using the more detailed site associations. Although officially part of the Alpine Group, alpine wetlands (Wa) are described with the other wetlands due to their similarity in soil and vegetation characteristics.

Disturbance in wetlands

Many wetlands have been disturbed by external factors that affect vegetation communities. The use of disturbance coding as a modifier for wetland classification is described on page 339. This includes a subset of disturbance codes from the *Field Manual for Describing Terrestrial Ecosystems* (LMH 25) for disturbances commonly encountered in wetland sites, and an explanation of using the "$" symbol and square brackets [] to denote disturbances.

Wetlands dominated by aggressive invasive species

Where extremely aggressive species have overtaken wetlands (or floodplains[1]), special coding can be used to classify ecosystems (see page 340). Five aggressive invasive wetlands types have been identified: !.1 reed canarygrass (*Phalaris arundinacea*), !.2 yellow iris (*Iris pseudacorus;* also known as yellow-flag iris), !.3 purple loosestrife (*Lythrum salicaria*), !.4 European common reed (*Phragmites australis* ssp. *australis*; also known as giant reedgrass), and !.5 knotweeds (*Fallopia* spp.).[2] Some of these communities (reed canarygrass

[1] Aggressive invasive species can also dominate in cleared floodplain ecosystems.

[2] Coding is described on page 339.

and European common reed) are briefly described in *Wetlands of British Columbia* (MacKenzie and Moran 2004) but were not previously assigned a site association code since they do not represent naturally occurring, native plant communities and frequently occur across more than one site class.

Following disturbance from aggressive invasive species and other factors (e.g., land clearing or damming in wetland and flood ecosystems), it is often difficult to recognize which site class best represents a given sampling area. For example, many reed canarygrass sites were originally cottonwood floodplains (Fm) prior to land clearing and have since been colonized by (or seeded with) reed canarygrass. Reed canarygrass sites can also be cleared swamps (Ws) or low bench floodplains (Fl), or drained marshes (Wm). Determining the pre-disturbance wetland ecosystem will often require a "best-guess" approach. This can be based on assessing hydrological regime and soil characteristics, adjacent undisturbed ecosystems, remnant native species, or historical documentation for the site, where available. The aggressive invasive species coding includes the following species:

Reed canarygrass [!.1]
Reed canarygrass includes both native and European strains that occur in wetland and flood associations. It is strongly rhizomatous and produces a dense sod and full canopy that excludes most other species. Reed canarygrass communities are common in reservoir drawdown zones and old field sites that have been seeded or have self-seeded and are typically classified as Wm!.1, Ws.!1, Fl!.1, or Fm!.1.

Yellow iris [!.2]
Yellow iris (also known as yellow-flag iris) is an introduced, highly invasive, ornamental forb that produces dense thickets that exclude other wetland plants. It spreads by seeds and by rhizomes that often break off and drift downstream. Yellow iris replaces native cattails, sedges, and rushes, and typically occurs either as Ww!.2 or Wm!.2, and occasionally as Fl!.2.

Purple loosestrife [!.3]
Purple loosestrife is a woody perennial "half-shrub" that forms dense monocultures along canals, ditches, marshes, streams, and lake shorelines. It is native to Eurasia and has spread as an escaped ornamental. Purple loosestrife spreads by vegetative propagation and prolific seed production; one plant can produce millions of seeds that are spread through water and by animals or humans. Purple loosestrife communities are typically either Ww!.3 or Wm!.3, and occasionally Fl!.3.

European common reed [!.4]
European common reed (also known as giant reedgrass) is an increasingly invasive wetland species in the Creston Valley and the East Kootenay. European common reed is a separate subspecies from the similar American common reed (*Phragmites australis* ssp. *americanus*),[3] which is native to British Columbia and also occurs in southern British Columbia. European common reed is rhizomatous and produces a dense sod and full canopy that excludes most other species. It may also release toxins from its roots into the soil to kill or hinder the growth of surrounding plants. European common reed often grows in tall (up to 4 m), impenetrable "fence-like" masses at wetland, stream, or lake margins, particularly where the water table has been artificially controlled and no longer fluctuates substantially during the growing season or from year to year. Nutrient inputs from agriculture and other sources are known to increase growth. These communities are most often found as Wm!.4 but may also occur as Fl!.4 or Ww!.4.

Knotweeds [!.5]
Knotweeds, including Japanese knotweed (*Fallopia japonica*), Bohemian knotweed *(F.* x *bohemica),* Giant knotweed *(F. sachalenensis)*, and Himalayan knotweed *(Polygonum polystachyum),* thrive in riparian areas, stream banks, irrigation canals, ditches, and other sites with high soil moisture. They are an ornamental escapee that forms dense thickets. They have small white-green flowers that grow in showy, branched clusters and hollow, upright, "bamboo-like" stems. Knotweeds are spread primarily through seeds, but also roots. Human activities (horticultural planting, soil disturbance, accidental transport of seed) are key vectors of spread. Knotweed infestations expand rapidly and are difficult to eradicate due to root systems that extend up to 20 m laterally and up to 3 m in depth (ISCBC 2014). Knotweed prefer well-drained soils and sites are typically Fl!.5 or Fm!.5, but can be Ws!.5 or Wm!.5.

Common wetland ecosystems in the south-central Columbia Mountains

Fens, marshes, swamps, and shallow water wetlands are the most common wetland classes in the south-central Columbia Mountains. This section describes the wetland ecosystems that are expected to occur in the field guide area. Users may wish to consult the *Wetlands of British Columbia* field

[3] The non-native, invasive subspecies differs from the native subspecies in that it grows taller; out-competes other species, resulting in near-monocultures; has tan or beige stems with blue-green leaves instead of reddish-brown stems and yellow-green leaves; and has very dense seed heads.

guide (MacKenzie and Moran 2004) for additional information or for sites that do not appear to "fit" the units described here.

Bog Class (Wb)

Bogs are part of the Peatland Group and are very uncommon in the field guide area. Bogs are shrubby or treed, nutrient-poor peatlands with distinctive communities of ericaceous shrubs and hummock-forming peat-moss species that are adapted to highly acidic and oxygen-poor soil conditions. Bogs typically develop in basins where peat accumulation has elevated the wetland surface above groundwater influence. No bog types are described in this field guide, but they may occur. Detailed descriptions of bogs are provided in *Wetlands of British Columbia* (MacKenzie and Moran 2004).

Fen Class (Wf)

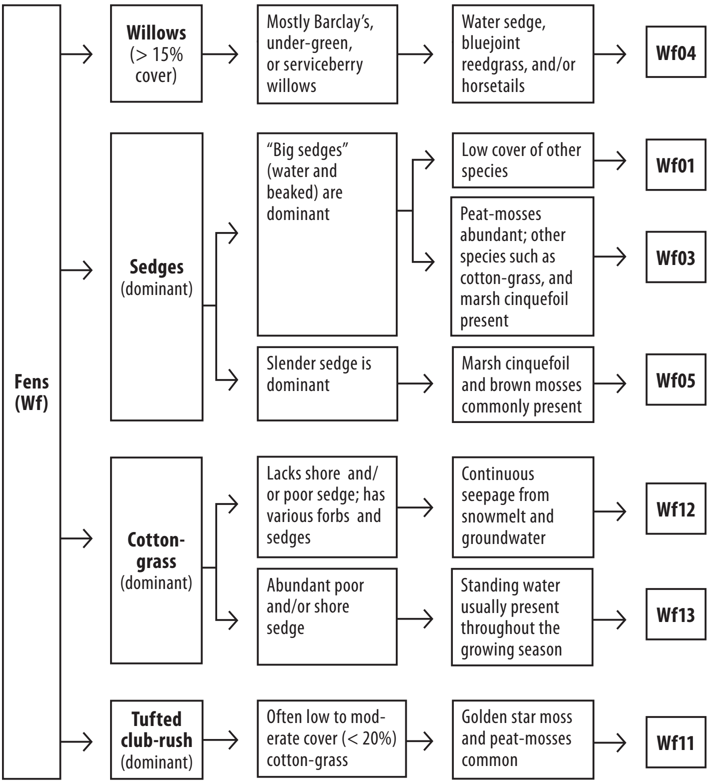
Fens are nutrient-medium peatlands where groundwater inflow maintains relatively high dissolved mineral and oxygen content within the rooting zone. They commonly develop along pond and lake margins, in basins, and along seepage slopes where the water table is usually at or just below the peat surface for most of the growing season. Fens are characterized by non-ericaceous shrubs, sedges, grasses, reeds, brown mosses, and some peat-mosses. Fens occur infrequently throughout the south-central Columbia Mountains.

Distribution of fen (Wf) site associations by biogeoclimatic unit[a]

Zone	ICH					ESSF								
Unit/BEC	ICHxw	ICHdw1	ICHdm	ICHmw2	ICHmw4	ESSFwh1	ESSFwc4	ESSFwh2	ESSFwm2	ESSFwh3	ESSFwm3	ESSFwm4	ESSFwmw	ESSFwcw
Wf01	*	*	*	X	*	*	*	*	*	*	*	*		
Wf03						X	X	X	X	*	X	*	*	*
Wf04						*	X	*	X	*	*	*	X	X
Wf05	*	*	*	X	*									
Wf11						X	X	*	*	*	*	*		
Wf12						*	X	*	X	*	X	*	*	X
Wf13						*	X	*	X	*	*	*	*	X

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Fens (Wf)



Vegetation Table – Fens

Layer	Scientific name	Wf01	Wf03	Wf04	Wf05	Wf11	Wf12	Wf13	Common name
	Number of plots	107	15	28	56	46	76	16	
Shrubs	*Picea engelmannii*		□□	*					Engelmann spruce
	Salix barclayi[a]			■■■■■					Barclay's willow
Herbs	*Carex aquatilis*	■■■■■	□□□□	□□□□□	□□□				water sedge
	Carex utriculata	■■■■■	*	*	*				beaked sedge
	Carex spp.[b]	*	□□□	*		*	□□□	*	sedges
	Calamagrostis canadensis	*	□□	□□□				□□	bluejoint reedgrass
	Eriophorum angustifolium		□□	*		■■■	■■■■■	■■■■	narrow-leaved cotton-grass
	Comarum palustre		□□	*	□□				marsh cinquefoil
	Equisetum spp.			□□					horsetails
	Senecio triangularis			□					arrow-leaved groundsel
	Carex lasiocarpa				■■■■■				slender sedge
	Kalmia microphylla					□	□	□	western bog-laurel
	Trichophorum cespitosum					■■■■■			tufted clubrush
	Carex magellanica/limosa							■■■■	poor/shore sedge
Moss layer	"brown mosses"[c]	*	*	□□□	□□□□	□□□□	□□□	*	brown mosses
	Sphagnum spp.		■■■■■	□□□□		■■■■	□□□□	■■■■■	peat-moss
	Aulacomnium palustre		□□□	□□□			*	*	glow moss

[a] Typically also includes under-green willow (*Salix commutate*) and serviceberry willow (*S. pseudomonticola*).
[b] Includes other Carex species not listed here; see Appendix 1.2 for lists of species grouped to genera.
[c] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Wf01 Water sedge – Beaked sedge
The Wf01 is the most common fen type in British Columbia. It occurs in depressions, adjacent to small water bodies, and along lakeshores. Wf01 sites are saturated to the surface in the spring but typically experience drawdown later in the season. Sites are characterized by very abundant water sedge and/or beaked sedge. If other herb species occur, they generally have low cover. The moss layer is typically sparse but can be variable, with some sites in in low- to mid-elevation BEC zones (e.g., ICH) having high cover of brown mosses or peat-mosses. Wf01 sites have the same vegetation complex as the Wm01 (marsh) but can be distinguished by the presence of thick (> 40 cm), peaty, organic soil.

Wf03 Water sedge – Peat-moss
The Wf03 usually occurs in small depressions and along gentle seepage slopes in the ESSF. It is distinguished by an abundance of water sedge and peat-mosses. Smaller amounts of narrow-leaved cotton-grass, marsh cinquefoil, and a variety of other forbs and grasses, including leatherleaf saxifrage, arrow-leaved groundsel, western bog-laurel and bluejoint reedgrass are usually present. The Wf03 differs from the Wf01 by having higher forb and graminoid diversity, more peat-mosses, and a more stable water table. The Wf03 frequently occurs adjacent to the Wf12.

Wf04 Barclay's willow – Water sedge – Glow moss
Wf04 sites occur in frost-prone basins, on high-elevation seepage slopes, and on gentle areas adjacent to creeks. Sites are characterized by an abundance of willows, primarily Barclay's (*Salix barclayi*), under-green (*S. commutata*), or serviceberry (*S. pseudomonticola*) willow. The herb layer is diverse, but water sedge and/or bluejoint reedgrass are usually dominant, and beaked sedge and common horsetail (*Equisetum arvense*) may be present. Moss cover is minimal; minor cover of glow moss, brown mosses, and peat-mosses is most common. The Wf04 is typically a higher-elevation ESSF unit (including woodland) that occurs alone or adjacent to sedge (Wf03) or cotton-grass (Wf12) fens.

Wf05 Slender sedge – Common hook-moss
The Wf05 is found surrounding small lakes or ponds and in palustrine basins (i.e., wet depressions) at low to mid elevations. The water table remains at the surface throughout the growing season. High cover of slender sedge is characteristic, but small amounts of water sedge, beaked sedge, and marsh cinquefoil are also common. An assortment of brown mosses, including common hook-moss (*Drepanocladus aduncus*), golden star-moss (*Campylium stellatum*), and scorpion-mosses (*Scorpidium* spp.) are usually present.

Wf11 Tufted clubrush – Star-moss
The Wf11 occurs on level and gently sloped sites with mineral-rich parent materials. Sites are permanently saturated but rarely inundated. Tufted clubrush, peat-mosses, and brown mosses, especially golden star-moss, are characteristic. Low to moderate amounts of narrow-leaved cotton-grass (< 20% cover) and small amounts of western bog-laurel are also common. In the south-central Columbia Mountains, the Wf11 occurs infrequently from mid to high elevations in the ESSF and very infrequently at upper elevations in the ICH.

Wf12 Narrow-leaved cotton-grass – Marsh-marigold
The Wf12 occurs on level to gentle seepage slopes with continuous moisture from snowmelt and groundwater. Narrow-leaved cotton-grass is always present and typically dominant, although a variety of other species generally occurs with low to moderate cover, including leatherleaf saxifrage, western bog-laurel, mountain marsh-marigold, and (in the southern Columbia Mountains) elephant's-head lousewort (*Pedicularis groenlandica*). A wide variety of sedges is often present, and black alpine sedge is common at higher elevations. The moss layer is variable but is frequently dominated by peat-mosses, glow moss, and brown mosses. The Wf12 occurs across the ESSF elevation gradient, including woodland units, and often occurs in larger wetland complexes that include the Wf03. On higher-elevation sites in the parkland and IMA, and on colder sites in the ESSF, alpine wetland (Wa) units are more common.

Wf13 Narrow-leaved cotton-grass – Shore sedge
The Wf13 occurs in depressions and along gentle slopes in areas with persistent standing water throughout the growing season. Sites are dominated by narrow-leaved cotton-grass and poor or shore sedge. Bluejoint reedgrass, western bog-laurel, and other sedges may be present. Abundant peat-mosses contribute to deep organic soil deposits. The Wf13 is wetter than the Wf12, and the two often occur together in complexes that may also include Wf03 and Wf11. The Wf13 occurs mainly in the ESSF, including woodland, and occasionally parkland units. At higher elevations in the IMA and parkland, and on colder sites within the ESSF and woodland, alpine wetland (Wa) units are more common.

Marsh Class (Wm)

Marshes are permanently to seasonally flooded mineral wetlands that are dominated by emergent grass-like vegetation. Marshes occur along lakeshores, on floodplains, and in old oxbows, potholes, and depressions. They are most often shallowly flooded, but fluctuating water tables are common, both throughout a single growing season and between years. Marshes are nutrient rich due to continuous water flow that supplies oxygen and minerals and circulates nutrients. Mineral soils are characteristic and are most often Gleysolic. They may be capped with a thin (< 40 cm), well-decomposed organic layer or a thicker layer of mixed mineral and organic "muck."

The degree of water flow (hydrodynamic index) is a key determinant of species composition. Marshes are characterized by the presence of sedges, rushes, grasses, and occasionally forbs, horsetails, and aquatic plants. Trees and shrubs are generally absent from marsh ecosystems; sites with > 10% tree or shrub cover are defined as swamps. Most marshes have low species diversity with only one or two dominant species.

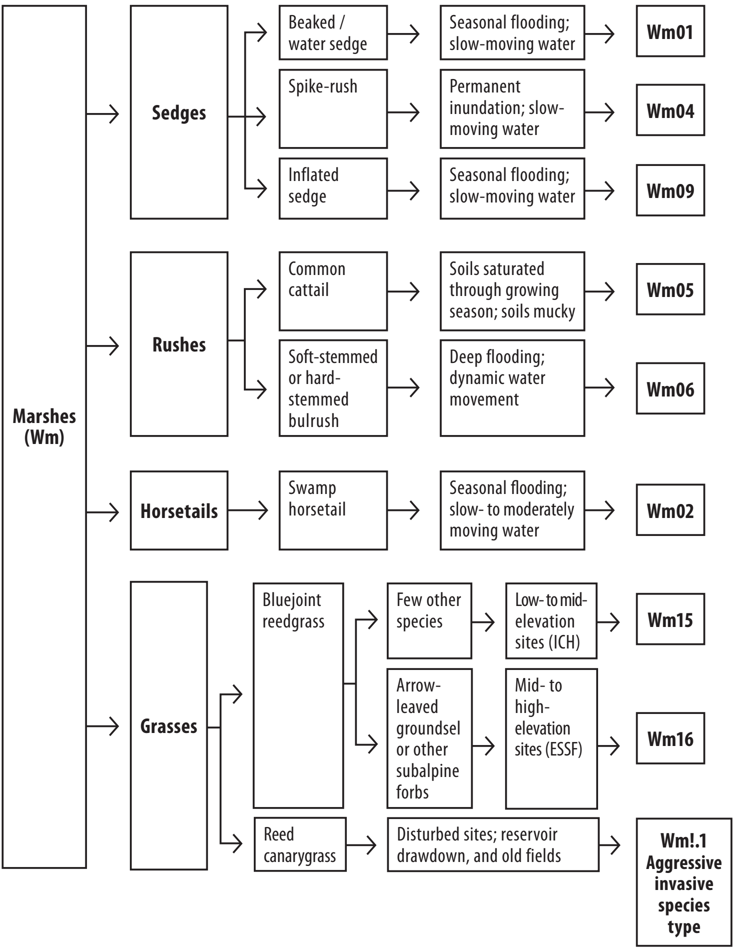
Marshes are most common in warmer, drier climates and at lower elevations. They are the most dynamic wetland class, and species composition can shift rapidly following a few wet or dry years, particularly in dry to very dry climates (e.g., IDF, PP, BG). Marshes are the most heavily used wetland type for most wetland-associated wildlife species. They provide palatable vegetation for smaller and larger animals, and cover and open water for waterfowl, amphibians, and semi-aquatic mammals.

Distribution of marsh (Wm) site associations by biogeoclimatic unit[a]

Zone	ICH					ESSF								
Unit/BEC	**ICHxw**	**ICHdw1**	**ICHdm**	**ICHmw2**	**ICHmw4**	**ESSFwh1**	**ESSFwc4**	**ESSFwh2**	**ESSFwm2**	**ESSFwh3**	**ESSFwm3**	**ESSFwm4**	**ESSFwmw**	**ESSFwcw**
Wm01	X	X	X	X	*	X	X	*	*	*	*	*	*	*
Wm02	*	*	*	X	*									
Wm04	*	*	X	X	*									
Wm05	X	X	X	X	*									
Wm06	*	*	*	*										
Wm09	*	*		*										
Wm15		*	*	*	*	*								
Wm16						*	X	X	*	*	*	X	*	*

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Marshes (Wm)



Vegetation Table – Marshes

Layer	Scientific name	Wm01	Wm02	Wm04	Wm05	Wm06	Wm09	Wm15	Wm16	Common name
	Number of plots	133	40	16	66	70	17	6	9	
Herbs	*Carex utriculata*	■■■■■	□□□□		*			□		beaked sedge
	Carex aquatilis	□□□□						□		water sedge
	Calamagrostis canadensis	*						■■■■■	■■■■■	bluejoint reedgrass
	Equisetum fluviatile		■■■■■							swamp horsetail
	Eleocharis palustris			■■■■■						common spike-rush
	Typha latifolia				■■■■■					common cattail
	Schoenoplectus tabernaemontani					□□□□□				soft-stemmed bulrush
	Schoenoplectus acutus					□□□□□				hard-stemmed bulrush
	Carex exsiccata						■■■■■			inflated sedge
	Senecio triangularis								■■■	arrow-leaved groundsel
	Valeriana sitchensis								□□□	Sitka valerian

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Wm01 Beaked sedge – Water sedge

The Wm01 is the most common marsh ecosystem across British Columbia. It occurs on seasonally flooded sites with some late-season drawdown near ponds, along lake margins, on floodplains with slow-moving flood water, and in flooded basins. It is dominated by an abundance of beaked sedge and/or water sedge. A scattering of other species is common, but variable, and generally of low cover. The Wm01 contains the same vegetation complex as the Wf01, though typically, beaked sedge is more prominent. The Wm01 occurs on mineral soils (often with a < 40 cm thick organic layer) with deeper flooding and more dynamic hydrology. The Wm01 occurs from low to subalpine elevations but is most common in the ICH in the south-central Columbia Mountains. The Wm15 occurs on similar sites but is dominated by bluejoint reedgrass. Wm01 sites with disturbance, particularly disturbances that cause drier conditions, can show an increase in bluejoint reedgrass. These sites are considered to be seral (Wm01$).

Wm02 Swamp horsetail – Beaked sedge

The Wm02 typically occurs in depressions, in protected bays of larger lakes, and along slow-moving streams. High cover of swamp horsetail characterizes the Wm02, but beaked sedge may also be present in significant amounts. The Wm02 occurs infrequently in the ICH and is often adjacent to tall-willow swamps (most often Ws06 in the south-central Columbia Mountains).

Wm04 Common spike-rush

The Wm04 is uncommon in depressions and along streams and lakeshores with slow-moving water. Shallow water is typically present throughout the growing season. High cover of common spike-rush characterizes the Wm04, often with a minor component of submerged or floating aquatic species. Other species are usually absent. Soils are most often sandy or gravelly Gleysols. The Wm04 occurs in several ICH units in southeast British Columbia.

Wm05 Cattail

The Wm05 is common in depressions and along lakeshores and pond edges, in climates with warm summers. It is easily recognized by an abundance of common cattail. Additional species typically have low cover. The Wm05 occurs at low to mid elevations (in the ICH within the area covered by this field guide).

Wm06 Great bulrush[4]

The Wm06 is uncommon in the drier, hotter ICH subzones. It occurs along lake margins and in depressions in very dry environments. Floodwaters can be up

[4] "Great bulrush" refers to both soft-stemmed bulrush (*S. tabernaemontani*) and hard-stemmed bulrush (*Schoenoplectus acutus*); the Wm06 includes both species.

to 1.5 m deep in spring but sites dry up significantly into the growing season. The vegetation community is characterized by very abundant hard-stemmed bulrush and/or soft-stemmed bulrush. Overall, plant species diversity is low.

Wm09 Inflated sedge

The Wm09 occurs in depressions and adjacent to small lakes and ponds, on sites with shallow flooding of mineral soils. Standing water is usually present in the spring but dries up by late summer. Sites are dominated by inflated sedge. Other species occur only in very small amounts. Within the field guide area, the Wm09 occurs infrequently in the ICH, particularly in the Shuswap. This ecosystem is briefly described in *Wetlands of British Columbia* (MacKenzie and Moran 2004) but was not previously assigned a site association code.

Wm15 Bluejoint – Beaked sedge

Wm15 sites occur across low-elevation biogeoclimatic units (ICH, IDF, and occasionally MS) on level areas, in shallow depressions, and along pond and lake margins. They have high cover of bluejoint reedgrass and usually low cover of beaked sedge and/or water sedge. Additional herbs may occur with minor cover. Soils frequently have a well-decomposed peaty organic veneer. At higher elevations (ESSF, MS), the Wm15 is replaced by the Wm16, which has arrow-leaved groundsel, Sitka valerian, and/or other subalpine forbs in addition to abundant bluejoint reedgrass. Bluejoint reedgrass can also be common in other wetland types (e.g., Wf01, Wf02), where its occurrence represents seral conditions, usually associated with drying. This ecosystem is briefly described in *Wetlands of British Columbia* (MacKenzie and Moran 2004) but was not assigned a site association number.

Wm16 Bluejoint – Arrow-leaved groundsel

The Wm16 occurs at mid to high elevations in the ESSF, particularly in dry and moist climates, and occasionally in the MS. It generally occurs on level sites, in depressions, and along pond and lake margins. Bluejoint reedgrass is abundant. Arrow-leaved groundsel, violets, Sitka valerian, other subalpine forbs, and common horsetail are usually present in minor amounts. Minor cover of shrub-sized Se or Bl may be present. Soils frequently have a peaty organic veneer. The Wm16 often occurs in large wetland complexes that are associated with meandering, low-velocity creeks and rivers. It generally occupies slightly drier portions of the wetlands as distinct bands or extensive patches between upland coniferous forests and other wetland units that occupy wetter areas. At lower elevations, the Wm16 is replaced by the Wm15 (where bluejoint reedgrass dominates) or the Wm01 (where water sedge and/or beaked sedge dominate). These lower-elevation types lack subalpine forb species. The Wm16 is newly described; it is not included in *Wetlands of British Columbia* (MacKenzie and Moran 2004).

Swamp Class (Ws)

Swamps are nutrient-rich wetlands where significant groundwater flow, periodic surface aeration, and/or elevated microsites on otherwise overly wet soils allow for growth of trees or tall shrubs under wet site conditions. Swamps occur in a variety of locations, including toe slopes, wetland margins, back-levee depressions, floodplains, and gullies. The water table is semi-permanent during the growing season due to water fluctuations and/or moisture flow-through. Mineral soils are typical, and are often capped with a humic organic layer that may exude a foul sulfur odour. In steep terrain, swamps are often limited to narrow strips near water bodies, and are most common where extensive flat areas occur.

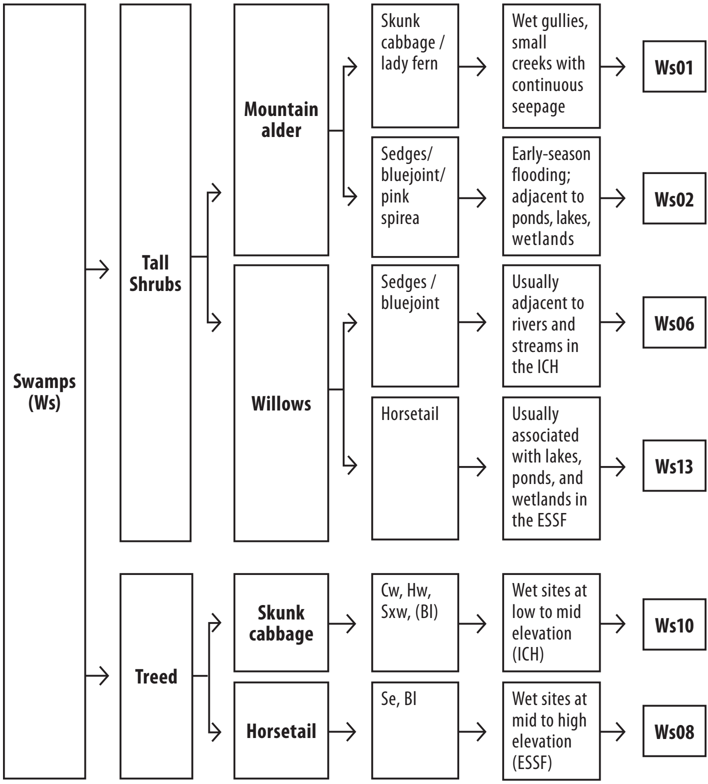
Swamps can be divided into two distinct subgroups: one characterized by tall shrub dominance; the other by trees. Swamps are often hummocky, with shrubs and/or trees growing on mounds, and forbs, grasses, sedges, and mosses dominating in wetter hollows.

