LAND MANAGEMENT HANDBOOK

71

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

The East Kootenay

2018

British Columbia

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The East Kootenay

Deb MacKillop, Audrey Ehman,
Kristi Iverson, and Evan McKenzie

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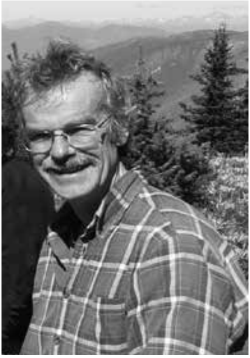
DEDICATION



Gareth Kernaghan (1949–2018)

This field guide is dedicated to Gareth Kernaghan: his wisdom, humour, and passion for ecosystems of the Kootenays have been instrumental in its development. Without his guidance, calm demeanour, and efficient approach to collecting data, we would have been lost, especially in the early days of this project. As a consultant for almost 30 years, not a day goes by that Gareth's field data, ideas, and analysis have not contributed to a better understanding of ecology and management of Kootenay ecosystems. And he sure was a lot of fun to work with. Gareth, you will be missed!

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 included 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 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 mosquitoes" (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 more than 25 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, Mike van Wijk, and Amy O'Neill.

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Del Meidinger and Ray Coupé offered extremely detailed edit and review comments on earlier 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, Carmen Cadrin, Jo-Anne Stacey, Merle Crombie, Chuck Bulmer, Paul Rehsler, Jay Hallet, 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, to avalanche slopes with alder over their heads. Mike Ryan and Will MacKenzie worked tirelessly with us to finalize the non-forested classification presented here. Hillary Page, Alisa Seimens, and Francis Njenga provided helpful comments on the Grassland section.

Vicky Lipinski's fastest fingers in the west kept the data entered and organized, while Will Burt, Huapeng Chen, Adrian Walton, and Rhian Davis 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 and Maija Finvers provided critical support and feedback for the soils, geology, and landforms sections. Peter Holmes used his vast experience in the area to provide a comprehensive review of the entire field guide, with a focus on wildlife and habitat issues.

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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 our typos in the proofreading 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 Strategy program, first through the Forest Investment Account with support from BC Timber Sales, Canfor Industries (previously Tembec), and Interfor, and later through the Forest Analysis and Inventory Branch, Resource Practices Branch, and the Kootenay-Boundary Region. Many thanks go to Marcie Belcher 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 executive champion and data custodian, respectively. And of course, ongoing support from our Regional Management Team, led by our Director of Resource Management, John Krebs, and our Regional Executive Directors, Paul Rasmussen and Garth Wiggill, is greatly appreciated.

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1 INTRODUCTION

This field guide presents site classification and identification information for ecosystems of the East Kootenay, 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 eastern slopes of the Purcell Mountains, the southern Rocky Mountain Trench, and the Rocky Mountains from the United States border to the Kicking Horse River. The area corresponds to much of the Cranbrook and Invermere Timber Supply Areas (TSAs), the southern extent of the Golden TSA, large areas of Tree Farm Licence 14, and most of Kootenay and Yoho National Parks.

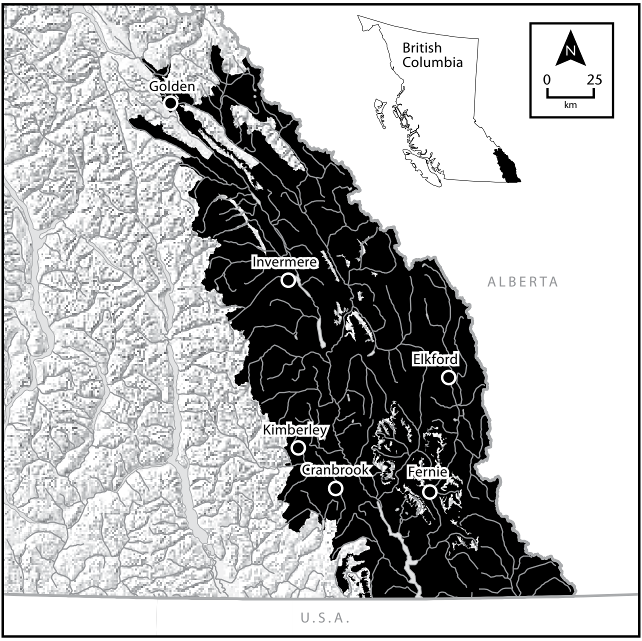


FIGURE 1.1 *Geographic area covered by this guide: East Kootenay.*

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 natural 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, as a classification system, 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 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.

The first ecosystem sampling by the Ministry of Forests was initiated in southeast British Columbia in the late 1970s and early 1980s. 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 for the East Kootenay since the early 1990s when Braumandl and Curran (1992) published field guides for the former Nelson Forest Region. 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 GIS 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). Ecosystem classification for areas to the west is covered in Land Management Handbook (LMH) 70 (MacKillop and Ehman 2016). An additional field guide is in progress for the north Columbia Mountains; it covers areas to the north of this field guide area. For a more detailed discussion of the field methodology used to describe ecosystems, refer to Land Management Handbook 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, surficial materials, soils, climate, zonal vegetation, and disturbance history
5. Classification and description of biogeoclimatic units and forested site series
6. Classification and description of non-forested site units for wetland, flood, grassland, rock, 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 11 biogeoclimatic subzones/variants. 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 East Kootenay. The site series described represent the mature and old stages of relatively common ecosystems sampled throughout the biogeoclimatic 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.

Pinegrass
Calamagrostis rubescens

Nodding onion
Allium cernuum

Meadow death-camas
Toxicoscordion venenosum

Mountain death-camas
Anticlea elegans

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).

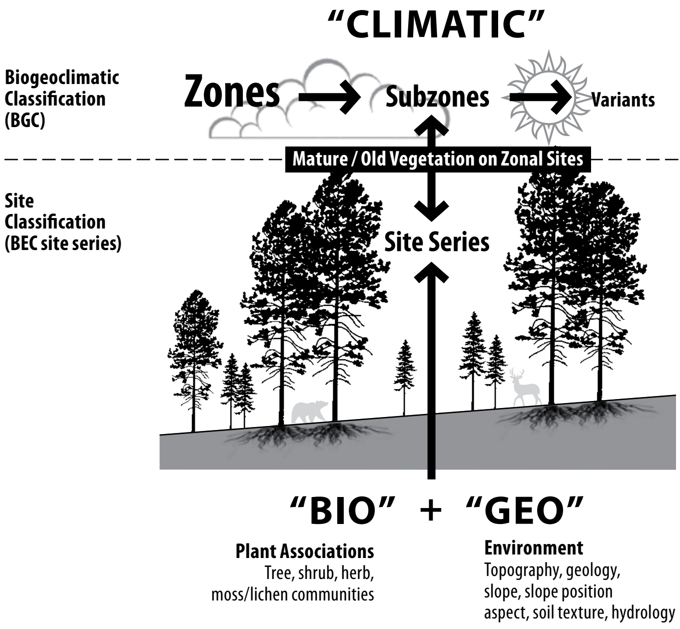


FIGURE 2.1 *Relationship between regional climate and site classification levels of BEC.*

[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. In essence, 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 variables. 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). In the BEC system, 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

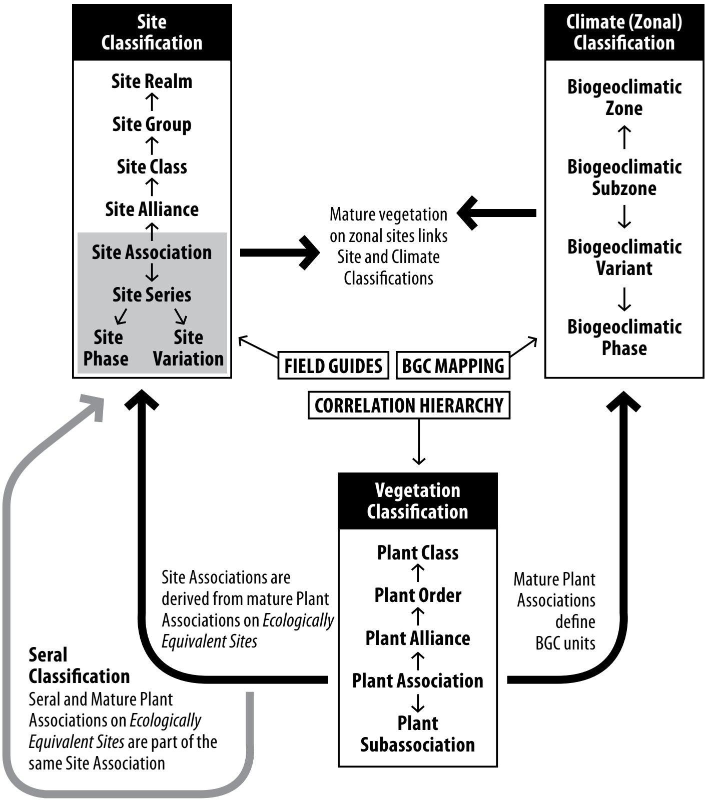


FIGURE 2.2 *Relationship between the components of BEC, including key applications of each: climate (zonal) classification (BGC mapping); site classification (field guides); and vegetation (correlation hierarchy). The shaded grey portion of the site classification shows the units most commonly described 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 IDF denotes the Interior Douglas-fir 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 and include geographic areas 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 of subzone and to 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 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, IDFxk represents the very dry, cool IDF 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 (IMA) above.

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

Precipitation	Code	Temperature	Code
very dry	x	very hot	x
dry	d	hot	h
moist	m	warm	w
wet	w	mild	m
very wet	v	cool	k
		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, often with 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 may apply. Biogeoclimatic phases are used infrequently.

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 Terrain Resource Information Mapping (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 IDFxx2 to IDFdm2, MSdw, ESSFdk1, ESSFdkw, ESSFdkp, 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 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 in the ICHwk (typically lower slopes), and on hygric sites in the ICHmw (generally moist toe slopes). Site associations are more variable in climatic and site conditions than site series, and are, therefore, 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 and site associations are usually the most detailed level of site classification, they can be further subdivided into phases and variations. A **phase** is used where site conditions are different but mature

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

vegetation is too similar to differentiate distinct plant associations for the two site conditions. For example, the ICHmk4/102 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 (ICHmk4/102a) and a subxeric shallow/coarse soils phase (ICHmk4/102b). A site series 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 series 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 MSdw/104, grouseberry and low bilberry can be dominant or they can be sparse or absent. Two variations are used to describe these situations: MSdw/104.1 describes the grouseberry/low bilberry variation, while MSdw/104.2 describes sites with little or no grouseberry/low bilberry. Site series 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 series variations.

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. Vegetation communities, however, change with time and disturbance, so 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 are the primary focus 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, *IDFdm2/Fd(Lw) – Pinegrass – Twinflower* represents the zonal site series in the IDFdm2 variant.

Historically, forested site series were given a two-digit numeric code. The 01 site series was always zonal, and site series were numbered sequentially from dry to wet and secondarily from very poor to very rich. This guide uses a new system designed to eliminate any confusion that may arise from changes in site

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

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 and higher 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).

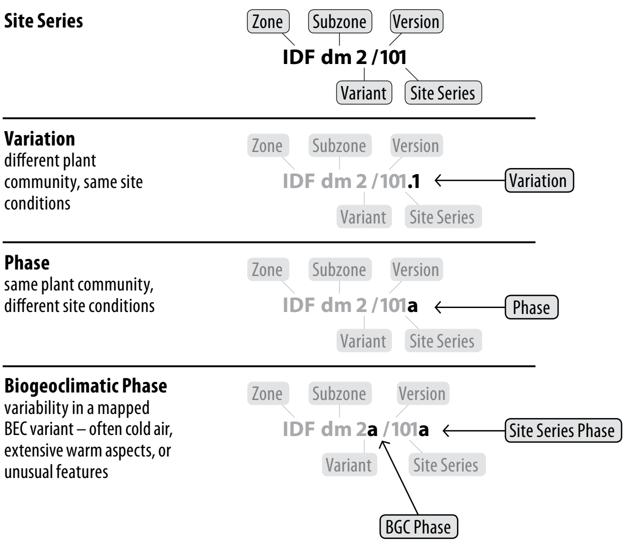


FIGURE 2.3 *Coding for site series, site series variations, site series phases, and biogeoclimatic phases.*

2.3 Seral Vegetation Classification

Vegetation composition (the species present) and structure (size distribution and spatial arrangement of trees and other plants) changes over time—a process traditionally called succession. Within BEC, the mature and old 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 stands 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 in which it occurs, but it is a different (young seral) plant association than the mature one used to name the site association and site series.

Seral vegetation, or younger/disturbed stands, are coded within the BEC system using a "$" to denote the younger stand or disturbed 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 ICHmk4 could be coded as ICHmk4/110$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).

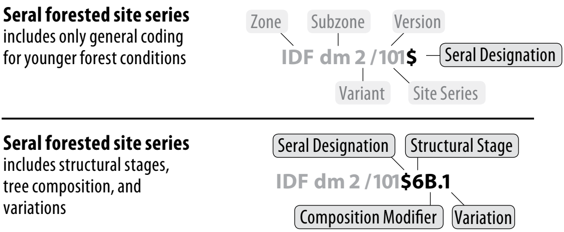


FIGURE 2.4 *Coding for seral (younger or disturbed) ecosystems.*

[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 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, when the subzone/variant is recorded (e.g., IDFdm2/Wm01). More information on non-forested ecosystems is provided in Chapter 6.

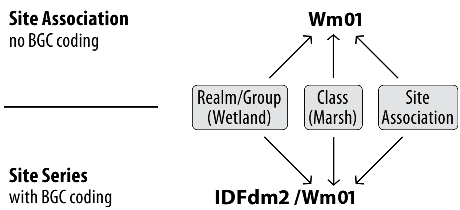


FIGURE 2.5 *Coding for non-forested units, as site associations or site series.*

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 focus on the most common conditions on mature and older successional stages of site units. 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.

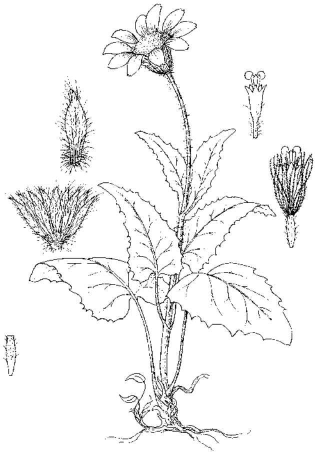
Climate change impacts on ecosystems are likely to be expressed initially as changes in vigour, relative productivity, and disturbance susceptibility, and later as changes in the range and distribution of species already present and likely to be introduced or lost. At longer time scales, climate change 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.

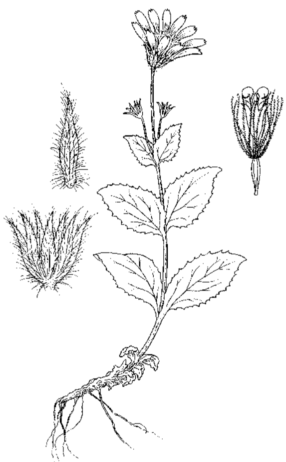
The database used for the BEC classification in this field guide currently includes more than 65 000 sites sampled throughout the province. These data provide a historical record of the site, soils, and vegetation features that have occurred on the landscape since the 1960s. This information, along with 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 still be critical. 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. 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 East Kootenay, 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 4.3, 4.4, and 4.5: zonal vegetation comparisons (Chapter 4); and
- Table 4.8: comparison of climates (Chapter 4).

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 in the field, transitional characteristics may become evident, particularly along north/south gradients and higher/lower elevations. If an area is located in the transition ecosystem 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 ~50–100 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" or geomatics data warehouse)
- 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, particularly on zonal or mesic sites in the area
- referring to BGC descriptions in Chapter 5, and zonal vegetation comparisons in Chapter 4

→ **Example: IDFdm2**

2. Identifying the Site Unit (Site Series; Site Association for non-forest)

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; defined in Section 3.2.2)

→ **Example: IDFdm2/104**

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 ends 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 in the field guide area, 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 either 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 that includes 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 3.8 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 classifying 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 nutrients 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-forested 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). 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.

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 on 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 System (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 inferred from site, soil, and vegetation characteristics. Assessment of SMR and SNR is inferred from observations but is rarely based on quantitative data. In addition, space on the edatopic grid (i.e., number of cells occupied) is not related to the size or distribution of a site series across the landscape. A site

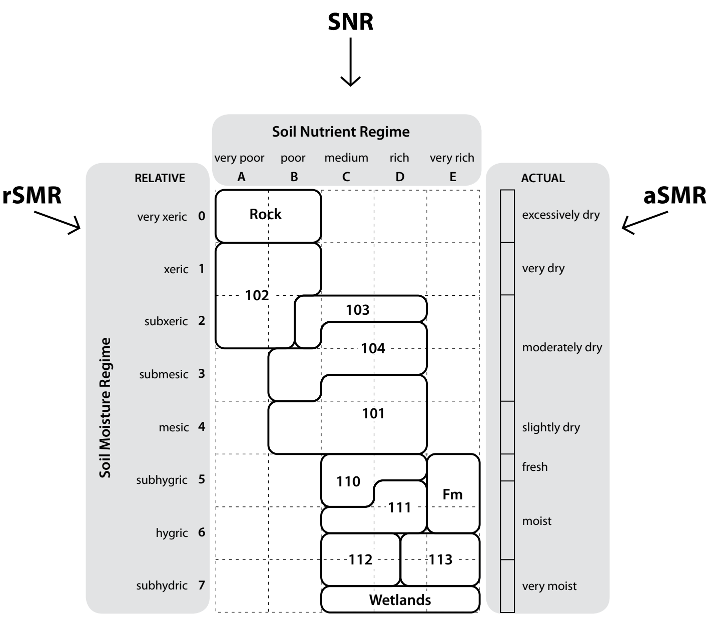


FIGURE 3.2 *Example of an edatopic grid.*

series that occupies a large area on the edatopic grid can be very uncommon on the landscape

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 in this field guide are based on calculated values using Version 5.4 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, with the same mature plant community, occurs in riparian areas in the ICHmw2, on lower-slope receiving sites in the ICHwk1, and on mid-slope zonal sites in the ICHvk1. Differences in precipitation across the subzones/variants drive the variability in landscape position/rSMR and the similarity in **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. Version 5.4 was released in 2017.

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

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[b] ≤ 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] AET – 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), the common name and the scientific name are both 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 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 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 tables 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.

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 indicator 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 with parentheses ( ), 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 or ridge; 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).

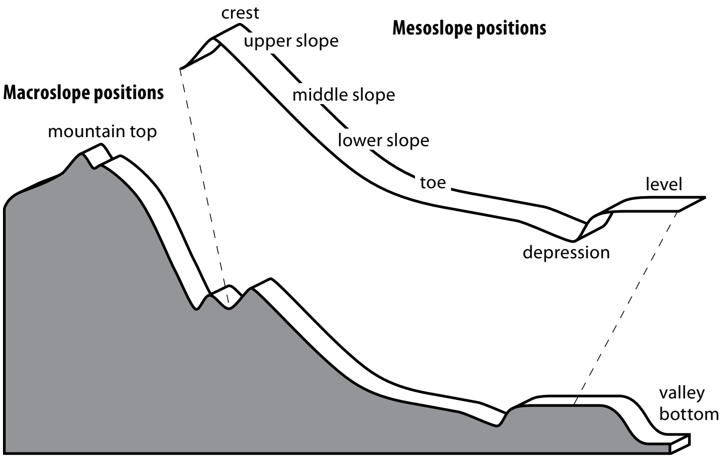


FIGURE 3.3 *Mesoslope positions.*

Typical slope/aspect and common compensating conditions: In many cases, the interaction between environmental factors is critical for determining site conditions. For example, submesic sites often occur on medium-textured soils on mid slopes of warm aspects or on moderately coarse soils on 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 for 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 3.6 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: Coarse fragment content reflects the percentage of coarse particles (> 2 mm diameter), or rocks, in the soil. A categorical summary of coarse fragment content is used in the environmental tables (see Appendix 3.2 for more information and for keys to coarse fragment size classes). 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 subzone/variant crosswalk
- 2.2 Site series crosswalk

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 Canadian System of Soil Classification
- 3.5 Rock identification and characteristics
- 3.6 Common surficial materials in southeast British Columbia
- 3.7 Tree species codes
- 3.8 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 are soil and site characteristics.

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 temporarily 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 often 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 younger 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. The environment tables and site unit descriptions in Chapter 5 provide useful information. 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 frequently 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). A subset of common non-forest disturbance codes is also provided in Section 6.1. 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 less subcanopy light and less understorey vegetation.

3.4 Mapping Site Units

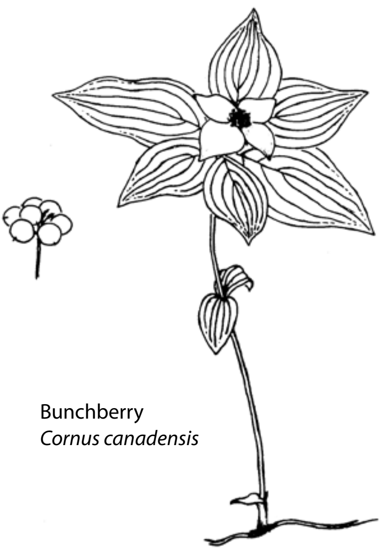
An ecosystem map is a useful tool for effective resource planning and management. A map provides a permanent record of the location and distribution of ecosystems, and thus acts as a spatial framework for developing site-specific management prescriptions for all potential resource values. A map also 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 Mapping (TEM) or Predictive Ecosystem Mapping (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. Each of these applications uses 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 provides 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.



Bunchberry
Cornus canadensis

4 THE ENVIRONMENT OF THE EAST KOOTENAY: REGIONAL OVERVIEW

The following section provides an overview of the East Kootenay environment, including its cultural history, biogeoclimatic subzones/variants, vegetation patterns, climate, physiography, bedrock geology, surficial materials, and soils, and the typical pattern of site series in mountainous terrain. Figure 1.1 shows the extent of the area covered by this field guide (see Chapter 1).

4.1 Cultural History

The East Kootenay is the traditional territory of the Ktunaxa and Shuswap First Nations. Archaeological evidence suggests that Indigenous people have inhabited the East Kootenay since the last glaciation more than 10 000 years ago. European settlement began in the early 1800s when David Thompson established the first fur trading post in the Rocky Mountain Trench near Invermere as part of his exploration of the Columbia and Kootenay Rivers. Non-indigenous settlement was slow until the Kootenay Gold Rush of the 1860s. The Canadian Pacific Railway completed routes through Rogers Pass in 1885 and the Crowsnest Pass in 1898, which facilitated expanded settlement in the previously remote East Kootenay region.

Historically, Indigenous land management included prescribed burning in dry ecosystems to maintain plant communities as food sources and forage for wildlife. Cessation of Indigenous burning, combined with improved fire suppression techniques, shifted stand and landscape patterns. The creation of new settlements, prompted by mining activity and the development of railways, was accompanied by increased logging and cattle ranching. By the mid-1900s, grasslands were overgrazed, which resulted in changes to native plant communities, particularly at low elevations (Eastham 1949). Similarly, logging around the turn of the 20th century targeted large Py, Lw, and Fd trees at lower elevations, removing much of the historically present old trees and forests (Eastham 1949). In the mid-1990s, efforts to restore native habitats began, and are ongoing: thinning, understorey removal, and prescribed fire treatments are the primary restoration tools being used.

Today, the East Kootenay is home to numerous unincorporated towns and eight municipalities: Cranbrook, Fernie, Kimberly, Sparwood, Elkford, Radium Hot Springs, Canal Flats, and Invermere. Four Indigenous communities also occur within the area: Tobacco Plains (ʔakink'umǂasnuqǂiʔit), St. Mary (ʔaq'am), Columbia Lake (ʔakisq'nuk), and Shuswap. Major sources of employment are mining, forestry, tourism, agriculture (mostly ranching), and government services. Major anthropogenic developments are large coal mines and hard-rock mines in the Elk Valley and Kimberley area, respectively; urban and rural development, largely in valley-bottom areas; ranching; and logging. The Koocanusa Reservoir, created by the Libby Dam in Montana in 1973, shifted hydrologic dynamics and flooded more than 150 000 ha in British Columbia from the U.S. border to Wardner. The completion of the Grand Coulee Dam in the United States in 1933 resulted in the end of salmon spawning in the Columbia River system.[1]

The East Kootenay field guide area intersects two national parks (Kootenay and Yoho) and includes the following provincial parks: Mount Assiniboine, Height of the Rockies, Elk Lakes, Purcell Wilderness Conservancy, Top of the World, Kikomun, Akamina-Kishinena, and Gilnockie. It also includes several smaller parks and recreation areas. The diversity of climates, geology, and ecosystems has long been a key driver of cultural history in the East Kootenay.