Distribution of swamp (Ws) site associations by biogeoclimatic unit[a]

Zone	ICH					ESSF								
Unit/BEC	ICHxw	ICHdw1	ICHdm	ICHmw2	ICHmw4	ESSFwh1	ESSFwc4	ESSFwh2	ESSFwm2	ESSFwh3	ESSFwm3	ESSFwm4	ESSFwmw	ESSFwcw
Tall shrub swamps														
Ws01	*	X	*	X	*									
Ws02		X		X										
Ws06	*	X	X	X	X									
Ws13						*	X	*	*	*	*	*	*	X
Treed swamps														
Ws08						*	*	*	*	*	*	*	*	*
Ws10	X	X	*	X	*									

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Swamps (Ws)



Vegetation Table – Swamps

Layer	Scientific name	Tall shrub swamps				Treed swamps		Common name
		Ws01	Ws02	Ws06	Ws13	Ws08	Ws10	
	Number of plots	17	22	25	20	26	40	
Trees	*Picea* spp.	□□	*			■■■■	□□□	spruce
	Abies lasiocarpa					■■■	*	subalpine fir
	Thuja plicata						■■■■	western redcedar
	Tsuga heterophylla						■■■■	western hemlock
Regen	*Picea* spp.	*			*	■■■	*	spruce
	Abies lasiocarpa				□□	■■■		subalpine fir
	Thuja plicata						■■■	western redcedar
	Tsuga heterophylla						■■■	western hemlock
Shrubs	*Alnus incana*	■■■■■	■■■■	*			*	mountain alder
	Spiraea douglasii	*	□□□□	□□□				pink spirea
	Lonicera involucrata	*	*	*		□□	*	black twinberry
	Vaccinium ovalifolium					□□□	□□□	oval-leaved blueberry
	Oplopanax horridus						□□□	devil's club
	Salix sitchensis			■■■■■				Sitka willow
	Salix commutate/barclayi				■■■■■			under-green/Barclay's willow
	Rhododendron albiflorum					□□□		white-flowered rhododendron
	Vaccinium membranaceum					□□	*	black huckleberry

Layer	Scientific name	Tall shrub swamps				Treed swamps		Common name
		Ws01	Ws02	Ws06	Ws13	Ws08	Ws10	
	Number of plots	17	22	25	20	26	40	
Herbs	*Lysichiton americanus*	■■■■■		*			■■■■■	skunk cabbage
	Athyrium filix-femina	■■■■					■■■■	lady fern
	Equisetum spp.	□□□	*	□□□	■■■	■■■■	■■	horsetails
	Calamagrostis canadensis	□□	□□□	□□	*	■■■		bluejoint reedgrass
	Gymnocarpium dryopteris	□□				*	□□□	oak fern
	Carex utriculata/aquatilis	*	■■■■■	■■■■■		*		beaked/water sedges
	Senecio triangularis		*		■■	■■■		arrow-leaved groundsel
	Streptopus amplexifolius					□□	□	clasping twistedstalk
	Comarum palustre		□□	□□				marsh cinquefoil
	Valeriana sitchensis				□□	□□□		Sitka valerian
	Leptarrhena pyrolifolia				*	□□		leatherleaf saxifrage
	Trollius albiflorus					□□		globeflower
	Rubus pedatus					■■■	*	five-leaved bramble
	Ligusticum canbyi					□□□		Canby's lovage
	Caltha leptosepala					□□		white mountain marsh-marigold
	Cornus canadensis					**	■■■	bunchberry
Moss layer	"Leafy mosses" [a]	*	*		*	□□□□	■■■■	leafy mosses
	Sphagnum spp.		*			■■■■■	*	peat-mosses
	Aulacomnium palustre				*	□□□		glow moss
	Pleurozium schreberi					***	□□□	red-stemmed feathermoss

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Tall Shrub Swamps

Ws01 Mountain alder – Skunk cabbage – Lady fern
Ws01 swamps occur in wet gullies, in depressions, along small streams, and on poorly drained level areas adjacent to sedge fens. Surface seepage is usually continuous throughout the growing season. High cover of mountain alder is characteristic in the shrub layer, along with abundant lady fern and skunk cabbage in the herb layer. Scattered Sxw is common, and small amounts of bluejoint reedgrass and/or horsetails may occur. The moss community is variable, but leafy mosses are often present. Other mountain alder–dominated ecosystems occur in the south-central Columbia Mountains, including the Fl01 and Fl02 low bench floodplains (see Section 6.3), but they lack skunk cabbage and occur on floodplains, not on sites with "swamp soils." The Ws01 occurs in the ICH and is often associated with Ws10 forested swamps.

Ws02 Mountain alder – Pink spirea – Sitka sedge
The Ws02 occurs adjacent to beaver-flooded areas and at the margins of ponds, lakes, and low-gradient streams where there is poor drainage. Sites experience early-season flooding and have continuous seepage near the surface throughout the growing season. Mountain alder is typically dominant, but pink spirea can be abundant in wetter areas. Black twinberry is often present in significant amounts. The herb layer is usually dominated by large sedges (water, beaked, and occasionally Sitka [*Carex sitchensis*] sedges), although small-flowered bulrush (*Scirpus microcarpus*) or bluejoint reedgrass may predominate in some areas. Marsh cinquefoil is often present. In southern British Columbia, the Ws02 occurs at lower elevations in the MS and ICH, and is uncommon in the ICHdw1 and ICHmw2 in the south-central Columbia Mountains.

Ws06 Sitka willow – Sitka sedge
The Ws06 is typically associated with fluvial systems or the margins of basins and depressions. It occurs on sites with prolonged periods of saturation and brief early-season flooding. It often occurs adjacent to Wm01 or Wm02 marshes or low bench floodplain ecosystems (Fl) in back-levee depressions or lake margins. It is typically dominated by Sitka willow, but lesser amounts of pink spirea, black twinberry, or mountain alder may occur along with various other willow species. The herb layer is most often composed of water sedge, Sitka sedge, and/or horsetails (mostly common horsetail). Bluejoint reedgrass may be present. Disturbed or earlier seral stands may have abundant small-flowered bulrush. The Ws06 occurs across the

Southern Interior Mountains; in the south-central Columbia Mountains, it occurs primarily in the ICH. The Ws06 is similar to the Ws04 (*Drummond's willow – Beaked sedge*), which generally occurs in cooler, drier climates from the Okanagan Highland through the Interior and Northern Plateaus.

Ws13 Barclay's willow – Common horsetail – Arrow-leaved groundsel
The Ws13 occurs on a variety of sites, including margins of large wetland complexes, in shallow depressions, and adjacent to streams. It is characterized by high cover of willows, primarily under-green and/or Barclay's willows, and a diverse herb layer with common horsetail and subalpine forbs, such as arrow-leaved groundsel and Sitka valerian. The Ws13 is a high-elevation wetland type that occurs only in the ESSF and woodland. This unit is newly described; it is not included in *Wetlands of British Columbia* (MacKenzie and Moran 2004).

Treed Swamps

Treed swamps have greater than 10% cover of conifer trees and soils that indicate a wetland environment. They are very uncommon in the ICH and ESSF in the south-central Columbia Mountains. At a provincial scale, treed swamps are given a non-forest site association code (e.g., Ws08 and Ws10 for treed swamps in the south-central Columbia Mountains); however, these sites are also part of the wettest forested site series described in this guide and have a corresponding site series number. In many cases, the wettest forested site series includes sites that are both "swamp" and "upland" environments, with similar plant community composition. For these forests, site phases are used.

Phases are used to identify treed swamps in the ESSF in this guide. Treed swamps are described as a "swamp phase" (e.g., ESSFwc4/112b) and sites with upland soils are coded as a "riparian phase" (e.g., ESSFwc4/112a).[5] Users can refer to swamp phase sites with the forested site series and phase (see Table 6.2.2) and/or the Ws08 swamp code (e.g., ESSFwc4/112b(Ws08.1)). The Ws08 also has two variations based on slight differences in plant species composition: *Ws08.1 Subalpine fir – Sitka valerian – Horsetail* and *Ws08.2 Engelmann spruce – Subalpine fir – Horsetail – Canby's lovage* (see below for descriptions).

[5] In the south-central Columbia Mountains, most sites are part of the riparian phase (coded with "a"), which are generally riparian-associated forests that meet the definition of a high bench conifer-dominated floodplain. These sites have gleyed soils (e.g., Gleyed Regosols) and a thin (or absent) organic veneer. Swamp sites occur where drainage is very poor, and they have Gleysolic soils with a thick organic veneer. Cover of sedges and peat-mosses is usually higher on swamp phase sites, but otherwise vegetation is very similar.

In the ICH, the *Ws10 Western redcedar – Spruce – Skunk cabbage* swamp ecosystem is analogous to several forested site series described in Chapter 5. These sites are always swamps and are not coded with a separate swamp phase. They can be classified using both the site series coding listed in Table 6.2.2 and described in Chapter 5 and/or the Ws10 site association code. There is no *Western redcedar – Spruce – Skunk cabbage* site series described in the ICHdm and ICHmw4 because this ecosystem has not been sampled or observed in those biogeoclimatic units. However, it is possible that small areas occur; if found, users can code as Ws10.

TABLE 6.2.2 *Treed swamp site associations and analogous site series and phases*[a]

	Ws10[b]	**Ws08.1**	**Ws08.2**
ICHxw	113		
ICHdw1	113		
ICHdm	*		
ICHmw2	114		
ICHmw4	*		
ESSFwc4		112b	
ESSFwh1			111b
ESSFwh2			112b
ESSFwh3			112b
ESSFwm2			112b
ESSFwm3			112b

[a] See Chapter 5 for site series descriptions.
[b] The * indicates BEC subzones/variants where the Ws10 may occur but there is no equivalent site series described.

Ws08 Subalpine fir – Sitka valerian – Horsetail
The Ws08 occurs very infrequently in the ESSF in the south-central Columbia Mountains. It occurs on very wet sites in depressions adjacent to gentle streams, lakeshores, and marshes or fens. Se and Bl are typical in the relatively open canopy, with abundant horsetails, sedges, bluejoint reedgrass, and peat-mosses in the understorey. The Ws08 is also described as a swamp phase of the wettest forested site series in the ESSF. The swamp phase can be differentiated from the riparian phase (usually riparian-associated, high

bench flood sites) by the presence of "wetland soils" (e.g., Gleysols) with subhydric moisture regimes (SMR 7), a thick organic veneer, very poor drainage, and lower tree productivity. Two variations of the Ws08 are presented:

Ws08.1 Subalpine fir – Sitka valerian – Horsetail
Horsetails, arrow-leaved groundsel, and Sitka valerian; lacks Canby's lovage

Ws08.2 Engelmann spruce – Subalpine fir – Horsetail – Canby's lovage
Canby's lovage is present and often abundant; occurs in variants of the ESSFwm and wh

Ws10 Western redcedar – Spruce – Skunk cabbage
The Ws10 describes rich, wet sites on toe slopes adjacent to broader wetland or riparian areas, and in depressions or basins. Sites have a diverse understorey that includes species such as foamflower, oak fern, wild ginger, and lady fern, but are distinguished by the dominance of skunk cabbage. Cw and Sxw are typical, although Hw and Bl may also be present. The Ws10 is also described as a forested site series in several ICH subzones/variants in Chapter 5 (Table 6.2.2). It is increasingly uncommon across the south-central Columbia Mountains, largely due to extensive valley-bottom development for rural/urban areas and hydroelectric dams.

Shallow Water Class (Ww)

Shallow water wetlands are permanently flooded by still or slow-moving water and are dominated by submerged and floating-leaved aquatic plants. Although grass-like plants such as sedges or cattails may be present, their cover does not exceed 10%. Ww ecosystems are most common at the edges of ponds and lakes, and are often bordered by marshes or swamps where emergent vegetation (mostly graminoids) is > 10%. Plant communities are typically species-poor, and are usually dominated by yellow pond lily (*Nuphar lutea*), although bladder-worts (*Utricularia* spp.) or pondweeds (*Potamogeton* spp.) can be present and occasionally dominate plant communities. Shallow water ecosystems may also be referred to as "aquatic wetlands." Water levels typically vary from 0.5 to 2 m deep but can be as deep as 5 m in clear waters. Shallow water ecosystems provide important fish and wildlife habitat and are sensitive to nutrient loading and sedimentation.

Shallow water communities occur from low to high elevations; however, additional sampling is required to provide a complete inventory of the site associations within shallow water environments. At the time of publication, two subgroups of shallow water ecosystems were recognized: **yellow pond lily types** and **pondweed types.** No site associations have been described.

Alpine Wetland Class (Wa)

Alpine wetlands occur in the IMA and ESSF parkland and woodland, and occasionally in cold-air basins at upper elevations in the ESSF. They occur on seeps and saturated flats that have site characteristics that are similar to lower-elevation swamps or marshes, but because of the constraints of cold climate, these wetlands support low-stature vegetation that is dominated by forbs, dwarf willows, and/or mosses. Permafrost may also occur in some alpine wetlands, particularly at higher elevations. Unlike fens and marshes, forbs rather than graminoid species are usually dominant (except for black alpine sedge).

At the time of publication, only a limited number of alpine wetlands had been defined with a focus on those types that occur in the woodland and upper ESSF in the area covered by this field guide. Work is under way to complete the alpine wetland classification for the remainder of the province; users should consult the BECWeb site for future updates. Three alpine wetland site associations are described for the ESSF and woodland (and associated parkland and IMA) in the south-central Columbia Mountains. Because of the limited number of units, a flowchart is not provided.

Vegetation Table – Alpine wetlands

Layer	Scientific name	Wa01	Wa02	Wa03	Common name
	Number of plots	33	8	9	
Herbs	*Carex nigricans*	■■■■■	■■■■■	□□	black alpine sedge
	Caltha leptosepala	■■■■		■■■■	white mountain marsh-marigold
	Leptarrhena pyrolifolia	□□□	■	■■■	leatherleaf saxifrage
	Senecio triangularis	■■	■■	■■■	arrow-leaved groundsel
	Luetkea pectinata	□□		*	partridge-foot
	Erigeron peregrinus	□□		□□□	subalpine daisy
	Carex spp.[a]	*	□□□	□□	sedges
	Trollius albiflorus	*		□□	globeflower
	Kalmia microphylla		■■■	□	western bog-laurel
	Veratrum viride		□	■■	false hellebore
	Pedicularis groenlandica		□□		elephant's-head lousewort
	Podagrostis humilis		□□		alpine bentgrass
	Parnassia fimbriata			□□	fringed grass-of-Parnassus
Moss layer	*Aulacomnium palustre*	■■■■	■■■■	□□□□	glow moss
	Sphagnum spp.	□□□	■■■■	□□	peat-moss

[a] Mostly showy sedge (*Carex spectabilis*) and sheep sedge (*C. illota*).

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots
□ 50–70% of plots

Wa01 Alpine sedge – Glowmoss
The Wa01 occurs in the parkland and woodland of wet climates in the central and northern Columbia Mountains (ESSFwcw, wcp, vcw, vcp) and in the interior–coast transition in the Coast and Cascade Ranges. It occasionally occurs on exceptionally cold sites within the ESSF (particularly wc4 and vc). Black alpine sedge is always present and dominant and can form dense mats. White mountain marsh-marigold, leatherleaf saxifrage, arrow-leaved groundsel, partridge-foot, and subalpine daisy are typically present with varying cover. Glow moss and peat-mosses are characteristic, with covers ranging from sparse to abundant. Shrubs are typically absent. Two variations are presented for the Wa01:

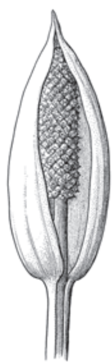
> **Wa01.1 Alpine sedge – Marsh-marigold – Glow moss**
> Marsh-marigold is abundant; leatherleaf saxifrage is sparse or absent (< 1% cover)
>
> **Wa01.2 Alpine sedge – Leatherleaf saxifrage – Glow moss**
> Leatherleaf saxifrage is present with moderate cover; other forbs, including arrow-leaved groundsel, partridge-foot, subalpine daisy, and globeflower often have low to moderate cover (1–5%); marsh-marigold is often absent

Wa02 Alpine sedge – Bog-laurel – Peat-moss
The Wa02 is uncommon in the ESSFwmw and ESSFwmp and on exceptionally cold sites in the ESSFwm2, wm3, and wm4. Black alpine sedge is dominant, along with various herbs, including bog-laurel, elephant's-head lousewort, alpine bentgrass, arrow-leaved groundsel, and showy sedge. Glow moss and peat-mosses are usually abundant. The Wa02 has species similar to those of the Wf12 but lacks cotton-grass and typically has a thinner peaty organic veneer with mineral soil closer to the surface.

Wa03 Marsh-marigold – Globeflower – Springmoss
The Wa03 has low but consistent cover of black alpine sedge and higher cover of mixed subalpine forbs, including white mountain marsh-marigold, arrow-leaved groundsel, leatherleaf saxifrage, subalpine daisy, globeflower, and fringed grass-of-Parnassus. Moss cover is variable, with glow moss and peat-mosses most common. The Wa03 is more common in wetter climates at the northern extent of the area covered by this field guide (ESSFwc4, wcw, wcp) and in the wetter ESSFvc, vcw, and vcp. It occurs on more active seepage sites with more dynamic water flow than the Wa01.

Elephant's-head lousewort
Pedicularis groenlandica

Narrow-leaved cotton-grass
Eriophorum angustifolium



Skunk cabbage
Lysichiton americanus

6.3 Flood Ecosystems and Cottonwood Forests

This section provides a brief overview of classification and identification of the most common floodplain units in the south-central Columbia Mountains. Information has been adapted from the *Wetlands of British Columbia* field guide (MacKenzie and Moran 2004) and from new field data.

Ecological significance of flood ecosystems and cottonwood forests

Flood ecosystems and cottonwood forests are part of the Flood Group and are regularly flooded by river or lake waters for sufficient duration to preclude establishment of conifer forest. The Flood Group includes four classes: shrub-dominated low bench floodplains (Fl), flood fringe sites (Ff), active channel flood sites (Fa), middle bench cottonwood floodplains (Fm), and high bench conifer-dominated floodplains (Fh).

Flood ecosystems are inundated during the spring freshet in the early part of the growing season but are elevated above the mid-season water table. Soils are derived from fluvial sands, gravels, and silts, with new deposition of fluvial or lacustrine materials added, or removed through scouring, during annual flooding. Cumulic Regosolic soils of stratified silts, sands, and gravels are typical. Inter-annual variability in flood duration and intensity is typical.

Flood ecosystems are part of the broader riparian areas of stream, river, lake, and some wetland complexes. Flood sites are geomorphically dynamic, with frequent flooding, erosion, and deposition influencing site conditions. Changes in stream channel dynamics can lead to succession of vegetation and site conditions from low bench to middle bench to high bench ecosystems over time, often with the location of each flood type shifting with changes in sedimentation and erosion dynamics. These shifts occur annually and over decades or centuries. Vegetation on flood ecosystems is specifically adapted to frequent inundation by either tolerating flooded conditions or being able to re-sprout following floods.

Floodplains provide critical habitat for a number of fish and wildlife species, including many species at risk. Lush vegetation provides cooler, moister habitats, along with abundant food, cover, and nesting, roosting, and denning sites. Flood ecosystems also act as sediment traps and prevent rapid erosion of streambank soils by binding soils and slowing floodwaters. They are major contributors of small and large organic matter that provides nutrients and habitat structure to the stream ecosystem. Flood ecosystems adjacent to small streams provide shade and moderate stream temperatures.

Throughout much of southeast British Columbia, floodplain sites have been seriously affected by hydroelectric development and human settlement.

Creation of the Arrow, Duncan, Kinbasket, Revelstoke, and Pend d'Oreille hydroelectric reservoirs has significantly altered the distribution of cottonwood forests, along with low bench and flood fringe ecosystems (MacKillop et al. 2008; Utzig and Schmidt 2011). Dams not only flood habitat in upstream reaches; they also cause downstream effects on flood ecosystem distribution and composition through changes in timing and intensity of stream flow, moderation of annual flooding, and reduced contribution of upstream sediment deposition. Livestock grazing, land clearing for agriculture, urban development, and development of transportation corridors have further reduced the distribution and ecological integrity of flood-associated ecosystems.

Naming and coding of flood ecosystems

Five flood classes are recognized in the BEC system: shrub-dominated low bench floodplains (Fl), middle bench cottonwood floodplains (Fm), flood fringe sites (Ff), herb- or moss-dominated active channel flood sites (Fa), and high bench floodplains (Fh) dominated by coniferous trees. Low bench flood sites have a tall shrub structure dominated by willows, alders, and other species that are tolerant of extended flooding and erosion. Middle benches have similar shrub species, but they also have a canopy dominated by deciduous trees, primarily black cottonwood (Act), and often paper birch (Ep) or trembling aspen (At). A lesser component of conifer trees often occurs in middle bench floodplains.

High bench floodplain site associations are described with other forested site series. They include many riparian-associated, conifer-dominated site series described throughout Chapter 5. Examples include many hygric sites (often coded as 111, 112, or 113). High bench floodplains often have a substantial deciduous (cottonwood or aspen) component, particularly at low to mid elevations, but conifers dominate at maturity.

Flood fringe ecosystems occur on upland sites in slope draws and gullies in areas with dry, hot climates (typically BG, PP and dry IDF). Flood fringe ecosystems are rarely flooded by surface waters but experience subirrigated moisture inputs that differentiate them from surrounding ecosystems. These sites are essentially "flooded" below ground from a rising water table for short to moderate durations during spring freshet or summer storms. Ff ecosystems are characterized by tall broadleaf shrubs or low-growing trees (generally stunted At trees < 10 m tall). Ff ecosystems are very uncommon in the south-central Columbia Mountains, and are not described further in this guide.

Duration of flooding is the primary environmental gradient that differentiates flood ecosystems at the site level. Low benches experience longer (20–40 days) and more powerful flooding than middle benches (< 25 days). Flood fringe ecosystems may not experience any surface flooding, but subirrigation during spring runoff or growing-season rainstorms influences vegetation. Active channel sites are highly variable and experience considerable annual flooding and in-stream scouring. Figure 6.3.1 provides a schematic depiction of flood ecosystems, while Figure 6.3.2 is a key to flood classes.

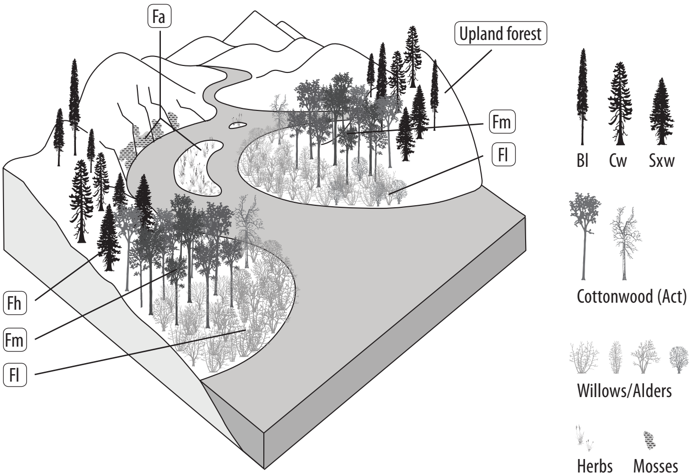


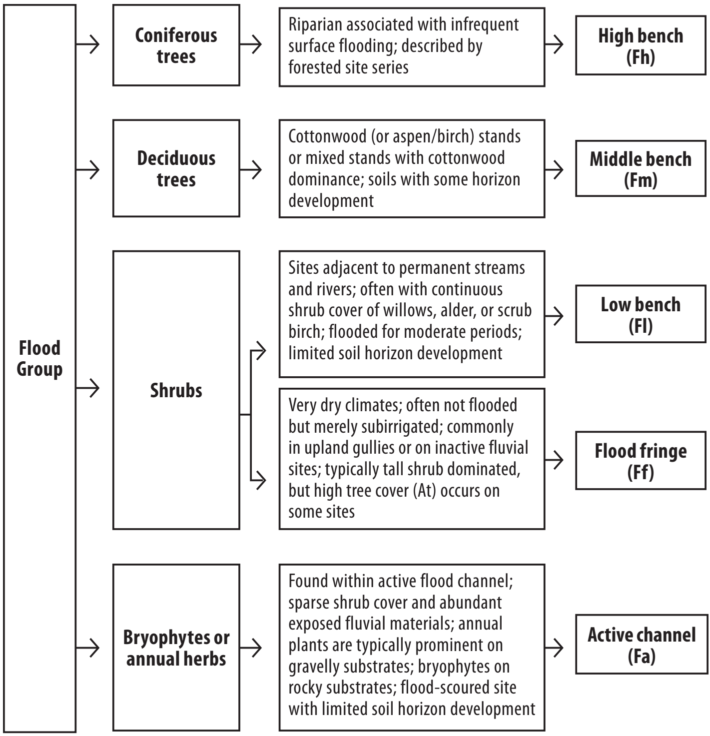
FIGURE 6.3.1 *Flood ecosystems in a typical mountainous environment in southeast British Columbia.*

Disturbance in flood ecosystems

Anthropogenic and other atypical disturbances can have significant effects on vegetation communities in flood communities. The coding and approach for describing disturbances is outlined in the introduction to non-forested ecosystems (Section 6.1). Common disturbances in flood ecosystems in the south-central Columbia Mountains include dams and other diversions [W.d], domestic livestock [B.d], and other activities.

The wetlands section (page 347) describes sites occupied by extremely aggressive invasive species and provides coding and explanations applicable to flood ecosystems, particularly where reed canarygrass (*Phalaris arundinacea*), yellow flag (*Iris pseudacorus*), purple loosestrife (*Lythrum salicaria*), European common reed (*Phragmites australis* ssp. *australis*; also known as giant reedgrass), and knotweeds (*Fallopia* spp.) have overtaken former floodplain plant communities.

Flowchart – Flood Ecosystem Classes



Common flood ecosystems in the south-central Columbia Mountains

Flood ecosystems are highly variable due to differences in local climates, severity and frequency of flooding, and other factors. The site units presented in this guide are broad and are based on a compilation of data from across British Columbia. Only those units that are expected to be common in the south-central Columbia Mountains are presented here. Users may wish to consult the *Wetlands of British Columbia* field guide (MacKenzie and Moran 2004) for additional information.

Middle Bench Flood Class (Fm)

Middle bench ecosystems occur along lakes, streams, and rivers, on sites that are briefly flooded (10–25 days) during freshet, which allows tree growth, but forests are dominated by flood-tolerant broadleaf species, usually black cottonwood, and sometimes trembling aspen.[1] Conifers often occur as part of deciduous-dominated mixes. Due to the dynamic nature of flooding on these sites, vegetation is highly variable. Soils usually have some horizon development, usually with buried layers resulting from repeated flooding. Nutrient availability is usually very high due to continuous inputs of oxygenated water through subirrigation.

Five middle bench site associations are recognized in southern British Columbia, although only three are common in the south-central Columbia Mountains (see below). The *Fm05 Cottonwood – Douglas-fir – Douglas maple – Snowberry* and *Fm06 Cottonwood – Poison ivy* site associations are newly recognized and are unlikely to be encountered in the subzones/variants covered by this field guide. They will be described in subsequent field guides. The *Fm03 Cottonwood – Subalpine fir – Devil's club* is described in the *Wetlands of British Columbia* field guide (MacKenzie and Moran 2004) and is restricted to central and northwest British Columbia.

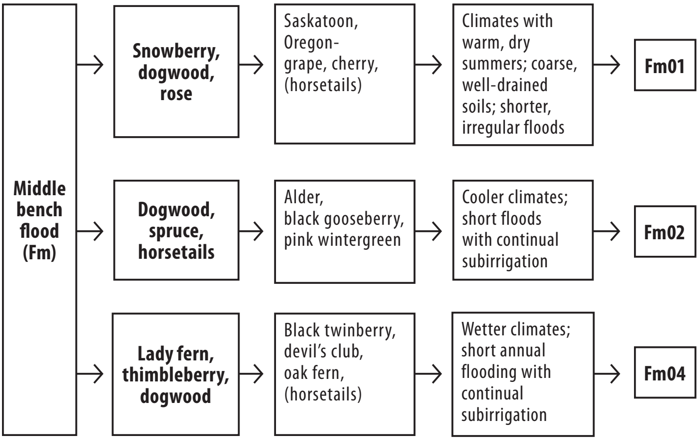
Distribution of cottonwood forest middle bench flood (Fm) site associations by biogeoclimatic unit[a]

Zone	ICH				
Unit/BEC	ICHxw	ICHdw1	ICHdm	ICHmw2	ICHmw4
Fm01	X	X	X	X	*
Fm02		*	X	X	*
Fm04		*	*	X	

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

[1] Full species names are used in this section for broadleaf species due to their prominence in the ecosystems described. Codes are used for conifer species (defined in Appendix 3.6)

Flowchart – Middle bench flood ecosystems (Fm)



Fm01 Cottonwood – Snowberry – Rose

The Fm01 is the most common cottonwood floodplain ecosystem in southeast British Columbia. It occurs at low elevations, in warm climates with dry summers, including the IDF, dry ICH, and warmer sites in the MS and the moist ICH. It is most common on sandy–gravelly flats in riparian zones adjacent to streams, rivers, and lakes. Brief flood events are usually associated with the spring freshet and may not occur every year. Black cottonwood is always present and significant in the overstorey but paper birch, aspen, and/or a range of conifers are often present with minor cover, including Cw, Fd, Lw, and Pl. Shrub diversity is typically high, with snowberry and red-osier dogwood consistently present. Nootka rose, baldhip rose, Oregon-grape, mountain alder, black hawthorn (*Crataegus douglasii*), choke cherry (*Prunus virginiana*), red raspberry (*Rubus idaeus*), and beaked hazelnut (*Corylus cornuta*) are often present. Understorey herbs are also diverse and variable, with minor amounts of horsetails (mostly common [*Equisetum arvense*]), scouring-rush (*E. hyemale*), wild sarsaparilla, sedges (*Carex* spp.), and blue wildrye. Weedy species such as dandelion (*Taraxacum* spp.), vetch (*Vicia americana*), and buttercups (*Ranunculus* spp.) are often present in disturbed sites, and Kentucky bluegrass (*Poa pratensis*) is common on sites grazed by cattle.

Vegetation Table – Middle bench flood ecosystems[a]

Layer	Scientific name	Fm01	Fm02	Fm04	Common name
	Number of plots	49	26	8	
Trees	*Populus trichocarpa*	■■■■■	■■■■■	■■■■■	black cottonwood
	Betula papyrifera	✻		□□□□	paper birch
	Picea engelmanni x *glauca*		□□□	■■■■	hybrid spruce
	Thuja plicata			□□□	western redcedar
Regen	*Populus trichocarpa*	□□			black cottonwood
	Picea engelmanni x *glauca*		✻	□□	hybrid spruce
	Thuja plicata			■■■	western redcedar
Shrubs	*Cornus stolonifera*	■■■■	■■■■■	■■■■	red-osier dogwood
	Symphoricarpos albus	■■■■	✻	✻	snowberry
	Rosa nutkana	□□□			Nootka rose
	Amelanchier alnifolia	□□			saskatoon
	Alnus incana	✻	□□□	✻	mountain alder
	Rosa gymnocarpium	✻			baldhip rose
	Mahonia spp.	✻			Oregon-grape
	Ribes lacustre		□□	□	black gooseberry
	Viburnum edule		□□	□	highbush-cranberry
	Lonicera involucrata		✻	■■■	black twinberry
	Rubus parviflorus			■■■■	thimbleberry
	Oplopanax horridus			□□□□	devil's club
Herbs	Equisetum spp.	□□	■■■	□□	horsetails
	Equisetum hyemale	□□			scouring-rush
	Elymus glauca	□□	✻		blue wildrye
	Osmorhiza spp.		□□	□□	sweet-cicely
	Pyrola asarifolia		□□		pink wintergreen
	Galium triflorum		□	■■	sweet-scented bedstraw
	Gymnocarpium dryopteris		✻	■■	oak fern
	Athyrium filix-femina			■■■■	lady fern
	Aralia nudicaulis			□□□	wild sarsaparilla
	Rubus pubescens			□□	dwarf red raspberry
	Tiarella trifoliata var. *unifoliata*			□□	one-leaved foamflower
	Dryopteris expansa			□	spiny wood fern
	Streptopus amplexifolius			■	clasping twistedstalk

[a] Vegetation is based on plots in southern British Columbia only; plots from northern and coastal British Columbia have been excluded.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% ✻ 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots
□ 50–70% of plots

Fm02 Cottonwood – Spruce – Dogwood[2]

In southeast British Columbia, the Fm02 occurs in cool, low- to mid-elevation climates, primarily in the IDF, MS, and on cooler sites in the ICH. Fm02 stands occur on sandy or gravelly fluvial materials adjacent to streams and rivers that have short spring flood events followed by continual subirrigation. Black cottonwood is present in the overstorey, with minor Sxw, Cw, and/or Bl. Red-osier dogwood is dominant in the shrub layer but frequently occurs with mountain alder, highbush-cranberry, black twinberry, and black gooseberry. Red raspberry, willows, and snowberry are also common. Horsetails, sweet-cicely, and pink wintergreen are typical herbs, often with minor cover of bluejoint reedgrass, false Solomon's-seal (*Maianthemum racemosum*), oak fern, and/or blue wildrye.