4.2 Biogeoclimatic Units in the Field Guide

Fourteen biogeoclimatic (BGC) subzones/variants are described in this field guide. They occur within five zones: Interior Mountain-heather Alpine (IMA), Engelmann Spruce – Subalpine Fir (ESSF), Montane Spruce (MS), Interior Cedar – Hemlock (ICH), and Interior Douglas-fir (IDF). Detailed descriptions are provided for 11 subzones/variants; brief descriptions are provided for the high-elevation units, including the IMA and ESSF parkland (described in Section 6.7). The ESSFwmw, which occurs within the field guide area, is described in detail in LMH 70 (MacKillop and Ehman 2016).

The East Kootenay has a high diversity of ecosystems, from extensive grasslands in the IDF at valley bottom in the Rocky Mountain Trench to wet ESSF forests with high snowpack and infrequent stand-replacing fires in the Fernie/Sparwood area. The diversity in climates and ecosystems occurs across very short distances and is mediated by elevation, latitude, and prevailing weather patterns. The largest subzones/variants in the East Kootenay field guide area are the ESSFdk2, MSdk, ESSFdk1, and ESSFdkw. The smallest units are the ESSFwmp, ESSFwmw, IDFxk, ESSFwm1, and ICHmk4 (Table 4.1).

High-elevation biogeoclimatic units are described at broader scales than other ecosystems in the field guide. Site series classifications for the ESSFdkw are provided in Chapter 5; classifications for the ESSFwmw are provided in LMH 70 (MacKillop and Ehman 2016). Brief descriptions are provided for the alpine (IMAun) and parkland (ESSFdkp and ESSFwmp) units, with an emphasis on subzone characteristics and non-forested site classes found at

[1] Prior to the building of the Grand Coulee Dam, salmon travelled from the Pacific Ocean to as far as Columbia Lake to spawn.

TABLE 4.1 *Area covered by each biogeoclimatic subzone/variant described in the East Kootenay field guide*

Zone	Subzone/ variant	Name	Area (ha)[a,b]
IMA	IMAun	Undifferentiated Interior Mountain-heather Alpine	143 686
IDF	IDFdk5	Columbia Dry Cool Interior Douglas-fir	73 423
	IDFdm2	Kootenay Dry Mild Interior Douglas-fir	209 183
	IDFxk	Very Dry Cool Interior Douglas-fir	33 087
	IDFxx2	Kootenay Very Dry Very Hot Interior Douglas-fir	83 677
MS	MSdk	Dry Cool Montane Spruce	313 887
	MSdw	Dry Warm Montane Spruce	271 575
ICH	ICHmk4	Elk Moist Cool Interior Cedar – Hemlock	68 205
ESSF	ESSFwm1	Fernie Wet Mild Engelmann Spruce – Subalpine Fir	68 766
	ESSFdk1	Elk Dry Cool Engelmann Spruce – Subalpine Fir	313 324
	ESSFdk2	Columbia Dry Cool Engelmann Spruce – Subalpine Fir	404 141
	ESSFdkw	Dry Cool Woodland Engelmann Spruce – Subalpine Fir	300 006
	ESSFdkp	Dry Cool Parkland Engelmann Spruce – Subalpine Fir	176 900

[a] Excluding major water bodies and ice; based on BEC version 11.
[b] Areas may change with mapping revisions. Consult updated mapping through the BECWeb site or the British Columbia government's spatial data warehouse.

higher elevations (see Section 6.7). Subsequent publications are expected to provide classification details for high-elevation site associations.

Woodland and parkland units are described and mapped at the subzone level rather than the variant level. They can also be described as separate variants based on the ESSF variant that occurs at lower elevations. For example, the ESSFwmw covers an extensive area across the Selkirk, Purcell, and Rocky Mountains; it occurs above the ESSFwm2 and ESSFwm4 in the Purcell Mountains (including areas in the Rocky Mountain District) and above the ESSFwm3 in the Selkirk Mountains (see LMH 70 [MacKillop and Ehman 2016]). Within the field guide area, it occurs above the ESSFwm1 (see

TABLE 4.2 *Area covered by woodland and parkland variants*

Subzone	Variant	Geographic area/field guide	Area (ha)[a,b]
ESSFdkw	ESSFdkw1	East Kootenay (south)	95 219
	ESSFdkw2	East Kootenay (north)	204 787
		SUBTOTAL	300 006
ESSFdkp	ESSFdkp1	East Kootenay (south)	33 304
	ESSFdkp2	East Kootenay (north)	143 596
		SUBTOTAL	176 900
ESSFwmw[c]	ESSFwmw1	East Kootenay (Fernie)	28 500
	ESSFwmw2	Central Purcell Mountains	70 229
	ESSFwmw3	South Selkirk Mountains	26 136
	ESSFwmw4	South Purcell Mountains	21 856
		SUBTOTAL	146 721
ESSFwmp[c]	ESSFwmp1	East Kootenay (Fernie)	9 007
	ESSFwmp2	Central Purcell Mountains	53 840
	ESSFwmp3	South Selkirk Mountains	3 003
	ESSFwmp4	South Purcell Mountains	4 791
		SUBTOTAL	70 641
		TOTAL	**694 268**

a Excluding major water bodies and ice; based on BEC version 11.
b Areas may change with mapping revisions. Consult updated mapping through the BECWeb site or the British Columbia government's spatial data warehouse.
c The ESSFwm2, ESSFwm3, ESSFwm4, ESSFwmw, and associated informal variants of the ESSFwmw are described in LMH 70 (MacKillop and Ehman 2016).

Chapter 5) in the Rocky Mountains. Table 4.2 shows the area of each unofficial variant in the woodland and parkland units described in this guide.

Maps and detailed descriptions of the subzones/variants described in this field guide are provided in Chapter 5; maps of all subzones/variants are available as GIS digital files through the BECWeb site and the British Columbia government's spatial data warehouse.

4.3 Forests of the East Kootenay

Forests and ecosystems of the East Kootenay are a function of the unique climate, bedrock geology, surficial materials, and soils of the area (see Sections 4.5–4.9). The IDF occurs at the lowest elevations in the field guide area, and ranges from the very hot and very dry IDFxx2 at valley bottoms in the south to the dry cool IDFdk5 in the north. Fd[2] is the dominant tree species throughout the IDF. Other tree species have variable ranges, with Py and Lw restricted to the southern half to two-thirds of the area, and Pl occurring in all BGC units but limited to circum-mesic sites in the IDFdm2 and dk5 and wetter sites in the IDFxx2 and xk. Stand structure varies from open forests on drier sites to closed forests on mesic and wetter sites. Grasslands are prominent in the IDFxx2, xk, and dm2, and wetlands are abundant in the floodplains of the Columbia River, particularly in the IDFxk and dk5.

The MS and ICH occur at mid elevations. Sxw, Fd, and Pl forests characterize the MSdk and MSdw, with Lw frequently being prominent in the MSdw and at the southern extent of the MSdk. Bl is often a minor component of stands. At and Ep are common in seral stands on some dry, warm-aspect sites, and in mixed floodplain stands that are dominated by Act. Pf, a tree species at risk, is uncommon on dry, rocky sites in both the MSdw and MSdk.[3] Grasslands provide important habitat diversity and are generally restricted to the MSdw. The ICHmk4 is the only ICH variant described in this field guide. Together with the ESSFwm1, it occurs within a large area of Moist climate surrounded by the Dry climate subregion (see Figure 4.1). Common tree species are Cw, Sxw, Fd, and Lw. Bl, Pl, At, Ep, and Act also occur. Unlike most other ICH subzones, Hw is uncommon in the ICHmk.

Bl and Se are the primary tree species in the ESSFdk1, ESSFdk2, and ESSFwm1, although Pl and Fd can be common and abundant, particularly on drier sites in the ESSFdk1 and ESSFdk2. Pa, another species at risk, is often a component of stands on dry, rocky sites, but its presence has declined due to white pine blister rust and mountain pine beetle. Although the ESSF is primarily forested, avalanche tracks and rock outcrops are common throughout the unit in the East Kootenay. The ESSF woodland and parkland subzones occur at higher elevations, where Bl is dominant, Se is common, and Pa and La are typically restricted to drier sites. The IMA occurs at the highest elevations, above treeline, and is common throughout the field guide area. It is characterized by a mosaic of low-growing shrubs, mountain-heather–dominated heath, grass-sedge-forb meadows, tundra, rock, snow, and ice.

[2] Tree species codes are described in Appendix 3.7.

[3] Pf is also known to occur in the IDF and occasionally in the ICH and at lower elevations in the ESSF.

Several other biogeoclimatic units occur in the broader area known as the East Kootenay. The ICHmk5 occurs within the northern portion of the area covered by this field guide, and will be described in a subsequent publication. The ICHdm occurs in the southern Purcell Mountains as well as in a small area of the Rocky Mountains adjacent to the ICHmk4. A small area of ICHmw2 occurs in the St. Mary drainage in the Purcell Mountains and the ICHdw1 occurs at the southern extent of Moyie Lake. The ICHdm, mw2, and dw1 are mapped primarily to the west of this field guide area, and are described in LMH 70 (MacKillop and Ehman 2016). The ESSFwh2, ESSFwm2, and ESSFwm4 occur in the south-central Purcells to the west of the field guide area (including areas of the Rocky Mountain District) and are described in LMH 70 (MacKillop and Ehman). The ESSFmm3 occurs at the northern end of the field guide area (e.g., Spillimacheen and upper Kootenay Rivers) and will be described in a future field guide.

4.4 Zonal Vegetation in the Biogeoclimatic Units of the East Kootenay

Zonal sites support plant communities that best reflect the local climate. As described in Chapter 2, they occur on mid-slope, neutral-aspect sites with medium-textured, deep soils. The mature vegetation on zonal sites is used to differentiate biogeoclimatic subzones. Zonal vegetation comparisons are shown in Tables 4.3 (IDF and MS), 4.4 (ICH), and 4.5 (ESSF) to illustrate the variability of plant communities on zonal sites across biogeoclimatic subzones that are covered by this field guide and in adjacent areas. Zonal vegetation summaries are provided at the subzone scale, not the variant scale. For two biogeoclimatic variants to be correlated in the same subzone, the zonal vegetation must be very similar (generally the same plant association, but different plant subassociations) (see Chapter 2). Full species lists for zonal site associations in each biogeoclimatic subzone/variant are provided in Chapter 5.

Zonal vegetation comparison tables show the major patterns of tree, shrub, herb, and moss layer species distributions across subzones/variants. This is helpful for recognizing broad-scale patterns of vegetation and for delineating subzones across the landscape. For example, Lw grows on zonal sites in the IDFdm but is absent on zonal sites in the drier IDFxx and the cooler IDFdk. In contrast, bluebunch wheatgrass is often present in the herb layer on zonal sites in the IDFxx and IDFxk subzones but not in the moister IDFdm and IDFdk. Similarly, Sxw occurs on zonal sites in the MS and ESSF but not in the IDF, while Cw occurs on zonal sites in the ICH.

TABLE 4.3 *Zonal vegetation comparisons for subzones/variants of the IDF and MS*

Layer	Scientific name	IDFxx2	IDFxk	IDFdm2	IDFdk5	MSdw	MSdk	Common name
Trees	*Pinus ponderosa*	■■■■■						ponderosa pine
	Pseudotsuga menziesii	■■■■	■■■■■	■■■■	■■■■■	□□	■■■■	Douglas-fir
	Larix occidentalis			■■■■		■■■		western larch
	Pinus contorta			*	□□□	■■■	□□□	lodgepole pine
	Picea engelmannii x *glauca*					■■■■	■■■■	interior spruce
	Abies lasiocarpa					■■■	□□□	subalpine fir
Regen	*Pinus ponderosa*	■						ponderosa pine
	Pseudotsuga menziesii	■■■	■■■	■■■	■■■	*	*	Douglas-fir
	Abies lasiocarpa					■■■	■■■	subalpine fir
	Picea engelmannii x *glauca*				*	■■■	□□	interior spruce
Shrubs	*Amelanchier alnifolia*	■	□	■■	□□	*	*	saskatoon
	Spiraea lucida		■■	■■■	□□	■■	□	birch-leaved spirea
	Berberis spp.	*		■■■■	■■	*	*	Oregon-grape
	Shepherdia canadensis		■■	□□□	■■■	□□	*	soopolallie
	Juniperus scopulorum		■■					Rocky Mountain juniper
	Menziesia ferruginea					■	□□□	false azalea
Herbs	*Calamagrostis rubescens*	■■■■	■■■■	■■■■■	■■■■	■■■	*	pinegrass
	Pseudoroegneria spicata	□□□	■■					bluebunch wheatgrass
	Eurybia conspicua		■■	■■	■■■	□□	□	showy aster
	Arnica cordifolia			□□	*	■■■	□□	heart-leaved arnica
	Linnaea borealis			*	□□	□□	■■	twinflower
	Cornus canadensis					■■■	■■■	bunchberry
Moss layer	*Hylocomium splendens*	*	*	*	*		■■■■	step moss
	Pleurozium schreberi	*	*	□□□	■■■■	■■■■	■■■■■	red-stemmed feathermoss
	Ptilium crista-castrensis					*	■■■	knight's plume

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 4.4 *Zonal vegetation comparisons for subzones/variants of the ICH*

Layer	Scientific name	ICHdw1[a]	ICHdm[a]	ICHmw2[a]	ICHmk4	ICHmk5[b]	Common name
Trees	*Tsuga heterophylla*	□□□□	■■■■■	■■■■■			western hemlock
	Thuja plicata	■■■■	■■■	■■■■	■■■■	■■■	western redcedar
	Pseudotsuga menziesii	■■■■	*	*	□□□	■■■■	Douglas-fir
	Abies lasiocarpa		□□□		□□□	□□□	subalpine fir
	Larix occidentalis	□□□	□□□	*	□□□		western larch
	Picea engelmannii x *glauca*		□□□		■■■■	■■■■	interior spruce
	Pinus contorta	*				□□□	lodgepole pine
Regen	*Tsuga heterophylla*	■■■■	■■■■	■■■■			western hemlock
	Thuja plicata	□□□	□□□	■■■	■■■	■■■	western redcedar
	Abies lasiocarpa		*		□□□	■■■	subalpine fir
	Picea engelmannii x *glauca*				*	■■	interior spruce
Shrubs	*Paxistima myrsinites*	■■■	■■	■■	■■	*	falsebox
	Vaccinium membranaceum	■■	■■	■■	■■	□	black huckleberry
	Acer glabrum	□□			■■	□□	Douglas maple
	Spiraea lucida	*	*		□□	■	birch-leaved spirea
	Menziesia ferruginea		■		□	□□	false azalea
Herbs	*Clintonia uniflora*	■■■	■■	■■	■■	*	queen's cup
	Linnaea borealis	■■■	□□	■■	*	■■	twinflower
	Chimaphila umbellata	■■■	□□	□		■	prince's pine
	Tiarella trifoliata var. *unifoliata*	*	□□	■■	*		foamflower
	Arnica spp.		*		■■■	*	arnicas
	Cornus canadensis		*	□□	□	■■■	bunchberry
Moss layer	*Rhytidiopsis robusta*	■■■■	■■■	■■■	*		pipecleaner moss
	Pleurozium schreberi	□□□	□□□	■■■■	□□□	■■■■■	red-stemmed feathermoss
	Ptilium crista-castrensis			*	*	■■■	knight's plume
	Hylocomium splendens			□□□□		□□□	step moss

[a] Described in LMH 70 (MacKillop and Ehman 2016); adjacent to subzones/variants described in this field guide.
[b] The ICHmk5 will be described in a subsequent field guide.

TABLE 4.5 *Zonal vegetation comparisons for subzones/variants of the ESSF*

Layer	Scientific name	ESSFdk1	ESSFdk2	ESSFdkw	ESSFmm3[a]	ESSFwh2[b]	ESSFwm1	ESSFwm2[b]	ESSFwm4[b]	ESSFwmw[b]	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
	Tsuga heterophylla					□□□					western hemlock
Shrubs	*Menziesia ferruginea*	■■■■	■■■■	□□□	■■■■	■■■	■■■■	■■■■	■■■■		false azalea
	Vaccinium membranaceum	□□	□□	□□□	■■■	■■■■	■■■■	■■■■	■■■■	■■■■	black huckleberry
	Rhododendron albiflorum	*		□□□□	*	■■■	■■■■	■■■■	■■■■	■■■■	white-flowered rhododendron
Herbs	*Vaccinium scoparium/myrtillus*	■■■	■■■	■■■■					□□	□□	grouseberry/low bilberry
	Arnica spp.	■■■	■■	■■■	□□	□□	■■■	■■■	■■■	□□	arnicas
	Cornus canadensis		■■■		*	*					bunchberry
	Rubus pedatus				■■■	■■■		□□			five-leaved bramble
	Tiarella trifoliata var. *unifoliata*				□□	■■■	■■■	■■■	■■		one-leaved foamflower
	Veratrum viride						■■	■■	□□		false-hellebore
	"mitreworts"[c]						■■	■■	□	■■	mitreworts
	Luzula spp.			*			■■	■■	□□	■■■■	wood-rushes
Moss layer	*Brachythecium* spp.	■■■	*	□□□	*	■■■	■■■	■■■■	■■■	■■	ragged-mosses
	"leafy liverworts"[c]	□□	□□	■■■■	□□□□	■■■	■■	■■■	□	□□□□	leafy liverworts
	Pleurozium schreberi	*	■■■■■		■■■■	■■■		*			red-stemmed feathermoss
	Dicranum spp.	*	□□	□□□	■■■	■■■	□	■■■	□	■■■	heron's-bill mosses
	Ptilium crista-castrensis		■■■		□□□						knight's plume

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] The ESSFmm3 occurs adjacent to the ESSFdk2, and will be described in a subsequent BEC field guide.
[b] The ESSFwh2, wm2, wm4, and wmw are described in LMH 70 (MacKillop and Ehman 2016).
[c] Lists of grouped species are provided in Appendix 1.1.

4.5 Climate Overview

The weather systems in British Columbia are dominated by a pattern of west-to-east air flows that bring a series of low- and high-pressure systems across the province. As weather systems from the Pacific Ocean meet the Coast Mountains, large amounts of precipitation are released as moisture-laden maritime air masses are forced to move up and over the mountain ranges. These air masses cross the rainshadow of the interior plateau, warming and picking up more moisture before they meet the Monashee, then Selkirk, and Purcell Mountains, where, again, precipitation is released as the air masses move up and over each range. The amount of precipitation is linked to the size of the mountains and the amount of rainshadow effects. Dry, arctic air masses also influence climates in the field guide area, especially in the Rocky Mountains.

In southeast British Columbia, 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 four climate subregions: Very Dry, Dry, Moist, and Wet (see Figure 4.1). Climate subregions correspond to differing biogeoclimatic zone and subzone/variant sequences across changes in elevation.

The **Wet climate subregion** incorporates the wettest portions of the inland temperate rainforest, and occurs in the northern Monashee and Selkirk Mountains and extends north and west into areas of the Northern Interior and Cariboo. It does not occur in the field guide area. The **Moist climate subregion** occurs in the central Monashee Mountains, the south and central Selkirk Mountains, areas of the Purcell Mountains, along much of the Kinbasket Reservoir in the Rocky Mountains and northern Selkirk Mountains, and, in the field guide area, in the lower Elk and Bull drainages in the Rocky Mountains. The **Dry climate subregion** occupies rainshadow areas of the Coast and Columbia Mountains. In the west, it includes the Okanagan Highland and areas of the southern Monashee Mountains, including the Kettle River and lower Granby River drainages, as well as the southernmost areas of the Columbia and Kootenay River valley bottoms. In the field guide area, the Dry climate subregion includes areas of the Rocky Mountain Trench and much of the slopes of the eastern Purcell and southern Rocky Mountains. The **Very Dry climate subregion** occurs at low elevations within the mountain rainshadow areas, and includes low elevations in the Okanagan Valley, the lower Kettle and Granby valleys, and, in the field guide area, much of the bottom of the Rocky Mountain Trench. The BG, PP, and the driest IDF subzones occur in this climate subregion.

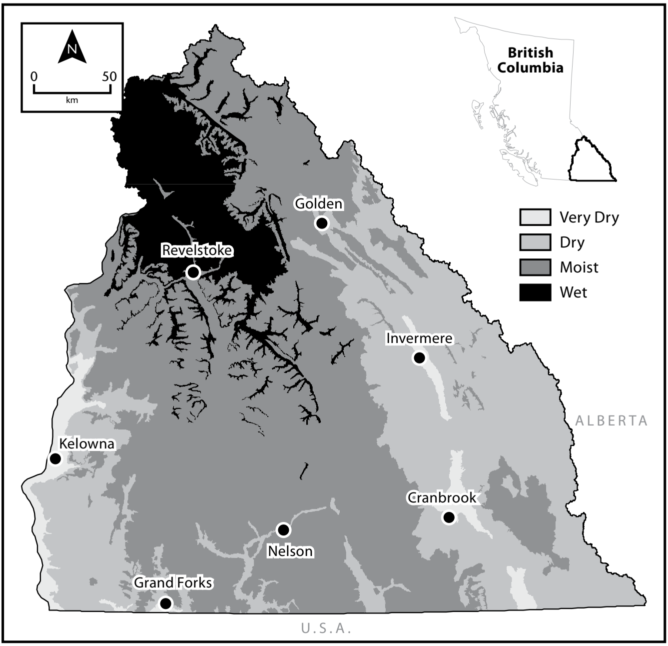


FIGURE 4.1 *Climate subregions of southeast British Columbia.*

Within the Biogeoclimatic Ecosystem Classification (BEC) system, each biogeoclimatic subzone/variant reflects a "bioclimate envelope"—a set of climatic conditions across a geographic area where relatively homogeneous vegetation communities occur on similar topoedaphic sites.[4,5] 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; Wang et al. 2012b). Where two biogeoclimatic subzones/variants or climate subregions occur in close proximity, transitional climates occur.

[4] Topoedaphic refers to the interaction between topography (slope position, slope gradient, aspect) and soil factors.

[5] As described in Chapter 2, a subzone/variant is mapped to reflect the climate for the distribution of a given zonal site series; mature vegetation communities on zonal sites imply climate distribution.

A categorical approach was used to describe climate conditions for biogeoclimatic units across the province. Snowfall and snowpack categories are presented in Table 4.6, and categories for average seasonal (winter, spring, summer, fall) temperature and precipitation are provided in Table 4.7. Summaries of these climate variables are presented in Table 4.8 for subzones/variants in this field guide area.

Although not included here, many other climate variables have important influences on plant community development and distribution (e.g., extreme climate values, moisture deficit indices, continentality, frost patterns, and humidity). Annual and inter-annual variability can also influence vegetation–climate relationships. For more information, additional climate variables are available from both historical station data and modelled outputs.

TABLE 4.6 *Categories for mean snowfall and snowpack*

Snowpack 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 (Wang et al. 2012)[6] 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 historical and future conditions across a continuous surface throughout British Columbia and North America. Values were also compared to Environment

[6] Version 5.4, accessed online from the Centre for Forest Conservation Genetics, University of British Columbia, Feb. 2017.

TABLE 4.7 *Categories for mean seasonal temperature and precipitation*

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

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

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

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

[a] Occurs only in coastal climates.

Canada historical climate station data summaries (Canadian Climate Program 1993) 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, values in Table 4.8 were adjusted. Modelled data were selected as the primary source because the 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 sourced from weather station data or calculated from modelled approaches (e.g., ClimateBC, ClimateWNA).

The area covered by this field guide is, in general, very dry at the lowest elevations (IDF), dry in the mid elevations (ICH, MS), and slightly moist at upper elevations (ESSF). Spring is the wettest season[7] across most subzones/variants in the East Kootenay. The wettest area is in the Elk/Bull River drainages where higher precipitation falls in the ICHmk4, ESSFwm1, ESSFwmw, and ESSFwmp. The higher precipitation is related to the configuration of mountain ranges and weather patterns to the west. The prevailing storms that move from west to east retain more moisture when they reach this area because the mountains of the southern Monashee and Purcell Ranges are much lower than those to the north.

Weather in the East Kootenay can be very diverse. Extreme weather events, including extreme cold (and warm) in winter and heat waves in summer, are increasingly common throughout the field guide area. Extreme cold temperatures in the ESSFdk2 are as low as -42°C, while in Cranbrook, extreme cold temperatures are lower than -32°C and summer heat can reach close to 37°C. Cold-air inversions are also common, particularly during fall and winter in the Rocky Mountains, but also throughout the Purcell Mountains. During cold-air inversions, valley bottoms have cooler temperatures than the mountain slopes above. Arctic air masses can lead to prolonged inversion events (Achuff et al. 1984). Chinook winds and associated warm temperatures occur along the eastern slopes of the Rocky Mountains. Chinooks are more common and extensive in Alberta, but areas covered by this field guide are also affected, particularly at the eastern extent of the Elk Valley and Kootenay and Yoho National Parks.

[7] Relative to the scale used for the province for spring; in many subzones/variants, winters have more total precipitation, although rainfall is generally highest in spring.

TABLE 4.8 *Climate comparisons for subzones/variants described in the field guide and adjacent areas*

		Precipitation				Temperature				Snowfall
Zone	**BGC unit**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Annual**
IDF	**IDFxx2**	Very dry	Very dry	Very dry	Very dry	Cool	Warm	Very hot	Hot	Shallow
	IDFxk	Very dry	Very dry	Very dry	Very dry	Cool	Warm	Hot	Warm	Shallow
	IDFdm2	Very dry	Dry	Very dry[a]	Very dry	Cool	Warm	Hot	Hot	Moderate
	IDFdk5	Dry	Dry	Dry	Very dry	Cool	Mild	Warm	Warm	Moderate
MS	**MSdw**	Dry	Moist	Dry[a]	Dry	Cool	Mild	Warm	Warm	Moderately deep
	MSdk	Dry	Dry	Moist	Dry	Cold	Mild	Warm	Cool	Moderately deep
ICH	**ICHmk4**	Dry	Moist	Moist	Dry	Cool	Mild	Warm	Warm	Moderately deep
	ICHmk5[b]	Dry	Dry	Moist	Dry	Cold	Mild	Warm	Warm	Moderately deep
	ICHdw1[b]	Dry	Moist	Dry	Dry	Mild	Warm	Hot	Hot	Moderate
	ICHdm[b]	Dry	Moist	Dry[a]	Dry	Cool	Mild	Warm	Warm	Moderately deep
	ICHmw1[b]	Moist	Moist	Moist	Dry	Cold	Mild	Warm	Warm	Deep
ESSF	**ESSFwm1**	Moist	Wet	Moist[a]	Moist	Cold	Cool	Cool	Cool	Deep
	ESSFwm2[b]	Moist	Wet	Moist[a]	Moist	Cold	Cool	Cool	Cool	Deep
	ESSFwm4[b]	Moist	Wet	Moist–Dry	Moist	Cool	Cool	Cool	Cool	Deep
	ESSFwmw[b]	Moist	Wet	Wet	Moist	Cold	Cold	Cold	Cold	Very deep
	ESSFwmp[b]	Wet	Wet	Wet	Wet	Cold	Cold	Cold	Cold	Very deep
	ESSFmm3[b]	Moist	Wet	Moist	Moist	Cold	Cool	Cool	Cold	Deep
	ESSFdk1	Moist	Moist	Moist	Dry	Cold	Cool	Cool	Cool	Deep
	ESSFdk2	Moist	Moist	Moist	Dry	Cold	Cold	Cool	Cold	Deep
	ESSFdkw	Moist	Wet	Wet	Moist	Very cold	Cold	Cold	Cold	Deep
	ESSFdkp	Moist	Wet	Wet	Moist	Very cold	Cold	Cold	Cold	Deep

[a] Indicates that summer precipitation values are based on July/August data because June precipitation is proportionally much higher.
[b] The ICHdw1, dm, and ESSFwm2, wm4, wmw, and wmp are described by MacKillop and Ehman (2016); the ICHmk5, ICHmw1, and ESSFmm3 will be described in a future field guide.

4.6 Physiographic Regions and Associated 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. Deposition, compaction, and cementation of marine sediments in association with mountain-building and associated tectonic activity are dominant processes in the Rocky Mountains.

The nature of bedrock strongly influences site characteristics. Physical properties such as hardness and resistance to weathering strongly influence the structure and complexity of the terrain at a landscape level. Physical and chemical properties of bedrock also affect site characteristics such as depth and texture of surficial materials and associated soils, coarse fragment content, soil nutrient status, and sensitivity to geological processes such as mass wasting, erosion, and redistribution of materials. The distribution of bedrock types and geological processes form the basis for differentiating the area into 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 has an extremely diverse landscape. For the purposes of this field guide, the southeast part of the province is described using four physiographic regions: the Rocky Mountain Trench, the Rocky Mountains, the Columbia Mountains (Figure 4.2), and the Highlands (Okanagan and Shuswap) (see Holland 1976; Ryder 1978; Church and Ryder 2010).

This field guide covers the **Rocky Mountain Trench** and the **Rocky Mountains** (including numerous subranges) south of the Kinbasket Reservoir, as well as most of the eastern **Purcell Mountains** in the Columbia Mountains physiographic region (Figure 4.2). LMH 70 describes the south-central Columbia Mountains to the west (MacKillop and Ehman 2016), which includes the western Purcell Mountains. Subsequent field guides will address areas of the Columbia and Rocky Mountains to the north of this field guide.

A wide variety of bedrock types occurs across these physiographic regions. The most common bedrock types in the mountain landscapes that occur throughout the East Kootenay region are summarized by physiographic area in Table 4.9 (see Ryder 1978 for more information). Keys to rock types, including detailed summaries of rock characteristics and their effect on ecosystems, are provided in Appendix 3.5.

The **Rocky Mountain Trench** physiographic region[8] is a linear depression 3–16 km wide that separates the Columbia Mountains to the west from the Rocky Mountains to the east (Holland 1976). It also occurs north of the field guide area, where it separates the Rocky Mountains from the Omenica and Cassiar Mountains (not described here). It was created during the folding and uplift of the Rocky Mountains and has been modified by erosional and depositional forces of multiple glaciations and by the forces of wind, water, and gravity. Sediment-laden ice moving down the trench reworked materials from previous glaciations, and down-wasting (melting of stagnant ice) created a complex mosaic of materials deposited by ice, rivers, and lakes. As a result, the trench is infilled with tens of metres of glacial and post-glacial sediments that form the irregular, rolling topography seen today. This complex mixture of laterally diverse and layered materials is derived from highly variable parent materials and geological processes that are unrelated to local bedrock.

Much of the area in the Rocky Mountain Trench has gravelly silt loam soils derived from mixed glaciofluvial materials, often overlain with eolian deposits of variable thickness. This gives rise to a mosaic of edaphic conditions where soil moisture availability changes rapidly across small areas and over variable soil depths. At the bottom of the Rocky Mountain Trench, the Columbia River flows north from Columbia Lake. while the Kootenay River flows south to the Koocanusa Reservoir. The trench is in stark contrast to the surrounding mountains and uplands, where slopes are steeper and soils are more closely related to the underlying bedrock.

The **Rocky Mountains** are east of the Rocky Mountain Trench. They extend south into the United States, east into Alberta, and north beyond the area covered by this field guide. Throughout the field guide area, the Rocky Mountains are comprised of folded and faulted sedimentary and metamorphic rocks that are predominantly limestones, quartzites, schists, and slates (Ryder 1978). Other common bedrock types include dolomite, siltstone, sandstone, mudstone, shale, and argillite. The mountains are rugged with high relief and are dominated by steep rocky slopes with relatively thin deposits of morainal (till) and colluvial surficial materials. Narrow valleys and basins situated between ranges trend in northerly to southerly directions and contain deeper deposits of morainal, glaciofluvial, and fluvial materials. The Kootenay, White, Elk, Bull, and Flathead Rivers and their tributaries occupy the floors of the valleys and basins. The Rocky Mountains

[10] The Rocky Mountain Trench is also used as a term to describe the general geographic area that includes the valley bottom and the mountainous areas in the Purcell and Rocky Mountains that are immediately adjacent to the physiographic Trench.

can be divided into several ranges and basins. For the purposes of this field guide, six ranges and two basins are described (Figure 4.2).

To the east of the Rocky Mountain Trench, the steep, high peaks of the **Kootenay and Galton Ranges** create a strong contrast to the valley bottom. The Kootenay Ranges exhibit the most complex geology of all the ranges in the field guide area. They are dominated by mudstone, siltstone, shale, dolomite, and limestone. The Galton Range, just north of the United States border, is comprised predominantly of dolomite, sandstone, and siltstone. In the Flathead and Wigwam valleys, the **MacDonald and Clark Ranges** surround low-lying areas in the **Flathead Basin.** The mountains here are dominated by argillite, siltstone, and sandstone, and include areas of limestone. The Flathead Basin contains gentler terrain; the wide, rolling valley bottom is surrounded by steep, rugged mountains. Similarly, to the north, the **Fernie Basin** includes the wide valley bottom of the lower Elk River. It is surrounded by the **Front Ranges** in the Elk Valley and the southern portions of the Bull River valley. The mountains in this range are dominated by dolomite and mixed sedimentary rocks, including limestone in some areas. The **Park Ranges** extend north from the Bull River to beyond the field guide area. These ranges contain the highest, most rugged peaks in the area, and consist of a variety of sedimentary rocks, including limestone, siltstone, sandstone, and argillite (Figure 4.2).

The **Columbia Mountains** include the Monashee, Selkirk, Purcell, and Cariboo Ranges (Figure 4.2). The field guide area encompasses the east side of the **Purcell Mountains**. This mountain range originally formed as the western coast of North America in the Mesoproterozoic eon (up to 1.5 billion years ago). Subsequent continental drift and associated subduction, uplift, tectonic activity, and metamorphic processes have created a complex geological history in the Purcells. The mountains are dominated by sedimentary and metamorphic rocks, including shale, mudstone, siltstone, and phyllite. Areas of limestone and coarse-grained intrusions of granodiorite are also common. The largest peaks are found in the northern part of the range. Steep east–west trending valleys drain into Kootenay Lake and the Duncan River to the west and either the Kootenay or Columbia River systems to the east.

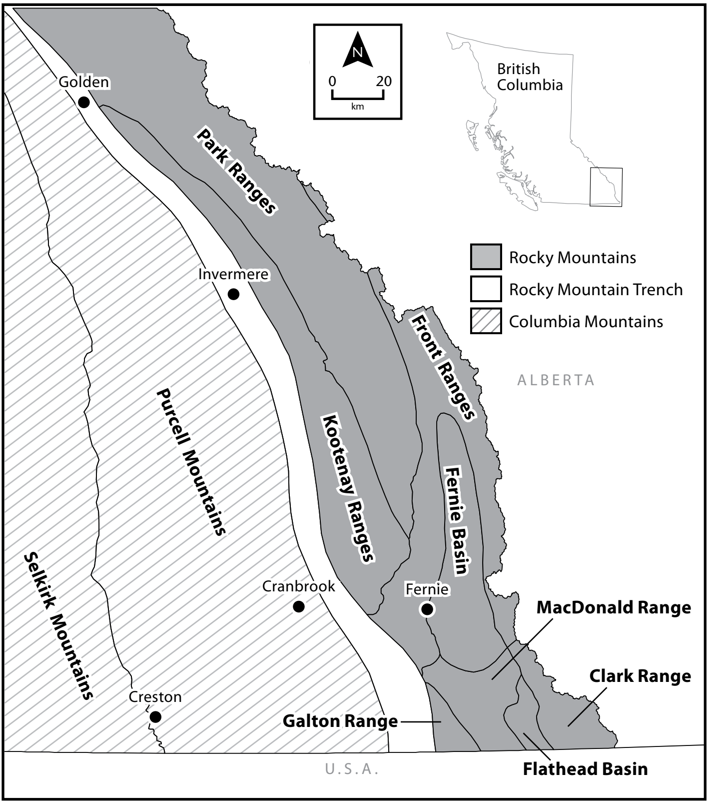


FIGURE 4.2 *Physiographic regions of the field guide area.*

TABLE 4.9 *Common bedrock types within physiographic regions*[a]

Physiographic region	Geographic area	Sub-range/basin	Dominant rock types	Subdominant rock types	Resulting soil textures[b] and characteristics	BGC units described in this field guide[c,d]
Rocky Mountains	**Elk and Bull Rivers**	**Fernie Basin**	Sandstone, siltstone, shale	Limestone and dolomite	Nutrient-rich, silty to (fine) sandy textures	ICHmk4, ESSFwm1, MSdw, ESSFdk1 (ESSFdkw, ESSFdkp)
		Front Ranges	Dolomite	Sandstone, siltstone, shale, and coal	Nutrient-rich, silty to (fine) sandy textures	ICHmk4, ESSFwm1, ESSFwmw, ESSFwmp, MSdw, ESSFdk1, ESSFdkw, ESSFdkp
	Bordering the Rocky Mountain Trench	**Kootenay Ranges**	Sedimentary rocks such as mudstone, siltstone, shale, limestone, slate, and dolomite	Marble, sandstone, breccia, and conglomerate	Nutrient-rich, silty to (fine) sandy textures; carbonate-enriched (Cca) layers common where calcareous parent material occurs	MSdk, ESSFdk2, ESSFdkw, ESSFdkp (IDFdm2, MSdw)
		Galton Range	Sandstone, dolomite, siltstone	Basalt and andesite	Nutrient-rich, silty to (fine) sandy textures	MSdw, ESSFdk1, ESSFdkw, ESSFdkp
	Flathead and Wigwam Rivers	**Mac-Donald Range**	Sedimentary rocks such as sandstone, siltstone, limestone, and dolomite	Mudstone, marble, shale	Nutrient-rich, silty to (fine) sandy textures; Cca layers common where calcareous parent material occurs	MSdw, ESSFdk1, ESSFdkw (ESSFdkp)
		Flathead Basin	Dolomite, limestone	Mudstone, siltstone, shale, coal	Nutrient-rich, silty to (fine) sandy textures; Cca layers common where calcareous parent material occurs	MSdw, ESSFdk1, ESSFdkw, ESSFdkp
		Clark Range	Sedimentary rocks such as sandstone, siltstone, shale, limestone, coal	Dolomite, argillite, sandstone, conglomerate	Nutrient-rich, silty to (fine) sandy textures; Cca layers common where calcareous parent material occurs	MSdw, ESSFdk1, ESSFdkw, ESSFdkp

Rocky Mountains	**Northern tributaries of the Kootenay River**	**Park Ranges[e]**	Mixed sedimentary rocks, including sandstone, conglomerate, siltstone, argillite, and limestone	Quartzite and dolomite	Nutrient-rich, silty to (fine) sandy textures; Cca layers common where calcareous parent material occurs	MSdk, ESSFdk2, ESSFdkw, ESSFdkp
Rocky Mountain Trench	**South of Kinbasket Reservoir**		Dominated by thick glacial sediments from repeated glacial processes and sources (glaciolacustrine, glaciofluvial, often capped with eolian); unrelated to local bedrock geology	Small areas of bedrock-controlled ridges with limestone, dolomite, sandstone, slate, siltstone, and argillite	Highly variable soil textures and nutrients; Cca layers very common	IDFxx2, IDFdm2, IDFxk, IDFdk5 (MSdk)
Eastern Purcell Mountains	**Northern**		Sedimentary and metamorphic rock types such as phyllite, mudstone, siltstone, shale, quartzite	Small granodioritic intrusions	Nutrient-rich, loamy-textured soils with areas of nutrient-poor, coarse-textured soils where intrusive rocks occur	MSdk, ESSFdk2, ESSFdkw, ESSFdkp, (IDFdk5)
	Central		Sedimentary rocks such as sandstone, siltstone, conglomerate, 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	MSdw, MSdk, ESSFdk1, ESSFdk2, ESSFdkw, ESSFdkp (IDFdm2)
	Southern		Mixture of sedimentary rocks such as argillite, sandstone, siltstone, conglomerate, and dolomite	Granodioritic intrusive rocks; limestone and phyllite	Medium to rich nutrient content, (coarse) loamy-textured soils; nutrient-poor, coarse-textured soils where intrusive rocks occur	MSdw, ESSFdk1, ESSFdkw (ESSFdkp, IDFdm2)

[a] Appendix 3.5 provides additional 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] Other BGC units occur in several of the physiographic units but are described in other guides.
[d] Parentheses indicate BGC units that are less common.
[e] Described only for the area covered by the field guide; the Park Ranges extend north of the field guide area.

4.7 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 often 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 unrelated to the underlying bedrock when they are transported long distances by glaciers, water, or wind. For example, river sands and gravels or glaciolacustrine silts and clays that have been washed, sorted, transported, and deposited by water can be derived from a number of sources, including distant bedrock and parent materials, and may have properties that do not reflect the local bedrock geology. The materials can also be greatly modified depending on the mode of transport and deposition.

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 and in greater detail in Appendix 3.6. They are frequently described based on the depth of the deposit, with blankets (b) being greater than 1 m deep, and veneers (v) less than 1 m deep. Veneers 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 physical 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). Morainal materials tend to have a mix of subangular to subrounded coarse fragments of various sizes.
- Glaciofluvial and glaciolacustrine materials result from meltwaters at the time of glacial retreat. Glaciofluvial materials are deposited by moving waters, may be sorted and stratified, and tend to have rounded coarse fragments, while glaciolacustrine materials result from sediment

deposition in stagnant or slow-moving waters behind ice dams and generally are finer textured and lack coarse fragments.
- Fluvial and lacustrine deposits are typically more recent than the last glaciation and are derived from rivers and lakes that are usually still present on the landscape. Fluvial materials are generally well sorted.
- Colluvium results from mass wasting (rockfalls, landslides, or mudslides) and the effects of gravity on soils, including slumps and very slow soil creep on slopes steeper than 50%. Colluvium typically has angular coarse fragments.
- 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 of the deposits.
- Anthropogenic materials are those that have been modified by humans.

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 mountainous landscapes in the East Kootenay. Morainal materials are usually dominant where glaciers scoured mountain slopes and occupied extensive valleys. Glaciofluvial materials can be abundant, particularly at the bottom of larger U-shaped valleys and as kame terraces along valley walls at mid to upper elevations.[9] In the main valleys, the deposits are often capped by eolian or fluvial veneers. Fine-textured glaciolacustrine deposits of clay, silt, and fine sands occur where ice-dammed lakes formed during glacial times, and are common in the Rocky Mountain Trench between Brisco and Canal Flats and in other areas along the Kootenay River. In the Southern Rocky Mountain Trench, multiple glaciation events and post-glaciation geological processes have created extremely complex surficial geology that reflects mixtures of many processes and types of parent materials. Local surficial materials have often been reworked and transported great distances, through advances and melting of multiple glaciation events, and it is often difficult to classify the materials.

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

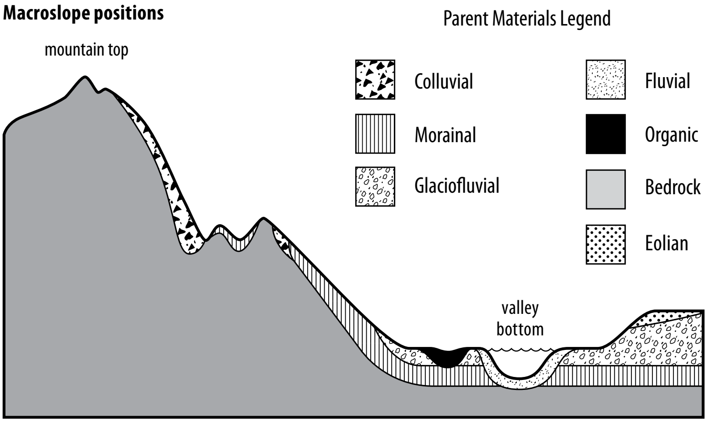


FIGURE 4.3 *Generalized distribution of surficial materials in the mountainous terrain of the East Kootenay.*

Eolian deposits are common, particularly on gentle slopes and terraces throughout the Rocky Mountain Trench and in lower valley slope positions. They are most commonly derived at the time of post-glaciation and vary considerably in thickness, ranging from < 1 cm to > 1 m in depth. Eolian deposits are typically fine-textured and unconsolidated (loose), and lack coarse fragments (unless more recent soil mixing has occurred, such as on steeper slopes or where animals have been digging). In the dry climate areas of the East Kootenay, particularly in the Rocky Mountain Trench, the depth of the eolian deposits has a large effect on local soil moisture conditions and associated vegetation. In the IDF, the following is a general rule for determining soil moisture regime where eolian deposits are present:

< 30 cm = submesic (rSMR 3)
> 50 cm = mesic (rSMR 4)
30–50 cm = depends on other compensating factors

Deposits of fine volcanic ash also occur in upper soil horizons throughout the Columbia and Rocky Mountains. 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.[10]

[10] Mount Mazama is located at Crater Lake, Oregon; Mount St. Helens is in Skamania

Mazama ash is usually deeper in the soil profile and is orange–brown, while Mount St. Helens ash often forms a thin (< 2 cm) discontinuous layer within the A soil horizon (see Page-Dumroese et al. 2007).

Colluvium occurs on steep slopes, which often dominate mountainous terrain. Colluvium and morainal materials are the most common surficial material throughout the area covered by this field guide. Exposed bedrock is also common in the Rocky Mountains; it occurs at higher elevations and on steep-sided valley walls at all elevations, particularly along large river valleys (e.g., the Elk, Bull, and White Rivers) that flow into the Trench. In the Purcell Mountains, exposed bedrock is concentrated at upper elevations but is more scattered on slopes at low to middle elevations.

Since deglaciation, water, gravity, wind, and biota have further modified the landscape. Present-day rivers have formed floodplains and fluvial fans. Rockfalls and landslides have created colluvial fans, cones, talus slopes, and undulating landslide deposits. Organic materials continue to accumulate in wet depressions. They are typically uncommon on the landscape, but large areas of organic deposits occur in the valley bottoms of the Kootenay and Columbia valleys. Human-related development, including settlements, agriculture, road building, mining, and hydroelectric projects, has changed surficial materials throughout the area.

Maps of surficial materials in the region 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). The maps provide details at the landscape scale, although assessment is best done in the field to capture finer-scale differences at the stand level.

4.8 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 carbon, gases, nutrients, and water. Soil formation is the combined result of topography, surficial material, time, climate, and biota. For example, warmer, wetter climates tend to have faster soil development than cooler, drier climates, while finer-grained, softer, darker rocks often weather to soils with higher nutrient content than coarse-grained, hard, light-coloured rocks.

Soil features 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), which is outlined broadly in Appendix 3.4. Soil or terrain map units are named by their parent material, development process, BEC zone, and drainage qualities, and are described in the following historic soil survey reports: *Biophysical Resources*

County in Washington State.

of the East Kootenay Area: Soils (Lacelle 1990), *Ecological Land Classification of Kootenay National Park (*Achuff et al. 1984), *Biophysical (Ecological) Inventory of Yoho National Park* (Coen and Kuchar 1982), *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 orders can vary by elevation, climate, and parent material. At low elevations in the IDF, hot dry climatic conditions and calcareous parent materials have a major influence on soil formation. Eutric and Melanic Brunisols are common in dry forested areas, while Dark Brown and Dark Grey Chernozems with thick (≥ 10 cm), organic-enriched (Ah) surface horizons occur in grassland environments (see Appendix 3.4). Where soils are derived from calcareous materials, a carbonate-enriched (Cca) layer often occurs in the upper 30 cm to 1 m of the soil profile. Weakly developed Luvisols, with clay-enriched (Bt) subsurface horizons, are more common in slightly moister areas with fine- to medium-textured parent materials derived from sedimentary bedrock.