Fm04 Cottonwood – Redcedar – Dogwood – Lady fern

Fm04 stands occur in the wet "rainforest" climates of southeast British Columbia in the moist to wet ICH. They occur on sandy or gravelly flats adjacent to streams and rivers with relatively prolonged flood durations. Annual spring flood events are short during the freshet, but prolonged subirrigation maintains wet conditions throughout the growing season. Black cottonwood forms an open canopy with scattered Sxw, Cw, and Ep. Devil's club is usually present and can be abundant. Other common and abundant shrubs include thimbleberry, black twinberry, and red-osier dogwood. Lady fern dominates the lush understorey herb communities on these sites, generally with oak fern, clasping twistedstalk (*Streptopus amplexifolius*), false Solomon's-seal, wild sarsaparilla, sweet-cicely, horsetails, sweet-scented bedstraw, foamflower, and bluejoint reedgrass. The Fm04 is a newly described cottonwood flood ecosystem that was not described in *Wetlands of British Columbia* (MacKenzie and Moran 2004).[3]

Low Bench Flood Class (Fl)

Low bench ecosystems occur on sites that are flooded for moderate periods (< 40 days) during the growing season. These conditions limit the canopy to tall shrubs, especially willows and alders. Annual erosion and deposition of sediments (sands and silts) generally limit development of mosses and humus. These ecosystems are most commonly associated with fluvial

[2] The Fm02 was first described in *Wetlands of British Columbia* (MacKenzie and Moran 2004) when it included sites in the boreal region that are dominated by balsam poplar (*Populus balsamifera*). Those stands are now recognized as a separate site association.

[3] The closest ecosystem in *Wetlands of British Columbia* was Fm03, although this site association is limited to colder climates in central and northern British Columbia.

systems but also occur on wave-washed beaches and shores of larger lakes. They are floristically related to many shrubby swamps, but low bench flood ecosystems are subirrigated throughout the growing season and have aerated soils. In contrast, shrub swamps have wetland soils with accumulations of organic peat surface layers, poorly oxygenated soils, and an abundance of hydrophytic herb species. Low bench flood ecosystems also occur adjacent to the stream channel or along lake shores, whereas swamps are often associated with inactive floodplain back channels, peatland margins, and depressions and gullies.

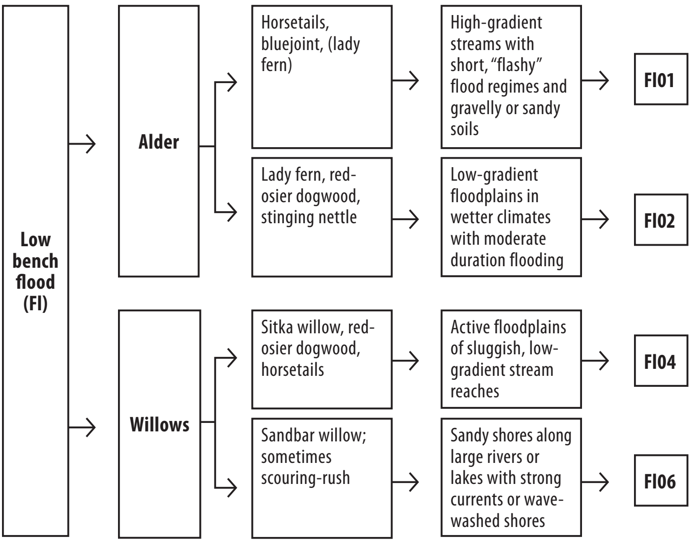
Low bench flood units cover a broad range of vegetation types but are typically restricted to lower elevations within mountainous terrain (ICH, IDF, MS, PP, BG, and lower-elevation ESSF). At the time of publication, seven Fl site associations had been described for low bench floodplains across the interior of the province. Four of these units commonly occur in the south-central Columbia Mountains.

Distribution of low bench flood (Fl) site associations by biogeoclimatic unit[a]

Zone	ICH					ESSF		
Unit/BEC	ICHxw	ICHdw1	ICHdm	ICHmw2	ICHmw4	ESSFwh1	ESSFwh2	ESSFwh3
Fl01		*	X	X	X	*	*	*
Fl02		*	*	X	*	*		
Fl04		X	X	X	X			
Fl06	X	*		*				

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Low bench flood ecosystems (Fl)



Vegetation Table – Low bench flood ecosystems[a]

Layer	Scientific name	FI01	FI02	FI04	FI06	Common name
	Number of plots	12	31	29	6	
Shrubs	*Alnus incana*	■■■■■	■■■■■	*		mountain alder
	Lonicera involucrata	■■■	■■■■	□□		black twinberry
	Cornus stolonifera	*	■■■	■■■■	*	red-osier dogwood
	Sambucus racemosa	*	■■■			elderberry
	Salix sitchensis		**	■■■■■		Sitka willow
	Salix drummondiana			□□□		Drummond's willow
	Salix exigua				■■■■■	narrow-leaf willow
Herbs	*Equisetum* spp.	■■■■■	■■■	□□□□		horsetails
	Gymnocarpium dryopteris	□□□	□□□			oak fern
	Calamagrostis canadensis	□□□	□□	□□		bluejoint reedgrass
	Athyrium filix-femina	■■	■■■			lady fern
	Viola spp.	□□	■■■			violets
	Galium triflorum	□□	□	*		sweet-scented bedstraw
	Heracleum maximum	□	■■			cow-parsnip
	Urtica dioica	*	■■■			stinging nettle
	"mitreworts"[b]		□□			mitreworts
	Equisetum hyemale				□□□□	scouring-rush

[a] Vegetation is based on plots in southern British Columbia only; plots from northern and coastal British Columbia have been excluded.
[b] Lists of commonly grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% | ■■ 1–3% | ■■■ 3–10% | ■■■■ 10–25% | ■■■■■ > 25% | * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots | □ 50–70% of plots

Fl01 Mountain alder – Common horsetail
The Fl01 occurs on coarse-textured gravel or sand bars adjacent to relatively high-gradient creeks and streams that can have a "flashy" flood regime. Flood events are short during annual spring flooding and occur occasionally following summer storms. Mountain alder and horsetail are the dominant species, but oak fern, lady fern, violets, bluejoint reedgrass, and sweet-scented bedstraw are also common.

Fl02 Mountain alder – Red-osier dogwood – Lady fern
Fl02 sites occur along streams and in creek gullies on low-gradient floodplains with loamy or fine-textured soils. Flood duration is moderate, and sites are most common in wetter climates. Mountain alder, red-osier dogwood, and black twinberry usually occur with lady fern, stinging nettle, mitreworts, and common horsetail. In colder climates, cow-parsnip is common. Fl02 sites often occur adjacent to Fm02 or Fm04 sites.

Fl04 Sitka willow – Red-osier dogwood – Horsetail
The Fl04 occurs on levees and sand/gravel bars in the active floodplains of sluggish, low-gradient streams. Soils are typically fine-sandy, well-drained, and saturated at depth for most of the growing season. Sitka willow is the dominant shrub, but mountain alder, Drummond's willow (*Salix drummondiana*), and Pacific willow (*S. lucida*) are also common and can have high cover. Common and meadow horsetails are typical on most sites, along with a variety of other herbs, except where herb cover is sparse due to recent flooding and sediment deposition. Fl04 sites often occur adjacent to Fm02 or Fm04 sites. In the south-central Columbia Mountains, the Fl04 occurs most often in the ICH and occasionally at lower elevations in the wet to moist ESSF. The *Fl05 Drummond's willow – Bluejoint* is more common than the Fl04 in the plateau areas and highlands of south and central British Columbia, including the Okanagan and Shuswap Highlands (see MacKenzie and Moran 2004).

Fl06 Sandbar willow – Scouring rush[4]
Sandbar willow sites occur on sandy lateral bars and islands along very large river systems where prolonged spring flooding with strong currents is common. In hotter, drier climates, the Fl06 also occurs around large lakes on wave-washed shores. Plant diversity is low and sandbar willow and/or narrow-leaf willow dominate, often with minor black cottonwood and

[4] Sandbar willow (*Salix interior*) and narrow-leaf willow (*S. exigua*) were previously treated as one species; this site association includes both.

mountain alder mixed in at the upper fringes. Scouring rush is common and often mixes with annual weedy herbs that establish on the exposed mineral soils of these sites. Fl06 sites occur infrequently along the Kootenay and Columbia River systems but were likely more common prior to development of the dams.

Active Channel Flood Class (Fa)

Active channel ecosystems occur on sites that are annually flooded, and often scoured, for prolonged periods. Sites are usually immediately adjacent to the river channel at lower water levels and under water at high water levels. On unstable substrates, such as gravel bars and islands, Fa ecosystems are usually dominated by opportunistic annuals or perennial herb-layer species with extensive root systems that are able to re-sprout after the aboveground structures have been removed by flooding and scouring. Unlike Fl ecosystems, plant communities on Fa sites are herb dominated and have little to no cover of shrubs such as willows and alders. Fa sites on active channel sites with stable substrates are typically dominated by bryoid communities; these include mossy bedrock or talus communities below the high water mark in small to medium-sized creeks and streams. Site associations have not been described for Fa ecosystems.

Red-osier dogwood
Cornus stolonifera

Oceanspray
Holodiscus discolor

Mallow ninebark
Physocarpus malvaceus

6.4 Grassland Group: Brushland and Grassland Ecosystems

The Grassland Group describes ecosystems where conditions are too dry for tree establishment as a result of semi-arid **climate** or because **sites** within forested zones are too dry and warm. Four classes are recognized in the Grassland Group: Grassland (Gg), Brushland (Gb), Shrub-steppe (Gs), and Alkaline/saline meadow (Ga). This section provides a brief overview of classification and identification of the most common brushland and grassland ecosystems in the south-central Columbia Mountains. Although part of the Alpine Group (see Section 6.7), alpine grasslands (Ag) are described in this section due to their similarity to lower-elevation grasslands.

Brushlands are the most common grassland site class in the south-central Columbia Mountains. Grasslands and alpine grasslands are extremely uncommon, with only a limited number of site associations present. Shrub-steppe and alkaline/saline meadows do not occur in the area covered by this field guide.

Ecological significance of brushlands and grasslands

Brushlands and grasslands occur from low-elevation dry ICH sites to the ESSF woodland and parkland. Soil moisture availability and drainage characteristics are key determinants of ecosystems within the Grassland Group. Timing of moisture delivery and depth of available moisture are also critical in determining plant composition in dry environments. Most grassland and brushland ecosystems are considered at risk and often provide habitat for at-risk species and species of concern, both plants and animals (see the Conservation Data Centre, B.C. Ministry of Environment).

Brushlands typically occur on warm-aspect sites with rubbly, coarse-textured, shallow soils. They often occur in a mosaic with other ecosystems, including dry, open forests, rock outcrops, and grasslands. In landscapes largely dominated by forests, brushlands provide important structural diversity. Brushlands provide important habitat for ungulates (deer and elk browse), reptiles (western skink, western yellow-bellied racer, and rubber boa), and birds (common nighthawk and yellow chat).

Although grass-dominated sites (grasslands) are extremely uncommon in the south-central Columbia Mountains, they do occur on the driest sites in the area covered by this field guide and are found from low elevations in the dry ICH to the ESSF woodland. Where present, grasslands often occur in small (< 1 ha) openings on dry, warm, upper-slope, coarse, shedding sites within broader forested, rock outcrop, and brushland complexes. Larger grassland complexes (> 1 ha) are limited to a few areas on south-facing slopes in the ESSF.

Alpine grasslands occur on very cold sites from the ESSF to the parkland but are extremely uncommon in the field guide area. They differ from the physiognomically similar Grassland Group in that cold winters, growing-season frosts, and intermittent or low snow cover are the driving factors rather than heat and associated growing-season aridity. In southern British Columbia, alpine grasslands are dominated by timber oatgrass, while grasslands are characterized by bunchgrasses.

Fire can be important in maintaining open structure in brushland and grassland ecosystems. Forest ingrowth due to fire suppression can negatively affect these ecosystems by: (1) increasing shade, which alters species composition and distribution; (2) affecting phenological adaptations to high fire frequency, including limiting species with serotinous seeds; (3) removing the opportunity for vegetative growth fluxes of key shrubs and grasses after fires; and (4) reducing palatability of browse .

In the ICH, major threats, both current and past, include human settlement in valley bottoms, flooding from hydroelectric dams, invasive species, sulphur dioxide pollution in the Lower Columbia Valley, domestic grazing, and construction of linear corridors for roads, power transmission lines, and natural gas pipelines. In the ESSF, major threats include linear corridors for roads, power lines, and pipelines, as well as livestock grazing (primarily cattle).

Soil disturbance creates opportunity for establishment of invasive species, which can have a major detrimental effect on grassland and brushland communities, especially at low elevations. Weedy species are a major threat to native species. After sampling brushlands in the dry ICH, McKenzie and Hill (2010) noted that "As a result of habitat loss due to human activities, the spread of non-native species and forest ingrowth, it is becoming increasingly difficult to locate undisturbed dry site ecosystems at low elevations in the southern West Kootenays [covering the southern Monashee, Selkirk, and Purcell mountains]." Although a number of species occur, the most common weedy species in brushland and open forests include knapweed (*Centaurea* spp.), common St. John's-wort (*Hypericum perforatum*), oxeye daisy (*Leucanthemum vulgare*), and sulphur cinquefoil (*Potentiall recta*). Non-native hawkweeds (*Hieracium* spp.) and cheatgrass (*Bromus tectorum*) are also significant threats.

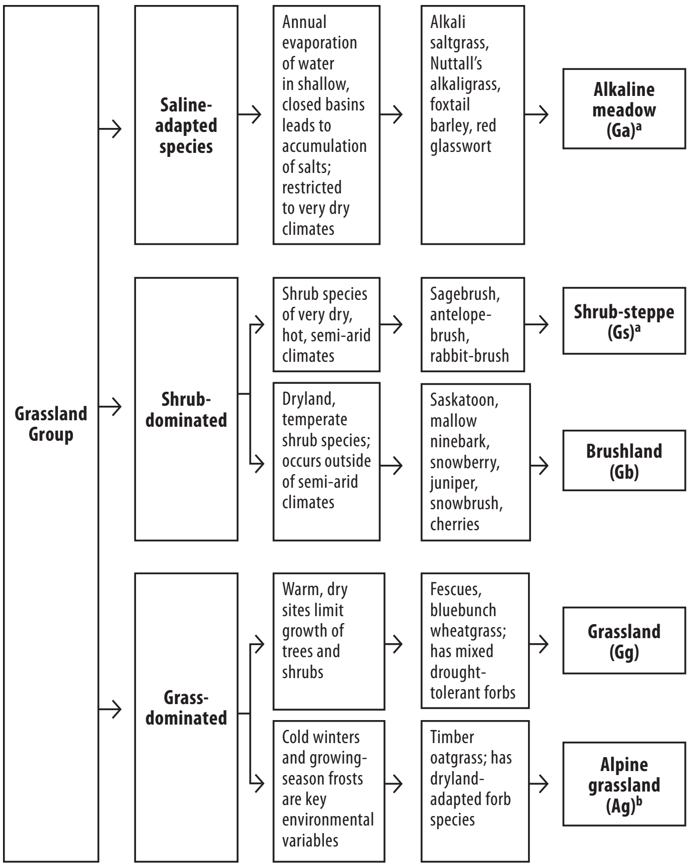
Naming and coding of the Grassland Group

The Grassland Group includes four classes: Grassland (Gg), Brushland (Gb), Alkaline/saline meadow (Ga), and shrub-steppe (Gs). Alpine grasslands (Ag) are described in this section due to their similarity to lower-elevation grasslands. A flowchart outlining the differences between classes is provided below.

Disturbance codes for brushlands and grasslands

Anthropogenic disturbances can have significant effects on vegetation communities in brushland and grassland ecosystems. The coding and approach for describing disturbances is outlined in the introduction to non-forested ecosystems (Section 6.1). Common disturbances in brushland and grassland ecosystems in the south-central Columbia Mountains include invasive species [B.v], recreation-related effects [R], and domestic livestock [B.d] (see Section 6.1).

Flowchart – Grassland Group



[a] Does not occur in the south-central Columbia Mountains.
[b] Part of the Alpine Group.

Common brushland and grassland ecosystems in the south-central Columbia Mountains

Three brushland site associations, three grassland site associations, and one alpine grassland site association are described for the south-central Columbia Mountains.

Brushland Class (Gb)

Brushland ecosystems occur in dry to moist climates on warm, dry, insolated sites. They typically occur on sites with rockier and shallower soils than those of grassland sites. Typical dryland shrubs include mallow ninebark, snowberry, saskatoon, juniper, oceanspray, and cherries. In contrast, shrub-steppe (Gs) sites are limited to very hot, dry climates (found in the Okanagan, Boundary, and Rocky Mountain Trench in southeast British Columbia) and are dominated by desert-adapted shrub species such as big sagebrush (*Artemesia tridentata*) and antelope-brush (*Purshia tridentata*). Brushlands are associated with dry to moist climates and hot, dry sites; they do not include ecosystems dominated by moist shrub species such as alders (*Alnus* spp.), white-flowered rhododendron (*Rhododendron albiflorum*), and thimbleberry (*Rubus parviflorus*) since these ecosystems are not regulated by dry conditions.[1] Three brushland site associations are described for the south-central Columbia Mountains.

In many climates, it can be difficult to distinguish between early seral broad-leaved plant communities of dry site series (e.g., 103 forested site series) and Gb sites due to similarities in plant communities. Seral forested plant communities can be identified based on the presence of stumps and by coniferous regeneration or broadleaf saplings (At or Ep) that are expected to develop into stands with > 10% tree cover.

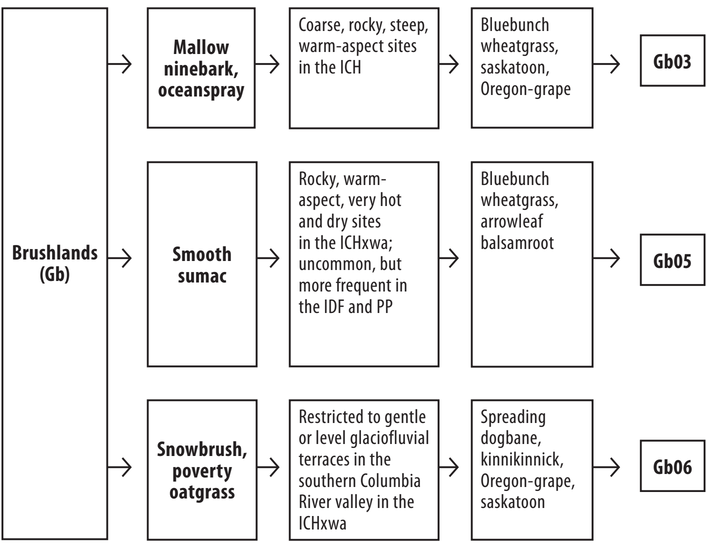
[1] Moist to wet brush sites that do not support tree growth are not classified at this time but can be coded as Xv-s – persistent or self-maintaining disclimax shrub communities with no apparent tree-limiting growth factors. An example is alder swales on mid slopes of wet and very wet ESSF and ICH forests. At higher elevations on dry, frost-prone sites, subalpine shrubland ecosystems (Sc-b) may occur (MacKenzie 2012). Site associations may be described for Xv-s and Sc-b ecosystems in future publications.

Distribution of brushland (Gb) site associations by biogeoclimatic unit[a]

Unit/BEC	ICHxw	ICHdw1	ICHdm	ICHmw2	ICHmw4
Gb03	X	X	*	*	*
Gb05	*				
Gb06	X				

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Brushlands



Vegetation Table – Brushlands

Layer	Scientific name	Gb03	Gb05	Gb06	Common name
	Number of plots	17	4	6	
Shrubs	*Physocarpus malvaceous*	■■■■			mallow ninebark
	Holodiscus discolor	■■■			oceanspray
	Amelanchier alnifolia	■■■		■■	saskatoon
	Mahonia spp.	■■■		■■■	Oregon-grape
	Symphoricarpos albus	■■■		□	common snowbrush
	Prunus virginiana	□□		■	choke cherry
	Rhus glabra		■■■■		smooth sumac
	Ceanothus velutinus			■■■■	snowbrush
Herbs	*Pseudoroegneria spicata*	■■■	■■■■		bluebunch wheatgrass
	Arenaria serpyllifolia	□□□			thyme-leaved sandwort
	Collinsia parviflora	□□			small-flowered blue-eyed Mary
	Lupinus sericeus	□□			silky lupine
	Bromus tectorum	□□	■■■		cheatgrass
	Achillea millefolium	■■	□		yarrow
	Lomatium spp.	□□			lomatiums
	Sedum lanceolatum	■			lance-leaved stonecrop
	Koeleria macrantha	*		□□	junegrass
	Selaginella densa	*	■■		compact selaginella
	Hesperostipa comata		□□□		needle-and-thread grass
	Balsamorhiza sagittata		■■		arrowleaf balsamroot
	Eriogonum heracleoides		□		parsnip-flowered buckwheat
	Phacelia linearis		□		thread-leaved phacelia
	Apocynum androsaemifolium		*	□□□	spreading dogbane
	Danthonia spicata			■■■■	oatgrass
	Arctostaphylos uva-ursi			■■	kinnikinnick
Moss layer	Polytrichum spp.	■■	*	■	haircap moss
	Racomitrium spp.	□			rock-moss
	Tortula ruralis		□		sidewalk screw-moss

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots
□ 50–70% of plots

Gb03 Ninebark – Oceanspray – Bluebunch wheatgrass
The Gb03 occurs on steep, warm slopes with shallow, coarse, usually rocky soils and occasionally with exposed bedrock. Fd and Py, if present in the tree layer, are sparse (< 10% cover). The abundant shrub community is characterized by mallow ninebark, snowberry, oceanspray, saskatoon, Oregon-grape, and often mock-orange and wild cherries (mostly *Prunus virginiana* but also *P. emarginata* and *P. pensylvanica*). Herbs can be very diverse. Bluebunch wheatgrass is usually present and can have high cover (> 20%). Other grasses such as pinegrass and fescues (mostly *Festuca idahoensis*) are common, along with a number of dryland species, such as yarrow, thyme-leaved sandwort, small-flowered blue-eyed Mary, silky lupine, and dryland sedges (*Carex* spp.). Invasive weedy species such as knapweeds, St. John's-wort, cheatgrass, and non-native hawkweeds are also common on these sites and pose a serious threat to their resilience. Heavy wildlife browsing by deer and elk is common. Gb03 ecosystems occur throughout the ICHxw, xwa, dw1, and dw4, and are scattered and uncommon on very warm sites in the ICHmw2, mw4, mw5, and dm, particularly at low elevations in areas transitional to the ICHdw1.

Gb05 Sumac – Bluebunch wheatgrass
The Gb05 occurs on very dry, rocky sites in the PP and dry IDF in Boundary and the south Okanagan, and occasionally on warm, rocky slopes in the ICHxwa. Smooth sumac is always present. Understorey herbs are diverse, and bluebunch wheatgrass is commonly present in moderate amounts. Other species include compact selaginella, parsnip-flowered buckwheat, arrowleaf balsamroot, and grasses. Weedy invasive species, especially cheatgrass, are usually present.

Gb06 Snowbrush – Poverty oatgrass
The Gb06 occurs on very coarse-textured glaciofluvial terraces where historic disturbance from fire was frequent and kept stands in a persistent disclimax condition. Snowbrush is the dominant shrub, although Oregon-grape, snowberry, and saskatoon are often present with moderate cover (< 7%). Poverty oatgrass is typical, along with junegrass and/or kinnikinnick. Scattered Py may be present at low densities (< 5% cover). Invasive weedy species such as knapweeds and non-native hawkweeds are a common threat to these ecosystems. Snowbrush often occurs in early seral stands following fire or land clearing; these sites are seral forested site series and are not brushlands. The Gb06 has a very limited distribution in British Columbia; it is restricted to the ICHxwa south of Trail. This ecosystem is very uncommon, both in British Columbia and in adjacent areas of the USA.

Grassland Class (Gg) and Alpine Grassland Class (Ag)

Grassland ecosystems described in this field guide occur primarily on sites with high sun exposure and thin or coarse-textured soils. Although soils are typically shallow, they are not usually as rocky as brushland sites. Grasslands often occur on sites where there is a thin surface layer of fine-textured eolian (wind-deposited) material. Grasslands are typified by bunchgrasses, including Idaho fescue, rough fescue, and bluebunch wheatgrass. Grasses comprise a significant component of the vegetation, although a number of forbs are typically present.

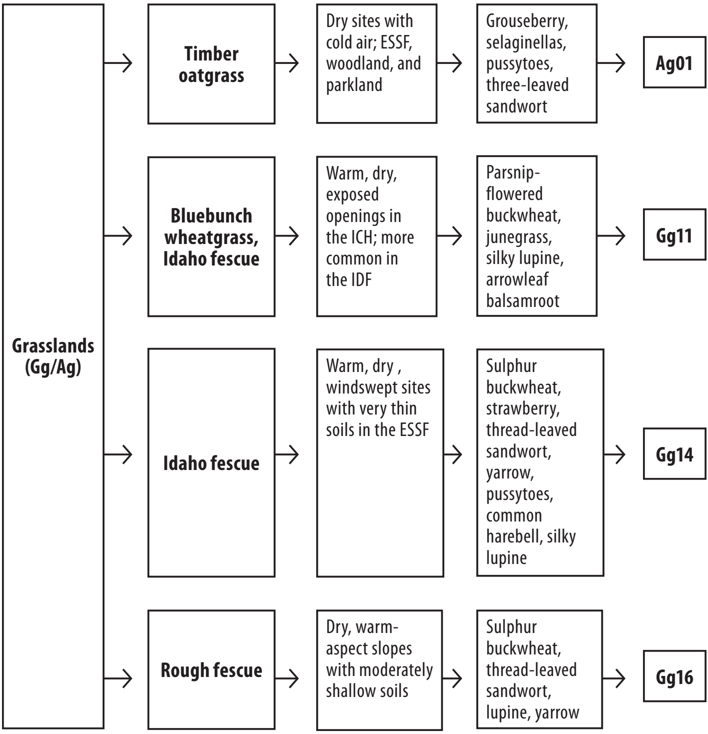
Alpine grasslands occur at higher elevations where cold-air ponding or growing-season frosts, rather than excessive aridity, prevent tree establishment. In southern British Columbia, these grasslands are dominated by timber oatgrass. Grasslands and alpine grasslands are extremely uncommon in the south-central Columbia Mountains.

Distribution of grassland (Gg/Ag) site associations by biogeoclimatic unit[a]

Zone	ICH					ESSF								
Unit /BEC	ICHxw	ICHdw1	ICHdm	ICHmw2	ICHmw4	ESSFwh1	ESSFwc4	ESSFwh2	ESSFwm2	ESSFwh3	ESSFwm3	ESSFwm4	ESSFwmw	ESSFwcw
Gg11	*	*	*	*	*									
Gg14											*	*	*	
Gg16											*	*	*	*
Ag01											*	*	*	*

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Grasslands



Vegetation Table – Grasslands

Layer	Scientific name	Gg11	Gg14	Gg16	Ag01	Common name
	Number of plots	16	25	56	10	
Herbs	*Pseudoroegneria spicata*	■■■■				bluebunch wheatgrass
	Festuca idahoensis	■■■	■■■■		*	Idaho fescue
	Lupinus sericeus	■■■	□□□	□□		silky lupine
	Selaginella spp.	■■■	**	□□	■■■	selaginellas
	Achillea millefolium	■■	■■	■■	■■	yarrow
	Balsamorhiza sagittata	□□□				arrowleaf balsamroot
	Koeleria macrantha	■■■				junegrass
	Bromus tectorum	□□				cheatgrass
	Eriogonum heracleoides	■■				parsnip-flowered buckwheat
	Lomatium spp.	□				lomatiums
	Eriogonum umbellatum		■■	■■■	*	sulphur buckwheat
	Eremogone capillaris		■■	■■	■■	thread-leaved sandwort
	Fragaria spp.		■■	□□	□□	strawberry

Layer	Scientific name	Gg11	Gg14	Gg16	Ag01	Common name
	Number of plots	16	25	56	10	
Herbs	*Penstemon* spp.		□□	■■	□	penstemons
	Antennaria spp.		■■	*	■	pussytoes
	Sedum spp.		□	□	□	stonecrops
	Allium cernuum		□			nodding onion
	Campanula rotundifolia		■	*		common harebell
	Festuca campestris			■■■■		rough fescue
	Potentilla diversifolia			□□	□	diverse-leaved cinquefoil
	Carex phaeocephala			□□	*	dunhead sedge
	Danthonia intermedia				■■■■■	timber oatgrass
	Vaccinium scoparium/myrtillus				■■■	grouseberry/low bilberry
Moss layer	*Cladonia* spp.	□□□	□□		□□	clad lichens
	Polytrichum spp.	□□□			■■■	haircap moss
	Tortula ruralis		□□			sidewalk screw-moss
	Peltigera spp.		□		■■	pelt lichens

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Gg11 Idaho fescue – Bluebunch wheatgrass – Junegrass
The Gg11 occurs on exposed, windswept, moderate to steep sites on long, warm-aspect slopes. It is most common in the IDF and PP but occurs in small, exposed openings in the ICH. Soils are usually shallow with much exposed mineral soil. Bunchgrasses are dominant, with widely scattered bluebunch wheatgrass and Idaho fescue, and minor to moderate amounts of junegrass (< 10% cover). Silky lupine is usually present with scattered parsnip-flowered buckwheat, selaginellas, and yarrow. Arrowleaf balsamroot often occurs and can be abundant (> 15% cover). Mosses and lichens have low cover; clad lichens and haircap mosses are common.