In the Purcell and Rocky Mountain areas covered by this field guide, Brunisols are the most common soil types at lower to mid elevations in the MS and ICH. Eutric Brunisols (more basic, higher nutrients) are more common where calcareous parent materials occur, and Dystric Brunisols (more acidic, poorer nutrients) are typically present in non-calcareous parent materials. Luvisolic soils with weakly developed Bt horizons also occur in low- to subalpine elevation areas (IDF to ESSF units) with calcareous and/or finer-textured parent materials.

Eutric Brunisols are also common in the ESSF in areas with calcareous parent materials. Where soils are acidic, Humo-Ferric Podzols and, to a lesser extent, Dystric Brunisols are common. The podzolic soil development reflects higher precipitation and cooler temperatures. At higher elevations in parkland and alpine environments, soil development is often inhibited by the harsh climate, and Regosols are common. Melanic and Sombric Brunisols with deep, turfy Ah horizons occur under high-elevation grassland and tundra vegetation.

Soil Orders and Great Groups are described in detail in *The Canadian System of Soil Classification* (Soil Classification Working Group 1998). An overview of soil orders and terminology used in this guide is provided in Appendix 3.4. More detailed keys are provided in the Keys and Codes section of LMH25 – *Field Manual for Describing Terrestrial Ecosystems* (Province of British Columbia 2010).

4.9 Typical Site Series Patterns across Landscapes in the Mountainous Terrain of Southeast British Columbia

Patterns of site series (ecosystem) distribution are predictable within mountainous terrain because they are driven largely by topoedaphic factors: (1) slope gradient and aspect, (2) slope position, and (3) soil depth, texture, drainage, and mineralogy inherited from parent materials. These factors contribute to the relative soil moisture regime (rSMR)[11] and soil nutrient regime (SNR) on a site, which are key drivers of plant community composition and characteristics, such as productivity, structure, stand development patterns, and resilience. 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;
- finer-textured soils hold moisture longer than coarse-textured soils and generally contain more available soil nutrients; and
- coarse soils shed moisture faster than fine-textured soils and tend to have lower nutrient availability.

These principles are useful in identifying and describing forested site series within biogeoclimatic subzones/variants in the field guide.

Chapter 2 provides a detailed overview of the relationships between site, climate, and plant community classification in the BEC framework. At the simplest levels, climate drives the distribution of biogeoclimatic subzones/variants at the regional scale; at the site level, topoedaphic factors (reflected by rSMR and SNR) determine the distribution of site series.[12] Within each subzone/variant, there is a range of site conditions from dry (e.g., rocky, shallow soils on warm aspects) to wet (moisture-receiving sites on lower and toe slopes and in depressions), with intermediate (mesic and submesic) conditions in between. The pattern of site conditions that corresponds to topography and soil factors translates into a predictable pattern of site series (and their associated plant communities) across similar sites within a subzone/variant. This pattern is reflected in the definition (and numbering) of site series throughout the field guide. Figure 4.4 shows a schematic diagram of this pattern within a single biogeoclimatic subzone/variant with site series, and their associated dominant tree species, linked to slope, aspect, slope position, and surficial material. Characteristics of the typical site series pattern in mountainous terrain are further described and summarized in Table 4.10.

[11] See Section 3.2.2 for a detailed definition of actual and relative soil moisture regimes.

[12] Other factors, including disturbance patterns and history, climate change, invasive species, etc., will also influence patterns of ecosystem distribution.

Although this site series pattern repeats in each subzone/variant, the unique climate within a given BGC unit leads to different plant communities, growth potential, habitat values, and other important ecosystem functions. For example, in the dry, warm climate of the IDFdm2, Fd and Py are the only tree species that can grow on dry/warm, rocky or shallow sites, but in the cooler, moister ESSFdk1, Fd also grows on similarly dry/warm, rocky, or shallow sites but with Pl, Se, Pa, and/or Bl. Following the same principles, plant communities in mature forests on wet riparian sites are *CwSxw – Devil's club* in the ICHmk4, *SxwBl – Azalea – Bunchberry* in the MSdw, *SxwFd – Snowberry – Sarsaparilla* in the IDFdm2, and *BlSe – Azalea – Foamflower* in the ESSFdk1. Each of these plant communities/ecosystems occurs on sites with the same topoedaphic conditions but in a different climate. Figure 4.5 provides a schematic depiction of the similarity in repeating patterns across different biogeoclimatic subzones/variants.[13]

TABLE 4.10 *Descriptions of the typical site series pattern for ecosystems in mountainous terrain in southeast British Columbia*

Site series	Typical site characteristics	Landscape prominence	rSMR
102	Upper slopes and crests with prominent exposed bedrock (sometimes talus) and minimal, very shallow soils	Uncommon	1
103	Steep, warm (insolated) sites with shallow and/or coarse soils, usually on upper or upper/mid slopes	Common	2 (1)
104	Moderate slopes with warm aspects in mid-slope positions and medium soil textures; also occurs on upper, moisture-shedding sites with cool to neutral aspects and/or coarse soils	Very common	3 (2–4)
101	Moderate slopes with neutral (cool) aspects in mid-slope positions and medium soil textures	Very common	4
110	Receiving sites in lower slope positions; often gentle slopes; seepage or water table at depth (often > 50 cm) throughout the growing season	Common	5
111	Toe slopes and gentle 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

[13] Note that the relative soil moisture regimes (rSMR) are the same (or similar) across biogeoclimatic subzones/variants, but the actual soil moisture regime (aSMR), the absolute availability of moisture in the growing season (see Chapter 2), differs across biogeoclimatic units due to differences in subregional climates.

4.9.1 Site series landscape prominence: common and uncommon site series

The most common site series across landscapes in the East Kootenay field guide area are the submesic (typically 104) and mesic/zonal[14] (always 101) site series. These site series generally occur on mid-slope positions with deep soils, with the mesic site series most common on cool- to neutral-aspect sites and the submesic site series most common on warm-aspect sites. Both site series also occur on a number of sites with common compensating conditions. The submesic site series often occurs on cool to neutral aspects on upper, shedding sites and/or where soils are coarse textured; the mesic site series often occurs on gentle slopes, regardless of aspect, and on sites in lower slope positions with warm aspects or moderately coarse soils.

Drier and wetter sites are generally less common but can be locally abundant in some landscapes. Dry and rocky (often 102) or steep and coarse sites (often 103) usually cover smaller areas of the landscape than submesic and mesic sites. Similarly, moist to wet sites (110 and higher site series numbers) are usually associated with riparian areas, or occasionally mid- to lower-slope seepage sites. These sites cover small areas in steep, mountainous terrain and are more abundant on gentle terrain in valley bottoms. The wettest sites (rSMR 7–8) are uncommon in all subzones/variants in the East Kootenay, except for the IDFxk and dk5 where the valley-bottom areas are occupied by the extensive Columbia River wetlands.

Edatopic grids are provided for each subzone/variant in Chapter 5. These show the distribution of each site series across soil moisture and nutrient gradients. Note that 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. A site series that covers a small portion of the grid may cover a large area of the landscape if that combination of SMR and SNR is common. Similarly, a site series that covers 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 many cells on the edatopic grid but are rare or uncommon on the ground, while the 101 site series may occupy only the 4 C–D cells but can be the most common ecosystem across the landscape.

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

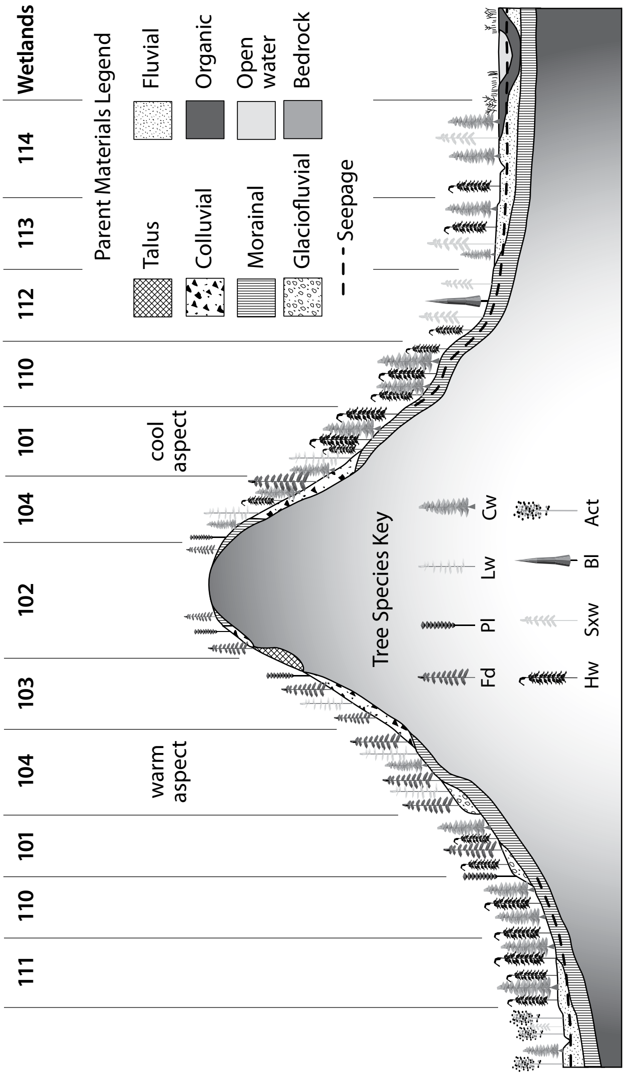


FIGURE 4.4 *Typical pattern of site series distribution within a biogeoclimatic subzone/variant across mountainous terrain in southeast British Columbia.*

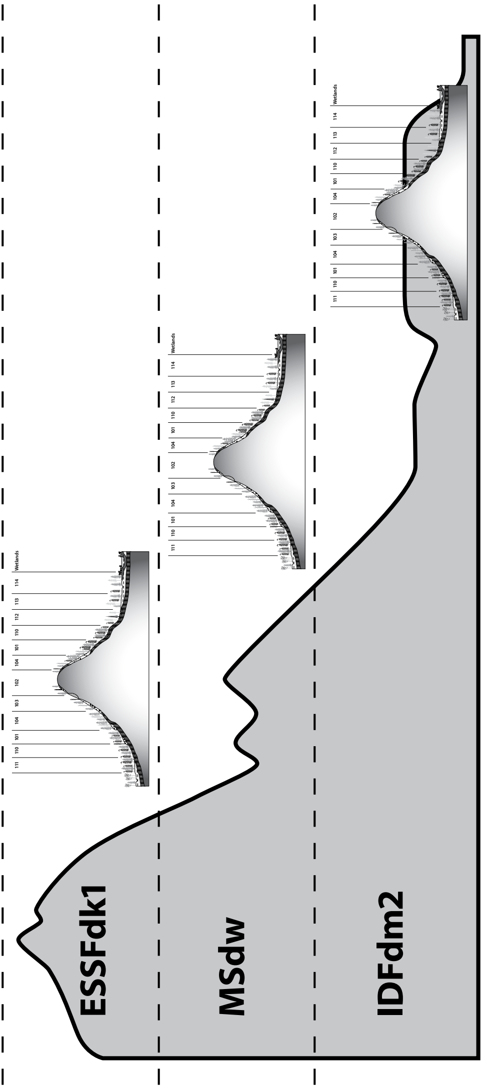


FIGURE 4.5 *Repeating site series patterns across multiple biogeoclimatic subzones/variants in a mountainous landscape.*

4.9.2 Exceptions to the patterns

The site series patterns described in Table 4.10 and shown in Figure 4.4 are consistent across most biogeoclimatic subzones/variants in the field guide, although several exceptions occur. These exceptions are addressed through the addition or exclusion of site series in some biogeoclimatic units. Exceptions to the typical patterns include the following:

- **Sites with poor nutrient availability**: Additional site series are described in biogeoclimatic subzones/variants where sites with poorer soil nutrient availability are common and support different plant communities than richer sites with similar moisture regimes. In this field guide, an additional site series is described in the MSdk for circum-mesic sites dominated by Labrador tea. In following the conventions of BEC site series numbering (see MacKenzie 2010), this site series is coded as 104 because it is drier and/or poorer than the next site series on the edatopic grid. As a result, the typical submesic site series is coded as 105.
- **Cool-aspect 110 (non-riparian)**: In the driest subzones/variants (IDFxk and IDFxx2), the 110 site series occurs on steep, cool-aspect, otherwise mesic (and sometimes slightly moister) sites. In the driest, hottest climates, solar insulation has a very large effect on plant community distribution, and these cool-aspect sites have lower evapotranspiration rates and, correspondingly, higher moss cover and denser overstorey conditions. In all other subzones/variants, the 110 represents moist, lower-slope, subhygric sites, often associated with riparian areas.
- **Combined site series for very dry and very rocky sites**: In some biogeoclimatic subzones/variants, insufficient data or infrequent distribution of dry, rocky sites results in the lumping together of two typically different site series. In these cases, site series phases are provided for users who require additional information (see Section 2.1.2 for a definition of site series phases). In these biogeoclimatic subzones/variants, users can separate the 102 site series into two phases: 102a for xeric sites with abundant exposed bedrock (or, occasionally, talus), and 102b for subxeric sites on steep, warm-aspect slopes with shallow and/or coarse soils. The 102b occurs on sites that are similar to the typical 103 (subxeric) site series described in Table 4.10. Both the 102a and 102b have similar vegetation in these biogeoclimatic units.
- **No separate subhygric and hygric site series**: In several biogeoclimatic subzones/variants in the field guide area, there are only two distinct site series that are wetter than mesic. The subhygric to hygric site series is coded as 110, and the wettest site series, typically dominated by Sxw or

Se and horsetails, is coded as 111. This is more common in the mostly Dry climate subregion of the East Kootenay than in other areas of southeast British Columbia.

- **Forested wetlands**: Forested sites (> 10% tree cover) on wetland soils fit into both the non-forest (and related ecosystems) portion of the BEC framework and the forested site series classification presented in Chapter 5. For example, several treed swamp and treed bog units occur in the field guide area. These are given a site series number in the relevant subzone/variant, as well as a non-forest code (see Chapter 6). They include Ws07 and Ws08 swamps as well as Wb15 and Wb16 bogs. Forested wetlands are described in both the biogeoclimatic subzone/variant sections (Chapter 5) and the wetland sections (Section 6.2).
- **Forested wetland and riparian site series phases:** Forested wetlands often have essentially the same plant community as the wettest riparian sites, which are often riparian-associated high bench flood sites. Where similar plant communities occur on both wetland soils and riparian sites, site series phases are used to differentiate. For example, in the MSdw, the 112 site series is dominated by Sxw and horsetails. Where it occurs on riparian (usually flood) sites, it is coded as the 112a riparian phase; where it occurs on wetland soils, it is coded as the 112b (Ws07) swamp phase.

Saskatoon
Amelanchier alnifolia

PART 1

Interior Douglas-fir

Montane Spruce

Interior Cedar – Hemlock

PART 2

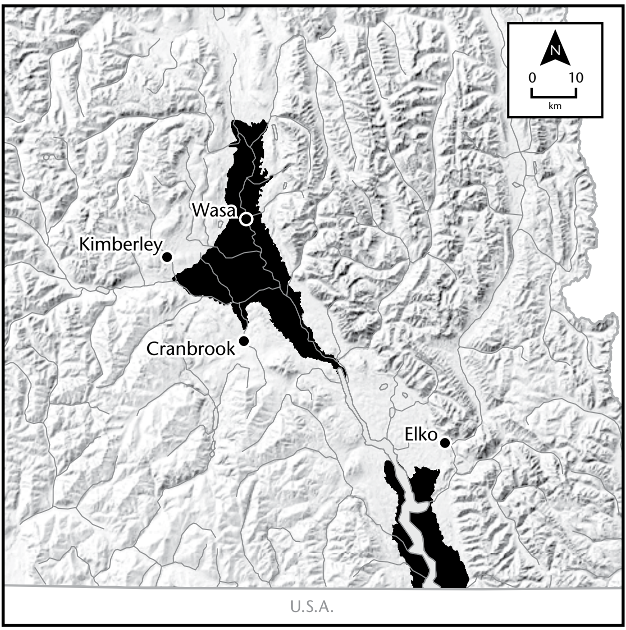
Engelmann Spruce – Subalpine Fir

IDFxx2
Kootenay Very Dry Very Hot Interior Douglas-fir

Geographic Distribution

The IDFxx2 occupies low elevations along the valley bottom of the southern Rocky Mountain Trench. It occurs in two separate areas: from the U.S. border to Kikomun Creek, and from Haha Creek and the Bull River to north of Skookumchuck. It occurs below and adjacent to the IDFdm2. The communities of Wasa, Fort Steele, Wycliffe, Skookumchuck, Newgate, and Rooseville, and both the Tobacco Plains (ʔakink'umǂasnuqǂiʔit) and St. Mary (ʔaq'am) Reserves are within the IDFxx2.

Distribution of the IDFxx2



Elevation Range

The IDFxx2 occurs from valley bottom (~ 750–770 m) to approximately 825–900 m on cool and neutral aspects and 900–1000 m on warm aspects.

Climate[1]

The IDFxx2 occurs in the Very Dry climate subregion; all seasons are characterized by very dry conditions. June is typically the wettest month, while July and August are driest. Winter is cool, spring is warm, summer is very hot, and fall is hot. Growing-season moisture deficits are common on mesic and drier sites and can affect subhygric sites in drier than normal years. Drought is common, and lack of soil moisture is a major limiting factor for tree growth. Snowpack depths are shallow (~ 25 cm) and often intermittent throughout the winter from late November or December to late February or early March. As a result, soils often freeze to shallow depths. Very little snow accumulates on insolated, warm-aspect sites where snowmelt is rapid. The IDFxx2 has the hottest summers of all subzones in the IDF zone, and is similar to, but moister than, the PP zone and colder in winter than similar IDF and PP variants in the southern Okanagan.[2] Extreme cold snaps in winter and extreme heat waves in summer are important influences on climate and vegetation in the IDFxx2. Late spring and early fall frosts are also common.

Forest and Vegetation Characteristics

Ecosystems in the IDFxx2 have been heavily influenced by several interacting factors, with dry climatic conditions and frequent, mixed-severity fires the most influential historical factors. In the last century, fire exclusion, heavy grazing by wildlife and livestock, timber harvesting, and increased human settlement have shifted natural patterns and dynamics. Forests were historically described as open and savannah-like with mixed grass, forb, and shrub cover in the understorey (Eastham 1949). Today, the landscape has a range of forest conditions and is dominated by multistoreyed stands, often with dense understoreys of Fd.

The IDFxx2 is unique among British Columbia's dry-belt climates and ecosystems because it has hot, dry growing conditions but is at a much higher elevation than other dry IDF and PP subzones/variants in southern British Columbia. Several plant species are at, or near, the northern extent of their range, and some species that are common in the Thompson-Okanagan Region, such as big sagebrush (*Artemisia tridentata*) and prickly-pear cactus

[1] See Section 4.5 for more information on climate variables.

[2] The IDFxx2 has characteristics of both the IDF and PP zones, and was previously mapped as PPdh2.

(*Opuntia fragilis*) are uncommon in the IDFxx2. In contrast, antelope-brush is one of the most abundant shrubs in the IDFxx2.

Py and Fd are the dominant trees throughout the IDFxx2. Sxw, Lw, Pl, At, and Act are restricted to moist sites, typically in riparian areas along the Kootenay River and its many tributaries. **Mesic sites** on gentle to moderate terrain are dominated by Py and Fd with pinegrass in the understorey; bunchgrasses and kinnikinnick are frequently present. On **drier sites**, grass dominance shifts from pinegrass to bunchgrasses, with bluebunch wheatgrass and fescues abundant beneath Fd and Py canopies. **Moister sites** have Lw, Sxw, Pl, and broadleaf trees in the overstorey, and are characterized by shrubby understoreys of choke cherry, snowberry, birch-leaved spirea, and red-osier dogwood. Herbaceous species that are indicative of moist to wet sites include wild sarsaparilla, horsetails, arnicas, fairybells, and star-flowered false Solomon's seal. A separate site series is identified for **steep, cool-aspect mesic sites** where Fd stands occur with a dense moss layer dominated primarily by feathermosses (110 site series; see p. 93).

Grasslands and associated ecosystems are an important component of the IDFxx2. They provide critical valley-bottom habitat for a range of species, including several at-risk species. Shrub-steppe sites only occur on very sandy or rocky soils, and are dominated by antelope-brush. Brushlands are uncommon and are most often dominated by snowberry and choke cherry. Alkaline/saline meadows occur infrequently and are often at risk from grazing effects.

The largest grassland areas occur in the St. Mary prairie and Tobacco Plains. A history of intensive grazing and anthropogenic disturbances for more than a century has made it difficult to determine "natural" grassland plant community composition. Rough fescue, Idaho fescue, and bluebunch wheatgrass dominate on sites in "good condition".[3] Junegrass, Kentucky bluegrass, and needlegrasses are abundant on heavily grazed grassland sites. Forbs are diverse and frequently include fleabanes and daisies (*Erigeron* spp.), golden-aster, *Phlox* spp., pussytoes, yarrow, penstemons, and arrowleaf balsamroot (see Section 6.4).

Other non-forest ecosystems also provide critical habitat diversity, especially wetlands and flood ecosystems. Wetland and flood ecosystems are extensive along the Kootenay River. Rock outcrop and talus ecosystems are uncommon in the IDFxx2 where thick glaciofluvial deposits dominate most of the landscape.

[3] Good condition is defined for grassland sites in Section 6.4 and refers to sites with plant communities that are similar to those that would be expected in the absence of alien invasive plants, livestock grazing, and anthropogenic disturbance.

Disturbance

Historically, **mixed-severity fire regimes** characterized disturbance in the IDFxx2. This includes frequent, low-severity, stand-maintaining fires that burned frequently, as well as less frequent stand-replacing fires.[4] High-frequency, low-intensity **fires**, together with different soil deposits, maintained a **patchy mosaic of grasslands, shrubby openings, and open forests** of widely spaced, fire-tolerant trees in the IDFxx2. Lower-frequency, higher-severity fires also led to occasional stand-replacing disturbances that resulted in closed-canopied forests. **Long-term fire exclusion** has led to **forest ingrowth** of historically open stands and to **grassland encroachment**. A long history of logging, particularly in the early 1900s, targeted mature and old trees (Eastham 1949).

The IDFxx2 also has a legacy of **intensive grazing**, which has resulted in livestock and wildlife populations competing for a diminishing supply of forage. Grassland and open-forest range values have deteriorated due to a reduction in fescues and bluebunch wheatgrass cover and an increase in invasive plant species and smaller, less palatable grasses. Ungulate browsing often limits the success of regenerating trees. **Ecosystem restoration treatments** that use combinations of partial cutting, understorey slashing, and/or prescribed fire have attempted to mitigate fire exclusion and improve forage production, but with mixed success (Forest Practices Board 2016).

The primary insects and pathogens of significance in the IDFxx2 are bark beetles, with **Douglas-fir bark beetle** on Fd, **spruce beetle** on Sxw, **western pine beetle** and **red turpentine beetle** on Py, and **mountain pine beetle** where Pl is present. Beetles have had variable effects over time in the IDFxx2, ranging from periods of minimal to extensive mortality. Western false hemlock looper is cyclical and causes defoliation and mortality of small to large Fd trees as far north as Radium. Low levels of black stain fungus and armillaria root rot occur in stands of all ages and can cause significant mortality in mature and regenerating stands, particularly to Fd, in localized areas within the IDFxx2. Rhabdocline needle cast can also affect regenerating Fd.

Urban and rural developments have also affected natural habitats, with agriculture, towns, and other settlements converting areas from natural to anthropogenic ecosystems. Significant losses of high-value habitats, particularly riparian floodplains and cottonwood forests, wetlands, and adjacent low-elevation forests, occurred when the Libby Dam was built to create the

[4] Data from nearby subzones/variants report an average low-severity fire return interval of 25–50 years (Daniels et al. 2011).

Koocanusa Reservoir (MacKillop et al. 2008; Utzig and Schmidt 2011). Alien invasive plant species are a serious concern across the IDFxx2.