Gg14 Idaho fescue – Sulphur buckwheat – Sandwort
The Gg14 occurs on gentle to moderately steep, windswept sites on upper-slope positions with very thin soils. It is primarily in the ESSFdkw, dkp, and dk1 but can occur in the ESSFwmw, wm3, and wm4 on sites with high sun exposure. Exposed mineral soil is common. Characteristic herbs include moderate cover of Idaho fescue, with strawberry, sulphur buckwheat, thread-leaved sandwort, and pussytoes. Selaginellas, Scouler's hawkweed (*Hieracium scouleri*), Parry's rush (*Juncus parryi*), and silky lupine may occur. The Gg14 occurs at higher elevations than the Gg11 and on more windswept sites with shallower soils than the Gg16.

Gg16 Rough fescue – Sulphur buckwheat – Sandwort
The Gg16 occurs on moderate to steep, warm, upper slopes. It is most common in the ESSFdkw and dkp but also occurs very infrequently in the ESSFwm3, wm4, and wmw. Soils are moderately shallow, often with exposed mineral soil. Rough fescue dominates the plant community, with low to moderate cover of thread-leaved sandwort, yarrow, and sulphur buckwheat. Common harebell and silky lupine often occur in the south Selkirk and Purcell Mountains. The Gg16 occurs at higher elevations than the Gg11 and at similar elevations as the Gg14 but typically on sites with deeper soils.

Ag01 Timber oatgrass – Grouseberry – Sandwort
The Ag01 occurs on neutral to warm, moderate to steep upper slopes in parkland and woodland subzones, and in gentle depressions where cold air accumulates in the ESSF. Soils are typically medium- to coarse-textured. The herb layer has high cover and is dominated by timber oatgrass with compact selaginella (*Selaginella densa*). Grouseberry and/or low bilberry, thread-leaved sandwort, and pussytoes commonly occur with low to moderate cover. The Ag01 is most common in the ESSFdk1, dkw, dkp, and IMAun in the East Kootenay. It occurs very infrequently in the south-central Columbia Mountains in the ESSFwm3, wm4, wmw, wmp, wcw, and wcp.

6.5 Avalanche Ecosystems

Ecosystems that experience repeated snow avalanches belong to their own site group. The Avalanche Group is divided into three classes: herb dominated (Vh), shrub dominated (Vs), and treed (Vt). This section describes the most common avalanche site associations within the south-central Columbia Mountains.

This is the first correlated BEC classification of avalanche plant communities for the Southern Interior; it is developed at a broad scale using limited available data. Although avalanche ecosystems contain diverse vegetation communities and highly varied disturbance regimes, the classification presented here is broad. Additional detail may develop over time as more data are collected, and users may find additional avalanche site associations and variations that are not well described in this guide.

Ecological significance of avalanche ecosystems

Avalanche paths occur in mountainous terrain and are more common in snowier environments. They typically extend from mountain tops, through steep forested terrain, to valley bottoms, and provide ecosystem diversity at stand and landscape scales through the creation and maintenance of herbaceous and shrubby vegetation in otherwise forested areas.

There are three generalized parts to an avalanche path: the initiation zone, the chute, and the run-out zone. Avalanche initiation zones typically occur on upper slopes in alpine meadows or heath, below steep rocky knolls, or on other high-elevation snow accumulation features. At upper elevations, the ecosystems within avalanche initiation zones are classified as different Terrestrial groups in the non-forested BEC hierarchy (e.g., Alpine or Rock groups [MacKenzie 2012]) (see Section 6.1, Figure 6.1.3). The chute and run-out zone can be herb-, shrub-, or small tree-dominated, depending on the frequency, size, and severity of avalanching and the soil moisture regime on the site.

Avalanches influence vegetation directly through the physical movement of snow and debris. The frequency, power, and amount of snow deposition in a path critically affect vegetation communities in avalanche ecosystems. Avalanche frequency varies from paths that experience multiple avalanches in a given year to very long return intervals—up to hundreds of years. Intensity of disturbance varies depending on terrain (shape and slope gradient), site exposure (to wind and solar radiation), weather, and snow characteristics (depth and type of instabilities, snow consistency, and moisture content). Mature trees are generally destroyed in larger avalanche events where existing paths are expanded or new slide paths are created. Avalanche plant communities typically persist unless high-severity slides scour the vegetation and soil, and re-initiate succession processes. Scouring is most common and severe in the chute portion of an avalanche path. Although trees and shrubs can be broken and bent by avalanches, most species growing in avalanche paths are able to persist under such conditions (Bebi et al. 2009).

Avalanche paths provide very different growing conditions for plants than those found in surrounding forests. Avalanches create and maintain open growing sites with more light, which benefits shade-intolerant species. In addition, species that are normally found at higher elevations and in alpine environments often occur at lower elevations within avalanche paths. This occurs through seed and propagule dispersal, through changes in microsite conditions from snow accumulation, removal, and redistribution, and through cold-air flow to lower elevations (Rixen et al. 2007).

The most common plant communities in avalanche paths are dominated by alder, willows, thimbleberry, fireweed, cow-parsnip, and ferns, although diversity both within and across avalanche paths is extremely high. Boundaries between avalanche paths and adjacent ecosystems can be discrete, and plant communities within a single path often form a mosaic of several avalanche site classes and site associations.

Plant communities in avalanche paths are influenced by climate, snow load, solar aspect, moisture availability, and the power and frequency of avalanches. Large amounts of snow are generally deposited in the run-out zone. This leads to late snowmelt, which shortens growing seasons and favours plant species that are adapted to higher elevations. Snow accumulation also contributes additional soil moisture for plant growth, and species typically associated with moist sites are common in run-out zones. In contrast, where snow is removed from mid-track positions, lower snow depths occur. This often leads to earlier snow-free conditions and longer growing seasons, particularly on warm-aspect sites where solar insolation accelerates snowmelt. On cooler aspects and in colder climates, snow removal in the mid-track can reduce the insulating effects of the snowpack, which creates colder microsites and favours higher-elevation plant species (Quinn and Phillips 2000; Rixen et al. 2007; Bebi et al. 2009).

In general, herbaceous plant communities (Vh) provide high forage value for most wildlife species, while shrub (Vs), and treed (Vt) communities have lower value. Avalanche paths are particularly important habitat for grizzly bears and mountain caribou. Avalanche tracks are often the first areas to green-up in the spring and provide important spring foraging areas for a wide variety of wildlife species. Avalanche paths also provide seasonal or year-round habitat for several species, including bats, bighorn sheep, wolverine, ground squirrels, chipmunks, marmots, and birds (Quinn and Phillips 2000).

Avalanches provide both benefits and hazards for resource management (see Weir 2002). They are a significant threat to infrastructure such as roads, recreation, and mountain settlements, but they also create cross-slope fire breaks, which can help reduce overall fire size and spread. Avalanches also provide nutrient inputs to creeks, but they can also add excessive sediment or block channels, which can cause flooding and other downstream effects.

Naming and coding of avalanche ecosystems

The Avalanche Group is divided into three classes: herb dominated (Vh), shrub dominated (Vs), and treed (Vt). This field guide presents site associations for the Vh and Vs classes; the Vt is described only at the class level.

The Avalanche Group does not include Alpine meadow, heath, and tundra ecosystems that often occur in initiation zones of the parkland and IMA; these are included in the Alpine Group. Similarly, the Avalanche Group does not include rock or talus areas affected by avalanches; these are placed in the Rock Group. In some cases, similar plant communities may occur in both the Avalanche Group and another group. For example, alpine meadow (Am) site associations and herb-dominated avalanche (Vh) site associations may have similar vegetation.

Due to the highly variable site conditions in avalanche ecosystems, floristically broad site associations have been created. Site associations are based on data from wide geographic ranges and broad biogeoclimatic subzones/variants. As a result, considerable variation in plant species composition should be expected within each site association. To assist users in site identification and interpretation, site variations have been described for site associations where a subset of sites has a distinct species component (e.g., *Vs01.2 Slide alder – Spiny wood fern*). These are provided in the site association descriptions but not in the flowcharts and vegetation tables. In most avalanche paths, several avalanche site associations (and potentially variations) typically occur.

Common avalanche ecosystems in the south-central Columbia Mountains

Avalanche ecosystems include the Avalanche Treed Class, the Avalanche Herb Meadow Class and the Avalanche Shrub Thicket Class.

Avalanche Treed Class (Vt)

Avalanche treed ecosystems are dominated by shrub-sized trees that are continually pruned by snow slides that prevent them from becoming forests. This does not include young forests that are regenerating following single extreme events; such sites are seral forested ecosystems. Trees in Vt ecosystems show evidence of breakage, pruning, and bark damage from repeated avalanche events. Treed avalanche classification is under development. Future publications may address detailed Vt site association classification.

Avalanche Herb Meadow Class (Vh)

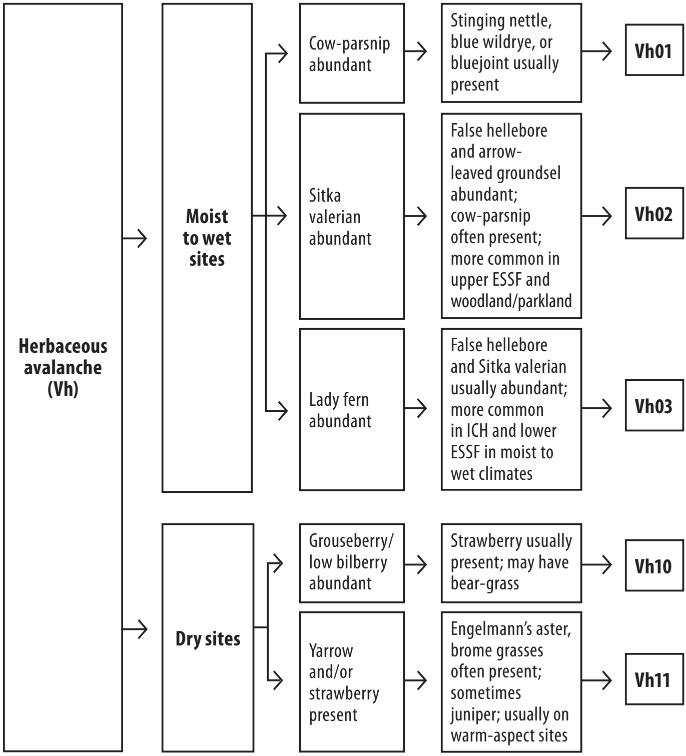
Herbaceous avalanche ecosystems are dominated by forbs, graminoids, and/or dwarf woody shrubs (e.g., grouseberry). They typically occur in both the central track and the run-out zone of avalanche paths. Where Vh communities occur, mid-track shrub and tree establishment is typically limited by movement of snow and soil substrates. In run-out zones, high snow accumulation frequently supports moist, herbaceous plant communities. Five herbaceous avalanche site associations are common within the field guide area.

Distribution of herb-dominated avalanche (Vh) site associations by biogeoclimatic unit[a]

Zone	ICH			ESSF								
Unit/BGC	ICHdm	ICHmw2	ICHmw4	ESSFwh1	ESSFwc4	ESSFwh2	ESSFwm2	ESSFwh3	ESSFwm3	ESSFwm4	ESSFwcw	ESSFwmw
Vh01	*	X	X	X	X	X	X	X	X	X	*	*
Vh02				*	X	*	X	*	X	X	X	X
Vh03		*	*	X		*		*				
Vh10	*		*				*	*	*	X	*	X
Vh11	*	*	*	*	*	*	*	*	*	*	*	*

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Herb-dominated Avalanche (Vh)



Vegetation Table – Herb-dominated Avalanche (Vh)

Layer	Scientific name	Vh01	Vh02	Vh03	Vh10	Vh11	Common name
	Number of plots	44	45	6	10	7	
Herbs	*Heracleum maximum*	■■■■	■■■ (grey)	■■ (grey)		*	cow-parsnip
	Chamerion angustifolium	■■■■	■■■	*	■■■■	■■■	fireweed
	Calamagrostis canadensis	■■■■ (grey)	*	■■■ (grey)			bluejoint reedgrass
	Thalictrum occidentale	■■■	■■■ (grey)		■■■	*	western meadowrue
	Urtica dioica	■■■					stinging nettle
	Elymus glaucus	■■■ (grey)				*	blue wildrye
	Viola spp.	■■ (grey)	■■ (grey)	■■			violets
	Valeriana sitchensis	*	■■■■	■■■■ (grey)	■■■	*	Sitka valerian
	Veratrum viride	*	■■■■	■■■■	*		false hellebore
	Senecio triangularis	*	■■■■	■■ (grey)	**		arrow-leaved groundsel
	Carex spectabilis		■■■ (grey)	*			showy sedge
	"mitreworts"[a]		■■ (grey)	■■			mitrewort
	Erigeron peregrinus		*		■■ (grey)		subalpine daisy
	Fragaria spp.				■■■	■■■■	strawberry
	Achillea millefolium				■	■■■	yarrow
	Athyrium filix-femina			■■■■■			lady fern
	Gymnocarpium dryopteris			■■■ (grey)			oak fern
	Vaccinium scoparium/myrtillus				■■■■■		grouseberry/low bilberry
	Allium cernuum					■■ (grey)	nodding onion
	Penstemon spp.					■■	penstemons

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots ■ (grey) 50–70% of plots

[a] Lists of grouped species are provided in Appendix 1.1.

Vh01 Cow-parsnip – Fireweed – Nettle

The Vh01 is common in run-out zones and lower track sections in the ICH and lower ESSF. Cow-parsnip is usually found with abundant fireweed and varying amounts of stinging nettle and meadowrues. Bluejoint reedgrass can have high cover but may be absent. Two variations are recognized:

Vh01.1 Cow-parsnip – Fireweed – Nettle
Fireweed, cow-parsnip, and stinging nettle are abundant; bluejoint is typically sparse or absent; blue wildrye is often present

Vh01.2 Cow-parsnip – Fireweed – Bluejoint
High cover of bluejoint reedgrass, often with arrow-leaved groundsel and false hellebore; blue wildrye is sparse or absent

This site association generally occurs on nutrient-rich soils with mesic to moist moisture regimes.

Vh02 Valerian – Hellebore – Fireweed

The Vh02 is common in the ESSF on cooler sites and at higher elevations, including the woodland and parkland. Sitka valerian, fireweed, false hellebore, and arrow-leaved groundsel are typical; cow-parsnip and western meadowrue are often present. Showy sedge can have high cover, particularly in wetter, snowier climates. Two variations are recognized:

Vh02.1 Valerian – Hellebore – Fireweed
Lacks showy sedge; often has more meadowrue

Vh02.2 Valerian – Showy sedge – Fireweed
High cover of showy sedge; snowier climates or sites than the Vh02.1

The Vh02 occurs on mesic to moist sites with medium to rich soils. It is most common in the run-out zone and in the lower track but occasionally occurs mid-track on seepage sites.

Vh03 Lady fern – Hellebore – Valerian

The Vh03 typically occurs on run-out sites with high snow accumulation in moist to wet climates in the ICH and lower ESSF. It is dominated by lady fern, usually with Sitka valerian, false hellebore, oak fern, and a wide variety of species associated with moist conditions. Sites generally have moist and wetter soil moister regimes with abundant soil nutrients.

Vh10 Fireweed – Grouseberry

The Vh10 is dominated by fireweed and grouseberry and/or low bilberry. Strawberry is common, along with Sitka valerian and western meadowrue. Bear-grass may be present. Vh10 sites are most common in the southern Purcell, Selkirk, Monashee, and Rocky Mountains, particularly in the ESSF and MS. The Vh10 typically occurs in upper- and mid-track positions. Soil moisture regimes are generally mesic and drier, while soil nutrients are poor to medium.

Vh11 Fireweed – Yarrow – Strawberry

The Vh11 occurs on dry sites and is characterized by fireweed, strawberry, and yarrow; juniper, grasses, and penstemons are often present, while moister species that are characteristic of other Vh units are sparse or absent. Blue wildrye is common in the Purcell Mountains, while cut-leaved anemone is often present in the Rocky Mountains. The Vh11 is most common in the mid- to lower-track positions at upper elevations in the ESSF and woodland. Soil moisture regimes are typically submesic and drier; soil nutrients are medium to rich.

Avalanche Shrub Thicket Class (Vs)

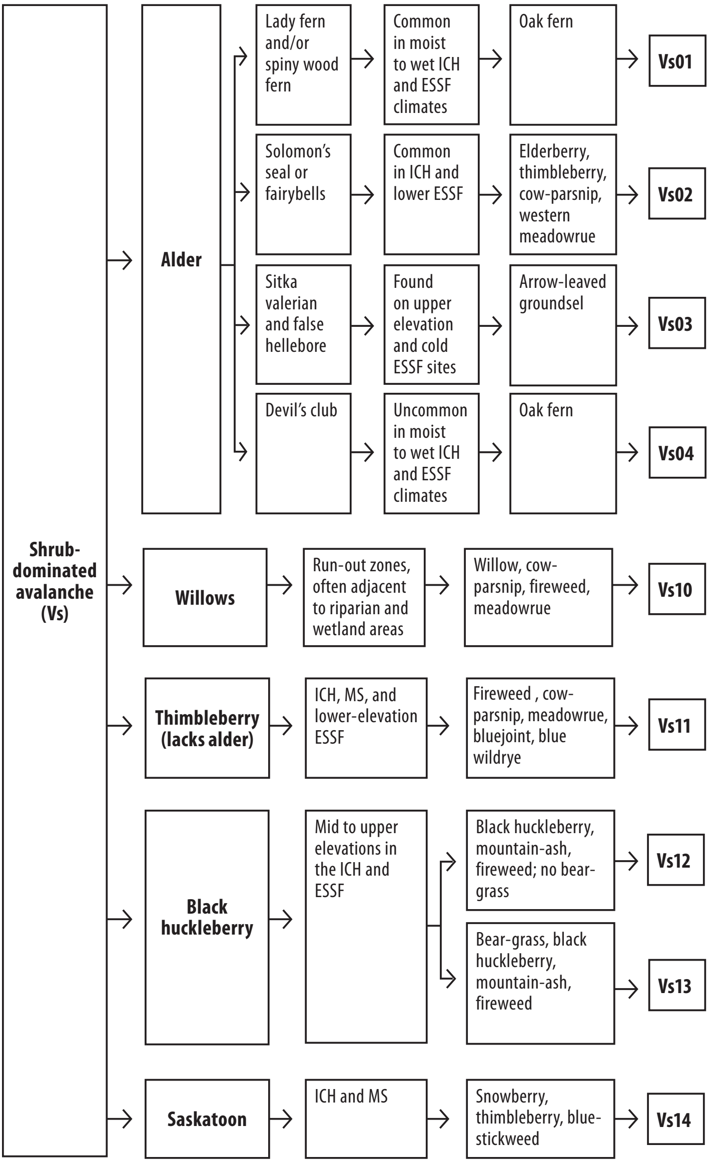
Shrub-dominated avalanche ecosystems (Vs) have abundant deciduous shrubs and are most frequently associated with the chute and lateral portions of the run-out zone where deep snow accumulation occurs infrequently and site conditions are mesic to wet. Nine shrub-dominated avalanche site associations are common in the south-central Columbia Mountains.

Distribution of shrub-dominated avalanche (Vs) site associations by biogeoclimatic unit[a]

Zone	ICH			ESSF								
Unit/BGC	ICHdm	ICHmw2	ICHmw4	ESSFwh1	ESSFwc4	ESSFwh2	ESSFwm2	ESSFwh3	ESSFwm3	ESSFwm4	ESSFwcw	ESSFwmw
Vs01	*	*	*	X	X	X	X	X	X	X	X	X
Vs02	*	*	*	X	*	X	*	X	*	*		
Vs03				*	X	*	X	*	X	X	X	X
Vs04		*	*	*		*		*				
Vs10	*	*	*	*	*	*	*	*	*	*	*	*
Vs11	*	*	*	*		*		*		*		
Vs12		*		*	*							
Vs13	*		*			*	*	*	*	*		*
Vs14	*	*	*									

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Shrub-dominated Avalanche (Vs)



Vegetation Table – Shrub-dominated Avalanche (Vs)

Layer	Scientific name	Vs01	Vs02	Vs03	Vs04	Vs10	Vs11	Vs12	Vs13	Vs14	Common name
	Number of plots	86	35	21	11	39	27	6	4	9	
Shrubs	*Alnus viridis* ssp. *sinuata*	■■■■■	■■■■■	■■■■■	■■■■■						Sitka alder
	Sambucus racemosa	■■■	■■■	■■	**		■■				red elderberry
	Rubus parviflorus	*	■■■				■■■■■			*	thimbleberry
	Oplopanax horridus				■■■■■						devil's club
	Salix spp.					■■■■					willows
	Sorbus spp.							■■■	■■■		mountain-ashes
	Abies lasiocarpa							■■■	■■■		subalpine fir
	Vaccinium membranaceum							■■■■	■■■■		black huckleberry
	Rhododendron albiflorum							■■■■	*		white-flowered rhododendron
	Spiraea betulifolia								■■	■■■	birch-leaved spirea
	Amelanchier alnifolia								■	■■■■	saskatoon
	Symphoricarpos albus									■■■■	snowberry

Layer	Scientific name	Vs01	Vs02	Vs03	Vs04	Vs10	Vs11	Vs12	Vs13	Vs14	Common name
	Number of plots	86	35	21	11	39	27	6	4	9	
Herbs	*Athyrium filix-femina*	■■■■		*	■■■						lady fern
	Dryopteris expansa	□□□□			□□□□						spiny wood fern
	Gymnocarpium dryopteris	■■■		*	■■■■						oak fern
	Maianthemum racemosum	□□	■■■		*		*				false Solomon's-seal
	Veratrum viride	□□	*	■■■■	*	*	*	*			false hellebore
	Streptopus amplexifolius	*	□□□	*	□□						clasping twistedstalk
	Thalictrum occidentale		■■■	□□		■■■	■■■			□	western meadowrue
	Heracleum maximum		□□	□□		■■■	■■■				cow-parsnip
	Urtica dioica		□□			□□□	■■■				stinging nettle
	Valeriana sitchensis			■■■		□□□		□□□	□		Sitka valerian
	Senecio triangularis			□□□		*					arrow-leaved groundsel
	Chamerion angustifolium					■■■	■■■■	□□□	■■	■■■	fireweed
	Xerophyllum tenax								■■■■■		bear-grass
	Fragaria spp.									■■■	strawberry

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Vs01 Sitka alder – Lady fern

The Vs01 is the most common and widespread shrub-dominated avalanche ecosystem in the Southern Interior, particularly in moist and wet climates in the ICH and lower ESSF. Sitka alder grows densely (typically 60–90% cover), with lady fern and/or spiny wood fern dominant beneath. Other understorey forbs include oak fern, stinging nettle, twistedstalks, and false hellebore. Elderberry and black gooseberry are often present. Two variations are described:

> **Vs01.1 Sitka alder – Lady fern**
> Lady fern dominates the herb layer
> **Vs01.2 Sitka alder – Spiny wood fern**
> Spiny wood fern dominates the herb layer

Sites are often moist or wet with rich soils, and occur in steep to moderately steep mid to lower portions of the track and less commonly in lateral run-out areas.

Vs02 Sitka alder – Solomon's-seal

The Vs02 has high cover of Sitka alder, with false Solomon's seal and/or fairybells in the herb layer. Cow-parsnip, stinging nettle, clasping twistedstalk, western meadowrue, violets, thimbleberry, and elderberry are often present. Fairybells are more common at lower elevations and are typically absent on Vs02 sites in the ESSF, while thimbleberry occurs more frequently in drier ESSF and MS climates. Sites typically occur in moderately steep mid to lower portions of the track and less commonly in lateral run-out areas. The Vs02 occurs on sites that are warmer (e.g., lower-elevation, warmer aspects) and slightly drier than the Vs01; sites are typically mesic with nutrient-medium soils.

Vs03 Sitka Alder – Hellebore

The Vs03 occurs at upper elevations in the ESSF, including the woodland. Sitka alder dominates the tall shrub layer, with false hellebore and Sitka valerian abundant in the understorey. Arrow-leaved groundsel, stinging nettle, western meadowrue, cow-parsnip, and violets are also common and frequently abundant. The Vs03 typically occurs in steep to moderately steep mid to lower portions of the track. Soils are usually mesic or wetter and nutrient rich.

Vs04 Sitka alder – Devil's club – Oak fern

The Vs04 occurs in the ICH and at lower elevations in the ESSF in moist to wet climates. Sitka alder grows with abundant devil's club in the shrub layers. Lady fern, spiny wood fern, and oak fern are consistently abundant along with a variety of other herbs. Soils frequently have very rocky substrates with continuous subsurface flows of nutrient-enriched water that supports the dense herb and shrub layers.

Vs10 Willow – Cow-parsnip – Fireweed
Vs10 sites are dominated by willows—usually Sitka (*Salix sitchensis*) or Barclay's (*S. barclayi*)—and commonly contain black twinberry, fireweed, cow-parsnip, western meadowrue, and stinging nettle. Sites are often associated with run-out zones adjacent to wetlands and riparian areas but can also occur on moist, lower avalanche slopes. Two variations are described:

> **Vs10.1 Sitka willow – Cow-parsnip – Fireweed**
> Sitka willow is dominant; Barclay's willow and other willows may be present
>
> **Vs10.2 Barclay's willow – Cow-parsnip – Fireweed**
> Barclay's willow is dominant (although other willows may be present)

Vs11 Thimbleberry – Cow-parsnip – Fireweed
Abundant thimbleberry characterizes the Vs11. Cow-parsnip, fireweed, western meadowrue, stinging nettle, and blue wildrye are typical in the understorey and in small openings between patches of thimbleberry. The Vs11 occurs in the ICH, MS, and lower ESSF, on sites with circum-mesic, medium to rich soils. It often occurs on gentle to moderately steep sites in the lower portion of the track or in the lateral run-out zone.

Vs12 Huckleberry – Rhododendron – Fireweed
The Vs12 occurs on dry, usually warm-aspect slopes in the ESSF and ICH in climates where bear-grass is not present. In the south-central Columbia Mountains, it is most common in the ESSFwc4 and wh1, and in the ICHmw2 and wk1. Common species include black huckleberry, mountain-ash, fireweed, and Sitka valerian; white-flowered rhododendron may have high cover, particularly on ESSF sites. Bear-grass is not present.

Vs13 Huckleberry – Bear-grass – Fireweed
The Vs13 occurs on dry, rocky, avalanche paths in the southern Selkirk and Purcell Mountains in the ESSFwh3, wm3, wm4, and wmw, and occasionally at upper elevations in the ICHmw4 and ICHdm. Bear-grass and black huckleberry are common. Mountain-ash, Utah honeysuckle, falsebox, saskatoon, birch-leaved spirea, shrub-sized Bl, fescues, and fireweed may be present with low cover. The Vs13 is similar to the Vs12 but bear-grass is present. Soils are usually submesic and drier with poor soil nutrient regimes.

Vs14 Saskatoon – Snowberry – Strawberry

Saskatoon, snowberry, and/or birch-leaved spirea are abundant in the Vs14. Common juniper may be present. Fireweed, strawberry, and yarrow usually occur with low to moderate cover. Fescues, blue stickseed (*Hackelia micrantha*), and western meadowrue are frequently present. The Vs14 usually occurs on warm aspects at lower elevations in the ICH and MS. Soils have mesic and drier moisture conditions with medium to rich nutrient availability.

Wood strawberry
Fragaria vesca

Wild strawberry
Fragaria virginiana

6.6 Rock Outcrop and Talus Ecosystems

The Rock Group includes sites with little soil, abundant cover of rock or bedrock, and generally low cover of vascular plants. Limited soil and abundant rock restricts vascular plant establishment and growth; trees are sparse to absent. The Rock Group is divided into five classes: Rock outcrops (Ro), Rock talus (Rt), Rock cliffs (Rc), Lava flows (Rl), and Dunes (Rd).[1] This section provides a brief overview of classification and identification of the most common vegetated rock outcrop and talus ecosystems in the south-central Columbia Mountains. Site associations for cliffs, lava flows, and dunes are not described. Alpine rock features are included with the alpine classification as subclasses of the Alpine Fellfield class (see Section 6.7).[2]

This section describes the first correlated rock outcrop and talus ecosystem classification for the Southern Interior of British Columbia; users may find additional rock outcrop and talus ecosystems that are not described in this guide. Ecosystem units are described at the site association scale, but, wherever possible, site variations have been used to capture finer-scale variability in vegetation patterns. Additional detail and new site associations may develop over time as more data are collected.

Ecological significance of rock outcrop and talus ecosystems

Plant composition and cover is usually highly variable depending on adjacent ecosystems, disturbance history, and depth of soil pockets. Rock characteristics, including geology and rock shape, also influence species composition. Soil pockets in these ecosystems also have a strong effect on plant communities due to their moisture and nutrient retention capacity.[3] Vascular plant cover is usually low on rock outcrop and talus ecosystems; mosses, lichens, and/or liverworts frequently have very high cover.

Rock and talus ecosystems are often interspersed with the driest forested site series (102). Due to the open, treeless nature of rock outcrops and talus sites, and the abundance of exposed rock, these sites often provide distinct habitat for ecosystem specialists, including birds, rodents, reptiles, and both vascular and non-vascular plants. Rare and at-risk plant and animal

1 Dunes are not strictly rock ecosystems but are included in this group due to the presence of similar species with similar autecology.

2 The Alpine Fellfield class has four subclasses: Rock (Af-r), Scree (Af-s), Felsenmeer (Af-n), and Fellfield (Af-f). See Section 6.7 for definitions.

3 For detailed field sampling, LMH 25 (Province of British Columbia 2010) describes the Dr sub-layer of the D-layer to differentiate between mosses, lichens, and liverworts growing on rock and those growing in soil pockets and humus. Plants on both substrate types should be recorded when sampling rock outcrops and talus ecosystems, particularly those growing on rock (Dr sub-layer), since rock is the dominant substrate in these ecosystems.

species can be associated with these ecosystems. Limited soil development and depth makes them highly susceptible to erosion and disturbance. Where pockets of deeper soils occur, there is a high risk of non-native invasive plant species establishment.