Soils, Geology, and Landforms

Thick, unconsolidated glacial deposits dominate the valley floor in the southern Rocky Mountain Trench where most of the IDFxx2 occurs. This layer of sediment contains a complex and somewhat unpredictable mixture of moraine and other ice-contact materials from numerous geographic origins. As a result, soil textures and parent materials can be highly variable within a short distance. The western portions of both IDFxx2 areas are not covered by this thick layer of glacial drift, and soils there are more closely related to the underlying bedrock. The dominant bedrock types in those areas are a mix of sedimentary rocks, including argillite, sandstones, conglomerates, and dolomites. Limestone with slate and siltstone and coarse-grained granodiorite also occur in the St. Mary River valley.

Within the complex matrix of landforms in the Kootenay River valley bottom, morainal deposits and glaciofluvial features are very common. Silt loam and loam textures are common in morainal material; glaciofluvial deposits often have silt loam to loamy sand textures and usually have high coarse fragment content. Fluvial deposits on the floodplains of large rivers and their tributary valleys are common and often occur adjacent to glaciolacustrine terraces. Silty to fine sandy eolian veneers are common over glaciofluvial deposits and occasionally on morainal materials. Organic matter–enriched (Ah) surface horizons are found in the grassland environments of this variant. Calcareous soils are common across the IDFxx2, and a carbonate-enriched and sometimes cemented (Cca) layer is frequently found in the upper metre of soil.

Vegetation patterns in the IDFxx2 are strongly linked to soil characteristics, particularly on gentle to level sites in the valley bottom of the Rocky Mountain Trench where the depth of finer-textured eolian deposits varies over short distances. In these areas, submesic soil moisture regimes (104 site series) occur on sites with shallow eolian deposits (< 30 cm deep), while mesic sites (101 site series) occur where deposits are deeper (> 50 cm). Other compensating conditions such as slope angle,[5] slope position, and aspect determine soil moisture and vegetation patterns on sites with eolian deposits of intermediate thickness. Depth and impermeability of a Cca layer will also influence site series and productivity patterns.

[5] In hot, dry climates, slope angle can have a large influence on solar insolation. On warm aspects, a slope angle > 15% is enough to shift the rSMR by one class. For example, a site with a deeper eolian veneer (> 50 cm) on a warm aspect with a 15% slope may have an rSMR of 3 (submesic) on what otherwise would have been a mesic site.

Wildlife Habitat

The IDFxx2 provides some of the highest-value **ungulate winter range** in the East Kootenay for large populations of **Rocky Mountain elk** and **bighorn sheep** as well as **mule deer** and **white-tailed deer**. The IDFxx2 supports high-value nesting/staging areas and a migratory corridor for an impressive diversity of **bird species** that use the Columbia and Kootenay River valley-bottom **wetland and riparian habitats**.

A variety of mammals, amphibians, and reptiles also use this ecosystem year-round, including **many species at risk**. Some breed in **wetland and riparian habitats** (northern leopard frog, western toad, painted turtle, American bittern, bank swallow, great blue heron, short-eared owl, and sandhill crane). A few species at risk are associated primarily with **rocky sites** (peregrine falcon, rubber boa, Townsend's big-eared bat, and little brown myotis), and many breed in **grassland or agricultural habitats** (American badger, barn swallow, bobolink, common nighthawk, long-billed curlew, prairie falcon, sharp-tailed grouse, short-eared owl, Swainson's hawk, and, more rarely, lark sparrow, Brewer's sparrow, burrowing owl, and monarch butterfly). Rivers and the Koocanusa Reservoir are used by fluvial and adfluvial fish species, including cutthroat trout and bull trout. Tributary streams provide important spawning habitat for other species, and the importance of kokanee salmon as a fall food source for bears continues to increase.

Open forests and/or **cottonwood riparian areas** are important for a variety of cavity and open nesters (e.g., waterfowl and other water birds, raptors, and woodpeckers) that rely on **old-forest structure** and **wildlife trees** for breeding, roosting, and/or perching substrates (e.g., Lewis's woodpecker, Williamson's sapsucker, flammulated owl, western screech-owl, and great blue heron). **Retention of old-forest structure**, including large fire-scarred trees, large wildlife trees in a range of species and decay classes (with cavities, hollows, heart rot, broken tops, perching limbs, etc.), and large coarse woody debris, is required to sustain these species.

A **very high diversity of listed vascular plants** occurs in the IDFxx2. Conservation of these species will require management of livestock grazing, invasive species, access, and various forms of anthropogenic disturbance and development.

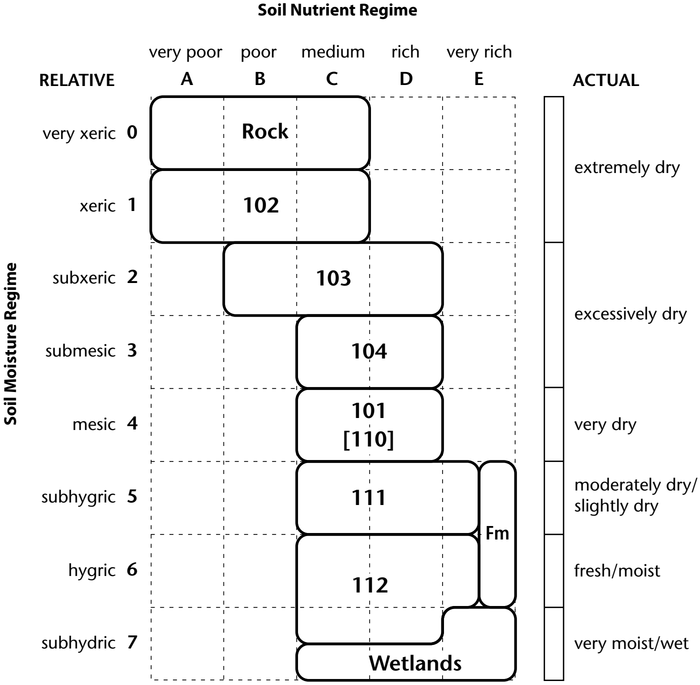
Common bird species in the IDFxx2 include chipping sparrow, American robin, red-breasted nuthatch, vesper sparrow, and dusky flycatcher.

Distinguishing the IDFxx2 from Adjacent Biogeoclimatic Units

In the **IDFdm2**, most sites have:	- Lw and Pl - more Fd and less Py - more Oregon-grape, soopolallie, snowberry - higher pinegrass cover
zonal sites have:	- Lw (Pl) - little or no Py - no bluebunch wheatgrass - minor cover of twinflower
dry sites have:	- less Py, more Fd - more common juniper and Rocky Mountain juniper - less bluebunch wheatgrass

Antelope-brush
Purshia tridentata

Edatopic Grid



Site series

101	FdPy – Pinegrass – Bluebunch wheatgrass
102	Py – Mock-orange – Bluebunch wheatgrass
103	Py(Fd) – Antelope-brush – Bluebunch wheatgrass
104	Py – Bluebunch wheatgrass – Rough fescue
110	Fd – Feathermoss – Step moss
111	FdLw – Snowberry – Pinegrass
112	Sxw – Dogwood – Horsetail
Fm01	Cottonwood – Snowberry – Rose[a]
Fm02	Cottonwood – Spruce – Dogwood[a]
Fm07	Aspen – Dogwood – Water birch[a]

[a] See Section 6.3 for descriptions.

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects
- shallow and/or coarse soils

- SMR 1
- exposed rock prominent in stand
- open Py, Fd stands with high shrub cover
- mock-orange, bluebunch wheatgrass, cliff ferns, and/or round-leaved alumroot

→ **102**

- SMR 2 (3)
- open Py, Fd stands
- steep/warm or coarse flats and crests
- antelope-brush, saskatoon
- bluebunch wheatgrass, arrowleaf balsamroot

→ **103**

SLIGHTLY DRY to MESIC FORESTS
- mid slopes
- deep soils

- SMR 3
- Py (Fd) stands
- gentle to level sites with thin Ev and/or coarse soils
- bluebunch wheatgrass, fescues, junegrass
- pinegrass absent or very sparse

→ **104**

- SMR 4
- Fd, Py stands
- thicker Ev (> 50 cm) and/or moderate-textured soils
- abundant pinegrass, especially in denser stands
- bunchgrasses with variable cover (1–10%)

→ **101**

- SMR 4
- Fd stands
- steep, cool, or neutral aspects; shaded
- birch-leaved spirea and pinegrass
- dense moss cover

→ **110**

MOIST to WET FORESTS
- level, lower, or toe slopes
- mottles or water table present

- SMR 5
- Fd, Lw (Sxw) stands
- saskatoon, choke cherry, snowberry, prairie rose
- pinegrass, arnicas, fairybells

→ **111**

- SMR 6–7
- Sxw stands
- level sites; water table at or near the surface
- red-osier dogwood and mountain alder
- horsetails abundant

→ **112**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Trees	*Pinus ponderosa*	■■■■	■■■■	■■■■■	■■■■■	*			ponderosa pine
	Pseudotsuga menziesii	■■■	■■■	□□□	■■■■	■■■■■	■■■■■		Douglas-fir
	Larix occidentalis						■■■■		western larch
	Picea engelmannii x *glauca*						□□□	■■■■■	interior spruce
Regen	*Pseudotsuga menziesii*	■	□□	□□	■■■	■■	■■■		Douglas-fir
	Pinus ponderosa	■	■■	■■	■				ponderosa pine
	Picea engelmannii x *glauca*						*	■■■	interior spruce
Shrubs	*Philadelphus lewisii*	■■■							mock-orange
	Purshia tridentata	■■	■■■	*					antelope-brush
	Amelanchier alnifolia	■■■	■■■	*	■	□	■■■	■■	saskatoon
	Prunus virginiana	■■■					■■■		choke cherry
	Symphoricarpos spp.	■■	*	*	□	□	■■■■	■■■■	snowberry
	Rosa spp.			□□	□□		■■■	■■	roses
	Juniperus communis				*	■	□		common juniper
	Spiraea lucida					■■■	■■■		birch-leaved spirea
	Berberis spp.					□□	■■■■	*	Oregon-grape
	Cornus stolonifera							■■■	red-osier dogwood
	Alnus incana							■■■	mountain alder
Herbs	*Pseudoroegneria spicata*	■■■■	■■■■	■■■■	□□				bluebunch wheatgrass
	Heuchera cylindrica	■■■							round-leaved alumroot
	Woodsia oregana	■■■							western cliff fern
	Achillea spp.	■	■■	■■	■				yarrow
	Balsamorhiza sagittata	■	■■■						arrowleaf balsamroot
	Festuca spp.		■■■	■■■■					fescues
	Koeleria macrantha		■■	■■					junegrass
	Antennaria spp.		□□	■■	■■				pussytoes

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Herbs	*Arctostaphylos uva-ursi*		□□	*	■■				kinnikinnick
	Astragalus miser		■						timber milk-vetch
	Lithospermum ruderale		■	□	□				lemonweed
	Lomatium triternatum		■	□	□				nine-leaved desert-parsley
	Anemone patens		□	□□	□				prairie crocus
	Allium cernuum		□	■	■				nodding onion
	Penstemon confertus		*	□	■				yellow penstemon
	Geum triflorum			□□					old man's whiskers
	Calamagrostis rubescens				■■■■	■■■	■■■■		pinegrass
	Arnica spp.					□□	■■		arnicas
	Galium boreale					□	■		northern bedstraw
	Eurybia conspicua					□	□□□		showy aster
	Prosartes spp.					□	■■	*	fairybells
	Aralia nudicaulis						□	□□□□	wild sarsaparilla
	Maianthemum stellatum						□	■■	star-flowered false Solomon's-seal
	Vicia americana						■	■	American vetch
	Equisetum spp.							■■■■■	horsetails
Moss layer	*Brachythecium* spp.	■■■		□□	■■	*	■■■	*	ragged-mosses
	Syntrichia ruralis	■■■							sidewalk screw-moss
	Polytrichum spp.	■■					□□		haircap mosses
	Cladonia spp.	■■	□□	*					clad lichens
	Peltigera spp.	■■	□			■■■	■		pelt lichens
	Dicranum spp.				□	■■			heron's-bill mosses
	Hylocomium splendens				*	■■■■	■■		step moss
	Pleurozium schreberi				*	■■■■	□□		red-stemmed feathermoss
	Rhytidiadelphus triquetrus				*	■■■■	*		electrified cat's-tail 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

Environment Table[a]

Site series	102	103	104	101	110	111	112
No. of plots	1	10	16	11	6	4	5
SMR	1	2 (3)	3	4	4	5	6–7
SNR	B–C (A)	C–D (B)	C–D (B)	D (C)	D (C)	D (C–E)	D–E (C)
Slope position	CR–UP	MD (UP, LV)	MD (UP)	LV (MD, LW)	MD	LW, TO (LV)	DP, LV (TO)
Typical slope/ aspect	Warm/steep	Steep–moderately steep/ warm	Gentle–level/ warm	Gentle–moderate/ neutral (cool)	Cool/steep	Gentle (level)	Gentle–level
Common compensating conditions		Coarse-textured crests and flats	Upper/cool–neutral	Gentle (< 15%)/ warm	Neutral/steep, shaded		
Surficial materials	Cxv/R, Mx/R	Ev/FG, Ev/Mb, FG	Ev/FG, Ev/Mb	Ev/Mb, Mb, (Ev/ FG, Lb)	Mb, FG, Cb	F, FG (LG)	F, L, Ov
Soil texture	SL, SiL	S, LS	SL, SiL (L)	SiL (L, SiCL)	SL, FSL, SiL (SCL)	SiL (SiCL, S, LS)	Si, SiL, SiCL
Coarse fragment content	High (moderate)	Moderate–high; often increases at depth	High (moderate); increases at depth	Moderate; may increase at depth	Low–moderate	Sparse–low; may increase at depth	Sparse–low; may increase at depth
Important features	Dominated by (bed)rock		Thin Ev (< 30 cm) over coarse- to very coarse-textured soils	Often with a deeper Ev (> 50 cm) over moderately coarse- to coarse-textured soils	Often Ev over coarser- textured soils	Mottles or seepage within top 50 cm; cold air	Water table within 30 cm; cold air

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

FdPy – Pinegrass – Bluebunch wheatgrass 101

General Description

SMR 4. The 101 site series occurs on gentle to moderate slopes with medium-textured soils or with a **deep, finer-textured eolian veneer** (> 50 cm) over **moderately coarse glaciofluvial or morainal** surficial materials. Soils are typically Eutric Brunisols with silt loam or loam textures, and often have a strongly calcareous and frequently cemented layer at depth.

Py usually dominates the overstorey. Fd is typically abundant in the overstorey and dominates the regeneration layer. **Pinegrass** is abundant, especially in stands with more shade and a denser overstorey. **Bluebunch wheatgrass** is usually present, with cover varying from minor (1%) to high (> 10%). Other bunchgrasses such as rough fescue (*Festuca campestris*), Idaho fescue (*F. idahoensis*), and needlegrasses (*Hesperostipa* spp. and *Achnatherum* spp.) may also be present, along with a variety of grassland forbs, including yellow penstemon, pussytoes, and nodding onion. Kinnikinnick usually occurs. Moss cover is generally low.

Differentiating from Other Site Series

Slightly drier sites (104) have more bluebunch wheatgrass, rough fescue, and junegrass, less Fd, and little or no pinegrass or kinnikinnick. Sites on steep, cool, mesic sites (110) have similar soil moisture regimes but differ by having abundant mosses and less Py. Slightly moister sites (111) have Lw and sometimes Sxw, and are generally more shrubby, with saskatoon, Oregon-grape, choke cherry, roses, and/or snowberry.

Variability

Bunchgrass cover is variable, with more open stands having higher covers. Two site series variations are described:

101.1 FdPy – Pinegrass – Bluebunch wheatgrass
sites with > 2% bunchgrasses (bluebunch wheatgrass, fescues, and needlegrasses)

101.2 FdPy – Pinegrass
sites where bunchgrasses are sparse or absent

Management Issues

Ungulate browsing, drought, and grass competition may limit tree growth and establishment. Where fire exclusion and forest ingrowth have increased understorey density, ecosystem restoration treatments may enhance habitat and ecosystem values. Invasive plant species are a serious concern. Where machinery is active, conserve surface soils and avoid exposure of unfavourable subsoils. Tree productivity is relatively low on these sites in comparison to zonal sites in other IDF subzones.

102 Py – Mock-orange – Bluebunch wheatgrass

General Description

SMR 1. The 102 **forested rock outcrop** site series is **uncommon** in the IDFxx2 where deep, glaciofluvial deposits dominate the landscape. It is restricted to sites with exposed bedrock or, occasionally, talus. Pockets of soil are sparse between exposed rock. Solar radiation is usually high, and stands often occur adjacent to open, non-forested rock outcrops, grasslands, and 103 forested sites.

Py dominates the open canopy, often with minor cover of Fd. **Mock-orange** is usually present, often with **choke cherry**, **saskatoon**, and sometimes **antelope-brush**. Bluebunch wheatgrass, **round-leaved alumroot**, **rock ferns** (mostly mountain cliff fern), and *Selaginella* spp. usually occur. The moss layer is well-developed with **sidewalk screw-moss**, **rock-mosses** (*Racomitrium* spp.), **ragged-mosses**, haircap mosses, and clad and pelt lichens.

Differentiating from Other Site Series

The 102 is the driest forested site series described in the IDFxx2. Drier sites are non-forested rock, grassland, or brushland ecosystems with < 10% tree cover. The 102 is easily differentiated from other forested site series by the abundance of (bed)rock. Slightly moister sites (103) also have more antelope-brush and arrowleaf balsamroot, and less mock-orange, choke cherry, rock ferns, round-leaved alumroot, and mosses.

Variability

This site series is described based on limited data. High variability in understorey species is expected due to the diversity of species that are associated with rock outcrops.

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. Drought stress can increase the susceptibility of trees to insects and disease. Invasive plant species are a serious concern.

Py(Fd) – Antelope-brush – Bluebunch wheatgrass 103

General Description

SMR 2 (3). 103 sites occur on **moderately steep to steep**, **warm-aspect slopes** and on rapidly drained, **coarse-textured crests and flats**. Thin eolian veneers are common, often with gravelly glaciofluvial or morainal materials below. Soils are typically Eutric or Melanic Brunisols with sandy or loamy sand textures and moderate to high coarse fragment content.

Open stands of **Py**, usually with Fd, are typical on these sites. **Antelope-brush**, **saskatoon**, **bluebunch wheatgrass**, and **arrowleaf balsamroot** distinguish the understorey vegetation. Minor amounts of timber milk-vetch, rough fescue, pussytoes, prairie crocus, and junegrass are also common. The moss layer is usually sparse, although a microbiotic crust[6] may be present.

Differentiating from Other Site Series

Slightly drier sites (102) have exposed bedrock, very shallow soils, and more alumroot, rock ferns, and mosses. Slightly moister sites (104) have less antelope-brush and arrowleaf balsamroot, and (usually) more rough fescue. The 103 site series is also similar to the Gs12, but that shrub-steppe site association has < 10% tree cover.

Variability

The 103 has a high diversity of grassland-associated forbs. Kinnikinnick is often more abundant on gentler terrain, while arrowleaf balsamroot is more abundant on steeper terrain. Antelope-brush is most abundant on sandy soils. Py is usually dominant in the overstorey, although Fd can have high cover.

Management Issues

Lack of soil moisture is a major limiting factor for tree growth and establishment. Sites with large trees, lower snow depths, and high forage availability provide important ungulate winter range. Where fire exclusion and forest ingrowth have increased understorey density, ecosystem restoration treatments may enhance habitat and ecosystem values. Care should be taken during harvesting and ecosystem restoration activities to conserve limited organic matter and to avoid soil disturbance. Invasive plant species are a serious concern.

[6] A biological soil crust of lichens, bryophytes, algae, cyanobacteria, and microfungi.

104 Py – Bluebunch wheatgrass – Rough fescue

General Description

SMR 3. The 104 site series is common on **gentle to level sites** with a **thin (< 30 cm), finer-textured eolian veneer over gravelly glaciofluvial or morainal materials**. It also occurs on mid slopes of warm aspects with moderate to moderately coarse-textured, deep soils and on upper, shedding slopes of neutral aspects with coarse soils. Soils are usually Eutric or Melanic Brunisols with silt loam or loam textures and high to fragmental coarse fragment content that often increases at depth. A strongly calcareous and frequently cemented layer is often present within one metre of the soil surface.

Py dominates the canopy, often with abundant Fd. **Bluebunch wheatgrass** and/or **rough fescue** are abundant in the understorey, with pussytoes, junegrass, yarrow, and nodding onion. Stands have diverse understoreys with minor amounts of many herb species, including prairie crocus, yellow penstemon, old-man's whiskers, and a range of other grassland species. Moss cover is usually low.

Differentiating from Other Site Series

Slightly drier sites (103) have abundant antelope-brush and arrowleaf balsamroot. Slightly moister sites (101) have abundant pinegrass, more Fd, and less bluebunch wheatgrass, fescues, and junegrass.

Variability

Grass cover varies on these sites. On heavily grazed sites, needlegrasses (*Achnatherum* spp.) have high cover, and rough fescue has lower cover. Idaho fescue is often present with low cover.

Management Issues

Ungulate browsing, drought, and grass competition may limit tree growth and establishment. Sites with large trees, lower snow depths, and high forage availability provide important ungulate winter range. Where fire exclusion and forest ingrowth have increased understorey density, ecosystem restoration treatments may enhance habitat and ecosystem values. Care should be taken during harvesting and ecosystem restoration activities to conserve limited organic matter and to avoid soil disturbance. Invasive plant species are a serious concern.

Fd – Feathermoss – Step moss 110

General Description

SMR 4. The 110 site series occurs on mesic sites on **cool-aspect**, **steep slopes** and occasionally on steep, shaded, neutral aspects. Soils are usually Eutric Brunisols with sandy loam or silt loam textures and variable coarse fragment content. Slopes are generally > 50%.

Closed-canopy, multi-storeyed Fd stands are typical on these sites. High cover of **feathermosses** is distinctive on these sites, although **pinegrass**, Oregon-grape, and birch-leaved spirea can also have high cover. Py and Lw are typically sparse or absent. Moss cover is very high (> 40% cover), and **step moss**, **red-stemmed feathermoss**, **wiry moss** (*Abietinella abietina*), and **electrified cat's-tail moss** are the most common species.

Differentiating from Other Site Series

The 110 occurs on sites with a similar soil moisture regime to the 101 site series but is restricted to steep, cool- or neutral-aspect sites. Vegetation on 101 has more Py, higher diversity of forbs (usually species associated with grassland/dryland conditions), less birch-leaved spirea, and considerably less moss cover. Slightly moister sites (111) have Lw and/or Sxw, higher shrub cover with snowberry, choke cherry, rose, and Oregon-grape, and fewer feathermosses.

Variability

Stands often have dense Fd cover. Herb and shrub cover is generally low to moderate (up to ~ 25% cover for each), while moss cover dominates in the understorey. Pinegrass is usually present, although cover can vary from low (< 1%) to moderate (up to 20%).

Management Issues

The moister, cooler conditions of the 110 create favourable conditions for regeneration and growth of Fd compared to other site series in the IDFxx2. Where machinery is active, conserve surface soils and avoid exposure of unfavourable subsoils. Invasive plant species are a serious concern.

111 FdLw – Snowberry – Pinegrass

General Description

SMR 5. The 111 site series occurs on **receiving sites** with **seasonal seepage** or **moisture at depth**. Soils are typically derived from glaciofluvial or fluvial materials and have silt loam or sandy textures. Coarse fragment content varies but often increases at depth, particularly on sites with finer soils. This site series is **uncommon**, and often occurs as a narrow transition between mesic and wetter sites. Sites are usually associated with or adjacent to **riparian areas** and often have **cold-air** and/or **frost exposure**.

Fd, **Lw**, and **Sxw** occur in the overstorey, with snowberry, roses, saskatoon, Oregon-grape, birch-leaved spirea, and choke cherry in the well-developed shrub layer. **Pinegrass**, arnicas, fairybells, and showy aster are typical of the moderately lush herb layer. The moss layer usually contains ragged-mosses with low cover of feathermosses.

Differentiating from Other Site Series

Slightly drier sites lack Sxw, snowberry, and choke cherry, and have little or no Lw. Sites on steep, cool aspects (110) are Fd-dominated in the tree layers with abundant mosses, while mesic sites on gentle to moderate terrain (101) generally have Py, kinnikinnick, and minor cover of bunchgrasses. Slightly moister sites (112) have abundant horsetails.