Common rock and talus ecosystems in the south-central Columbia Mountains

Six rock outcrops and seven talus units commonly occur in the south-central Columbia Mountains.

Rock Outcrop Class (Ro)

Rock outcrop ecosystems occur where the dominant substrate is exposed bedrock. On these features, soil development is very limited. Drought-tolerant bryophytes and lichens are often prominent, while herbs and shrubs are usually restricted to pockets of soil or cracks in the rock surface. Mosses and lichens frequently dominate plant communities on rock outcrops.

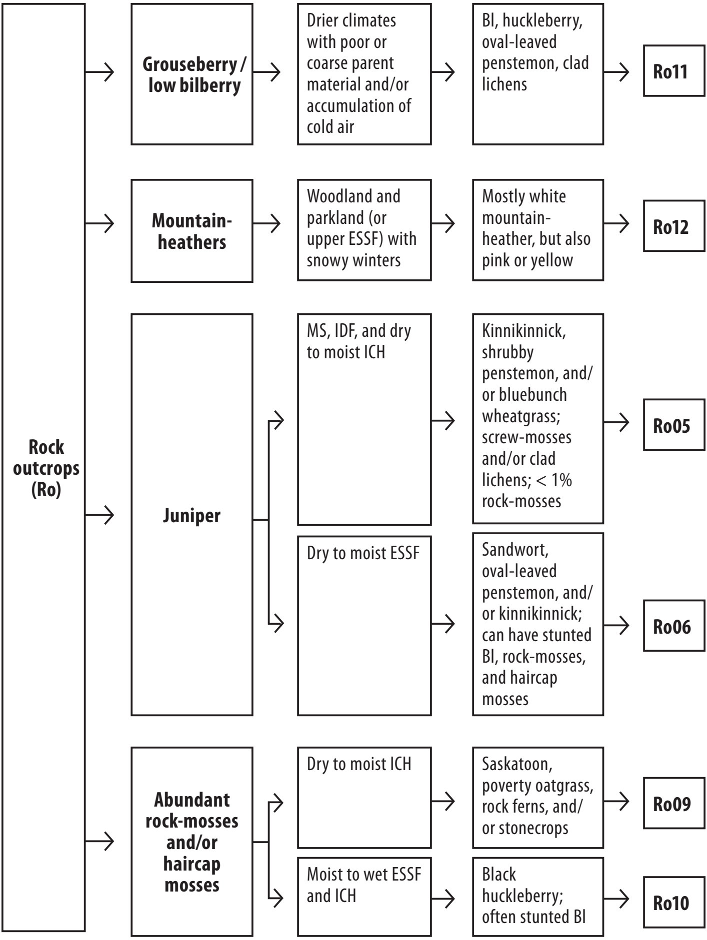
Diversity in species composition and variability in cover are very high across the Rock Outcrop Class because of differences in bedrock geology, the shape and configuration of naturally occurring rock and other substrates, and climate variability. Some rock outcrops are dominated by mosses and lichens and have minimal herb or shrub cover, while others have much higher cover and diversity in herb and shrub communities. Site variations are used frequently to describe this variability.

Distribution of rock outcrop (Ro) site associations by biogeoclimatic unit[a]

Zone	ICH					ESSF								
Unit/BGC	ICHxw(a)	ICHdw1	ICHdm	ICHmw2	ICHmw4	ESSFwh1	ESSFwc4	ESSFwh2	ESSFwm2	ESSFwh3	ESSFwm3	ESSFwm4	ESSFwmw	ESSFwcw
Ro05	*	X	X	X	*									
Ro06						X	X	X	X	X	X	X	*	*
Ro09	X	X	X	X	X									
Ro10		*	*	*	*	X	X	X	X	X	X	X	X	X
Ro11							*		*		*	X	*	*
Ro12							X		*		*	*	X	X

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Rock outcrops (Ro)



Vegetation Table – Rock outcrops

Layer	Scientific name	ICH		ICH/ESSF	ESSF			Common name
		Ro05	Ro09	Ro10	Ro06	Ro11	Ro12	
	Number of plots	64	45	36	45	17	12	
Shrub-size trees	*Pseudotsuga menziesii*	□□	□□					Douglas-fir
	Abies lasiocarpa			■■	□□	□□	■■	subalpine fir
Shrubs	*Juniperus communis*	■■■	□□		■■■	*		common juniper
	Spiraea betulifolia	□	□□					birch-leaved spirea
	Amelanchier alnifolia	□	■■					saskatoon
	Paxistima myrsinites		□□		*			falsebox
	Vaccinium membranaceum			■■■		□□	■■	black huckleberry
Herbs	*Arctostaphylos uva-ursi*	■■■	*		□□□			kinnikinnick
	Pseudoroegneria spicata	□□□						bluebunch wheatgrass
	Penstemon fruticosus/ellipticus	■■	□		□□	□□		shrubby/oval-leaved penstemon
	Achillea millefolium	□	□		■			yarrow
	Sedum spp.	■	□		■			stonecrops
	Antennaria spp.	□			□□		□	pussytoes
	Selaginella spp.	*	□□		□□	*		selaginellas
	"rock ferns"[a]	*	■■					rock ferns
	Heuchera cylindrica	*	□					round-leaved alumroot

Layer	Scientific name	ICH Ro05	ICH Ro09	ICH/ESSF Ro10	ESSF Ro06	ESSF Ro11	ESSF Ro12	Common name
	Number of plots	64	45	36	45	17	12	
Herbs	"saxifrages"[a]	*		□□			■■	saxifrages
	Eremogone capillaris				■■			thread-leaved sandwort
	Lupinus arcticus							arctic lupine
	Vaccinium scoparium/myrtillus					■■■		grouseberry/low bilberry
	Phyllodoce empetriformis						□	pink mountain-heather
	Cassiope mertensiana						■■■■	white mountain-heather
	Carex spectabilis						■■	showy sedge
	Vahlodea atropurpurea						■■	mountain hairgrass
	Luetkea pectinata						□□	partridge-foot
Mosses, lichens, liverworts	*Cladonia* spp.	■■■	■■■	■■■	□□	■■■	■■■	clad lichens
	Tortula ruralis	□□□				*		sidewalk screw-moss
	Peltigera spp.	■■	□		□	□□		pelt lichens
	Polytrichum spp.	*	■■■	■■■	□□□	■■	■■■	haircap mosses
	Racomitrium spp.		■■■■■	■■■■	□□	*	■■■■	rock-mosses
	Dicranum spp.			□□□		□□□	□□□	heron's-bill mosses

[a] Lists of grouped species are provided in Appendix 1.1.

Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

Ro05 Juniper – Kinnikinnick – Penstemon
The Ro05 is a low- to mid-elevation rock outcrop association that is common across the dry to moist ICH in the field guide area. It is also common in the MS, and IDF in other areas. These rock outcrops are characterized by moderate to abundant cover (3–20%) of common juniper with kinnikinnick, shrubby penstemon, clad lichens, and sidewalk screw-moss. Where common juniper is absent or sparse (< 3% cover), kinnikinnick and shrubby penstemon are typically present. Other common shrubs in the Ro05 include Rocky Mountain juniper, saskatoon, birch-leaved spirea, and falsebox. Pussytoes, round-leaved alumroot, pinegrass (*Calamagrostis rubescens*), and/or spotted saxifrage (*Saxifraga bronchialis*) may occur with variable cover. Bluebunch wheatgrass cover is occasionally high (~5–15%). The Ro05 and Ro09 both occur in the ICH in the south-central Columbia Mountains, but the Ro05 lacks rock-mosses, which are abundant in the Ro09. The Ro05 usually occurs adjacent to forests dominated by Fd, often with Pl and occasionally with Py (at the driest extent).

Ro06 Juniper – Stonecrop – Sandwort
The Ro06 occurs across the ESSF in southern British Columbia, from very dry to moist and wet subzones. It is characterized by common juniper (~2–10% cover), thread-leaved sandwort, and selaginellas. Minor amounts of stonecrops, yarrow, and pussytoes are common. In moister climates, oval-leaved penstemon, round-leaved alumroot, rock-mosses, and haircap mosses are more common, while kinnikinnick is typical in drier, colder climates. Pelt and clad lichens often grow on exposed rock. Two variations of the Ro06 are recognized:

> **Ro06.1 Juniper – Stonecrop – Sandwort**
> Rock-mosses, haircap mosses, and penstemons are common; more commonly found in the moister climates of the ESSFdc1, mh, wh, and wm
>
> **Ro06.2 Juniper – Kinnikinnick – Stonecrop – Sandwort**
> Kinnikinnick is abundant; more commonly found in the drier climates of the ESSFdc2, dc3, and xc (described in other field guides)

The Ro06 is replaced by the Ro05 at lower elevations in the ICH, MS, and IDF. Ro06 sites usually occur adjacent to forests with Se, Sxw, and/or Bl.

Ro09 Saskatoon – Rock-moss – Clad lichen
The Ro09 is the most commonly observed rock outcrop type in the very dry to moist ICH (xw, dw, dm, and mw) in southeast British Columbia. Rock-mosses and clad lichens typically form a dense mat, although other mosses can also occur with low cover. Shrub cover averages ~10% but ranges from

sparse (< 3%) to abundant (> 20%). Small amounts of saskatoon, falsebox, birch-leaved spirea, Oregon-grape (*Mahonia* spp.), and/or common juniper are usually present. Oceanspray (*Holodiscus discolor*) and mallow ninebark (*Physocarpus malvaceus*) are common in the ICHxw and dw1, and at lower elevations in the ICHdm, mw2, and mw4. Rock ferns (mostly parsley fern [*Cryptogramma acrostichoides*] and cliff ferns [*Woodsia* spp.]), round-leaved alumroot, stonecrops, and selaginellas often occur with low cover (< 5% each). Two variations are presented to reflect variability in cover of poverty oatgrass:

Ro09.1 Saskatoon – Rock-moss – Clad lichen
Poverty oatgrass is sparse (< 5%)

Ro09.2 Saskatoon – Poverty oatgrass – Rock-moss – Clad lichen
Poverty oatgrass is prominent (> 5%); reindeer lichens (*Cladina* spp.) are often present

The Ro09 typically occurs adjacent to forests with Fd, Cw, Lw, and/or Pl.

Ro10 Huckleberry – Rock-moss – Haircap moss

The Ro10 is common in the moist and wet ESSF (mh, wh, wm, wc) and also occurs in the moist to very wet ICH (mw, wk, vk). It is characterized by the presence of black huckleberry, rock-mosses, and haircap mosses (mostly awned [*Polytrichum piliferum*]). Bl is often present as scattered, stunted trees or saplings, often with very minor Se or Sxw. Herb cover is typically sparse, with minor cover of Alaska saxifrage, and/or Ross' sedge (*Carex rossii*) and other dry sedge species. Clad lichens, heron's-bill mosses, and leafy liverworts (mostly *Barbilophozia* spp.) commonly occur. Variability in vegetation can be high, with cover of black huckleberry, rock-mosses, and haircap mosses ranging from sparse (< 1%) to high (> 10%). The Ro10 is usually replaced by the Ro09 on warmer sites and at lower elevations. These ecosystems typically occur adjacent to forests with Se, Bl, (or Hm) in the ESSF, or adjacent to ICH forests with Cw, Hw, and/or Fd.

Ro11 Grouseberry – Clad lichen

The Ro11 occurs in the dry ESSF and in the MS in areas outside the south-central Columbia Mountains, but it is also found where grouseberry and/or low bilberry are common in the ESSFwh3, mh, wm3, wm4, and wmw, and on colder, drier sites in the wcw. It is characterized by high cover of low bilberry and/or grouseberry. Clad lichens are frequently present. Bl is often present as scattered, stunted trees or saplings. Other species often include black huckleberry, oval-leaved penstemon, dry sedges (usually Ross' sedge), heron's-bill mosses, and clad lichens. Selaginellas and rock-mosses frequently occur, especially in moister climates, while stunted Pl trees are common in drier climates. Bedrock types are often coarse grained and nutrient poor. Ro11 sites frequently occur adjacent to forests with Se, Sxw, Bl, and/or Pl.

Ro12 Mountain-heather – Alaska saxifrage – Rock-moss
The Ro12 occurs where snow cover is deep at upper elevations in the wet to very wet ESSF (wc, wm, vc) and associated woodland and parkland units. It is characterized by moderate cover of mountain-heathers, mostly white mountain-heather, but often pink and/or yellow mountain-heather (*Phyllodoce glanduliflora*), particularly in the southern half of the field guide area. Clad lichens, haircap mosses, rock-mosses, and heron's-bill mosses are typically present and abundant. Alaska saxifrage, showy sedge, and mountain hairgrass are common. Partridge-foot often occurs in the wettest climates, particularly in the northern half of the ESSFwcw and wcp. Ro12 sites typically occur adjacent to Se, Bl, and/or Hm forests.

Rock Talus Class (Rt)

Talus ecosystems are comprised of rock debris and include stable slopes comprised of boulders, and unstable slopes made of smaller cobbles and gravels that are actively moving (often imperceptibly slow) due to gravity.[4] Talus sites are distinct in that they have minimal soil (particles < 2mm) in the spaces between rocks. Vegetation either adheres to the surface of rocks or grows in the limited soil in the spaces between rocks. Lack of soil and/or mobility of rock substrates are limiting factors for the establishment and growth of vascular plants. Talus ecosystems often have high lichen and bryophyte cover. Herb and shrub species are frequently similar to those in adjacent rock outcrop communities. Some stable talus ecosystems may have low to moderate cover of deciduous trees or shrubs.

Vegetation communities in talus ecosystems are strongly linked to climate (heat and moisture) and rock material. Talus slopes comprised of hard rocks such as granitics (e.g., granite, granodiorite), volcanics (e.g., andesite, basalt), and metamorphic gneiss weather very slowly and have limited soil. This limits establishment and growth of vascular plants. Sedimentary (e.g., limestone, shale) and softer metamorphic (e.g., schist, shale) rock types are more easily weathered and tend to break down rapidly into fine-textured materials or smaller particle sizes. Finer textures support the establishment of herbs, shrubs, and some trees, although the smaller, plate-like rock pieces are also more mobile, which also limits plant establishment.

[4] Some authors refer to stable slopes as "talus" and unstable slopes as "scree." No distinction is made in this field guide, and the Rt ecosystems described can occur on both types.

Distribution of talus (Rt) site associations by biogeoclimatic unit[a]

Zone	ICH					ESSF								
Unit/BGC	**ICHxw(a)**	**ICHdw1**	**ICHdm**	**ICHmw2**	**ICHmw4**	**ESSFwh1**	**ESSFwc4**	**ESSFwh2**	**ESSFwm2**	**ESSFwh3**	**ESSFwm3**	**ESSFwm4**	**ESSFwmw**	**ESSFwcw**
Rt01	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rt02	*	X	X	X	X	X	X	X	X	X	X	X		
Rt03	X	X	X	X	X	*		*		*				
Rt06	X	*	*											
Rt07			*			X	X	X	X	X	X	X		
Rt08	*	*	*											
Rt21							*		X		X	X	X	X

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

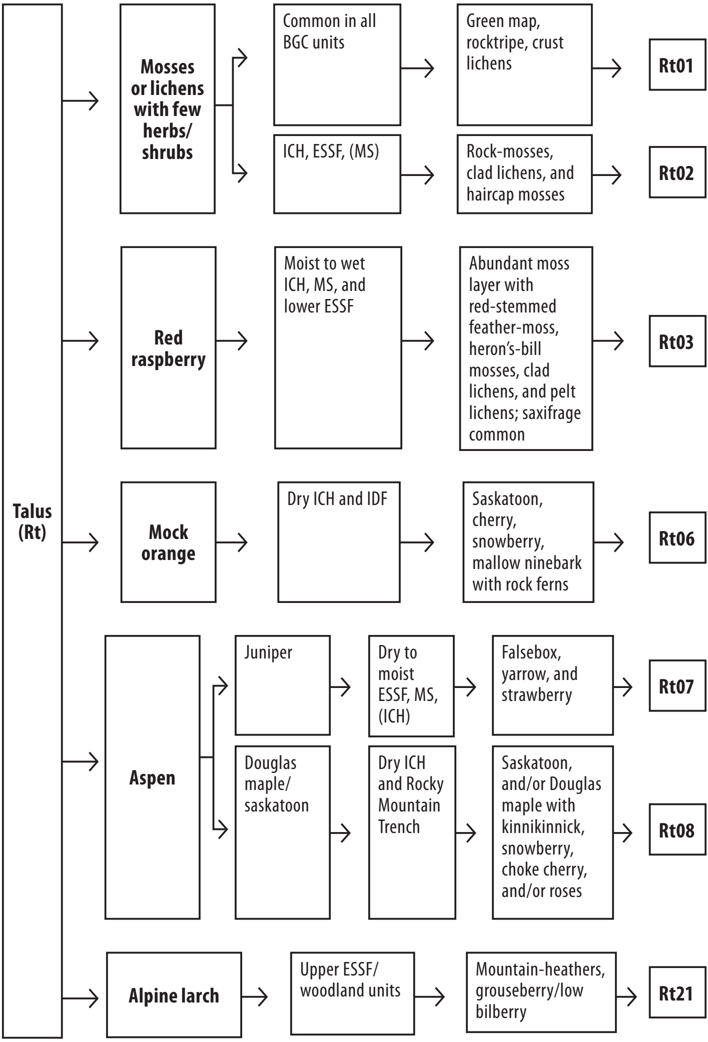
Rt01 Rocktripe – Green map

The Rt01 is common throughout all BGC units in southeast British Columbia, from valley bottom to the ESSF. It is characterized by lichen-covered, stable, blocky talus and limited cover (usually < 2% each) of moss, herb, and shrub species. Common lichens on these sites include a wide array of crustose lichen species (often in the genera *Caloplaca, Buellia, Lecanora,* and *Rinodina*) along with rocktripe lichens, green map, and clad lichens. This ecosystem is common on relatively stable talus slopes derived from hard rocks such as granitics and volcanics, with no soil.

Rt02 Rock-moss – Clad lichen

The Rt02 is common in the ICH and ESSF in the moist climate subregion. It also occurs in the MS (described in other field guides), particularly in sheltered areas where cool or moist local conditions lead to lower evaporation rates (e.g., on steep cool aspects, in narrow canyons, or on slopes adjacent to lakes). It is characterized by moss-covered rock and is common on slopes of large, blocky talus with little to no soil. These sites support high cover of clad lichens, rocktripe, rock-mosses, and/or haircap mosses, and limited cover of herbs and shrubs (typically < 5% in each layer). The Rt02 occurs in moister climates than the Rt01 or on cooler sites in the same biogeoclimatic units. Other Rt site associations have more herbs and shrubs.

Flowchart – Talus (Rt)



Rt03 Raspberry – Feathermoss – Clad lichen

The Rt03 occurs throughout the moist to wet ICH, throughout the MS, and at lower elevations of the ESSF in southeastern British Columbia. Substrates consist of boulders, or sometimes cobbles, usually with small pockets of mineral soil. Minor to moderate cover of red raspberry (0.1–10%) is characteristic, with abundant cover in the moss layer, including red-stemmed feathermoss, haircap mosses, heron's-bill mosses, and clad lichens. Other common species with low cover include rocktripe lichens, pelt lichens, spotted saxifrage, and rock ferns (particularly parsley fern [*Cryptogramma acrostichoides*] and cliff ferns [*Woodsia* spp.]). Red-stemmed feathermoss is often sparse to absent in the south Selkirk Mountains. Fd, Py, Pl, and Lw are common in adjacent forests.

Rt06 Saskatoon – Mock-orange – Bluebunch wheatgrass

The Rt06 occurs on dry, warm sites in the dry ICH (xw, xwa, and dw) in the south-central Columbia Mountains and on cooler sites in the PP and IDF in the Boundary, Okanagan, and Rocky Mountain Trench. Most sites are relatively stable and are comprised of small to large angular rocks, but portions may be unstable and support little or no vegetation. Sites can be very shrubby with abundant saskatoon, mock-orange, and choke cherry. Snowberry, Douglas maple, mallow ninebark, and other cherries (occasionally bitter cherry [*Prunus emarginata*] or pin cherry [*P. pensylvanica*]) may occur. Bluebunch wheatgrass, rock ferns, and round-leaved alumroot are often present with low cover. Fd and Py are common in adjacent forests. The Gb03 has similar shrub species as the Rt06 but occurs on sites with deeper, although rubbly, soils with high coarse fragment content.

Rt07 Aspen – Juniper – Rocktripe

The Rt07 occurs primarily in dry cool or cold biogeoclimatic units in the IDF and MS, but it also occurs in the ICH (dm and mk), in lower elevations of the dry ESSF subzones/variants (e.g., dk), and on warm aspects in the ESSFwm4. Substrates typically consist of cobbles and stones. These sites are generally stable and may occur intermixed with other Rt units. Common juniper is present and often abundant. Other common species include falsebox, rock ferns, shrubby penstemon, rocktripe, and clad lichens. Aspen is frequently present as stunted individuals or open clonal patches, but, given the harsh site conditions, will persist but never form a continuous mature forest. Two variations are presented to reflect sites with and without aspen:

> **Rt07.1 Aspen – Juniper – Rocktripe**
> Aspen is present, typically with > 5% cover
> **Rt07.2 Juniper – Rocktripe**
> Aspen is absent or sparse

Vegetation Table – Talus

Layer	Scientific name	Rt01	Rt02	Rt03	Rt06	Rt07	Rt08	Rt21	Common name
	Number of plots	26	35	12	11	24	18	6	
Shrub-sized trees	*Pseudotsuga menziesii*				■■				Douglas-fir
	Populus tremuloides					■■■	■■■■		trembling aspen
	Larix lyallii							■■■■	subalpine larch
	Abies lasiocarpa							■■■	subalpine fir
Shrubs	*Rubus idaeus*		■	■■■	*				red raspberry
	Amelanchier alnifolia				■■■		■■■		saskatoon
	Prunus virginiana				■■■		■■		choke cherry
	Philadelphus lewisii				■■■				mock-orange
	Acer glabrum				*		■■■		Douglas maple
	Juniperus communis					■■■■	*		common juniper
	Paxistima myrsinites					■■			falsebox

Layer	Scientific name	Rt01	Rt02	Rt03	Rt06	Rt07	Rt08	Rt21	Common name
	Number of plots	26	35	12	11	24	18	6	
Herbs	"rock ferns" [a]	*	□	■■	■■	■	□		rock ferns
	Saxifraga bronchialis			□□□					spotted saxifrage
	Penstemon fruticosus					□□	■		shrubby penstemon
	Arctostaphylos uva-ursi					*	□□□		kinnikinnick
	Phyllodoce empetriformis							■■■	pink mountain-heather
	Vaccinium scoparium/myrtillus							□□□	grouseberry/low bilberry
Moss layer	"crust lichens" [a]	■■■■			□□□	□□			crust lichens
	Umbilicaria spp.	■■■	■■■	*		□□	*		rocktripe lichens
	Rhizocarpon geographicum	□□□	*						green map
	Cladonia spp.	■■	■■■	■■■	*	■■	□	■■	clad lichens
	Racomitrium spp.	□	■■■■	*					rock-mosses
	Dicranum spp.		■■	■■■				■■■■	heron's-bill mosses
	"leafy liverworts" [a]		*	□□□				□□□□	leafy liverworts
	Cladina spp.		□□□	□□					reindeer lichens
	Pleurozium schreberi		*	■■■■					red-stemmed feathermoss

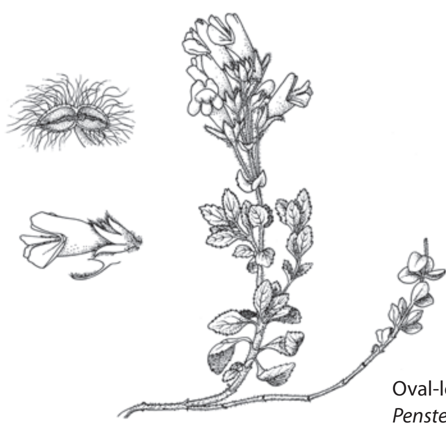
Mean cover: ■ < 1% ■■ 1–3% ■■■ 3–10% ■■■■ 10–25% ■■■■■ > 25% * 25–50% of plots and >1% cover

Constancy: ■ > 70% of plots □ 50–70% of plots

The Rt08 also has aspen but differs from the Rt07 due to the lack of juniper and the abundance of saskatoon and/or Douglas maple. Fd, Pl, Sxw, Se, and Bl are common in adjacent forests.

Rt08 Aspen – Douglas maple – Saskatoon
The Rt08 is common in the MS and ICHmk in the Rocky Mountain Trench and occurs infrequently in the dry ICH (dm, dw, xw). It commonly occurs on stable cobbly materials consisting of rocks between 10 and 30 cm in diameter. Stunted At trees dominate the plant community, along with saskatoon and Douglas maple. Other common species with low to moderate cover include kinnikinnick, snowberry, choke cherry, roses, rock ferns (mostly cliff ferns), shrubby penstemon, and round-leaved alumroot. Adjacent forests are often dominated by Fd, Lw, Pl, and/or Sxw.

Rt21 Subalpine larch – Pink mountain-heather – Heron's-bill
The Rt21 occurs on blocky talus in the ESSFwm woodland and upper ESSF units, and in the southern areas of the ESSFwc4 and wcw. It is restricted to very cold sites, typically on cool-aspect slopes, often above high-elevation lakes and basins. La is dominant as stunted trees in the shrub layer, and often occurs scattered in the tree layer (> 10 m tall). Pink mountain-heather, grouseberry/low bilberry, and black huckleberry are usually present in the understorey, with mountain leafy liverwort (*Neoorthocaulis floerkei*), heron's-bill mosses, and clad lichens. The Rt21 has many characteristics that are similar to krummholz (Sk) but occurs on blocky talus sites with limited soil.



Oval-leaved penstemon
Penstemon ellipticus

6.7 High-elevation Ecosystems

Classification of high-elevation ecosystems is currently in progress. The following sections provide an overview of the site classes in the Alpine and Subalpine Shrub groups. Detailed site association classifications are not presented but are expected in subsequent publications.

Biogeoclimatic zones and subzones of high-elevation ecosystems in the south-central Columbia Mountains

Three high-elevation biogeoclimatic units are mapped in the south-central Columbia Mountains: undifferentiated Interior Mountain-heather Alpine (IMAun), Engelmann Spruce – Subalpine Fir wet cold parkland (ESSFwcp), and Engelmann Spruce – Subalpine Fir wet mild parkland (ESSFwmp).

The IMA occurs at uppermost elevations and is defined by climates that are too cold to support tree growth. Parkland subzones occur below the IMA or at mountain tops where elevations do not reach IMA climate conditions. Parkland subzones have subalpine climates that support tree survival, but cold growing seasons and harsh winters allow for only stunted krummholz tree growth. Parkland subzones support mixed krummholz and alpine ecosystems, with patchy krummholz stands interspersed with herb- or shrub-dominated alpine plant communities.

Woodland subzones occur below the parkland and reflect climates at the uppermost forested elevations, where tree cover is consistent but with reduced productivity in response to shorter growing seasons and increased snowpack. Woodland subzones/variants are transitional between montane forests and subalpine environments, and are described in Chapter 5. Two subzones are described: Engelmann Spruce – Subalpine Fir wet cold woodland (ESSFwcw) and Engelmann Spruce – Subalpine Fir wet mild woodland (ESSFwmw). The high-elevation ecosystems described in this section frequently occur in the woodland, particularly on colder sites, including north-facing basins, near high-elevation lakes, and where cold air pools. Descriptions and coding used here are appropriate for use in the woodland and occasionally in upper elevations of the ESSF.

Interior Mountain-heather Alpine (IMA)

The IMA is the coldest, snowiest, harshest environment in the south-central Columbia Mountains. Temperatures are cold for most of the year, and high winds are typical. Very deep snow, lasting for at least half of the calendar year, is common throughout the IMA in the South Columbia Mountains. Snow accumulation typically begins in October and lasts through to June or July.

Cold conditions preclude establishment of trees in the IMA, although limited sites with occasional "shin tangle," very low-growing krummholz-form trees—primarily Bl—may occur. Dwarf shrub or sedge-dominated plant communities are common. In the snowy environments of the IMA in the south-central Columbia Mountains, a broad spectrum of alpine ecosystems occurs: tundra (At), heath (Ah), meadow (Am), fellfield (Af), and late snowbed (As). Alpine grasslands (Ag) are very uncommon and are restricted to the driest, warm-aspect sites in the southern Selkirk and Purcell Mountains (see Section 6.4). Avalanche chutes and start zones are common (see Section 6.5). Currently, no subzone/variant differentiation has been completed for the IMA, although future mapping and delineation may occur.

Engelmann Spruce – Subalpine Fir Wet Mild Parkland (ESSFwmp)

The ESSFwmp occurs above the ESSFwmw in the Purcell Mountains, the south Selkirk Mountains, and the Lizard Range in the Rocky Mountains. Although described and mapped as one biogeoclimatic unit, users who require further subdivisions can separate the ESSFwmp based on the ESSFwm variants that occur below: ESSFwmp1, ESSFwmp2, ESSFwmp3, and ESSFwmp4.

Krummholz (Sk) forest types are typically dominated by Bl, with lesser amounts of Se, La, or Pa. Trees have stunted growth, but krummholz stands commonly exceed 10 m in height, especially at lower elevations of the subzone. The ESSFwmp, along with the ESSFwmw, has one of the highest concentrations of alpine larch (La [*Larix lyalli*]) in the world, particularly in the Purcell Mountains. Prior to white pine blister rust and mountain pine beetle effects, Pa was historically common on dry ridges. Alpine ecosystems, including tundra (At), meadows (Am), late snowbed (As), and fellfield (Af), are commonly interspersed with krummholz (Sk). Avalanches are common in steep terrain (see Section 6.5). Heath ecosystems (Ah) are moderately common on drier than mesic sites with high snow cover. Alpine wetlands (Wa) are restricted to seeps and saturated flats (see Section 6.2).