Variability

The well-developed shrub layer is characteristic of this site series, although individual shrub species vary across sites. Fd is typically the dominant tree species with lesser amounts of Lw and Sxw. Pl, At, and/or Ep may be present on some sites. Pinegrass cover can be highly variable, ranging from dominant (> 10% cover) to minor cover (1–2%). Low cover of wild sarsaparilla, northern bedstraw, and/or American vetch may occur.

Management Issues

Tree species diversity is relatively high on these sites and should be maintained. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Vegetation competition may impede tree growth in regenerating stands. Invasive plant species are a serious concern.

Sxw – Dogwood – Horsetail 112

General Description

SMR 6–7. The 112 site series occurs on **level sites**, **in depressions**, and **on gently sloping toe slopes** where the **water table** is within 30 cm of the soil surface. Two site series phases are recognized to differentiate between flood and swamp sites (see Variability section below). On swamp sites, soils are usually Gleysols with a thick peaty, organic veneer (30–50 cm) and prominent mottles or gleying in the mineral soil below. Gleyed Humic Regosols with buried horizons are common on sites that **flood**. Sites are usually associated with **riparian areas** and often have **cold-air** and/or **frost exposure**.

Sxw dominates the overstorey, often with low cover of **Act** or **At**. Abundant shrubs and herbs are typical, and **red-osier dogwood**, snowberry, saskatoon, **mountain alder**, water birch (*Betula occidentalis*), and/or roses are the most common species in the shrub layer. **Horsetails** are distinctive; blue wildrye (*Elymus glaucus*), wild sarsaparilla, and star-flowered false Solomon's-seal often occur with varying covers.

Differentiating from Other Site Series

Slightly drier sites (111) lack horsetails and mountain alder and have more Fd. Slightly wetter sites are wetlands—usually swamps or marshes (see Section 6.2). Broadleaf-dominated sites with more dynamic flood regimes are classified in the Flood Group (middle bench Act or At stands or low bench willow or alder sites) (see Section 6.3).

Variability

The 112 site series can occur on high bench floodplains and on wetland sites. Occasionally, sites with very poor drainage and a thick organic veneer occur; these can be classified as treed swamps (Ws07) (see Section 6.2). Vegetation is very similar on both site conditions, and those who require additional information can use phases to differentiate:

- **112a** for high bench, riparian flood sites
- **112b** for the swamp phase; sites have a thick organic veneer, very poor drainage, and higher cover and diversity of mosses; swamp sites are equivalent to the Ws07 swamp site association (see Section 6.2)

Forb diversity can be high on these sites, with low cover of many species often occurring.

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Cold air and frost may limit tree regeneration. Invasive plant species are a serious concern. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

Other Ecosystems

The following ecosystems are known to occur in the IDFxx2. They are described in detail in Chapter 6.

Wetlands

Marshes (Wm) are the most common wetland type found in the low-elevation, dry climate of the IDFxx2, although swamps (Ws), shallow water wetlands (Ww), and occasionally fens (Wf) also occur. Section 6.2 provides descriptions of wetland ecosystems.

Cottonwood floodplains and flood ecosystems

Reservoir flooding resulted in significant losses of wetlands, riparian floodplain, cottonwood bottomlands, mixed deciduous stands, and wet coniferous forest areas. The most common cottonwood floodplain units are *Fm01 Cottonwood – Snowberry – Rose, Fm02 Cottonwood – Spruce – Dogwood*, and *Fm07 Aspen – Dogwood – Water birch.* Flood ecosystems are described in Section 6.3.

Grasslands, brushlands, shrub-steppe, and alkaline/saline meadows

Grassland (Gg) and brushland (Gb) ecosystems are ecologically significant in the dry climate of the IDFxx2. Alkaline/saline meadows (Ga) and shrub-steppe (Gs) also occur. Section 6.4 provides detailed descriptions for the Grassland Group.

Rock outcrops and talus

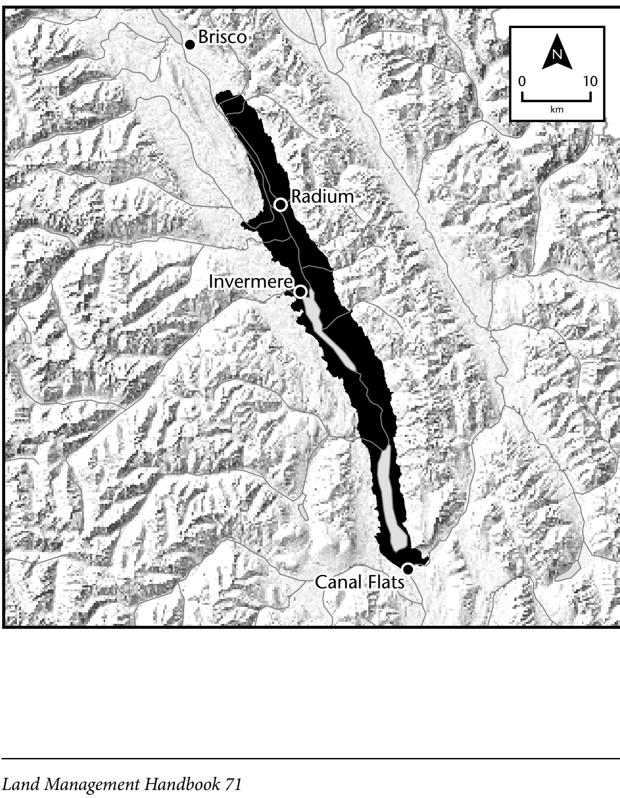
Rock outcrops (Ro) and talus (Rt) are uncommon in the IDFxx2 where complex glaciofluvial and morainal landforms are dominant. Section 6.6 provides descriptions for the Rock Group.

IDFxk
Very Dry Cool
Interior Douglas-fir

Geographic Distribution

The IDFxk occupies low elevations in the central portion of the Rocky Mountain Trench from Canal Flats to south of Brisco. This relatively small biogeoclimatic unit follows the Columbia River and is approximately 4–8 km wide and 75 km long. It includes Columbia and Windermere Lakes, Fairmont and Radium Hot Springs, the town of Invermere, the communities at Shuswap and Columbia Lake (?Akisq'nuk), and large areas of the Columbia Wetlands. Across most of its range, it occurs below the IDFdk5. At the southern extent, it occurs below and adjacent to the IDFdm2.

Distribution of the IDFxk



Elevation Range

The IDFxk extends from valley bottom (~ 800 m) to approximately 900–950 m on cool and neutral aspects and 1000–1050 m on warm aspects.

Climate[1]

The IDFxk occurs in the Very Dry climate subregion; all seasons are characterized by very dry conditions. Winters are cool, summers are hot, and spring and fall are warm. Growing-season moisture deficits are common on mesic and drier sites and can affect subhygric sites in drier than normal years. Drought is common, and lack of soil moisture is a major limiting factor for tree growth. The snowpack is shallow and can be intermittent, although it generally persists throughout the winter from late November or December through to late February or early March, except on insolated, warm-aspect sites where snow accumulation is lower and of shorter duration. Soils often freeze to shallow depths. Extreme cold snaps in winter and extreme heat waves in summer are important influences on climate and vegetation in the IDFxk. Growing-season frosts may occur.

Forest and Vegetation Characteristics

Conifer diversity is very low in the IDFxk where Fd is the dominant tree on most forested sites. Ep, Act, and Sxw are common on the wettest forested sites. At is relatively common and occurs on dry to wet sites, especially in seral/disturbed stands. Pl is uncommon throughout the IDFxk and is typically restricted to areas with cold air and growing-season frosts. Py is generally absent and occurs only on a few very dry sites at the southern edge of the IDFxk along Columbia Lake. Pf[2] occurs on isolated, rocky sites but is also uncommon.

Tree productivity is low on upland sites across the IDFxk, and Fd stands are often stunted in height. Ingrowth of smaller stems is also common, particularly with fire exclusion, which leads to poor productivity "Trench Fd" stands with dense regeneration. Poor growing conditions are a result of the dry climate and dry soils: depth and impermeability of a frequently cemented, carbonate-enriched (Cca) layer will also influence site capacity and productivity patterns.

Zonal sites are dominated by Fd with abundant pinegrass in the understorey. Drier than mesic sites are also Fd-dominated but tend to be more open. Bluebunch wheatgrass, rough fescue, kinnikinnick, junegrass, and common rabbit-brush are common. Understorey herbs are highly diverse and vary across mesic and drier forests of the IDFxk; a number of dry-site

[1] See Section 4.5 for more information on climate variables.

[2] Limber pine (*Pinus flexilus*).

species that are more commonly associated with grassland environments are present, such as cut-leaved anemone, spikelike goldenrod, nodding onion, brown-eyed Susan, Holbell's rockcress, prairie sagewort, and golden-aster. Wild sarsaparilla, star-flowered false Solomon's-seal, blue wildrye, Lindey's aster, and horsetails are common on **wetter sites**.

Common rabbit-brush is uniquely abundant in the IDFxk. Although it also occurs on grassland and shrub-steppe sites in the IDFdm2, common rabbit-brush is frequently abundant on similar sites in the IDFxk and often occurs in the driest forests of the unit.

Non-forest ecosystems cover a large portion of the IDFxk, with the Columbia Wetlands occupying much of the area adjacent to the Columbia River. This includes cottonwood and aspen **floodplain forests** and swamps, marshes, and shallow water **wetlands** that are important for wildlife habitat and biodiversity. In upland areas, grassland and brushland ecosystems are extensive, providing forage and habitat for wildlife and rangeland for livestock. Non-forest ecosystems provide critical valley-bottom habitat for a range of species, including several that are at risk and of conservation or management concern.

Disturbance

The IDFxk has a very long history of human alteration. The first trading post in the East Kootenay was established near Invermere in the early 1800s. This brought permanent European settlement, land clearing, and livestock grazing to the valley bottom around Windermere Lake and surrounding areas. Today, much of the landscape has been substantially changed from its pre-European condition. Many wetland and flood sites have been modified for agriculture, most of the upland areas are privately owned, fire has been largely excluded from the landscape, and urban development continues to grow at a rapid pace. With such a long history of change, most ecosystems in the IDFxk have experienced some form of "non-natural" modification.[3]

Historically, **mixed-severity fire regimes** characterized disturbance in the IDFxk. This includes frequent, low-severity, stand-maintaining fires that burned frequently, as well as less frequent stand-replacing fires.[4] **Fire exclusion** has facilitated **forest ingrowth** in historically open stands and **forest encroachment** into grasslands. Both changes have reduced forage and habitat suitability for wildlife that are dependent on those ecosystems. **Extensive grazing** by livestock and wild ungulates (deer, elk, and sheep)

[3] For many years, the IDFxk was mapped as "undifferentiated" in the BEC system (IDFun), partially because the high levels of disturbance make it difficult to define mature plant communities on zonal sites.

[4] Data from nearby subzones/variants report an average low-severity fire return interval of 25–50 years (Daniels et al. 2011).

has led to further habitat deterioration, which is exacerbated by the spread of alien invasive plant species. Ungulate browsing and livestock often limit tree regeneration.

The primary insects and pathogens of significance in the IDFxk are those that affect Fd, and **Douglas-fir bark beetle** is the most common source of mortality. Western false hemlock looper is cyclical and causes defoliation and mortality of small to large Fd trees as far north as Radium.

Very few old-growth forests remain in the IDFxk. Historic selective harvesting for railway ties and other activities often targeted the largest trees, and few large, fire-scarred veteran trees remain on the landscape. **Ecosystem restoration treatments** that combine partial cutting, post-harvest understorey slashing, and/or prescribed fire have been used to mitigate forest ingrowth.

Soils, Geology, and Landforms

In the southern portion of the IDFxk (south of Invermere), thick, unconsolidated glacial deposits dominate the valley floor. This layer of glacial-derived sediments contains a somewhat unpredictable mixture of moraine and ice-contact materials from numerous geographic and geologic sources. As a result, soil textures and parent materials can be highly variable within a short distance. In the remainder of the unit, where bedrock geology is not obscured by the thick deposits, the most common bedrock types west of the Columbia River are coarse-grained sedimentary rocks, including sandstones and conglomerates, and dolomite, mudstone, siltstone, and shale east of the river. Calcareous rock types such as limestone and marble also occur on the east side of the valley around Canal Flats, north of Fairmount, and with slate, siltstone, and argillite south of Windermere Creek.

Soils derived from morainal parent material in this subzone commonly have textures ranging from silt loam to sandy loam, and some may have clay-enriched (Bt) subsurface horizons. Along the Columbia River valley bottom, glaciofluvial and fluvial features are typically gravelly with highly variable soil textures ranging from silt to loamy sand. The deposits are usually capped by fluvial or eolian veneers with fine sandy loam to silt loam textures. Glaciolacustrine terraces and plains also occur adjacent to the Columbia River floodplain, as well as around Windermere and Columbia Lakes. They are easily identified by their silt loam to silty clay loam surface textures with no coarse fragments. Clay-enriched (Bt) layers are common in the fine-textured soils.

Eutric Brunisols (≥ 5.5 pH) are very common in the dry climate of the IDFxk. Where calcareous parent materials occur, soils typically have carbonate enriched (Cca) subsurface horizons that are often cemented. A relatively large proportion of this subzone is covered by the Columbia Wetlands, which include very poorly drained Gleysols and Organic soils.

Wildlife Habitat

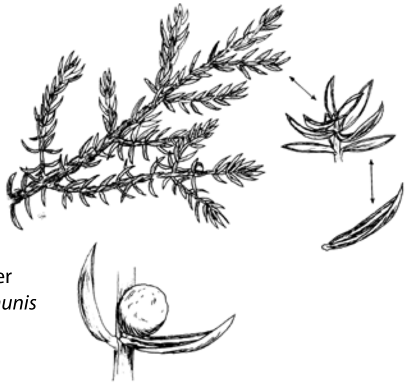
The IDFxk is characterized by **high habitat diversity** and consists of a mosaic of dry grasslands, brushlands, open forests, and rocky habitats bisected by large to small lakes, wetlands, and the Columbia River. High-value ungulate winter range provides habitat for provincially significant populations of **Rocky Mountain bighorn sheep, elk, and mule deer.**

The valley bottom of the IDFxk encompasses the southern extent of the **Columbia Wetlands**, an area recognized for its **extensive riparian and wetland habitats** and associated **diversity of waterfowl, shorebird, and migratory bird species**. Several **at-risk waterbird species** are known to use these habitats, including American avocet, American bittern, American golden-plover, American white pelican, California gull, great blue heron, long-billed curlew, red-necked phalarope, sandhill crane, tundra swan, upland sandpiper, western grebe, and yellow rail. The IDFxk also provides essential breeding habitat for listed **amphibians** (western toad), **reptiles** (painted turtle, northern rubber boa), **invertebrates** (vivid dancer), and **aquatic furbearers** (North American river otter, beaver, mink, and muskrat).

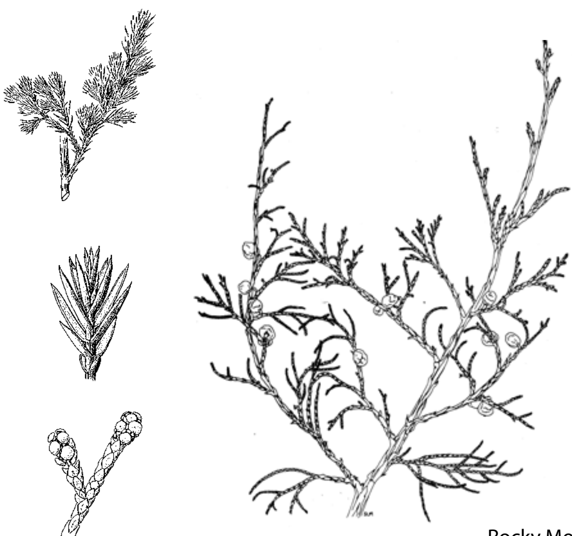
Grassland and open forest habitats in the IDFxk are critical habitats for a range of species, including at-risk species (e.g., American badger, bighorn sheep, bobolink, common nighthawk, prairie falcon, sharp-tailed grouse, short-eared owl, and Swainson's hawk). **Rock outcrops, talus, and cliffs** provide important breeding habitat for additional species at risk: **peregrine falcon, white-throated swift, black swift**, and **Townsend's big-eared bat**.

Old forest structure (large conifers and hardwoods with heart rot and cavities, broken tops, loose bark, and limbs for perching) in upland and riparian areas provides nesting, roosting, and foraging requirements for many species associated with **wildlife trees and coarse woody debris**. These include a large variety of primary and secondary cavity nesters and open nesters, including at-risk species: flammulated owl, Lewis's woodpecker, olive-sided flycatcher, and great blue heron. Many vertebrate species in the IDFxk (such as at-risk bank swallow, barn swallow, little brown bat, and Townsend's big-eared bat) feed on terrestrial and/or aquatic invertebrates, and bird and bat guilds in particular consume significant numbers of nuisance/pest species (mosquitoes, beetles, moths, etc.). Other common insectivorous bird species include dark-eyed junco, warbling vireo, American robin, mountain chickadee, vesper sparrow, and chipping sparrow.

The IDFxk supports a diversity of **at-risk vascular plants**, and controlled livestock grazing, in conjunction with invasive plant management, access restrictions, and reduced disturbance and development, is required to protect this diversity.



Common juniper
Juniperus communis



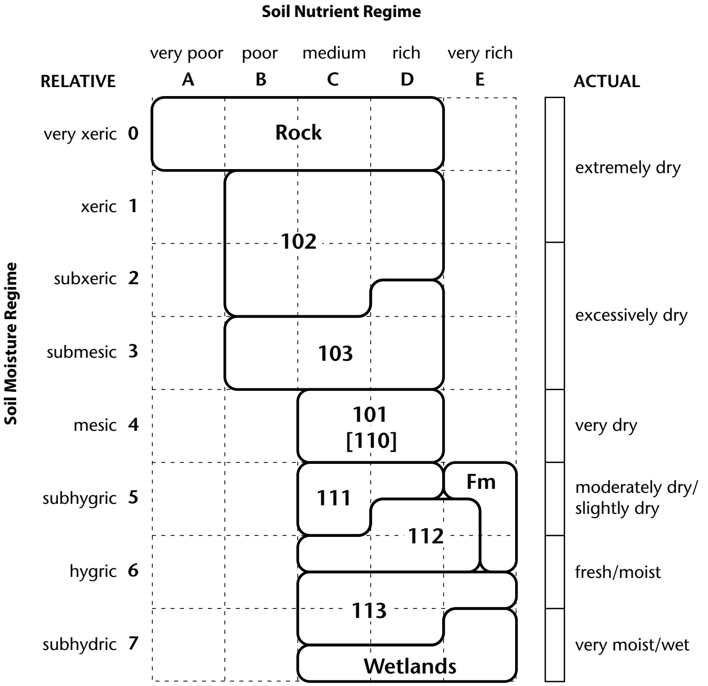
Rocky Mountain juniper
Juniperus scopulorum

Distinguishing the IDFxk from Adjacent Biogeoclimatic Units

In the **IDFdm2**, most sites have:	- fewer grasslands - more closed stand structure
zonal sites have:	- Lw and Pl - higher shrub cover - no bluebunch wheatgrass - Oregon-grape
dry sites have:	- Py - little or no common rabbit-brush
In the **IDFdk5**, most sites have:	- very few grasslands - more closed stand structure - Pl - relatively higher productivity Fd
zonal sites have:	- no bluebunch wheatgrass or Rocky Mountain juniper - Oregon-grape and twinflower - more snowberry and soopolallie
dry sites have:	- little or no common rabbit-brush

Wild sarsaparilla
Aralia nudicaulis

Edatopic Grid



Site series

101	Fd – Rocky Mountain juniper – Pinegrass
102	Fd – Rocky Mountain juniper – Bluebunch wheatgrass
103	Fd – Rocky Mountain juniper – Kinnikinnick
110	Fd – Feathermoss – Step moss
111	At – Prairie rose – Pinegrass
112	SxwFd – Dogwood – Sarsaparilla
113	Sxw – Dogwood – Horsetail
Fm01	Cottonwood – Snowberry – Rose[a]
Fm02	Cottonwood – Spruce – Dogwood[a]
Fm07	Aspen – Dogwood – Water birch[a]

[a] See Section 6.3 for descriptions.

Site Series Flowchart

VERY DRY to DRY FORESTS • warm aspects, often steep slopes • shallow/ coarse soils	• SMR 1–2 • Fd stands • Rocky Mountain juniper and common rabbit-brush • bluebunch wheatgrass, junegrass, and pussytoes • exposed rock/talus may be prominent in stand	102
SLIGHTLY DRY to MESIC FORESTS • mid slopes with deep soils	• SMR 3 (2) • Fd stands • warm aspects • bluebunch wheatgrass and kinnikinnick with moderate cover	103
	• SMR 4 • Fd stands • neutral aspects and level areas • soopolallie, Rocky Mountain juniper, and birch-leaved spirea • abundant pinegrass • diverse herb layer with many species, each usually having low cover	101
	• SMR 4 • dense Fd stands • moderately steep to steep, neutral to cool aspects; shaded • abundant feathermosses • minor cover of pinegrass	110
MOIST to WET FORESTS • lower or toe slopes and gullies • seepage or mottles present	• SMR 5 • At stands • receiving sites, seepage at depth • saskatoon, snowberry, birch-leaved spirea, and roses • pinegrass, Kentucky bluegrass, blue wildrye, and spreading dogbane	111
	• SMR 5–6 • Sxw (Fd, Ep, Act) stands • wild sarsaparilla • receiving sites, seepage within 50–70 cm of the surface • riparian	112
WET to VERY WET FORESTS • gentle to level • riparian	• SMR 6 (7) • Sxw stands • horsetails • water table at or near the surface	113

Vegetation Table

Layer	Scientific name	102	103	101	110	111	112	113	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■	■■■■■	■■■■■		□□□		Douglas-fir
	Populus tremuloides					■■■■■		□□	trembling aspen
	Picea engelmannii x *glauca*					*	■■■■	■■■■■	interior spruce
Regen	*Pseudotsuga menziesii*	■■■	■■■■	■■■	■■■				Douglas-fir
	Populus tremuloides					■■			trembling aspen
	Picea engelmannii x *glauca*					*	□□	■■■	interior spruce
Shrubs	*Juniperus scopulorum*	■■■	■■■	■■	■■	□	□		Rocky Mountain juniper
	Ericameria nauseosa	■■■	□	*					common rabbit-brush
	Juniperus communis	*	□□	□□		□	□		common juniper
	Spiraea lucida	*		■■	■■	■■■			birch-leaved spirea
	Amelanchier alnifolia		■■■	□	*	■■■■■	■■	■■	saskatoon
	Symphoricarpos spp.		□□	□	*	■■■	■■■	■■■■	snowberry
	Shepherdia canadensis		□	■■		□			soopolallie
	Rosa spp.			□		■■■	□□□	■■	roses
	Cornus stolonifera						□□□	■■■	red-osier dogwood
	Acer glabrum						□□□	□□	Douglas maple
	Betula occidentalis							□□□	water birch
Herbs	*Pseudoroegneria spicata*	■■■■	■■■	■■					bluebunch wheatgrass
	Koeleria macrantha	■■■	□	□					junegrass
	Antennaria spp.	■■	□	■					pussytoes
	Allium cernuum	■	■	■					nodding onion
	Achillea spp.	■	■	■					yarrow
	Anemone multifida	□	■	■					cut-leaved anemone
	Solidago glutinosa	□	*	■					spikelike goldenrod
	Gaillardia aristata	□	■						brown-eyed Susan
	Heterotheca villosa	■							golden-aster

Layer	Scientific name	102	103	101	110	111	112	113	Common name
Herbs	*Arctostaphylos uva-ursi*		■■■■	□□		□			kinnikinnick
	Festuca campestris		□□						rough fescue
	Calamagrostis rubescens		*	■■■■	■■■	■■■			pinegrass
	Eurybia conspicua			■■	■■	□			showy aster
	Astragalus miser			□	*				timber milk-vetch
	Penstemon confertus			■					yellow penstemon
	Prosartes spp.				*	□	■	*	fairybells
	Poa pratensis					■■■			Kentucky bluegrass
	Linnaea borealis					□□	□□	□	twinflower
	Symphyotrichum ciliolatum					■■	■■		Lindley's aster
	Elymus glaucus					■■	*	*	blue wildrye
	Apocynum androsaemifolium					■■			spreading dogbane
	Oryzopsis asperifolia					□	*		rough-leaved ricegrass
	Aralia nudicaulis					*	■■■■	□	wild sarsaparilla
	Maianthemum stellatum						■	■■	star-flowered false Solomon's-seal
	Equisetum spp.							■■■■	horsetails
Moss layer	*Syntrichia ruralis*	□□□							sidewalk screw-moss
	Cladonia spp.	□□□	□□						clad lichens
	Hylocomium splendens		□	□	■■■■■		*		step moss
	Peltigera spp.		□	□	■				pelt 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

Environment Table[a]

Site series	102[b]	103	101	110	111	112	113
No. of plots	10	10	7	12	4	9	1[c]
SMR	1–2	3 (2)	4	4	5	5–6	6 (7)
SNR	C–D (B)	C–D (B)	D (C)	D (C)	C–D	D (C–E)	D–E (C)
Slope position	UP, CR, MD	MD (LV)	MD (LV)	MD	LW, TO (GU)	LW, TO (DP)	LV, DP (TO)
Typical slope/ aspect	Steep/warm	Gentle–moderate/ warm	Moderate–steep/ neutral (cool)	Steep/cool	Gentle (moderate)/cool	Gentle (level)	Gentle–level
Common compensating conditions	Insolated crests; very coarse/warm	Upper/cool	Lower/ moderately coarse; level/ medium texture	Steep/neutral/ shaded		Steep/ receiving sites	
Surficial materials	Cxv, Cb (FG)	M, LG (FG)	LG, M (FG)	M, LG (FG)	LG, F (L)	LG, F	L, F (Ov)
Soil texture	SL, SiL	SiL (SL)	SiL, L (FSL, SiCL)	SiL, FSL	Si, SiL, SiCL	SiL (SiCL, FSL)	SiL, Si, SiCL
Coarse fragment content	Variable (low–high)	Variable	Low (moderate)	Low (moderate)	Sparse–low	Sparse; often increasing at depth	Sparse
Important features	Insolation and/or very shallow; often has exposed bedrock			Northerly aspects (cool sites)	Seasonal seepage at depth	Growing-season seepage within 50–70 cm; riparian	Water table at or near the surface; often an organic veneer

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.
[b] Two phases are presented: 102a (xeric phase) occurs where bedrock or talus is present; 102b occurs on shallow and/or coarse FG and C soils.
[c] Data are sparse for the IDFxk, and this site series is based on plot data for theie site association in nearby subzones.