Engelmann Spruce – Subalpine Fir Wet Cold Parkland (ESSFwcp)

The ESSFwcp always occurs above the ESSFwcw. It covers an extensive area throughout the Columbia Mountains, including the Monashee, Selkirk, Purcell, and Cariboo Ranges. Although described as one biogeoclimatic unit here, users who require additional subdivisions can separate the ESSFwcp based on the ESSFwc variants that occur below: ESSFwcp2, ESSFwcp3, and ESSFwcp4. The ESSFwcp4 occurs in the south-central Columbia Mountains; the ESSFwcp2 and ESSFwcp3 occur in the North Columbia Mountains.

Krummholz forests (Sk) of Bl, with lesser amounts of Se, are the most common ecosystem across the ESSFwcp. On drier sites, Pa is common. In the southern extent, particularly in the ESSFwcp4, La is also common. Pa is uncommon in the ESSFwcp3, and La is absent in both the ESSFwcp2 and ESSFwcp3. In krummholz (Sk) forests, trees have stunted growth but commonly exceed 10 m in height, especially at lower elevations. Alpine ecosystems, including tundra (At), meadows (Am), heath (Ah), late snowbed (As), and fellfield (Af), are commonly interspersed with krummholz (Sk). Avalanches are common in steep terrain (see Section 6.5). Alpine wetlands (Wa) are restricted to seeps and saturated flats (see Section 6.2). Shrub carr (Sc) ecosystems are restricted to moist, frost-prone sites, and are more common in northern areas in the ESSFwcp2 and ESSFwcp3 (see page 432).

Naming and coding of high-elevation ecosystems

Alpine ecosystems occur across the IMA, parkland, and woodland, and occasionally in the upper ESSF. The Subalpine Shrub Group is absent from the IMA. The Alpine Group includes eight[1] classes; the Subalpine Shrub Group includes two.

Distribution of alpine and subalpine site associations by biogeoclimatic unit[a]

Group	Class	Code	IMA	ESSFwcp	ESSFwmp	Woodland[b]
Alpine	Alpine meadow	Am	*	X	X	*
	Alpine grassland	Ag			*	*
	Alpine heath	Ah	X	X	*	*
	Alpine nivation (Late snowbed)	As	X	X	X	*
	Alpine tundra	At	X	X	X	*
	Alpine fellfield	Af	X	X	X	*
	Alpine zoogenic	Az	*	*	*	*
Subalpine Shrub	Shrubland/Shrub carr	Sc		*	*	*
	Krummholz	Sk		X	X	*

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.
[b] Includes ESSFwcw and ESSFwmw.

[1] Alpine wetlands are described in Section 6.2.

Alpine Group

The Alpine Group includes all ecosystems where the combination of cold, short growing seasons and harsh winters are too extreme for the establishment and growth of trees or tall shrubs. Steep, rugged terrain with extensive areas of exposed bedrock, talus, and ice characterize the landscape of the Alpine Group. Soils are often shallow and derived from weathered bedrock or colluvium.

Growing conditions are extreme, and small differences in micro-environments can have a large effect on plant communities. Snow depth and duration are the most important factors determining the distribution of plant communities in climates where the Alpine Group occurs. Other key environmental drivers include soil moisture regime; aspect; soil depth, texture, and temperature; frost; and exposure to wind. Eight site classes are described for the Alpine Group.

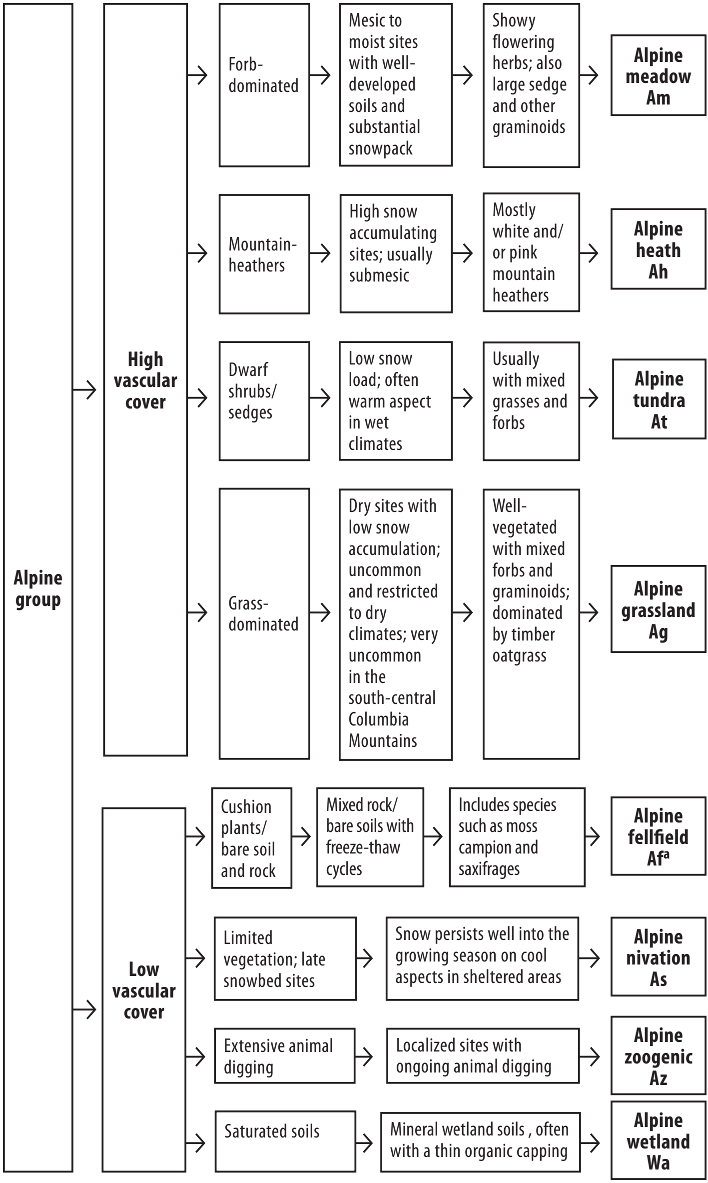
Alpine meadows (Am)

Forb-dominated alpine meadow ecosystems occur on mesic to moist sites with continuous winter snowpack and (usually) well-developed soils. Vegetation typically has high cover (> 50% in the herb layer) and high stature with showy flowering forbs, including subalpine daisy (*Erigeron peregrinus*), arrow-leaved groundsel (*Senecio triangularis*), Sitka valerian (*Valeriana sitchensis*), false hellebore (*Veratrum viride*), arctic lupine (*Lupinus arcticus*), western pasqueflower (*Anemone occidentalis*), and paintbrushes (*Castilleja* spp.). Large sedge-dominated plant communities (e.g., showy sedge [*Carex spectabilis*]) are also part of the Alpine Meadow Class. Alpine meadows are most common in parkland environments but also occur in the IMA and woodland.

Alpine heath (Ah)

Mountain-heather–dominated ecosystems occur on snow-accumulating sites with stable substrates. Moderate snow accumulations are of intermediate depth between tundra and late snowbed ecosystems. Site conditions are typically mesic and drier. Mountain-heather species are always prominent, with white mountain-heather (*Cassiope mertensiana*) and pink mountain-heather (*Phyllodoce empetriformis*) most common. Yellow mountain-heather (*P. glandulifora*) also occurs. Alpine heath ecosystems are most common in the ESSFwcp and IMA but also occur in the ESSFwcw, ESSFwmp, and ESSFwmw.

Flowchart – Alpine classes



[a] There are four subclasses for the Alpine Fellfield Class: Fellfield (Af-f), Rock (Af-r), Felsenmeer (Af-n), Scree (Af-s)

Alpine tundra (At)

Alpine tundra ecosystems are relatively well-vegetated ecosystems of mixed life-form composition, commonly with an abundance of dwarf shrubs and sedges (*Carex* spp.) mixed with forbs and grasses. These ecosystems occur on relatively exposed, cold, circum-mesic sites with moderate snow cover. Alpine tundra ecosystems are common on drier, warm aspects in the cool, wet climates of the IMA and parkland in the south-central Columbia Mountains but may occur on neutral and cool aspects in the ESSFwmp and ESSFwmw, particularly at the southern extent (e.g., ESSFwmp3, ESSFwmp4, and IMA above these).

Late snowbed (Nivation [As])

Areas with very deep or persistent snowpacks that last well into the growing season commonly support plant communities of low cover and low species diversity. These sites generally occur on cool aspects and in sheltered locations where snowmelt is slow. Few species can tolerate the short growing season and environmental conditions. Erosion during snowbed melting (nivation) and growing-season cryoturbation (soil mixing from freeze–thaw cycles) is extreme due to lack of vegetation cover and high soil moisture. Graminoids are most common; black alpine sedge (*Carex nigricans*) often forms a near-pure plant community on late snowbed sites.

Fellfield (Af)

Alpine fellfield can be divided into four subclasses based on substrate: Rock (Af-r) occurs on exposed bedrock; Scree (Af-s) occurs on mobile, rocky substrate; Felsenmeer (Af-n) occurs on boulder fields; and the typic Fellfield (Af-f) occurs on substrates of mixed rock and exposed mineral soil where freeze–thaw conditions physically push plants out of the soil. Fellfields are commonly populated by cushion plants (tufted perennials that grow close to the ground), although rockier sites are usually dominated by mosses and lichens. Common herb species include moss campion (*Silene acaulis*), thread-leaved sandwort (*Eremogone capillaris*), and saxifrages (*Saxifraga* spp.).

Alpine grassland (Ag)

Alpine grasslands are grass-dominated ecosystems of dry, cold climates with low snow load and well-developed soils. Alpine grasslands differ from the physiognomically similar Grassland Group (Gg) (see Section 6.4) in that cold winters and growing-season frosts are the dominant ecological factors rather than heat and associated growing-season aridity. Where they occur (very infrequently) in the south-central Columbia Mountains, alpine grasslands are dominated by timber oatgrass instead of bunchgrasses, which characterize grassland (Gg) ecosystems. Other ecosystems with grasses occur in the IMA, ESSFwmp, and ESSFwcp, but they typically have abundant sedges (*Carex* spp.), dwarf shrubs, and/or forbs, and meet the definition of alpine tundra (At) rather than true grasslands. Grasslands (Gg) are very uncommon on warm-aspect sites in areas of the ESSFwmw and ESSFwmp.

Alpine zoogenic (Az)
Communities that are strongly affected by ongoing animal activities occur in highly localized areas and have distinct vegetation from adjacent ecosystems. Marmots and ground squirrels are often responsible for perpetuation of these ecosystems.

Alpine wetland (Wa)
Alpine wetlands occur on seeps and saturated flats that have site characteristics that are similar to lower-elevation swamps or marshes: mineral soils, often with a thin organic capping, and persistent water table during the growing season. Due to their similarity to other wetland types, alpine wetlands are described with other wetlands in Section 6.2.

Subalpine Shrub Group

The Subalpine Shrub Group occurs in the parkland and woodland, is absent from the IMA, and may occur infrequently in upper areas of the ESSF that have cold air or cold soils. These ecosystems occur in subalpine climates with cold winters and short growing seasons, which limit but do not preclude the establishment and growth of trees. Shrubs or shrub-height conifer trees are characteristic. As with forested ecosystems, soil moisture is the primary environmental gradient that differentiates subalpine shrub ecosystems at the site level. Two Subalpine Shrub classes are identified.

Krummholz (Sk)
Krummholz ecosystems occur in climates at the upper elevation extremes for conifer tolerance. Conifers commonly have dwarfed stature (shrub size) due to harsh environmental conditions, including cold growing-season temperatures, winter frost, and wind damage. Bl is typically the most common tree species, although Se is common, and Pa or La may occur. In the south-central Columbia Mountains, individual krummholz trees often exceed 10 m in height but are significantly less productive than woodland forests at lower elevations.

Krummholz sites are typically well to rapidly drained, with thin or coarse-textured soils. Some krummholz types are floristically similar to lower-elevation subalpine forests, with species such as white-flowered rhododendron, black huckleberry, false hellebore, grouseberry/low bilberry, or Sitka valerian. Krummholz ecosystems are common in the ESSFwmp and ESSFwcp, and can occur on cold sites in the woodland. Site associations for krummholz ecosystems are under development.

Shrubland/ Shrub carr (Sc)

Deciduous, shrub-dominated ecosystems that develop on frost-prone sites that would otherwise support conifer trees are part of the Shrubland/Shrub carr Class. These ecosystems can be widespread in the parkland but also occur in frost-prone hollows at lower elevations in the woodland and upper ESSF. Two subclasses are recognized: shrub-carr (Sc-c) on moist sites and shrubland (Sc-b) on dry sites.

Shrub carr ecosystems (Sc-c) describe moist and very moist sites. These are described in *Wetlands of British Columbia* (MacKenzie and Moran 2004) as occurring on sites with cold mineral soils that are prone to cold air and frost. These "transitional ecosystems" do not flood, although groundwater is the primary sources of moisture. Willows are the dominant shrub species in the south-central Columbia Mountains, although shrub-carr ecosystems dominated by scrub birch (*Betula nana*) may occur. MacKenzie and Moran (2004) recognize three shrub-carr site associations; the *Sc03 Barclay's willow – Arrow-leaved groundsel* occurs within the south-central Columbia Mountains.

Shrublands (Sc-b) occur on dry sites where cold air, frost, and cold soils are the dominant environmental factors. Black huckleberry and white-flowered rhododendron are common shrubland species in the south-central Columbia Mountains. Shrublands differ from brushlands (Gb) in that cold air and growing-season frost are the dominant ecological drivers rather than hot, dry sites. Shrubland site associations have not yet been defined but are expected to be described in subsequent publications.

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APPENDIX 1 PLANT SPECIES NAMES AND ILLUSTRATIONS

Plant species names used in this field guide follow the current provincial standard for both scientific and common names (at the time of publication). Species grouped across genera but with similar lifeform and ecosystem indicator value are listed in Appendix 1.1, while species grouped within a genus are listed in Appendix 1.2. Appendix 1.3 shows the current and retired/old names for species that have undergone recent name changes. A list of plant illustrations shown in this field guide is provided in Appendix 1.4. A full list of species scientific and common names referred to in this field guide, along with species codes, is available on the BECWeb site.

Useful references for plant identification include the E-Flora BC website, *Plants of Southern Interior British Columbia* (Parish et al. 1996), *Illustrated Flora of British Columbia* (Douglas et al. 1998–2002), and the Flora of North America website. Nomenclature for the scientific names of plants of North America is undergoing a widespread updating process, and the names for many plant species in published books are not current. Provincial plant lists are updated annually to incorporate scientific or common plant name changes. For the most up-to-date nomenclature, see the table of taxonomic and nomenclature names in the "Official Provincial Plant Species Codes" on BECWeb.[1]

[1] Official species names, codes, and changes are also tracked by the British Columbia Conservation Data Centre.

1.1 Species grouped across genera[a]

Lifeform	Species	Scientific name	Common name
Herbs	"mitreworts"	*Mitella nuda*	common mitrewort
		Mitella spp.	
		Pectiantia breweri	Brewer's mitrewort
		Pectiantia pentandra	five-stamened mitrewort
	"saxifrages"	*Micranthes ferruginea*	Alaska saxifrage
		Micranthes spp.	
		Saxifraga bronchialis	spotted saxifrage
		Saxifraga spp.	
	"mountain-heathers"	*Cassiope mertensiana*	white mountain-heather
		Phyllodoce empetriformis	pink mountain-heather
		Phyllodoce glanduliflora	yellow mountain-heather
	"rock ferns"	*Cryptogramma acrostichoides*	parsley fern
		Cystopteris fragilis	fragile fern
		Polypodium hesperium	western polypody
		Woodsia oregana	western cliff fern
		Woodsia scopulina	mountain cliff fern
Mosses	"brown mosses"	*Campylium* spp.	star-mosses
		Campylium stellatum	golden star-moss
		Drepanocladus aduncus	common hook-moss
		Drepanocladus spp.	hook-mosses
		Sanionia uncinata	sickle-leaved hook-moss
		Sanonia spp.	hook-mosses
		Scorpidium scorpioides	hooked scorpion-moss
		Scorpidium spp.	scorpion-mosses
		Tomentypnum nitens	golden fuzzy fen moss
		Tomentypnum spp.	fen mosses
		Warnsotfia spp.	hook-mosses
		Warnstorfia exannulata	ringless hook-moss
	"leafy mosses"	*Plagiomnium insigne*	coastal leafy moss
		Plagiomnium medium	common leafy moss
		Plagiomnium spp.	
		Rhizomnium magnifolium	large-leaf leafy moss
		Rhizomnium nudum	naked leaf moss
		Rhizomnium punctatum	dotted leafy moss
		Rhizomnium spp.	
	"leafy liverworts"	*Barbilophozia barbata*	[no common name]
		Barbilophozia hatcheri	Hatcher's leafy wort
		Barbilophozia lycopodioides	common leafy liverwort
		Barbilophozia spp.	
		Neoorthocaulis floerkei	mountain leafy liverwort
		Tritomaria quinquedentata	[no common name]

[a] Lumped species names occur in vegetation tables and text throughout this field guide.

1.2 Species grouped to genera[a]

Lifeform	Genus	Scientific name	Common name
Shrubs	*Alnus spp.*	*Alnus incana*[b]	mountain alder
		Alnus viridis ssp. sinuata	Sitka alder
	Mahonia spp.	*Mahonia aquifolium*	tall Oregon-grape
		Mahonia nervosa	dull Oregon-grape
		Mahonia repens	creeping Oregon-grape
	Rosa spp.	*Rosa acicularis*[c]	prickly rose
		Rosa gymnocarpa	baldhip rose
	Sorbus spp.	*Sorbus scopulina*	western mountain-ash
		Sorbus sitchensis	Sitka mountain-ash
	Symphoricarpos spp.	*Symphoricarpos albus*	common snowberry
		Symphoricarpos occidentalis[d]	western snowberry
Herbs	*Antennaria* spp.	*Antennaria lanata*	woolly pussytoes
		Antennaria microphylla	white pussytoes
		Antennaria racemosa	racemose pussytoes
		Antennaria umbrinella	umber pussytoes
	Arnica spp.	*Arnica cordifolia*	heart-leaved arnica
		Arnica latifolia	mountain arnica
	Castilleja spp.	*Castilleja hispida*	harsh paintbrush
		Castilleja miniata	scarlet paintbrush
		Castilleja rhexiifolia	alpine paintbrush
	Centaurea spp.	*Centaurea diffusa*	diffuse knapweed
		Centaurea stoebe ssp. *micranthos*	spotted knapweed
	Epilobium spp.	*Epilobium anagallidifolium*	alpine willowherb
		Epilobium ciliatum	purple-leaved willowherb
		Epilobium minutum	small-flowered willowherb
	Equisetum spp.	*Equisetum arvense*	common horsetail
		Equisetum pratense	meadow horsetail
		Equisetum sylvaticum	wood horsetail
	Fragaria spp.	*Fragaria vesca*	wood strawberry
		Fragaria virginiana	wild strawberry
	Lomatium spp.	*Lomatium dissectum*	fern-leaved desert-parsley
		Lomatium geyeri	Geyer's desert-parsley
		Lomatium macrocarpum	large-fruited desert-parsley
		Lomatium triternatum	nine-leaved desert-parsley
	Osmorhiza spp.	*Osmorhiza berteroi*	mountain sweet-cicely
		Osmorhiza depauperata	blunt-fruited sweet-cicely
		Osmorhiza purpurea	purple sweet-cicely
	Penstemon spp.	*Penstemon confertus*	yellow penstemon
		Penstemon procerus	small-flowered penstemon
		Penstemon ellipticus	oval-leaved penstemon
		Penstemon fruticosus	shrubby penstemon

Herbs	*Platanthera* spp.	*Platanthera aquilonis*	northern green rein orchid
		Platanthera dilatata	fragrant rein orchid
		Platanthera stricta	slender rein orchid
	Prosartes spp.	*Prosartes hookeri*	Hooker's fairybells
		Prosartes trachycarpa	rough-fruited fairybells
	Ranunculus spp.	*Ranunculus acris*	meadow buttercup
		Ranunculus eschscholtzii	subalpine buttercup
		Ranunculus flabellaris	yellow water-buttercup
		Ranunculus gmelinii	small yellow water-buttercup
		Ranunculus sceleratus	celery-leaved buttercup
		Ranunculus uncinatus	little buttercup
	Sedum spp.	*Sedum lanceolatum*	lance-leaved stonecrop
		Sedum stenopetalum	worm-leaved stonecrop
	Selaginella spp.	*Selaginella densa*	compact selaginella
		Selaginella wallacei	Wallace's selaginella
	Viola spp.	*Viola adunca*	early blue violet
		Viola canadensis	Canada violet
		Viola glabellag	stream violet
		Viola orbiculata	round-leaved violet
		Viola palustrisg	marsh violet
		Viola renifolia	kidney-leaved violet
	Utricularia spp.	*Utricularia intermedia*	flat-leaved bladderwort
		Utricularia macrorhiza	greater bladderwort
		Utricularia minor	lesser bladderwort
Graminoids	*Carex* spp.[e]	*Carex concinnoides*	northwestern sedge
		Carex hoodia	Hood's sedge
		Carex phaeocephala	dunhead sedge
		Carex rossii	Ross' sedge
	Carex spp.[f]	*Carex aquatilis*	water sedge
		Carex canescens	grey sedge
		Carex deweyana	Dewey's sedge
		Carex diandra	lesser-panicled sedge
		Carex disperma	soft-leaved sedge
		Carex exsiccata	inflated sedge
		Carex illota	sheep sedge
		Carex interior	inland sedge
		Carex lenticularis	lakeshore sedge
		Carex limosa	shore sedge
		Carex magellanica	poor sedge
		Carex nigricans	black alpine sedge
		Carex pauciflora	few-flowered sedge
		Carex praegracilis	field sedge
		Carex sitchensis	Sitka sedge
		Carex spectabilis	showy sedge
		Carex utriculata	beaked sedge

Graminoids	*Festuca* spp.	*Festuca campestris*	rough fescue
		Festuca idahoensis	Idaho fescue
		Festuca occidentalis	western fescue
		Festuca saximontana	Rocky Mountain fescue
	Luzula spp.	*Luzula hitchcockii*	Hitchcock's wood-rush
		Luzula parviflora	small-flowered wood-rush
		Luzula piperi	Piper's wood-rush
Mosses, lichens, liverworts	*Brachythecium* spp.	*Brachythecium albicans*	lawn moss
		Brachythecium hylotapetum	woodsy ragged-moss
	Cladina spp.	*Cladina arbuscula*	reindeer lichen
		Cladina mitis	lesser green reindeer
		Cladina rangiferina	grey reindeer
	Cladonia spp.	*Cladonia bellidiflora*	toy soldiers
		Cladonia borealis	boreal pixie-cup
		Cladonia carneola	crowned pixie-cup
		Cladonia cenotea	miner's funnel
		Cladonia cervicornis	laddered pixie-cup
		Cladonia chlorophaea	mealy pixie-cup
		Cladonia cornuta	—
		Cladonia deformis	lesser sulphur-cup
		Cladonia ecmocyna	greater frost-soldiers
		Cladonia fimbriata	powdered trumpet
		Cladonia gracilis	bronzed pixie-cup
		Cladonia macroceras	bullet-proof soldiers
		Cladonia phyllophora	greater felt-soldiers
		Cladonia pleurota	mind-altering pixie-cup
		Cladonia pyxidata	pebbled pixie-cup
		Cladonia scabriuscula	many-winged clad
		Cladonia sulphurina	greater sulphur-cup
		Cladonia symphycarpia	thatch soldiers
	Dicranum spp.	*Dicranum fuscescens*	curly heron's-bill moss
		Dicranum pallidisetum	pale-stalked broom-moss
		Dicranum scoparium	broom-moss
	Peltigera spp.	*Peltigera aphthosa*	freckle pelt
		Peltigera canina	dog pelt
		Peltigera leucophlebia	freckle plet
		Peltigera malacea	apple pelt
		Peltigera membranacea	greater dog pelt
		Peltigera ponojensis	felt pelt
		Peltigera rufescens	felt pelt
	Plagiothecium spp.	*Plagiothecium denticulatum*	dented silk-moss
		Plagiothecium laetum	bright silk-moss
	Polytrichum spp.	*Polytrichum juniperinum*	juniper haircap moss
		Polytrichum lyallii	Lyall's polytrichum moss
		Polytrichum piliferum	awned haircap moss

Mosses, lichens, liverworts	*Racomitrium* spp.	*Racomitrium brevipes*	—
		Racomitrium canescens	grey rock-moss
		Racomitrium elongatum	long rock-moss
		Racomitrium ericoides	shaggy rock-moss
		Racomitrium heterostichum	yellow-green rock-moss
		Racomitrium sudeticum	—
	Scorpidium spp.	*Scorpidium revolvens*	rusty hook-moss
		Scorpidium scorpioides	hooked scorpion-moss
	Sphagnum spp.	*Sphagnum angustifolium*	poor-fen peat-moss
		Sphagnum capillifolium	common red peat-moss
		Sphagnum girgensohnii	common green peat-moss
		Sphagnum russowii	Russow's peat-moss
		Sphagnum squarrosum	shaggy peat
		Sphagnum subsecundum	cow-horn peat-moss
		Sphagnum warnstorfii	Warnstorf's peat-moss
	Umbilicaria spp.	*Umbilicaria americana*	frosted rocktripe
		Umbilicaria angulata	asterisk rocktripe
		Umbilicaria deusta	peppered rocktripe
		Umbilicaria havaasii	ragged rocktripe
		Umbilicaria hyperborea	blistered rocktripe
		Umbilicaria spp.	rocktripe lichens
		Umbilicaria torrefacta	punctured rocktripe
		Umbilicaria vellea	frosted rocktripe

[a] A number of other species occur within the field guide area, but only the most common species that are lumped here are listed in each genera.
[b] Alders are lumped only to genera on wetter sites.
[c] Additional rose species are not lumped and may occur in vegetation tables.
[d] Only lumped in the ICHdm where *S. occidentalis* and *S. albus* both occur.
[e] Dryland sedge species.
[f] Moist- to wet-associated sedge species.

1.3 Recently changed plant names

The following table lists common species referred to in this field guide whose names have changed, either very recently or since publication of commonly referred-to plant books (e.g., *Plants of Southern Interior British Columbia* [Parish et al. 1996]). Additional name changes should be expected in future years. A full database of plant names and changes is maintained on the BECWeb site and is updated annually.

Lifeform	Current scientific name	Current code	Current common name	Retired/old scientific name
Trees	*Populus trichocarpa*	POPUTRI	black cottonwood	*Populus balsamifera* ssp. *trichocarpa*
Shrubs	*Cornus stolonifera*	CORNSTO	red-osier dogwood	*Cornus sericea*
	Mahonia aquifolium	MAHOAQU	tall Oregon-grape	*Berberis aquifolium*
	Mahonia nervosa	MAHONER	dull Oregon-grape	*Berberis nervosa*
	Paxistima myrsinites	PAXIMYR	falsebox	*Pachistima myrsinites*
	Salix lasiandra	SALILAS	Pacific willow	*Salix lucida*
	Salix pseudomonticola	SALIPSE	serviceberry willow	*Salix monticola*
Herbs	*Anemone occidentalis*	ANEMOCC	western pasqueflower	*Pulsatilla occidentalis*
	Centaurea stoebe ssp. *micranthos*	CENTST01	spotted knapweed	*Centaurea maculosa*
	Chamerion angustifolium	CHAMANG	fireweed	*Epilobium angustifolium*
	Comarum palustre	COMAPAU	marsh cinquefoil	*Potentilla palustris*
	Eremogone capillaris	EREMCAP	thread-leaved sandwort	*Arenaria capillaris*
	Eriogonum umbellatum	ERIOUMB	sulphur buckwheat	*Eriogonum subalpinum*
	Eurybia conspicua	EURYCON	showy aster	*Aster conspicuus*
	Heracleum maximum	HERAMAX	cow-parsnip	*Heracleum lanatum*
	Hieracium scouleri	HIERSCO	Scouler's hawkweed	*Hieracium albertinum*
	Leucanthemum vulgare	LEUCVUL	oxeye daisy	*Chrysanthemum leucanthemum*
	Maianthemum racemosum	MAIARAC	false Solomon's-seal	*Smilacina racemosa*
	Micranthes ferruginea	MICRFER	Alaska saxifrage	*Saxifraga ferruginea*
	Mycelis muralis	MYCEMUR	wall lettuce	*Lactuca muralis*
	Orthilia secunda	ORTHSEC	one-sided wintergreen	*Pyrola secunda*
	Osmorhiza berteroi	OSMOBER	mountain sweet-cicely	*Osmorhiza chilensis*
	Pectiantia breweri	PECTBRE	Brewer's mitrewort	*Mitella breweri*
	Pectiantia pentandra	PECTPET	five-stamened mitrewort	*Mitella pentandra*

Lifeform	Current scientific name	Current code	Current common name	Retired/old scientific name
Herbs	*Prosartes hookeri*	PROSHOO	Hooker's fairybells	*Disporum hookeri*
	Prosartes trachycarpa	PROSTRA	rough-fruited fairybells	*Disporum trachycarpum*
	Saxifraga ferruginea	MICRFER	Alaska saxifrage	*Micranthes ferruginea*
	Streptopus lanceolatus	STRELAN	rosy twistedstalk	*Streptopus roseus*
	Symphyotrichum foliaceum	SYMPFOL	leafy aster	*Aster foliaceus*
	Trollius albiflorus	TROLALB	globeflower	*Trollius laxus*
Graminoids	*Eleocharis quinqueflora*	ELEOQUI	few-flowered spike-rush	*Eleocharis pauciflora*
	Festuca campestris	FESTCAM	rough fescue	*Festuca scabrella*
	Koeleria macrantha	KOELMAC	junegrass	*Koeleria cristata*
	Phragmites australis ssp. *americanus*	PHRAAUS2	American common reed	*Phragmites communis*
	Phragmites australis ssp. *australis*	PHRAAUS1	European common reed	*Phragmites communis*
	Pseudoroegneria spicata	PSEUSPI	bluebunch wheatgrass	*Elymus spicatus, Agropyron spicatum*
	Scirpus microcarpus	SCIRMIC	small-flowered bulrush	*Scirpus sylvaticus*
	Trichophorum cespitosum	TRICCES	tufted clubrush	*Scirpus cespitosus*
	Schoenoplectus acutus	SCHOACU	hard-stemmed bulrush	*Scirpus acutus*
	Schoenoplectus tabernaemontani	SCHOTAB	soft-stemmed bulrush	*Scirpus lacustris*
	Vahlodea atropurpurea	VAHLATR	mountain hairgrass	*Deschampsia atropurpurea*
Ferns	*Botrypus virginianus*	BOTRVIG	rattlesnake fern	*Botrychium virginianum*
	Cryptogramma acrostichoides	CRYPACR	parsley fern	*Cryptogramma crispa*
	Dryopteris expansa	DRYOEXP	spiny wood fern	*Dryopteris assimilis*
Mosses, lichens, liverworts	*Neoorthocaulis floerkei*	NEOOFLO	mountain leafy liverwort	*Barbilophozia floerkei*
	Rhizomnium glabrescens	RHIZGLB	large leafy moss	*Mnium glabrescens*
	Rhizomnium magnifolium	RHIZMAG	large-leaf leafy moss	*Mnium punctatum* var. *elatum*
	Rhizomnium nudum	RHIZNUD	naked leaf moss	*Mnium nudum*
	Sanionia uncinata	SANIUNC	sickle-moss	*Drepanocladus uncinatus*

1.4 Index of plant illustrations

Scientific Name	Common Name	Page Number
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APPENDIX 2 CROSSWALKS: BIOGEOCLIMATIC SUBZONES/ VARIANTS AND SITE SERIES

2.1 Biogeoclimatic subzone/variant crosswalk: old BEC to new BEC

TABLE 1 *ICH subzone/variant crosswalk*

Old BEC	New BEC	Summary of changes
ICHxw	ICHxw (ICHxwa)	The ICHxw is much larger and now includes areas previously mapped as ICHdw1 and ICHdw2. The warmest areas in the Pend d'Oreille Valley were removed and remapped as ICHxwa.
IDFun	ICHxwa	The IDFun is now mapped as ICHxwa.
ICHdw1[a]	ICHdw1 (ICHxw)	Mapped boundaries changed minimally except where lower-elevation areas were remapped as ICHxw in the southern Arrow, Boundary, and Kootenay Lake TSAs.
ICHdw2	ICHdw1 ICHxw (ICHmw5[b])	The northern portion of the ICHdw2 was remapped as ICHdw1 (with some ICHmw5); the southern area was remapped as ICHxw. The ICHdw2 is no longer recognized.
ICHdm	ICHdm	Map boundaries had minor adjustments; the ICHdm was previously described in the Supplement to LMH20 (Braumandl and Dykstra 2005).
ICHmw2	ICHmw2 ICHmw4 ICHmw5[b] ICHdw4[b]	Large areas were remapped as ICHmw5 in the Arrow, Boundary, and Okanagan TSAs; lower elevations in the Okanagan TSA were remapped as ICHdw4; where the ICHmw2 was mapped in the south Selkirk Mountains in the Arrow TSA, it was remapped as ICHmw4. The ICHmw2 covers a large area through Kootenay, Slocan, and Arrow Lakes, and in drainages in the Shuswap.
ICHmw4[c]	ICHmw4	The ICHmw4 now includes areas that were previously ICHmw2 in the south Selkirk Mountains in the Arrow TSA.