Fd – Rocky Mountain juniper – Pinegrass 101

General Description

SMR 4. The 101 site series occurs on **mid slopes** of **neutral aspects** and on level or gentle areas with **deep**, **medium-textured soils**. It can also occur on lower or gentle (< 15%) slopes on warm aspects. Soils are typically Eutric Brunisols derived from deep morainal or glaciolacustrine deposits, and less frequently from colluvium or eolian veneers over coarser glaciofluvial materials. Soils are primarily silt loam or loam, and sometimes have a clay-enriched layer or a coarse sandy loam layer, and a strongly calcareous and often cemented layer deeper in the soil profile.

Multi-storeyed Fd stands occur, and rarely include other tree species. Birch-leaved spirea, common and Rocky Mountain juniper, roses, and soopolallie comprise the moderately well-developed shrub layer. Pinegrass is usually dominant, with minor **bluebunch wheatgrass** and **showy aster**. Low cover of many dryland species is common, including common harebell (*Campanula rotundifolia*), cut-leaved anemone, spikelike goldenrod, pussytoes, yarrow, nodding onion, lemonweed (*Lithosperma ruderale*), and yellow penstemon. Moss cover is typically low.

Differentiating from Other Site Series

Slightly drier sites (103) have abundant kinnikinnick and bluebunch wheatgrass and little or no pinegrass, showy aster, and/or birch-leaved spirea. The 110 site series has a similar soil moisture regime but is restricted to steep, cool aspects and has abundant mosses. Slightly moister sites are At-leading with Fd, Sxw, and sometimes Pl (111), or Sxw-leading with red-osier dogwood, wild sarsaparilla (112), and/or horsetails (113).

Variability

Mature forests on zonal sites are uncommon, and often have partial harvest histories. Pinegrass cover varies, and is often lower in open stands where other species are abundant. Minor cover of dry-site species, such as common rabbit-brush and kinnikinnick, often occurs with pinegrass, soopolallie, and showy aster.

Management Issues

Ungulate browsing, drought, and grass competition may limit tree growth and establishment. Where fire exclusion and forest ingrowth have increased understorey density, ecosystem restoration treatments may enhance habitat and ecosystem values. Invasive plant species are a serious concern. Where machinery is active, conserve surface soils and avoid exposure of unfavourable subsoils. Tree productivity is relatively low on these sites in comparison to zonal sites in other IDF subzones.

102 Fd – Rocky Mountain juniper – Bluebunch wheatgrass

General Description

SMR 1–2. 102 forests occur on **steep, warm aspects**, typically with **coarse or shallow soils**. They are also common on warm, dry crests, and where exposed **bedrock** or **talus** is present. Sites occasionally occur on neutral aspects with extensive sun exposure, very coarse soils, and/or bedrock. Soils are usually derived from colluvial or glaciofluvial materials. Bare mineral soil is often present. Two site series phases are described below.

Stands are typically open-canopied Fd with abundant **bluebunch wheatgrass** and **common rabbit-brush** along with Rocky Mountain juniper and **junegrass**. Low cover of pussytoes, nodding onion, Holbell's rockcress (*Boechera retrofracta*), prairie sagewort *(Artemisia frigida),* and golden-aster is often present. Sidewalk screw-moss, clad lichens, and microbiotic crusts[5] are common.

Differentiating from Other Site Series

The 102 is the driest forested site series described in the IDFxk. Drier sites are non-forested rock, grassland, or brushland ecosystems with < 10% tree cover. Slightly moister sites (103) have kinnikinnick, more rough fescue, less bluebunch wheatgrass and common rabbit-brush, and occur where soils are deeper on warm aspects or where aspects are more neutral.

Variability

The 102 includes sites with and without exposed bedrock or talus. Two site series phases are presented to distinguish between these conditions:

102a for sites with prominent exposed bedrock/talus (xeric phase)
102b for sites on shallow and/or coarse soils (subxeric phase)

Rocky Mountain juniper and sidewalk screw-moss often have higher cover on 102a sites. Very low cover (< 1%) of kinnikinnick may be present in both phases.

Management Issues

Xeric phase sites (102a) are not recommended for timber harvesting due to limitations in soil, soil moisture, and growing space. Where fire exclusion and forest ingrowth have increased understorey density on 102b sites, ecosystem restoration treatments may enhance habitat and ecosystem values. Sites with large trees, lower snow depths, and high forage availability can provide important ungulate winter range. Where harvesting occurs, care should be taken to conserve limited organic matter and to avoid soil disturbance. Invasive plant species are a serious concern. Drought stress can increase the susceptibility of trees to insects and disease. Rocky sites (102a) sometimes contain Pf, an at-risk conifer species.

[5] A biological soil crust of lichens, bryophytes, algae, cyanobacteria, and microfungi.

Fd – Rocky Mountain juniper – Kinnikinnick **103**

General Description

SMR 3 (2). 103 forests typically occur on **gentle to moderate slopes** with **warm aspects** and **medium- to coarse-textured soils**. They also occur on cool or neutral aspects on upper slopes that are moisture-shedding and/or have coarse- to very coarse-textured soils. Surficial materials are commonly glaciofluvial, glaciolacustrine, or morainal, sometimes with a thin eolian capping of finer-textured soils. Most soils are rapidly to well-drained Eutric or Melanic Brunisols with silt loam textures. Soils often have a strongly calcareous and usually cemented layer within the upper 70 cm and may have a clay-enriched (Bt) layer.

The **Fd-dominated** canopy generally has abundant **bluebunch wheatgrass** and/or **kinnikinnick**, and **rough fescue** may be present. Several dryland species commonly occur with low cover, including cut-leaved anemone, brown-eyed Susan, spikelike goldenrod, pussytoes, nodding onion, and yarrow. **Saskatoon** and Rocky Mountain juniper are usually present with minor amounts of common juniper, snowberry, and common rabbit-brush. Dense Fd regeneration occurs in many stands. The moss layer generally has low cover, although microbiotic crusts often occur in openings.

Differentiating from Other Site Series

Slightly drier sites (102) have more bluebunch wheatgrass, junegrass, and common rabbit-brush and less kinnikinnick, rough fescue, and saskatoon. Slightly moister sites (101) have pinegrass, showy aster, and/or birch-leaved spirea.

Variability

Minor cover of Pl may occur. Most mature stands have had some trees selectively removed in the past 100 years. Understorey herbs can be very diverse, with low cover of many dryland species.

Management Issues

Productivity is low, and Fd trees are generally stunted. Ungulate browsing, drought, and grass competition may limit tree growth and establishment. Sites with large trees, lower snow depths, and high forage availability provide important ungulate winter range. Where fire exclusion and forest ingrowth have increased understorey density, ecosystem restoration treatments may enhance habitat and ecosystem values. Care should be taken during harvesting and ecosystem restoration activities to conserve limited organic matter and to avoid soil disturbance. Invasive plant species are a serious concern.

110 Fd – Feathermoss – Step moss

General Description

SMR 4. The 110 site series occurs on **moderately steep to steep sites** (usually > 50%) on **cool-aspect slopes**. It usually occurs on deep soils derived from morainal, glaciolacustrine, and sometimes glaciofluvial parent materials. Soils generally have silt loam textures and a Mor humus form. Coarse fragment content is low (or nil) in glaciolacustrine deposits and low to moderate in morainal deposits.

Stands are characterized by closed canopies of **Fd** with a well-developed moss layer. Abundant **step moss** and **red-stemmed feathermoss** are distinctive in this site series. Wiry moss (*Abietinella abietina*) and claw mosses (*Hypnum* spp.) often have high cover as well. Shrubs are usually sparse, with birch-leaved spirea and regenerating Fd most common. Minor cover of Rocky Mountain juniper may be present. **Pinegrass** and **showy aster** are typically present in the variable herb layer.

Differentiating from Other Site Series

The 110 site series occurs on sites with a similar soil moisture regime to the 101 site series, but the 110 is restricted to steep, cool- to neutral-aspect sites and has abundant moss cover. The 101 has less moss and more pinegrass, soopolallie, and dryland herb diversity. Slightly moister sites (111 and 112) typically have abundant At and/or Sxw, less Fd, and more snowberry, roses, wild sarsaparilla, and/or blue wildrye.

Variability

Pinegrass is usually present, although cover can vary from low (< 1%) to moderate (up to 20%), depending on tree density. Understorey plant species can vary, and minor cover of species that are associated with either moister or drier conditions is common on these moss-dominated sites.

Management Issues

The moister, cooler conditions of the 110 create favourable conditions for regeneration and growth of Fd compared to other site series in the IDFxk. Where machinery is active, conserve surface soils and avoid exposure of unfavourable subsoils. Invasive plant species are a serious concern.

At – Prairie rose – Pinegrass 111

General Description

SMR 5. 111 forests occur on lower slopes, toe slopes, and in gullies on moist sites with **seasonal seepage and moisture at depth**. Soils are frequently derived from glaciolacustrine, lacustrine, or fluvial sources, with low to moderate coarse fragment content. Orthic or Gleyed Eutric Brunisols with Moder hums forms and moderate to imperfect drainage are common. Sites are usually within or adjacent to riparian areas.

At is dominant in the canopy, usually with minor cover of Sxw, and occasionally with Pl or Ep in the overstorey and/or understorey. Snowberry, saskatoon, and roses are abundant in the understorey. Pinegrass is typically present along with blue wildrye and/or Kentucky bluegrass.

Differentiating from Other Site Series

Slightly drier sites (101) are Fd-dominated, lack At, and have little or no snowberry and saskatoon. On cool, steep slopes, 110 sites are also Fd-dominated, lack At, and have high moss cover. Slightly moister sites (112) have more Sxw and wild sarsaparilla. The *Fm07 Aspen – Snowberry – Water birch* flood unit (see Section 6.3) also has abundant At, but it lacks conifers, and it floods on a regular basis.

Variability

These sites may be seral ecosystems that, if given more time, would develop into conifer-dominated stands. Sxw, Pl, and occasionally Fd form part of the stands but do not typically dominate.

Management Issues

When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting or machine activity should occur when soils are dry or frozen. Vegetation competition may impede tree growth in regenerating stands. Invasive plant species are a serious concern.

112 SxwFd – Dogwood – Sarsaparilla

General Description

SMR 5–6. The 112 site series occurs on **lower and toe slopes or level sites** where **seepage is prolonged** and typically within 70 cm of the soil surface. Soils are derived from lacustrine or fluvial sources and are often calcareous with silt loam, silty clay loam, or fine sandy loam textures and low coarse fragment content. Sites are typically associated with **riparian areas**, and **cold-air** pooling is common.

Sxw is dominant in the generally open overstorey, and frequently occurs with **Ep and Fd**. **Snowberry and roses** are moderately abundant in the understorey, often with **red-osier dogwood**. Abundant **wild sarsaparilla** is distinctive in this site series. Very minor cover (< 3%) of horsetails, sedges, or other moist indicator species is common. Moss cover is variable but often sparse.

Differentiating from Other Site Series

Slightly drier sites (111) are dominated by At instead of Sxw. They also have more pinegrass and less wild sarsaparilla. Slightly moister sites (113) have moderate to abundant cover of horsetails and/or sedges and are usually Sxw-dominated with little or no Fd.

Variability

Ep can have high cover and may be dominant or codominant in younger stands. Minor amounts of At or Act may also occur. Despite the moist conditions, there is often minor cover of common and/or Rocky Mountain juniper.

Management Issues

Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. If harvesting occurs, it should take place when soils are dry or frozen. Vegetation competition, cold air, and frost may limit conifer regeneration. Invasive plant species are a serious concern. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

Sxw – Dogwood – Horsetail **113**

General Description

SMR 6 (7). The 113 site series is uncommon in the IDFxk.[6] It occurs on **level sites**, in **depressions**, and on **gently sloping toe slopes** where the **water table** is within the top 30 cm of the soil profile. Two site series phases are recognized to differentiate between flood and swamp sites (see Variability section below). On swamp sites, soils are usually Gleysols with a thick (30–50 cm) peaty, organic veneer and prominent mottles and/or gleying in the mineral soil below. Gleyed Humic Regosols with buried horizons are common on sites that **flood**. Sites are associated with **riparian areas** and **cold-air pooling** is common.

Open-canopied **Sxw** stands often have minor cover of At or Act. **Horsetails** are abundant in the understorey, sometimes with **sedges** (*Carex* spp.) and usually with various species associated with wet sites. **Mountain alder** (*Alnus incana*), **red-osier dogwood**, and roses are often present in the shrub layer and can be abundant.

Differentiating from Other Site Series

Slightly drier sites (112) have little or no horsetails (< 3% cover) and lack mountain alder. Slightly wetter sites are wetlands—usually swamps or marshes (see Section 6.2). Broadleaf-dominated sites with more dynamic flood regimes are classified in the Flood Group (middle bench Act or At stands, or low bench willow or alder sites) (see Section 6.3).

Variability

The 113 site series can occur on high bench floodplains and on wetland sites. Occasionally, sites with very poor drainage and a thick organic veneer occur; these can be classified as treed swamps (Ws07) (see Section 6.2). Vegetation is very similar on both sites and those who require additional differentiation can use phases:

> **113a** for high bench, **riparian flood sites**
>
> **113b** for the **swamp phase;** sites have a thick organic veneer, very poor drainage, and higher cover and diversity of mosses; swamp sites are equivalent to the **Ws07** swamp site association (see Section 6.2)

[6] Descriptions for this site series are based primarily on plot data from sites in the same site association in adjacent biogeoclimatic units. Although there are few plots from the IDFxk, this site series is known to occur in wetland and floodplain complexes along the Columbia River.

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Cold air and frost may limit tree regeneration. Invasive plant species are a serious concern. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

Other Ecosystems

The following ecosystems occur in the IDFxk. They are described in detail in Chapter 6.

Wetlands

The IDFxk encompasses large areas of the Columbia Wetlands, a Ramsar Wetland of International Importance and the largest riverine wetland system in British Columbia. This diverse complex of wetlands includes marsh (Wm), swamp (Ws), fen (Wf), and shallow water (Ww) wetlands. Section 6.2 provides details on wetland ecosystems.

Cottonwood floodplains and flood ecosystems

The most common cottonwood floodplain (Fm) units are *Fm01 Cottonwood – Snowberry – Rose, Fm02 Cottonwood – Spruce – Dogwood*, and *Fm07 Aspen – Dogwood – Water birch.* These, along with low bench (Fl) and other flood ecosystems, are described in Section 6.3.

Grasslands, brushlands, and alkaline/saline meadows

Grassland (Gg), brushland (Gb), and saline meadow (Ga) ecosystems are ecologically significant in the dry climate of the IDFxk, although many sites have been disturbed by grazing and/or human settlements. Section 6.4 provides details on ecosystems of the Grassland Group.

Rock outcrops and talus

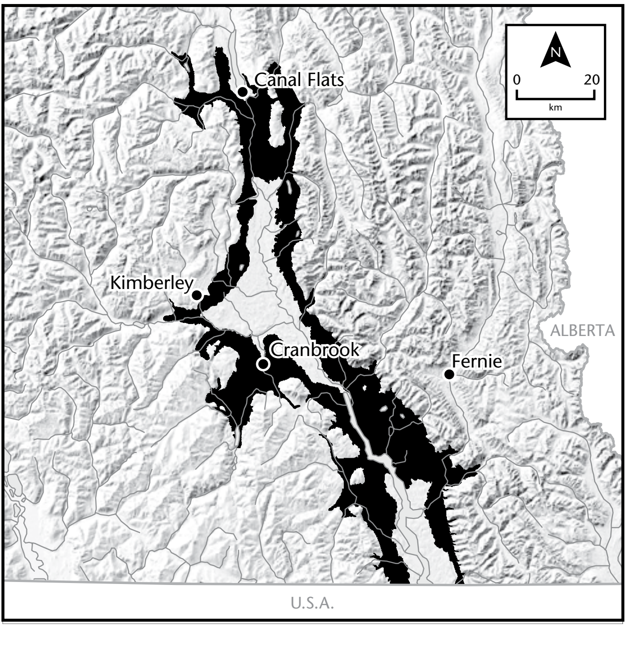
Rock outcrop (Ro) and talus (Rt) ecosystems are moderately common in the IDFxk, and are described in Section 6.6.

IDFdm2
Kootenay Dry Mild
Interior Douglas-fir

Geographic Distribution

The IDFdm2 occurs at low elevations in the southern Rocky Mountain Trench. It includes the subdued valley-bottom terrain of the trench and the lower slopes of the Purcell and Rocky Mountains. It extends from Columbia Lake south to the U.S. border, and includes the City of Cranbrook and the communities of Elko, Jaffrey, and Marysville. The IDFdm2 occurs below the MSdw and above the IDFxx2. At its northern extent, the IDFdm2 occurs above the IDFxk and abuts the IDFdk5 at similar elevations.

Distribution of the IDFdm2



Elevation Range

Throughout most of its range, the IDFdm2 extends to valley bottom. The exception is where it occurs above the IDFxx2. In these areas, lower elevation limits are between 800 and 950 m on cool and neutral aspects, and between 850 and 1000 m on warm aspects. On cool and neutral aspects, the IDFdm2 extends to upper elevations of between 1100 and 1200 m, and on warm aspects, to between 1200 and 1300 m.

Climate[1]

The IDFdm2 occurs in the Dry climate subregion. Winters are cool and summers are hot. Most seasons are characterized by very dry conditions, although spring is relatively moist. Snowpack depths are shallow to moderate and generally persist throughout the winter from late November or December through to late February or early March, except on insolated, warm-aspect sites where snow accumulation is lower and of shorter duration. Soils may freeze to shallow depths on sites with low snow cover. Growing-season moisture deficits are common on mesic and drier sites and can affect subhygric sites in drier than normal years. Extreme cold snaps in winter and extreme heat waves in summer are important influences on climate and vegetation in the IDFdm2. The IDFdm2 is slightly cooler and moister than the IDFxx2; it has similar precipitation to the IDFdk5 but is generally warmer in all seasons.

Forest and Vegetation Characteristics

A history of high-frequency, low-intensity wildfires in the IDFdm2 has led to a habitat mosaic comprised of open and moderately dense forests interspersed with grassy and shrubby openings. Long-term fire suppression has resulted in forest ingrowth and encroachment on many sites.

Fd and Lw are the dominant tree species throughout the IDFdm2, with Py often abundant on drier than mesic sites and Sxw occurring on the wetter sites. Common understorey species on most sites include pinegrass, snowberry, saskatoon, and birch-leaved spirea. Pl is common in younger stands, especially on submesic and mesic sites. **Zonal sites** are characterized by Fd and/or Lw in the overstorey, with pinegrass, arnica, showy aster, and Oregon-grape typically in the understorey. Py is common on **dry to submesic sites**, with Fd in the overstorey, and bunchgrasses, including bluebunch wheatgrass and fescues, arrowleaf balsamroot, and common and Rocky Mountain juniper in the understorey. **Wet sites** have Sxw, wild sarsaparilla, bunchberry, blue wildrye, red-osier dogwood, and less Fd and

[1] See Section 4.5 for more information on climate variables.

Lw. Ep, Act, and At occur in riparian areas and on floodplains, although At can be abundant in younger stands on dry through wet sites.

Tree species dominance varies across elevational and moisture gradients in the IDFdm2. In the warmest, driest areas of the IDFdm2, Py is more common and abundant and often occurs on mesic sites with very low cover. At upper elevations, where the IDFdm2 transitions to the MSdw, Lw and Pl are often dominant on mesic and submesic sites, especially in the Purcell Mountains and in the lower Elk and Bull River valleys. Py also occurs on the same sites but is rarely dominant and usually has lower cover than on similar sites at lower elevations where the IDFdm2 is transitional to the IDFxx2. Unlike the MSdw, mesic and drier forests in the IDFdm2 lack Sxw in both the overstorey and understorey. In the MSdw, grouseberry and/or low bilberry are also common.

Cottonwood and aspen **floodplain forests** are important for wildlife habitat and riparian function, and occur along the Kootenay River and major tributaries, including the St. Mary and Elk Rivers, and Sand, Gold, and Perry Creeks (see Section 6.3 for more details on the Flood Group). **Wetlands** provide important habitat in larger complexes along the Kootenay River and on smaller, scattered sites throughout the IDFdm2. **Grasslands**, **brushlands, shrub-steppe, and alkaline/saline meadows** form a very important part of the landscape in the IDFdm2 by providing forage and habitat for wildlife, as well as rangeland for livestock (see Grassland Group, Section 6.4).

Disturbance

Mixed-severity fire regimes characterize historical disturbance in the IDFdm2. This includes frequent, low-severity, stand-maintaining fires that burned, on average, every 25–50 years, as well as less frequent stand-replacing fires (Daniels et al. 2011). However, **long-term fire exclusion** has led to **forest ingrowth** of historically open stands and to **grassland encroachment**, and has reduced habitat suitability for wildlife that are associated with open stand structure. The IDFdm2 also has a legacy of **intensive grazing**, which has resulted in livestock and wildlife populations competing for a diminishing supply of forage. Ungulate browsing often limits the success of regenerating trees. Grassland and open-forest range have deteriorated due to a reduction in fescues and bluebunch wheatgrass cover and an increase in invasive plant species and smaller, less palatable grasses.

Few old-growth forests remain in the IDFdm2. Historic selective harvesting for railway ties and other activities often targeted the largest trees. More extensive forest harvest activity has occurred since the late 1970s.

Ecosystem restoration treatments that use combinations of partial cutting, understorey slashing, and/or prescribed fire have attempted to mitigate forest ingrowth and improve forage production, but have had mixed success (Forest Practices Board 2016). Urban and rural development is extensive through much of the IDFdm2, with towns, rural settlements, farms, and ranches covering large areas.