[a] The ICHdw was renamed ICHdw1 in 2003 when the ICHdw2 was mapped in the Granby Valley; the ICHdw2 is no longer recognized.
[b] The ICHmw5 and ICHdw4 will be described with the Boundary-Okanagan.
[c] The ICHmw4 was previously part of the ICHmw2 but was mapped and renamed in 2003; no classification was provided, so previous management continued to use ICHmw2.

TABLE 2 *ESSF subzone/variant crosswalk*

Old BEC	New BEC	Summary of changes
ESSFwc1	ESSFwh1 (ESSFwh3) (ESSFmh[a])	Most of the old ESSFwc1 is now ESSFwh1 (name change). Areas of previous ESSFwc1 were removed and changed to ESSFwh3 in the south Selkirk Mountains and ESSFmh in the central and southern Monashee Mountains and Norns Range.
ESSFwc4	ESSFwc4 (ESSFdc1[a]) (ESSFwcw) (ESSFwm3) (ESSFwh1)	Most of the old ESSFwc4 is still ESSFwc4. Large areas of previous ESSFwc4 were changed to ESSFdc1 in the central and southern Monashee Mountains and Norns Range, to ESSFwcw in the Arrow and Revelstoke TSAs, to ESSFwm3 in the south Selkirk Mountains in the Arrow TSA, and to ESSFwh1 where it was previously unmapped in the Shuswap Highland in the Okanagan TSA.
ESSFwcw	ESSFwcw	Expanded into the Arrow and Revelstoke TSAs; minor changes in the Kootenay Lake, and Okanagan TSAs.
ESSFwm	ESSFwm1[b] ESSFwm2 ESSFwh2 (ESSFmm3[c])	The former ESSFwm was separated into three geographic areas: southern Rockies (ESSFwm1), Purcells (ESSFwh2—lower elevations; ESSFwm2—higher elevations), and northern Purcells/Rockies (ESSFmm3).
ESSFwc5[d]	ESSFwh3	Renamed and expanded into the Arrow TSA in the south Selkirk Mountains (previously ESSFwc1).
ESSFwc6[e]	ESSFwm3	Renamed and expanded into the Arrow TSA (previously ESSFwc4) and into small areas of ESSFdm and ESSFwm near Kootenay Pass.
ESSFdm[f]	ESSFwm4	Renamed with minor adjustments to mapping; ESSFdm was described in the Supplement to LMH 20 (Braumandl and Dykstra 2005); was ESSFwm prior to that.
ESSFwmw	ESSFwmw	Minor changes to map boundaries in Kootenay Lake and Cranbrook TSAs; expanded into the Arrow TSA in the south Selkirk Mountains.

[a] The ESSFmh and ESSFdc1 will be described with the Boundary-Okanagan.
[b] The ESSFwm1 will be described with the East Kootenay-Rocky Mountain Trench.
[c] The ESSFmm3 will be described with the north Columbia Mountains.
[d] For the ESSFwc5 (now ESSFwh3), management applications followed ESSFwc1.
[e] For the ESSFwc6 (now ESSFwm3), management applications followed ESSFwc4.
[f] For the ESSFdm (now ESSFwm4), management applications followed Braumandl and Dykstra (2005) and used ESSFwm (Braumandl and Curran 1992) prior to 2005.

2.2 Site series crosswalk: new site series to old site series

TABLE 1 *ICH site series crosswalk*[a,b]

Current site unit	ICHxwa[c]	ICHxw[c]	ICHdw1[d]	ICHdm	ICHmw2	ICHmw4
101	(ICHdw/01a)	(ICHdw/01b) (ICHdw/01a) (ICHdw2/01)	ICHdw/01b (ICHdw2/01)	ICHdm/01	ICHmw2/01-NE ICHmw2/01-KA	ICHmw2/01
102	(ICHdw/02)	(ICHdw/02) (ICHdw2/02)	ICHdw/02 (ICHdw2/02)	ICHdm/02	ICHmw2/02-NE[e] (ICHmw2/02-KA)	ICHmw2/02[e]
103	(ICHdw/01a) (ICHdw/02)	(ICHdw/01a) (ICHdw/02) (ICHdw2/02)	ICHdw/02 (ICHdw/01a) (ICHdw2/02)	ICHdm/03	ICHmw2/03-NE ICHmw2/02-KA	ICHmw2/03
104	(ICHdw/01a) (ICHdw/02)	(ICHdw/01a) (ICHdw2/03)	ICHdw/01a (ICHdw2/03)	–	ICHmw2/04-NE ICHmw2/03-KA	ICHmw2/04
110	(ICHdw/01b)	(ICHdw/01b) (ICHdw2/04)	ICHdw/03 (ICHdw2/04) (ICHdw2/05)	ICHdm/04	ICHmw2/05-NE ICHmw2/04-KA	ICHmw2/05
111	(ICHdw/03)	(ICHdw/03) (ICHdw2/05)	ICHdw/04 (ICHdw2/06)	ICHdm/05	ICHmw2/06-NE ICHmw2/05-KA	(ICHmw2/06)
112	(ICHdw/04)	(ICHdw/04) (ICHdw2/06)	(ICHdw/04)	ICHdm/06	(ICHmw2/06-NE) (ICHmw2/04-KA)	ICHmw2/06
113	–	–	–	–	ICHmw2/07-NE ICHmw2/06-KA	(ICHmw2/06)
114	–	–	–	–	ICHmw2/08-NE ICHmw2/07-KA	ICHmw2/07

[a] Old site series shown in parentheses represent a poor fit to the new unit. This may be due to mapping changes or new site series concepts.
[b] All site series are from Braumandl and Curran (1992) except the ICHdm (Braumandl and Dysktra 2005) and the ICHmw2. In the ICHmw2, "NE" applies to the former Nelson Forest Region and follows Braumandl and Curran (1992), while "KA" refers applies to the former Kamloops Forest Region and follows Lloyd et al. (1990).
[c] The ICHxwa and ICHxw contain only secondary crosswalks because no classification was previously developed specific to the ICHxw or IDFun; many management applications used the old site series framework from the ICHdw.
[d] The ICHdw in Braumandl and Curran (1992) was changed (on maps) to ICHdw1 in 2003, but was not updated in the field guide.
[e] The ICHmw2/02-NE represented both non-forest and open rocky forest, whereas the new 102 describes only open, rocky, forested sites (> 10% tree cover); rock outcrop (Ro) ecosystems are described in Section 6.6.

TABLE 2 *ESSF site series crosswalk*[a]

Current site unit	ESSFwh1	ESSFwc4	ESSFwcw[b]	ESSFwh2	ESSFwm2	ESSFwh3	ESSFwm3	ESSFwm4	ESSFwmw[b]
101	ESSFwc1/01	ESSFwc4/01	(ESSFwc4/01) (ESSFwc4/04)	ESSFwm/01	ESSFwm/01	ESSFwc1/01	ESSFwc4/01	ESSFdm/04[c] (ESSFdm/01[d])	(ESSFwc4/01) (ESSFwm/01) (ESSFdm/04) (ESSFdm/01)
102	(ESSFwc1/02)	(ESSFwc4/02)	(ESSFwc4/02)	ESSFwm/02	ESSFwm/02	ESSFwc1/02	(ESSFwc4/02)	ESSFdm/02	(ESSFwc4/02) (ESSFwm/02) (ESSFdm/02)
103	ESSFwc1/02[e]	ESSFwc4/03 ESSFwc4/04	(ESSFwc4/03)	(ESSFwm/02) (ESSFwm/03)	ESSFwm/02	ESSFwc1/02[e]	ESSFwc4/03	ESSFdm/03 [d] (ESSFdm/01[d])	(ESSFwc4/03) (ESSFwm/02) (ESSFdm/03)
104	ESSFwc1/02[f]	–	(ESSFwc4/03)	ESSFwm/03	ESSFwm/02	ESSFwc1/02[f]	ESSFwc4/04 (ESSFwc4/03)	–	–
105	–	–	–	–	–	–	ESSFwc4/04 (ESSFwc4/03)	–	–
110	ESSFwc1/03	ESSFwc4/05	(ESSFwc4/05)	ESSFwm/04 (ESSFwm/01)	ESSFwm/04	(ESSFwc1/01)	ESSFwc4/05	ESSFdm/05	(ESSFwc4/05) (ESSFwm/04) (ESSFdm/05)
111	ESSFwc1/04	(ESSFwc4/06)	–	ESSFwm/04	(ESSFwm/04)	ESSFwc1/03	ESSFwc4/05	ESSFdm/06	–
112	–	ESSFwc4/06 (ESSFwc4/07[g])	–	(ESSFwm/04)	(ESSFwm/04)	(ESSFwc1/04)	ESSFwc4/06 (ESSFwc4/07[g])	–	–

[a] Old site series follow Braumandl and Curran (1992). Site series shown in parentheses represent a poor fit to the new site series. This may be due to mapping changes or new site series concepts.
[b] The ESSFwcw and ESSFwmw contain all secondary crosswalks because they are in areas previously mapped as ESSF or mapped as woodland without a published classification.
[c] The central concept of the ESSFwm4 has shifted; therefore, the old ESSFdm/04 is the best fit to the new ESSFwm4/101 unit.
[d] The ESSFdm/01 and ESSFdm/03 crosswalks include both the .1 and .2 variations.
[e] Best fit where the old unit (ESSFwc1/02) occurred on warm aspects.
[f] Best fit where the old unit (ESSFwc1/02) occurred on cool aspects.
[g] Applies where sites are forested swamps (112b).

APPENDIX 3 KEYS AND CODES

APPENDIX 3.1 SOIL MOISTURE AND NUTRIENT REGIMES

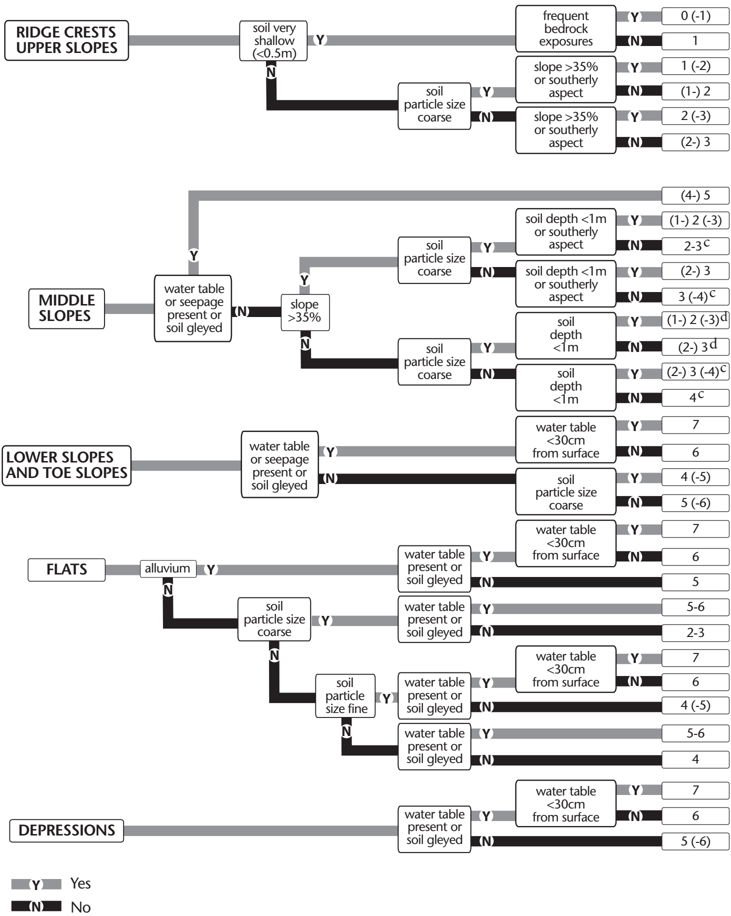
3.1.1 Definitions of terms used in the keys to identification of relative soil moisture and nutrient regimes [a]

Category	Definition
Ridge crest [b]	height of land; usually convex slope shape (soil water shedding).
Upper slope [b]	the generally convex-shaped, upper portion of a slope (soil water mostly shedding).
Middle slope [b]	the portion of a slope between the upper and lower slopes; the slope shape is usually straight (soil water shedding/ receiving more or less equally).
Lower slope [b]	the area towards the base of a slope; the slope shape is usually concave (soil water receiving). It includes toe slopes, which are generally level areas located directly below and adjacent to the lower slope.
Flat/level [b]	any level area (excluding the slopes); the surface shape is generally horizontal with no significant aspect (sites receive and maintain soil water, depending on soil depth and texture).
Depression [b]	any area that is concave in all directions; usually at the foot of a slope or in flat topography.
Alluvium/Fluvial Landforms	post-glacial, active floodplain deposits along rivers and streams in valley bottoms; usually a series of low benches and channels.
Soil depth	depth from the ground (forest floor) surface to a restricting layer, such as bedrock, strongly compacted materials, or strongly cemented materials (e.g.,"hardpan").
Gleyed	soils that have orange-coloured mottles indicative of a fluctuating water table. Permanently gleyed soils are blue grey to turquoise grey in colour.
Buried organic horizons	dark coloured organic bands or streaks occurring within mineral horizons at depth, resulting from mineral deposition over old surface (forest floor) horizons by flooding or soil turbation.
Soil particle size coarse	coarse sandy[c], sandy [c] with > 35% volume of coarse fragments, or loamy [c] with > 70% volume of coarse fragments.
Soil particle size fine	silty [c] or clayey [c] with < 20% volume of coarse fragments.

[a] Modified from Lloyd et al. (1990) and Green et al. (1994).
[b] See also Figure 3.3 Mesoslope position in chapter 3 of this document.
[c] coarse sandy – LS, S with sand ≥0.5 mm dia.; sandy – LS, S with sand < 0.5 mm dia.; loamy – SL, L, SCL; clayey – SiCL, CL, SC, SiC, C; silty – SiL, Si.

APPENDIX 3.1.2 RELATIVE SOIL MOISTURE REGIME KEYS

3.1.2.1 Key to relative soil moisture regimes [a, b]



[a] Caution: read the definitions of particle size and gleying in A 3.1.1.
[b] Adapted from Banner et al. (1993).
[c] Generally moister if aspect is N or NE.
[d] Generally drier if aspect is S or SW.

3.1.2.2 Key for evaluating site factors and determining relative soil moisture regime classes[a]

Site factors	Factors that reduce available moisture –			Intermediate moisture 0	Factors that increase available moisture +					Site assess-ment *
Mesoslope position	Crest -15	Upper -8		Middle or Level 0	Lower +3	Toe +5		Depression +10		
Slope gradient		> 60% -4	35–60% -2	5–35% 0	0–5% +2					
Aspect – Gentle slopes ≤35%		S SW -2	W NW -1	E SE 0	N NE +1					
Aspect – Steep slopes > 35%	SW -5	W S -4	SE NW -2	E 0		N NE +5				
Soil texture	S -10	LS -6	SL -2	SiL,L 0	Si,SCL CL, SiCL +1	SC, SiC, C +2		Organic +3		
Coarse fragment content	> 85% -10	65–85% -6	35–65% -3	10–35% 0	0–10% +2					
Soil depth (cm): for soils lacking a water table or gleyed horizon	0–25 -18	25–50 -8	50–100 -4	>100 0						
Depth to water or gleying (cm				Absent 0	100–150 +5	75–100 +15	50–75 +25	25–50 +55	< 25 +85	

* Totalling the values for each site factor gives an estimate of soil moisture regime. Total ________

Soil moisture regime classes and codes	Very Xeric 0	Xeric 1	Subxeric 2	Submesic 3	Mesic 4	Subhygric 5	Hygric 6	Subhygric 7
Class ranges	<-32	-32 to -21	-20 to -11	-10 to -5	-4 to +4	+5 to +39	+40 to +70	> 70

[a] From Lloyd et al. (1990).

APPENDIX 3.1.3 SOIL NUTRIENT REGIME KEYS

3.1.3.1 Key for indentifying soil nutrient regime factors on non-saturated sites[a]

Site factors	Factors that reduce available nutrients (–)			Intermediate nutrient status (0)	Factors that increase available nutrients (+)			Site assessment *
Rooting depth (cm)	< 10 -7	10–20 -5	20–35 -2	> 35 0				
Soil texture	S -3	LS -2	SL -1	SiL, L, Si 0	SCL, CL, SiCL +1	SC, SiC, C +2	Organic +3	
Coarse fragment content	> 85% -6	65%–85% -4	35–65% -2	10–35% 0	0–10% +1			
Humus form	Mor > 20cm -5		Mor -2	Mor Moder 0	Moder +3	Mull +6		
A horizon	Ae > 3 cm -3		Ae 1–3 cm -1	Thin or Absent 0	Ah 1–5 cm +3	Ah> 5 cm +6		
Seepage water				Absent 0	Temporary +3	Continous +5	Alluvial +7	
Coarse fragment geology ** – Colour	Light -3			Medium 0	Dark +3			
Coarse fragment geology ** – Crystal size		Coarse -2		Medium 0	Fine +1			
Coarse fragment geology ** – Hardness			Hard -1	Medium 0	Soft +1			

* Totalling the values for each site factor gives an estimate of soil nutrient regime.

** For sites with a mixed geologic composition, estimate the mean. Calcareous rock types should be rated +6.

Total ________

Nutrient regime classes and codes	Very Poor A	Poor B	Medium C	Rich D	Very Rich E
Class ranges	≤ -13	-12 to -6	-5 to +5	+6 to +12	≥ +13

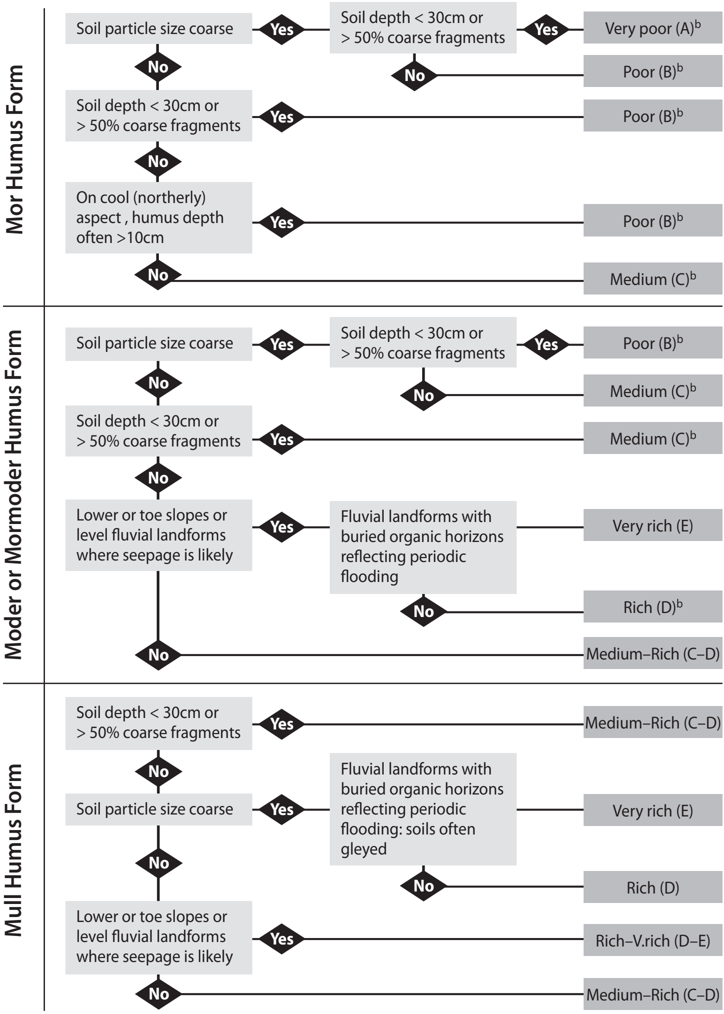
[a] Adapted from Lloyd et al. (1990). A 3.4.2 provides information on rock types and their colour, size, and hardness.

3.1.3.2 Table for estimation of soil nutrient regime[a]

<table>
<tr><th></th><th>A
very poor</th><th>B
poor</th><th>C
medium</th><th>D
rich</th><th>E
very rich</th></tr>
<tr><td>Available nutrients</td><td>very low</td><td>low</td><td>average</td><td>plentiful</td><td>abundant</td></tr>
<tr><td rowspan="3">Humus form</td><td colspan="4">Mor</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Moder</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Mull</td></tr>
<tr><td rowspan="3">A horizon</td><td colspan="3">Ae horizon present</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">A horizon absent</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Ah horizon present</td></tr>
<tr><td rowspan="3">Organic matter content</td><td colspan="3">low (light coloured)</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">medium (intermediate)</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">high (dark coloured)</td></tr>
<tr><td rowspan="3">C:N ratio</td><td colspan="3">high</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">moderate</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">low</td></tr>
<tr><td>Soil texture</td><td>very coarse</td><td>coarse</td><td>medium</td><td>fine</td><td>very fine</td></tr>
<tr><td>Examples</td><td>LS, 60% CF</td><td></td><td>L, 25% CF</td><td>SiCl, 15% CF</td><td>SiC, 15% CF</td></tr>
<tr><td>Slope position</td><td>upper</td><td></td><td>mid</td><td></td><td>lower</td></tr>
<tr><td>related to seepage</td><td>shedding</td><td></td><td>normal</td><td></td><td>receiving</td></tr>
<tr><td rowspan="2">Depth to impermeable layer</td><td>shallow</td><td></td><td>medium</td><td></td><td>deep</td></tr>
<tr><td>< 0.5 m</td><td></td><td>1–2 m</td><td></td><td>>2 m</td></tr>
<tr><td>Coarse fragment type — colour</td><td>light</td><td></td><td>medium, mixed</td><td></td><td>dark unless calcareous</td></tr>
<tr><td>texture</td><td>coarse</td><td></td><td>medium</td><td></td><td>fine</td></tr>
<tr><td>hardness</td><td>hard</td><td></td><td>medium</td><td></td><td>soft</td></tr>
<tr><td>examples</td><td>granite
quartzite
sandstone</td><td>granodiorite</td><td>diorite
schist
argillite</td><td>gabbro</td><td>basalt
slate
limestone</td></tr>
<tr><td rowspan="3">Soil pH</td><td colspan="2">extremely – mod. acid</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="3">moderately acid – neutral</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">slightly acid – mildly alk.</td></tr>
<tr><td>Water pH (wetlands)</td><td>< 4–5</td><td>4.5–5.5</td><td>5.5–6.5</td><td>6.5–7.4</td><td>> 7.4</td></tr>
<tr><td>Seepage</td><td></td><td></td><td colspan="3">temporary → permanent</td></tr>
</table>

[a] Modified from Banner et al. (1993).

3.1.3.3 Nutrient regime key for upland sites [a]



[a] SeeA 3.1.1 for definitions of terms used in this key.
[b] On sites dominated by mature broadleaf trees, increase nutrient regime class by one category (e.g., med to rich).
[c] From Delong et al. (2010).

APPENDIX 3.2 SOIL TEXTURE

Soil textures can only be accurately assessed in laboratory conditions, although estimates can be determined in the field through hand texturing. This section provides an overview of the procedures, terms, and tests used to hand texture soil in the field. Three approaches are provided.

3.2.1 Soil texture components and their characteristics

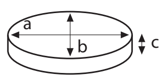
Soil texture refers to the relative proportions of **sand**, **silt**, and **clay** within a soil. These particles are referred to collectively as the **"fine fraction."** Coarse fragments also contribute to the overall characteristics of a soil.

> The **fine fraction** consists of particles less than or equal to 2 mm in diameter:
>
> % sand + % silt + % clay = 100% (fine fraction)
>
> Particle sizes of the fine fraction component are defined with the soil texture triangle on page 465.
>
> **Coarse fragments** consist of particles greater than 2 mm in diameter and are divided into three size classes. For rounded to angular coarse fragments, the size class is determined by measuring the widest point (b, in the diagram below); for thin, flat coarse fragments, the size class is determined by measuring the length (a, in the diagram below).

Coarse fragments	Diameter (cm)	Length (cm)
G – Gravels	< 7.5	< 15
C – Cobbles	7.5–25	15–38
S – Stones	> 25	> 38

PRINCIPAL AXES OF A COARSE FRAGMENT

a > b > c



> Coarse fragment content is estimated visually as a percentage of the whole soil:
>
> % stones + % cobbles + % gravels + % fine fraction = 100% (total soil)

Sand, **silt**, and **clay** particles each have a distinct "feel." **Sand** can always be felt as individual **grains,** but silt and clay cannot. Dry **silt** feels floury, and wet silt is **slippery or soapy** but not sticky. Dry **clay** forms hard lumps, is very sticky when wet, and is plastic (like plasticene) when moist.

Most soils are a mixture of sand, silt, and clay, so the graininess, soapiness, or stickiness will vary depending upon how much of each particle size is present. As the amount of clay increases, soil particles bind together better, form stronger "casts" and longer, stronger "worms" (see "Tests used in hand texturing" on page 463). As sand and silt content increases, the soil binding strength decreases, and only weak to moderately strong casts and worms can be formed. The various classes of soil texture (defined on the **soil texture triangle** on page 465) are named by a combination of the dominant particle sizes. The term **loam** refers to a relatively even mix of the three particle sizes.

Well-decomposed organic matter (**humus**) feels very similar to silt: it feels floury when dry and slippery when moist, but not sticky and not plastic. However, when subjected to the taste test, it is non-gritty. Humus is generally very dark when moist or wet, and stains the hands brown or black. Humus-enriched soils often occur on wet sites and on grassland sites. Humus is not used as a determinant of soil texture. "**Organic**" soil samples are those that contain more than 30% organic matter. Soil textures are not determined for organic soils. Most organic soils with thick (> 40 cm) organic horizons are found on wet sites, often in depressions or on floodplains.

Properties of fine fraction particles

Particle size	Description
Clay	Very hard when dry; feels smooth and is very sticky when wet; feels smooth when worked between front teeth.
Silt	Slightly hard to soft when dry; feels powdery or floury when dry; feels slippery or soapy and only slightly sticky or non-sticky when wet; silt cannot be felt as grains between thumb and forefinger, but can be felt as fine grittiness when placed between teeth.
Sand	Loose grains when dry; very grainy when felt between thumb and forefinger; individual grains are felt when placed between front teeth or on the tongue; non-sticky when wet.

Soil particle characteristics and descriptions used in soil texture keys[a]

Characteristic	Category	Description
Graininess (sand)	non-grainy	Little or no individual particles/grains can be felt (< 20% sand).
	slightly grainy	Some individual grains/particles are 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).
Grittiness[b,c] (silt)	non-gritty	Particles are not felt when soil is worked between teeth (< 10% silt).
	slightly gritty	A few fine particles are felt between teeth, but sand and/or clay dominate (10–25% silt).
	gritty	Many fine particles can be felt between teeth, but some individual sand grains are also felt or clay dominates (25–50% silt).
	very gritty	Continuous fine particles/grittiness is felt between teeth; almost no sand grains are felt (> 50% silt).
Soapiness[c] (wet silt)	non-soapy	Wet soil is not slick or soapy/slippery when worked between thumb and fingers (< 10% silt).
	slightly soapy	Some slipperiness or soapiness is felt, but graininess and/or stickiness dominate (< 10–25% silt).
	soapy	Soil feels like dish soap; thumb slides somewhat easily over wet soil on fingers, but some stickiness or graininess can be felt (25–50% silt).
	very soapy	Thumb slides easily over wet soil on fingers with little stickiness or graininess (> 50% silt).
Stickiness (moist clay)	non-sticky	Practically no soil material adheres to the thumb and forefinger (< 10% clay).
	slightly sticky	Soil material adheres to only one of the digits (thumb or forefinger) 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 material adheres strongly to both digits and stretches distinctly before breaking (> 40% clay).

[a] Percent limits are approximate.
[b] Grittiness is evaluated once graininess has been determined.
[c] Both soapiness and grittiness are used to evaluate silt content; grittiness is determined using the taste test.

3.2.2 Tests used in hand texturing

The soil texturing keys provided incorporate some or all of the following field tests to assist in the field determination of soil texture. Prior to using any of these tests, crush a small handful of soil in the hand, and remove coarse fragments (particles > 2 mm in diameter).

1. **Graininess test**: Rub the soil between your thumb and fingers. If sand is present, it will feel "grainy." Estimate whether sand comprises more or less than 50% of the sample. Sandy soils often sound abrasive when worked between the digits. Sand can be further divided into the subclasses described with the soil texture triangle on page 465. Fine and very find sands feel rough, like sandpaper.
2. **Moist[1] cast or ball test**: Gradually add water to the soil and, with a soil knife or fingers, work it into a moist ball. Compress the moist[1] (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.
3. **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.
4. **Soapiness test**: Rub wet soil between the thumb and forefinger. Degree of soapiness is determined by how soapy or slippery it feels and how much resistance to slip there is (i.e., from clay and sand particles).
5. **Shine test**: Roll moist[1] soil into a ball and rub once or twice against a hard, smooth object such as a knife blade or a thumb nail. A shine on the rubbed surface indicates clay in the soil. The more it shines, the more clay is in the soil.
6. **Ribbon test**: Roll moist[1] soil into a long thin shape and then squeeze out between the thumb and forefinger to form the longest and thinnest ribbon possible. The longer the ribbon, the more clay is in the soil. Soils with high silt content will tend to flake rather than ribbon.

[1] Moist soil feels damp but no visible water is present. A small amount of moisture can be observed on the palm of the hand when a sample is very tightly squeezed and then released. Moist soils can be molded into shapes. If the soil sample flows with the force of gravity, it is too wet. If it crumbles when rolled, it is too dry (unless it has high sand content).

7. **Taste test:** Not recommended due to health concerns. A small amount of soil is worked between the front teeth. Sand can be felt as individual grains between the teeth or on the tongue. Silt particles produce a general fine grittiness, but individual grains cannot be identified. Clay particles cannot be felt between the teeth.
8. **Worm test**: Roll some moist[1] 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).

3.2.3 Soil texturing key 1: Hand texturing using the soil texture triangle

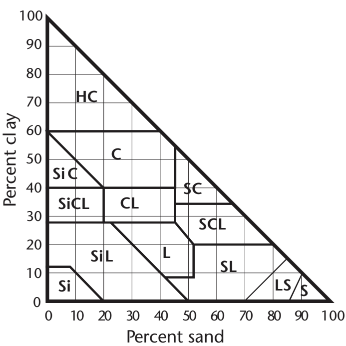
1. Determine **stickiness** and then the **graininess** of the soil sample by working it between the thumb and forefinger, pressing and then separating the digits. Estimates of clay and sand content can be made using the categories on page 462.
2. After stickiness and graininess have been determined, use **the hand texturing guide** (below) to approximate the textural class of the soil.

Hand texturing guide[a]

	Non-grainy (< 20% sand)	**Slightly grainy** (20–50% sand)	**Grainy** (50–80% sand)	**Very grainy** (> 80% sand)
Very sticky (> 40% clay)	Silty clay	Clay	Sandy clay	–
Sticky (25–40% clay)	Silty clay loam	Clay loam	Sandy clay loam	–
Slightly sticky (10–25% clay)	Silt loam or silt	Loam[b]	Sandy loam	–
Non-sticky (< 10% clay)	–	–	–	Loamy sand or sand

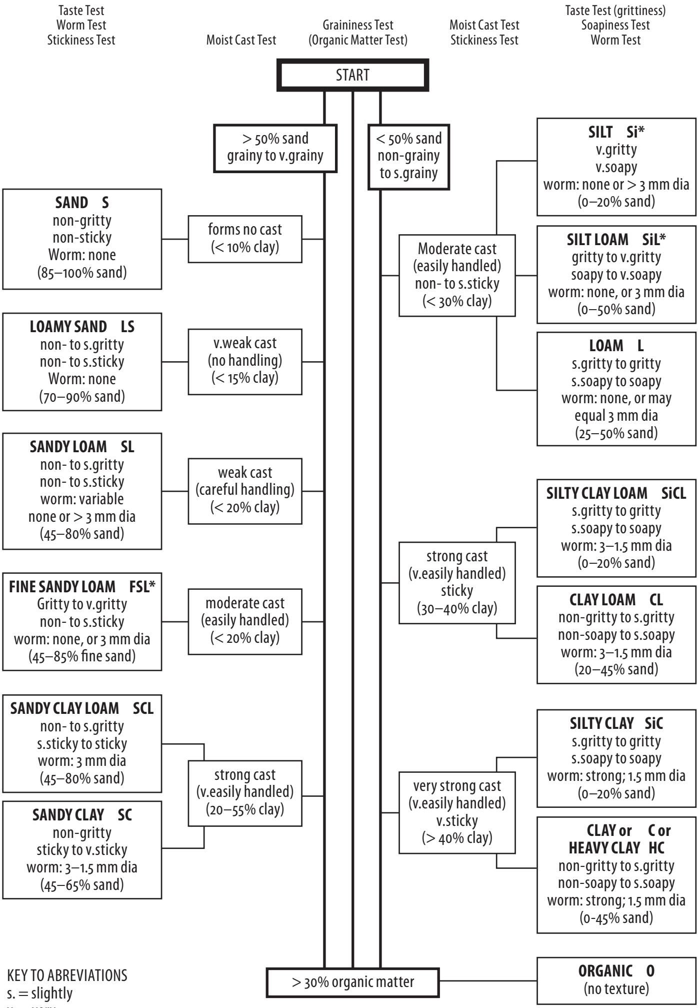
[a] Sand and clay limits are approximate.
[b] Loams contain balanced proportions of sand, silt, and clay and exhibit physical properties intermediate between them.

The **soil texture triangle** can be used to more accurately determine and confirm the soil texture class. The triangle should be used to cross-reference soil textures derived using the other keys.



Fine Fraction		(particle diameter)
SAND ....(S)		2–.05 mm
Sand subclasses		
– v.coarse	2–1 mm	
– coarse	1–0.5 mm	
– med.	0.5–0.25 mm	
– fine	0.25–0.1 mm	
– v.fine	0.1–0.05 mm	
SILT ....(Si)		.05–.002 mm
CLAY...........................(C)		<.002 mm
HEAVY CLAY ....(HC)		>60% clay
LOAM..........................(L)		mix of sand, silt, and clay

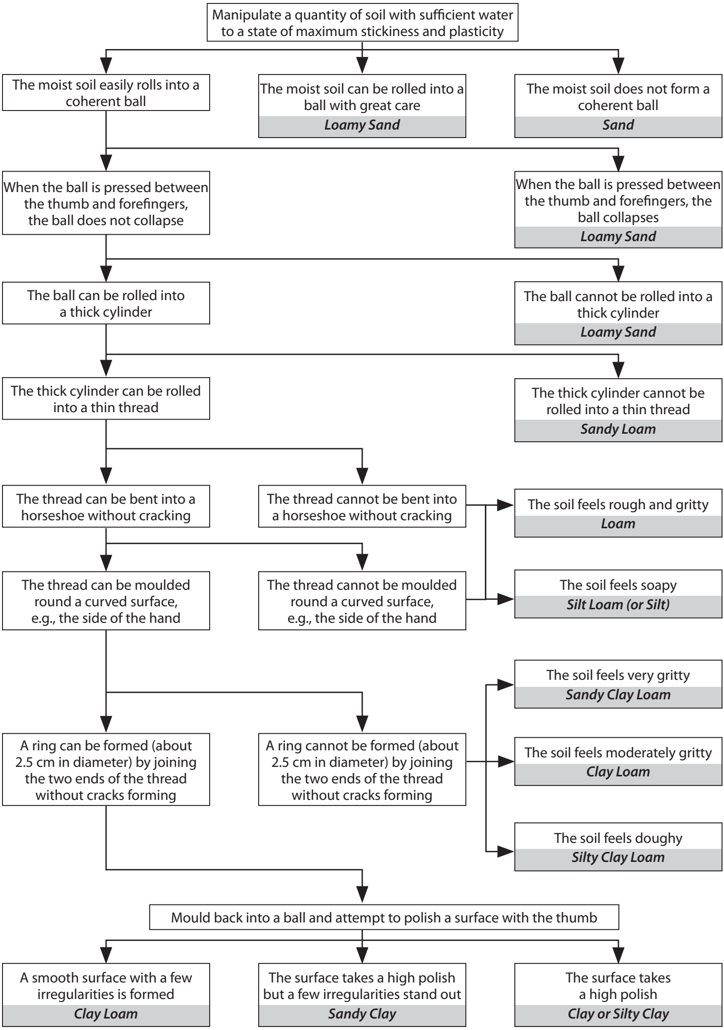
3.2.4 Soil texturing key 2: Traditional method



KEY TO ABREVIATIONS
s. = slightly
v. = very
dia. = diameter
* silt feels slippery or soapy when wet; fine sand feels stiffer, like fine sand paper.

Adapted from LMH 25 (Province of British Columbia 2010).

3.2.5 Soil texturing key 3 – Flowchart



Key developed by Scott Smith, Agriculture Canada.

APPENDIX 3.3 HUMUS FORM CLASSIFICATION

3.3.1 Description of humus form classification

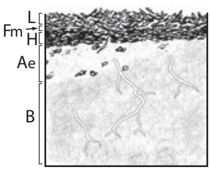
Full descriptions can be found in Green et al. (1993).

Humus is defined as a group of soil horizons located at or near the surface of a pedon, which have formed from organic residues. These horizons can have many forms depending on the physical and biotic environment and history of disturbance. Humus forms are organized in a two-tier classification of humus form Orders (three Orders: Mor, Moder, Mull) and humus form Groups (16 Groups; e.g., Hemimor or Rhizomull).

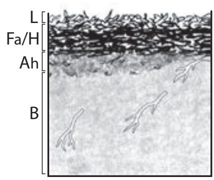
S layer – living layer of mosses, lichens, or hepatics.
L horizon – the organic (litter) horizon at the surface consisting of relatively fresh, undecomposed organic material.
F horizon – the organic (fermented) horizon consisting of partially decomposed organic material (below the L horizon).
H horizon – the organic (humic) horizon consisting of well-decomposed organic material (below the F horizon).

HUMUS FORM ORDERS

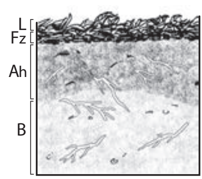
Mor
- L,F,H horizons prominent.
- matted 'Fm' dominant; fungal mycelia often abundant.
- usually abrupt transition to mineral soil.



Moder
- L,F,H horizons prominent.
- loose and friable (easily reduced to tiny particles) 'Fa' dominant; fungal mycelia less abundant.
- insects and droppings common.
- may have thin Ah horizons.



Mull
- F,H horizons < 2 cm.
- thin friable 'Fz.'
- Ah horizon dominant.



3.3.2 Key to humus forms

1a. Well to imperfectly drained sites; humus form not saturated for prolonged periods

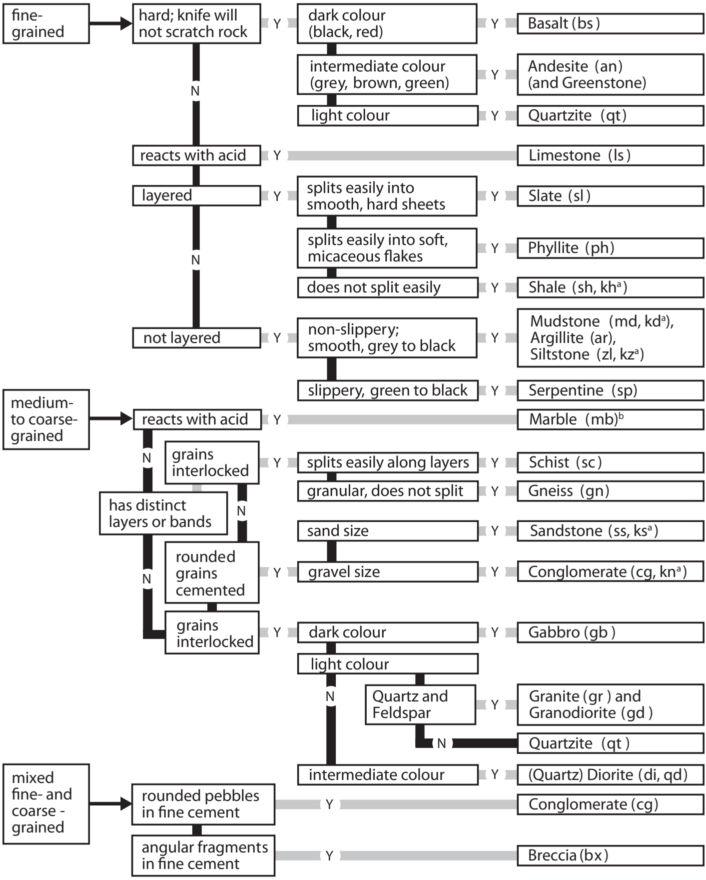
- 2a. Combined thickness of F and H horizons > 2 cm; or, if ≤2 cm, also has an Ah < 2 cm.
  - 3a. > 50% thickness of F horizon(s) is Fm . . . . **MORS (R)**
    - 4a. Decaying wood > 35% of organic matter volume in humus form profile . . . . **Lignomor (LR)**
    - 4b. Decaying wood ≤ 35% of organic matter volume in humus form profile
      - 5a. F horizon > 50% of thickness of F and H horizon . . . . . **Hemimor (HR)**
      - 5b. Hh horizon > 50% of thickness of F and H horizons . **Humimor (UR)**
      - 5c. Hr horizon > 50% of thickness of F and H horizons . . . . **Resimor (RR)**
  - 3b. F horizon(s) includes Fz and/or Fa . . . . **MODERS (D)**
    - 6a. Decaying wood > 35% of organic matter volume in humus form profile . . . . **Lignomoder (LD)**
    - 6b. Decaying wood ≤ 35% of organic matter volume in humus form profile
      - 7a. Fa horizon > 50% of thickness of F horizons; or Fm horizon present. . . . . **Mormoder (RD)**
      - 7b. Fz horizon > 50% of thickness of F horizons
        - 8a. F and H horizons greater than or equal to thickness of Ah horizon. . . . . **Leptomoder (TD)**
        - 8b. F and H horizons less than thickness of Ah horizon . . . . **Mullmoder (MD)**
- 2b. Combined thickness of F and H horizons ≤ 2 cm and Ah horizon ≥ 2cm. . **MULLS (L)**
  - 9a. Rhizogenous Ah horizon (sward or turfy) formed from decomposition of dense fine roots . . . . **Rhizomull (ZL)**
  - 9b. Zoogenous Ah horizon (granular) formed through actions of abundant earthworms . . . . **Vermimull (VL)**
  - **9c** Mechanical Ah horizon formed by physical processes (cryoturbation, colluviation, eolian) . . . . **Paramull (PL)**

1b. Poor to very poorly drained sites; humus form saturated for prolonged periods

- 10a. Combined thickness of F, H, and O horizons ≤ 2 cm and Ah horizon > 2 cm . . . . **Hydromull (YL)**
- 10b. Combined thickness of F, H, and O horizons > 2 cm if Ah < 2 cm
  - 11a. Thickness of F and H horizons ≥ O horizons
    - 12a. F horizon(s) is Fm . . . . **Hydromor (YR)**
    - 12b. F horizon(s) includes Fz and/or Fa . . . . **Hydromoder (YD)**
  - 11b. Combined thickness of O horizons greater than F and H horizons
    - 13a. Of horizon > 50% of thickness of O horizons . . . . **Fibrimor (FR)**
    - 13b. Om horizon ≥ 50% of thickness of O horizons . . . . **Mesimor (MR)**
    - 13c. Oh horizon > 50% of thickness of O horizons . . . . **Saprimoder (SD)**

APPENDIX 3.4 ROCK IDENTIFICATION AND CHARACTERISTICS

3.4.1 Key to common rock types of British Columbia



Adapted from Braumandl and Curran (1992) and Lloyd et al. (1990).

[a] Both calareous and non-calcareous rock types exist, if reacts with acid record code indicated by footnote "a."

[b] Other medium- to coarse-grained rock types do react to acid, although these rock types are less common in British Columbia.

3.4.2 Common rock types and their associated soil properties

		Rock Characteristics				
Rock Class	**Rock Type**	**Rock Colour**	**Grain Size**	**Hardness**	**Associated Nutrients**	**Associated Soil Textures**[a,b]
Igneous Intrusive	granite	light	coarse	hard	poor	loamy to sandy (coarse)
	granodiorite	light	coarse	hard	poor	loamy to sandy (coarse)
	diorite	medium	coarse	hard	medium	loamy to sandy (coarse)
	quartz monzonite	light	coarse	hard	poor	loamy to sandy (coarse)
	gabbro	dark	coarse	hard	rich	loamy to sandy (coarse)
	rhyolite	light	fine	medium	poor	silty to clayey
(Extrusive) Volcanic	andesite	medium	fine	hard	rich	silty to clayey
	basalt	dark	fine	hard	rich	silty to clayey
	siltstone[c]	dark	fine	soft	rich to very rich	silty to clayey
	mudstone	dark	fine	soft	rich to very rich	silty to clayey
	shale[c]	dark	fine	soft	rich	silty to clayey
	sandstone[c]	light	medium	medium	medium to very rich	silty to loamy
Sedi-mentary	greywacke	medium	medium	medium	poor	silty to loamy
	conglomerate[c]	medium	coarse	hard	poor	loamy to sandy (coarse)
	chert	medium	fine	hard	medium	silty to clayey
	limestone	light	fine	soft	very rich	silty to clayey
	dolomite	light	medium	soft	rich	silty to loamy
	slate	dark	fine	soft	rich	silty to clayey
	phyllite	dark	fine	soft	rich	silty to clayey
	schist	dark	medium	medium	rich	silty to loamy
Meta-morphic	gneiss	medium	coarse	hard	poor	loamy to sandy (coarse)
	argillite	dark	fine	medium	rich	silty to clayey
	quartzite	medium	coarse	hard	poor	loamy to sandy (coarse)
	serpentinite	dark	medium	soft	rich	silty to loamy
	amphibolite	dark	coarse	hard	medium	loamy to sandy (coarse)
	marble	light	medium	hard	rich	silty to loamy

[a] Associated soil textures refer to the soils commonly found in landscapes associated with each bedrock type.
[b] sandy = LS, S (coarse SL); loamy = SL, FSL, L, SCL; silty = SiL, Si; clayey = SiCL, CL, SC, SiC, C
[c] Calcareous and non-calcareous types occur.

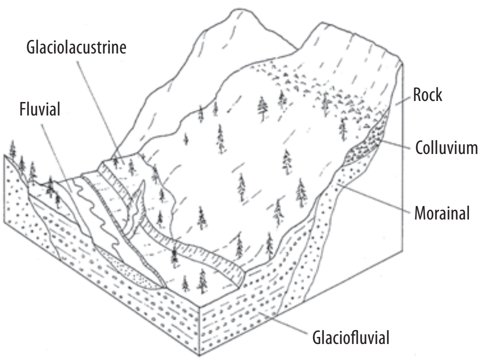
APPENDIX 3.5 COMMON SURFICIAL MATERIALS IN SOUTHEAST BRITISH COLUMBIA[a]

Surficial Material	Code	Definition*	Landscape Context
Morainal (Till)	M	Materials deposited directly by glaciers	Deep morainal (till) blankets are dominant on valley floors and side slopes in all slope positions where slopes are gentle to steep (< 60%). Thinner morainal veneers are also common on gentle crests and on slopes with convex surface shapes. Ablasion till is formed from ice melting in situ and is loose and non-compacted. It can have inclusions of glaciolacustrine and glaciofluvial materials. Deformation till is glacial deposits from previous glaciers that have been overridden and reworked by subsequent glacial ice. It resembles its material of origin. Basal till is deposited at the bottom of the glacier. It can be highly consolidated, compacted, and massive. It can cause root restriction and may underlie a layer of looser ablasion till or till that has been weathered by other processes.
Colluvial	C	Products of mass wasting and movement by gravity	Colluvial blankets and veneers overlying bedrock (or moraine) are dominant on steep (> 50%) slopes and ridge crests. They typically have angular coarse fragments. Talus is one type, but colluvial soils are equally common. Colluvium can be deposited by rockfalls, landslides, and other discrete events, but movement, often imperceptibly slow, generally continues in vegetated ecosystems on steep, colluvial soils.
Eolian	E	Materials deposited by wind action	Eolian cappings are common on terraces and gentle lower slopes where sources of sand and silt are abundant (or were abundant post-glaciation). These are silty or fine sandy cappings with low to absent coarse fragments that can form deep blankets in broad valleys or shallow veneers in more sheltered topography.
Fluvial	F	River and creek deposits	Fluvial terraces and plains are deposited from current (post-glacial) creeks and rivers. They are found in floodplains of major creek and river valleys. Soil textures can range from silty clay to sandy with variable amounts of gravels and cobbles.
Glaciofluvial	FG	Fluvial materials deposited when glaciers melted	Glaciofluvial deposits can cover extensive areas of valley bottom and lower valley terraces and plains. They are particularly common where two major valleys join and in U-shaped valleys. Glaciofluvial deposits generally form hummocky kames, narrow terraces, and steep scarp slopes. Hummocky glaciofluvial deposits are commonly found in complexes with ablasion till.
Lacustrine	L	Lake deposits	Lacustrine deposits are formed by current (post-glaciation) lake sediments. They develop as fine soil particles settle out and accumulate at the bottom of stagnant or slow moving waters in lakes and ponds and are exposed when waters recede. They are most common at the margins of lakes and floodplains where they typically cover a small area. Lacustrine deposits are comprised of very well sorted fine particles and lack coarse sands and gravels.

Glaciolacustrine	LG	Lacustrine material from glacial lakes	Glaciolacustrine deposits formed when valleys were dammed by glacial ice for significant lengths of time. These formations are generally restricted to the main river valleys in southeast British Columbia. Beach deposits, fans, and erosion features mark the upper limits of the historic glacial lake and are usually located between floodplains and lower valley slopes. Deposits are characterized by thin layers that reflect historic deposition of sediments.
Organic	O	Accumulation/ decay of vegetative matter	Organic accumulations generally occur on lower slopes, in valley bottoms, and in depressions. They can be common where undulating rock controls drainage patterns. In mountainous terrain they are generally very limited in size and distribution.
Bedrock	R	Outcrops and rock covered by less than 10cm of soil	Exposed bedrock commonly occurs on steep slopes and crests but also occurs in various landscape positions where bedrock is at or near the surface.
Weathered Bedrock	D	In situ, decomposed bedrock	Soils that have developed in situ from weathered bedrock. These are commonly very shallow veneers and are always found over the bedrock parent materials from which they were derived.
Anthropogenic	A	Human-modified materials	Anthropogenic surficial materials occur where soils have been modified by human activities such as road building, quarrying, mining, and other processes that redistribute rock and soil materials.

[a] Modified from Howse and Kenk (1997) and LMH 25, Table 2.5.

Cross-sectional diagram of common landforms



APPENDIX 3.6 TREE SPECIES CODES [1,2,3]

Native Conifers

Cedar	***Thuja***	**C**	
western redcedar	*Thuja plicata*		Cw
Douglas-fir	***Pseudotsuga***	**F**	
Douglas-fir	*P. menziesii*		Fd
interior Douglas-fir	*P. menziesii* var. *glauca*		Fdi
Fir (Balsam)	***Abies***	**B**	
grand fir	*A. grandis*		Bg
subalpine fir	*A. lasiocarpa*		Bl
Hemlock	***Tsuga***	**H**	
mountain hemlock	*T. mertensiana*		Hm
western hemlock	*T. heterophylla*		Hw
mountain x western hemlock hybrid	*T. mertensiana* x *heterophylla*		Hxm
Juniper	***Juniperus***	**J**	
Rocky Mountain juniper	*J. scopulorum*		Jr
Larch	***Larix***	**L**	
alpine larch	*L. lyallii*		La
western larch	*L. occidentalis*		Lw
Pine	***Pinus***	**P**	
limber pine	*P. flexilis*		Pf
lodgepole pine	*P. contorta*		Pl
interior lodgepole pine	*P. contorta* var. *latifolia*		Pli
ponderosa pine	*P. ponderosa*		Py
western white pine	*P. monticola*		Pw
whitebark pine	*P. albicaulis*		Pa
Spruce	***Picea***	**S**	
black spruce	*P. mariana*		Sb
Engelmann spruce	*P. engelmannii*		Se
white spruce	*P. glauca*		Sw
spruce hybrid	*Picea* cross		Sx
Engelmann x white	*P. engelmannii* x *glauca*		Sxw
Yew	***Taxus***	**T**	
western yew	*Taxus brevifolia*		Tw

[1] Data Custodian: Director, Forest Analysis and Inventory Branch.

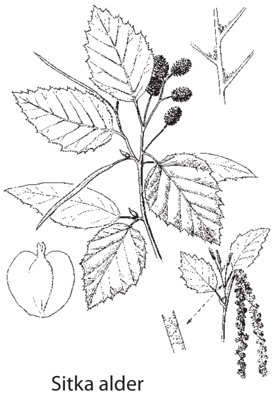
[2] Trees are defined as being woody, single stemmed, and capable of growing to greater than 10 m in height.

[3] A full list of native and non-native trees species codes is provided in LMH 25 (Province of British Columbia 2010).

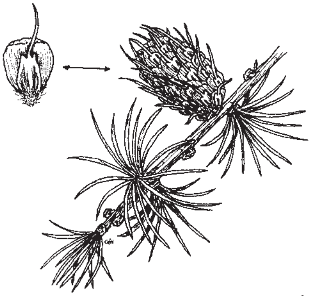
Native Hardwoods

Alder	***Alnus***	**D**	
green/sitka alder	*A. viridus*		Dg
mountain alder	*A. incana*		Dm
Aspen and Cottonwood	***Populus***	**A**	
black cottonwood	*P. trichocarpa*		Act
trembling aspen	*P. tremuloides*		At
Birch	***Betula***	**E**	
paper birch	*B. papyrifera*		Ep
Cascara	***Rhamnus***	**K**	
cascara	*R. purshiana*		Kc
Cherry	***Prunus***	**V**	
bitter cherry	*P. emarginata*		Vb
choke cherry	*P. virginiana*		Vv
pin cherry	*P. pensylvanica*		Vp
Maple	***Acer***	**M**	
Douglas maple	*A. glabrum*		Mr
Willow	***Salix* spp.**	**W**	
Bebb's willow	*S. bebbiana*		Wb
Pacific willow	*S. lucida*		Wp
Scouler's willow	*S. scouleriana*		Ws
Sitka willow	*S. sitchensis*		Wt

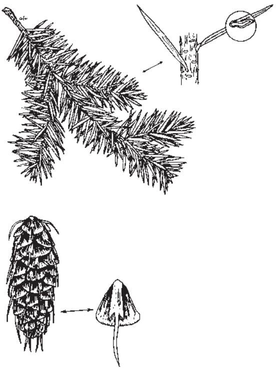
Paper birch
Betula papyrifera



Sitka alder
Alnus viridis ssp. *sinuata*

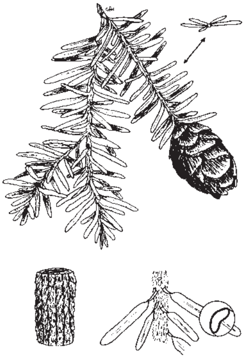


Western larch
Larix occidentalis



Douglas-fir
Pseudotsuga menziesii

Western redcedar
Thuja plicata



Western hemlock
Tsuga heterophylla

APPENDIX 3.7 VISUAL ESTIMATES OF PERCENT COVER

3.7.1 Tips for visual estimates of percent cover

Equivalent dimension-to-percent cover relationships for a 400 m^2 plot

Percent cover equivalent in 400 m^2	Dimensions	Equivalent Area
0.01%	20 x 20 cm	400 cm^2 (0.04 m^2)
0.1%	63 x 63 cm	0.4 m^2
0.25%	1 x 1 m	1 m^2
1%	2 x 2 m	4 m^2
5%	4 x 5 m	20 m^2
10%	6.3 x 6.3 m	40 m^2
25%	10 x 10 m	100 m^2

- For species with uneven distribution, try making estimates for subsections in each quarter of the plot and averaging across the plot.
- Alternatively, use the relationship between dimensions and percent cover in a 400 m^2 plot to tally up the cover across the plot. For example, if (from a bird's-eye view) the foliage, branch, and stem of an individual tree covers a 2 x 2 m area, it represents 1% cover in a 400 m^2 plot (see table above). If there are 12 trees of the same species of similar size in the plot, the total cover for that species would be 12%.
- Similarly, imagine compressing the total cover of a widely spread species into a single "clump" within the plot, then estimate the dimensions that the species clump would cover and compare it to the values in the table above.
- Do not use the percent cover equivalent dimensions for plots that do not cover 400 m^2 (i.e., 11.28 m radius or 20 x 20 m square plots); similar dimension-to-percent cover relationships can be determined for any sized plot using the following process:

  Equivalent Dimensions = sqrt (% cover equivalent area x plot area)

  For example, the Equivalent Area of 1% cover in a 50 m^2 plot area (3.99m radius plot) would be calculated as:

  $(1\% \times 50\ m^2) = 0.5\ m^2$

  $sqrt(0.5m^2) = 0.7\ m$

  Therefore, 1% of a 50 m^2 plot is equivalent to 70 cm x 70 cm
- **Always compare estimates to the visual comparison charts (A 3.7.2) as a cross-checking measure.**

3.7.2 Comparison charts for visual estimation of foliage cover