Bark beetles are important disturbance agents that cause endemic to extensive levels of mortality. **Mountain pine beetle** and **Douglas-fir beetle** have affected large areas of mature Pl and Fd, respectively. Western pine beetle and red turpentine beetle cause sporadic Py mortality, while spruce beetles affect isolated areas on moist to wet sites where Sxw is abundant. Western false hemlock looper is cyclical and causes defoliation and mortality of small to large Fd trees.

Low levels of black stain fungus and armillaria root rot occur in stands of all ages and can cause significant mortality in mature and regenerating stands, particularly Fd, Lw, and Pl in localized areas. Some of the other important pathogens that affect growth and form of regenerating trees include western gall rust on Pl, rhabdocline needle cast on Fd, and larch needle blight on Lw. Warren's root collar weevil can interact with pathogens on P1 to limit regeneration success.

Soils, Geology, and Landforms

The IDFdm2 is dominated by a mixture of sedimentary bedrock, including dolomite, quartzite, siltstone, argillite, sandstones, and conglomerate. In the vicinity of the lower Bull River and upper Koocanusa Reservoir and the area southeast of Columbia Lake, limestone, marble, and other calcareous rocks are also common.

Complex glaciofluvial deposits are very common on the valley floor of the Rocky Mountain Trench. The deposits contain a highly variable mixture of reworked glacial till and ice-contact materials that originated from diverse sources across broad geographic areas. As a result, parent materials and associated soils are often unrelated to the local bedrock geology and can have highly variable properties within a short distance.

On the valley sides, morainal materials typically dominate and glaciofluvial deposits occur infrequently. Soils derived from morainal parent materials cover much of the land base and often have silt loam to gravelly silt loam surface textures with variable amounts of coarse fragments. Colluvial derived soils are found in steeper terrain and have textures ranging from silt loam to sandy loam or loamy sand. Fluvial deposits are most extensive in floodplains of the Kootenay, Lussier, and St. Mary Rivers, and in other large tributary valleys. Glaciolacustrine deposits occur in the St. Mary River valley, in lower Perry Creek, Lodgepole Creek, and Findlay Creek, and in the vicinity of Cranbrook. Deep eolian veneers frequently overlie both glaciofluvial and morainal landforms.

Soils throughout the IDFdm2 are mildly to moderately **calcareous** and often contain a cemented and carbonate-enriched (Cca) layer at depth that can be root restricting. Weakly clay-enriched (Bt) subsurface horizons may also occur, particularly in soils derived from morainal materials. The most common soil groups in this variant are Eutric and Melanic Brunisols, although weakly developed Gray Luvisols also occur. Organic-enriched (Ah) mineral horizons are characteristic of grassland environments with Chernozemic soils. Organic soils are uncommon.

Vegetation patterns in the IDFdm2 are strongly linked to soil characteristics, particularly on gentle to level sites in the valley bottom of the Rocky Mountain Trench where the depth of finer-textured eolian deposits varies over short distances. In these areas, submesic soil moisture regimes (104 site series) occur on sites with shallow eolian deposits (< 30 cm deep), while mesic sites (101 site series) occur where deposits are deeper (> 50 cm). Other compensating conditions such as slope angle,[2] slope position, and aspect determine soil moisture and vegetation patterns on sites with deposits of intermediate depth. Depth and impermeability of a Cca layer will also influence site series and productivity.

Wildlife Habitat

The IDFdm2 provides **high-value ungulate winter range** for significant populations of Rocky Mountain elk, bighorn sheep, mule deer, and white-tailed deer. Wide-ranging carnivores such as **grizzly bear**, **black bear, cougar**, and **bobcat** move through this unit seasonally. Valley bottoms of major drainages, including the Kootenay, Elk, St. Mary, Bull, and Wigwam Rivers, as well as the smaller lakes and wetlands scattered through the IDFdm2, are **important breeding and staging areas** for a diversity of birds, mammals, and amphibians.

The IDFdm2 provides **habitat for at-risk species** that breed in open forests and are dependent on **old-forest structure**: Lewis's woodpecker, Williamson's sapsucker, flammulated owl, western screech-owl, great blue heron, and, rarely, white-headed woodpecker. Retention of **old-forest structure**, including large fire-resistant trees, large wildlife trees in a range of

[2] In hot, dry climates, slope angle can have a large influence on solar insolation. On warm aspects, a slope angle > 15% is enough to shift the rSMR by one class. For example, a site with a deeper eolian veneer (> 50 cm) on a warm aspect with a 15% slope may have an rSMR of 3 (submesic) on what otherwise would have been a mesic site.

species and decay classes (with cavities, heart rot, broken tops, limbs for perching, etc.), and sparse large coarse woody debris, is required to sustain these species. **Northern goshawk** occasionally breed in Lw-dominated stands (often with mistletoe), and require larger mature forest patches.

Several species at risk, including **American badger**, **sharp-tailed grouse**, **prairie falcon**, **long-billed curlew**, **Swainson's hawk**, **short-eared owl**, **common nighthawk**, **bobolink**, **barn swallow**, and **lark sparrow**, breed in grassland or shrubby habitats. Other at-risk species in the IDFdm2 breed in wetland and riparian habitats, including **western toad**, **painted turtle**, **bank swallow**, and **sandhill crane.** Rock outcrops, talus, and cliffs are required for nesting, roosting, and cover requirements of **peregrine falcon**, **rubber boa**, **Townsend's big-eared bat**, **black swift**, and **little brown myotis**. Common bird species in the IDFdm2 include dark-eyed junco, American robin, chipping sparrow, red-breasted nuthatch, and yellow-rumped warbler.

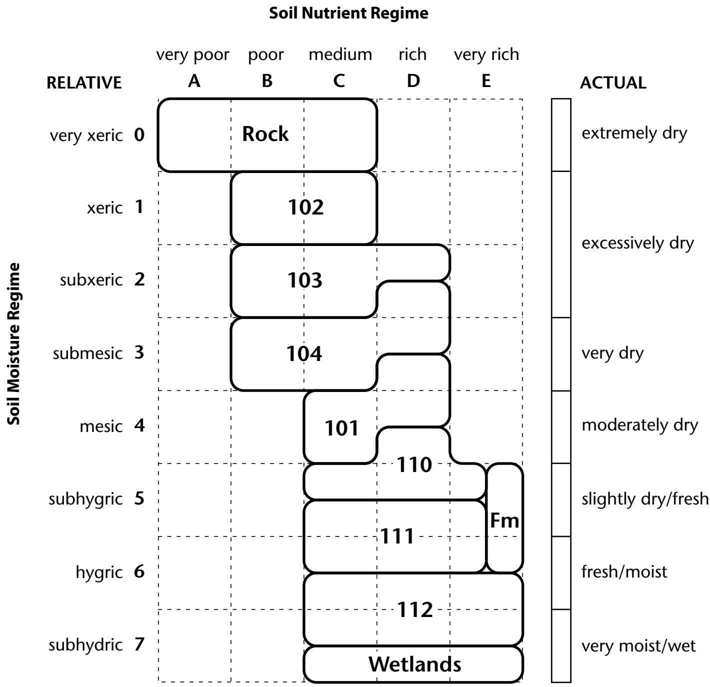
The IDFdm2 supports a **very high diversity of at-risk vascular plants**, and management of livestock grazing, invasive plants, access, and development are key management activities that can help protect this diversity.

Arrowleaf balsamroot
Balsamorhiza sagittata

Distinguishing the IDFdm2 from Adjacent Biogeoclimatic Units

In the **IDFxx2**, most sites have:	- more Py - no Pl or Lw - more open stands - more grasslands and shrub-steppe
zonal sites have:	- Py - bluebunch wheatgrass, often with variable cover (1–10%)
dry sites have:	- more bluebunch wheatgrass and fescues - antelope-brush
In the **IDFxk**, most sites have:	- no Lw, Py, or Pl - more open structured stands - more grasslands and shrub-steppe
zonal sites have:	- bluebunch wheatgrass and Rocky Mountain juniper - no Oregon-grape - less snowberry and soopolallie
dry sites have:	- common rabbit-brush
In the **IDFdk5**, most sites have:	- no Py - limited distribution of Lw (absent north of Brisco) - more feathermosses - more productive Fd
zonal sites have:	- abundant red-stemmed feathermoss and step moss
In the **MSdw**, most sites have:	- no Py - more Pl
zonal sites have:	- Sxw and/or Bl in the overstorey and/or understorey - grouseberry/low bilberry and/or bunchberry - thimbleberry and alder (often)
dry sites have:	- less cover of bunchgrasses - little or no Py - more Pl - Bl or Sxw in the understorey
wet sites have:	- more Sxw, less Fd - cow-parsnip, baneberry, and/or twistedstalks

Edatopic Grid



Site series

101 Fd(Lw) – Pinegrass – Twinflower
102 Fd – Rocky Mountain juniper – Kinnikinnick
103 Fd(Py) – Bluebunch wheatgrass – Pinegrass
104 Fd(Lw) – Pinegrass – Kinnikinnick
110 FdLwSxw – Pinegrass
111 SxwFd – Snowberry – Sarsaparilla
112 Sxw – Dogwood – Horsetail
Fm01 Cottonwood – Snowberry – Rose[a]
Fm02 Cottonwood – Spruce – Dogwood[a]
Fm07 Aspen – Dogwood – Water birch[a]

[a] See Section 6.3 for descriptions.

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects
- shallow soils and/or extensive rock

→
- SMR 1
- open Fd (Py) stands
- exposed bedrock/talus prominent
- common harebell, round-leaved alumroot
- sidewalk screw-moss and clad lichens

→ **102**

→
- SMR 2
- open Fd, Py stands
- steep, warm aspect; shallow and/or coarse soils
- bluebunch wheatgrass and arrowleaf balsamroot

→ **103**

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

→
- SMR 3 (2)
- Fd (Py) stands, often with Lw and Pl
- mid-slope, warm aspect; medium to coarse soils
- kinnikinnick and pinegrass
- may contain minor cover of bluebunch wheatgrass or arrowleaf balsamroot
- Oregon-grape is sparse or absent

→ **104**

→
- SMR 4 (3)
- Fd, Lw stands
- mid-slope, neutral to cool aspects
- little or no Py
- abundant pinegrass
- usually minor arnica, showy aster, twinflower, and/or Oregon-grape

→ **101**

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

→
- SMR 5 (4)
- Fd, Lw (Sxw) stands
- moisture-receiving sites with mottles at depth (> 50 cm)
- minor to moderate cover of wild sarsaparilla, fairybells, blue wildrye, and/or twinflower and < 10% pinegrass

→ **110**

→
- SMR 5 (6)
- Sxw (Fd, Lw) stands
- bunchberry, wild sarsaparilla, star-flowered false Solomon's-seal, and/or ricegrass
- riparian; cold air common

→ **111**

→
- SMR 6 (7)
- Sxw stands
- horsetails and/or sedges abundant
- riparian; cold air common

→ **112**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■	■■■■	■■■■	■■■■	□□□		Douglas-fir
	Pinus ponderosa	□□	□□□	□□□	*				ponderosa pine
	Larix occidentalis			□□□	■■■■	■■■■	■■■		western larch
	Pinus contorta			*	*				lodgepole pine
	Picea engelmannii x *glauca*					■■■	■■■■	■■■■■	interior spruce
Regen	*Pseudotsuga menziesii*	□□	□□□	■■■	■■■	□□□			Douglas-fir
	Picea engelmannii x *glauca*					*	■■■■	■■■	interior spruce
Shrubs	*Spiraea lucida*	■■■	□□	□□□	■■■	□□□			birch-leaved spirea
	Juniperus communis	■■■	□□□	□□	□□				common juniper
	Juniperus scopulorum	■■■	□□						Rocky Mountain juniper
	Symphoricarpos spp.	□	□	□□	■■■	■■■■	■■■	□□□	snowberry
	Amelanchier alnifolia	□	■■	■■	■■	□□	□□	*	saskatoon
	Shepherdia canadensis		*	■■■	□□□				soopolallie
	Berberis spp.			*	■■■■	■■■■	■■■		Oregon-grape
	Rosa acicularis				□	■■■			prickly rose
	Cornus stolonifera						■	■■■	red-osier dogwood
	Alnus incana							■■■■	mountain alder
Herbs	*Penstemon fruticosus*	□□	*						shrubby penstemon
	Pseudoroegneria spicata	□	■■■	□□					bluebunch wheatgrass
	Allium cernuum	□	■						nodding onion
	Koeleria macrantha	□	*						junegrass
	Campanula rotundifolia	□							common harebell
	Heuchera cylindrica	□							round-leaved alumroot
	Calamagrostis rubescens	*	□□□	■■■■	■■■■■	■■■			pinegrass
	Arctostaphylos uva-ursi	*	□□	■■■	□				kinnikinnick
	Balsamorhiza sagittata		□□□	*					arrowleaf balsamroot

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Herbs	*Fragaria* spp.		□	□□	□	*			strawberry
	Achillea spp.		□	■	□				yarrow
	Antennaria spp.			□□	■				pussytoes
	Eurybia conspicua			*	■■	□□	□		showy aster
	Arnica spp.				□□	*			arnica
	Linnaea borealis				*	□□□	□□		twinflower
	Aralia nudicaulis					□□□	■■■■	□□	wild sarsaparilla
	Elymus glaucus					□□	□□	■■	blue wildrye
	Prosartes spp.					□□			fairybells
	Maianthemum stellatum					□	■■	□	star-flowered false Solomon's-seal
	Oryzopsis asperifolia						■■		rough-leaved ricegrass
	Cornus canadensis						■■■	□□□	bunchberry
	Equisetum spp.						□	■■■■■	horsetails
	"mitreworts"[a]						□	□□□	mitreworts
	Rubus pubescens						□	□□	dwarf red raspberry
	Carex spp.							□□□□	sedges
Moss Layer	*Brachythecium* spp.	■■■■			□		□□	□□□	ragged-mosses
	Syntrichia ruralis	■■■							sidewalk screw-moss
	Cladonia spp.	■■■		*					clad lichens
	Peltigera spp.	■■		*	■■	□			pelt lichens
	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

Environment Table[a]

Site Series	102	103	104	101	110	111	112
No. of plots	6	20	24	19	9	8	9
SMR	1	2	3 (2)	4 (3)	5 (4)	5 (6)	6–7
SNR	B–C	C–D (B)	C–D (B)	D (C)	D (C–E)	D–E (C)	D–E (C)
Slope position	CR–UP	UP, MD, CR	MD (UP)	MD (LV, LW)	LW (LV)	LW, TO, LV	TO (DP, LV)
Typical slope/ aspect	Warm	Steep/warm	Moderate/ warm	Moderate (gentle)/ neutral (cool)	Cool (neutral); moderate–gentle	Gentle (level)	Gentle (level)
Common compensating conditions		Insolated crests	Upper/cool; lower/warm/ coarse	Lower/ moderately coarse; level/ medium texture		Steep/cool receiving sites	
Surficial materials	Cxv/R, Mx/R	Cv (Cb)	M, C, FG	M (Ev/FG, C)	M, FG (C, LG, Ev)	F, FG (LG, M)	F, Ov
Soil texture	SL (L, LS, SiL)	SiL, SL (LS, SiCL)	SL, SiL (L)	SiL, L (SiCL, SL)	SL, SiL (SiCL)	SiL (SiCL)	SiL, Si
Coarse fragment content	High (moderate)	Moderate–high	Variable (moderate–high)	Variable	Often increasing at depth	Low; may increase at depth	Low; may increase at depth
Important features	Dominated by (bed)rock	Insolation		Often Ev over coarser-textured soils	Often Ev over coarser-textured soils; mottles at 50 cm or deeper	Mottles within top 50 cm; cold air	Water table within 30 cm; riparian; cold air

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

Fd(Lw) – Pinegrass – Twinflower **101**

General Description

SMR 4 (3). 101 sites occur on **gentle** to **moderately steep**, **mid slopes** of **neutral to cool aspects** with **medium-textured soils** and, occasionally, on lower or gentle (< 15%) slopes on warm aspects. Soils are typically Eutric Brunisols derived from deep morainal deposits, and less frequently from colluvium or eolian veneers over coarser glaciofluvial materials. Textures are primarily silt loam or loam, sometimes with a strongly calcareous layer that is often cemented or a coarser sandy loam layer at depth.

Fd, Lw, and occasionally Pl form **closed-canopy forests** with abundant **pinegrass. The shrub layer is generally well-developed with** moderate to high cover of **Oregon-grape** and birch-leaved spirea, and variable cover of snowberry, saskatoon, and soopolallie. **Showy aster** and **heart-leaved arnica** are often present with low to moderate cover, along with minor cover of twinflower and pussytoes. The sparse moss layer generally includes red-stemmed feathermoss and pelt lichens.

Differentiating from Other Site Series

Slightly drier sites (104) have abundant Py, kinnikinnick, and minor cover of bluebunch wheatgrass, Idaho fescue and/or arrowleaf balsamroot, and lack heart-leaved arnica and twinflower. They also have coarse soils or solar insolation. Slightly moister sites (110) have Sxw, wild sarsaparilla, bedstraw (*Galium* spp.), fairybells, and/or star-flowered false Solomon's-seal and are in moisture-receiving sites.

Variability

Lw is often present, and can be the dominant species, especially at upper elevations where the IDFdm2 is transitional to the MSdw. Py may be present at very low densities, particularly at lower elevations. Pl is often present in mature stands and can be abundant in younger, post-fire stands, especially in cooler, moister areas of the IDFdm2. Common juniper and prickly rose frequently occur with low cover. Soopolallie and twinflower generally have higher covers at upper elevations, while Oregon-grape and pussytoes are more common at lower elevations in the IDFdm2.

Management Issues

These sites support a diversity of tree species, and species diversity should be maintained. Where machinery is active, conserve surface soils and avoid exposure of unfavourable subsoils. Where fire-exclusion and forest ingrowth have occurred, managing for variable tree densities may enhance habitat and ecosystem values. Invasive plant species are a serious concern.

102 Fd – Rocky Mountain juniper – Kinnikinnick

General Description

SMR 1. 102 forests occur where exposed **bedrock or talus** is extensive. Solar radiation is usually high, and stands often occur in larger complexes with open, non-forested rock outcrops, grasslands, brushlands, and/or 103 forested sites. Soil, where present between rocks, is typically shallow, often with high to fragmental coarse fragment content.

Fd is common and Py is frequently abundant. Both common and Rocky Mountain **junipers** occur with a diversity of understorey herbs such as shrubby penstemon, nodding onion, common harebell, round-leaved alumroot, and other **dry-site herbaceous species**. Mosses and lichens are typically abundant, covering bare rock with **sidewalk screw-moss**, ragged-mosses, haircap mosses, and clad lichens.

Differentiating from Other Site Series

Drier sites are non-forested rock outcrops (Ro) or talus (Rt) with < 10% tree cover. Slightly moister forested sites (103) lack prominent bedrock or talus, and have less moss and lichen and more bluebunch wheatgrass, arrowleaf balsamroot, and other grassland-associated species.

Variability

Forested rock outcrops and talus have highly variable vegetation depending on the bedrock characteristics, the depth of soil pockets between rock, and the adjacent ecosystems. Grasses, including bluebunch wheatgrass, pinegrass, and junegrass are often present on patches of soil. Py is frequently the dominant tree species.

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. Drought stress can increase the susceptibility of trees to insects and disease. Invasive plant species are a serious concern.

Fd(Py) – Bluebunch wheatgrass – Pinegrass 103

General Description

SMR 2. The 103 site series occurs on **steep, warm-aspect** sites, typically with **coarse**, **rocky**, and/or **shallow** soils, and on **gentle, warm crests**. Soils are usually rapidly drained Eutric Brunisols derived from colluvial materials. The 103 site series occasionally occurs on neutral-aspect sites with extensive sun exposure or very coarse soils. Sites often occur in a mosaic with 102 forests, non-forested rock outcrops or talus ecosystems, and/or grasslands.

Fd and Py commonly form **open stands**, with **bluebunch wheatgrass** and other bunchgrasses in the understorey. Pinegrass, arrowleaf balsamroot, kinnikinnick, and common juniper are usually present. Minor cover of grassland-associated species, including nodding onion, Holboell's rockcress (*Boechera retrofracta*), timber milk-vetch (*Astragalus miser*), mariposa lily (*Calochortus* spp.), desert-parsley (*Lomatium* spp.), and/or *Phlox* spp. is common. Moss cover is typically sparse, with exposed mineral soil more common.

Differentiating from Other Site Series

Slightly drier sites occur where exposed bedrock or talus is prominent, and have more mosses, lichens, and juniper and less bunchgrass cover. Slightly moister sites (104) have more soopolallie, pinegrass, and/or kinnikinnick, and often have minor cover of Lw or Pl.

Variability

Rocky Mountain juniper is often present. Bunchgrasses, such as fescues (western [*Festuca occidentalis*], Idaho [*F. idahoensis*], and rough [*F. campestris*]) and junegrass, are often present. Pinegrass may be present with moderate to high cover. Mallow ninebark (*Physocarpus malvaceus*) and antelope-brush (*Purshia tridentata*) occur on sites at the southern extent of the IDFdm2.

Management Issues

Ungulate browsing, drought, and grass competition may limit tree growth and establishment. Sites with large trees, lower snow depths, and high forage availability provide important ungulate winter range. Where fire exclusion and forest ingrowth have increased understorey density, ecosystem restoration treatments may enhance habitat and ecosystem values. Care should be taken during harvesting and ecosystem restoration activities to conserve limited organic matter and to avoid soil disturbance. Invasive plant species are a serious concern.

104 Fd(Lw) – Pinegrass – Kinnikinnick

General Description

SMR 3 (2). The 104 site series typically occurs on **moderately sloped** (< 35%), **mid-slope positions** of **warm aspects** with **medium- to coarse-textured soils**. It also occurs on **cool to neutral** aspects and gently sloped (< 15%) sites that are **moisture-shedding** or have coarse- to very **coarse-textured soils**. Soils are usually well-drained Eutric Brunisols with silt loam or sandy loam textures and coarser soils or higher coarse fragment content at depth. A strongly calcareous and frequently cemented layer is often present.

Fd is typically dominant in the overstorey. **Py** is often present, especially at lower elevations, while **Lw** and/or **Pl** can be abundant, especially at upper elevations or on cool sites. Understoreys are characterized by abundant **pinegrass**, minor amounts of **bluebunch wheatgrass**, and (frequently) fescues. **Kinnikinnick**, soopolallie, and common juniper are often present. The moss layer is variable but usually sparse.

Differentiating from Other Site Series

Drier sites (103) typically have a more open canopy structure with more bunchgrasses and less kinnikinnick and soopolallie. Slightly moister sites (101) have more Lw, Oregon-grape, pinegrass, heart-leaved arnica, twinflower, and/or showy aster, lack bluebunch wheatgrass, fescues, and other dry indicators, and have little or no Py.

Variability

Two site series variations are described:

104.1 Fd(Lw) – Pinegrass – Kinnikinnick
sites with abundant Fd, moderate Py, and minor Lw and Pl; typically at lower elevations

104.2 LwFd(Pl) – Pinegrass
sites with abundant Lw, Fd, and sometimes Pl; low to moderate cover of Py; kinnikinnick is often absent; typically at upper elevations, especially in the Purcell Mountains and the Elk and Bull River valleys.

Management Issues

Ungulate browsing, drought, and grass competition may limit tree growth and establishment. Sites on warm aspects with large trees, lower snow depths, and high forage availability can provide important ungulate winter range. Where fire exclusion and forest ingrowth have increased understorey density, ecosystem restoration treatments may enhance habitat and ecosystem values. Care should be taken during harvesting and ecosystem restoration activities to conserve limited organic matter and to avoid soil disturbance. Invasive plant species are a serious concern.

FdLwSxw – Pinegrass 110

General Description

SMR 5 (4). The 110 site series typically occurs on **receiving sites** on lower slopes and level sites where **seepage** occurs **at depth** (> 50 cm). Soils are frequently derived from glaciolacustrine or glaciofluvial sources. Calcareous subsurface horizons are frequently present. Orthic or Gleyed Eutric Brunisols with moderate to imperfect drainage are common. Sites are usually associated with **riparian areas**.

Abundant **Fd**, **Lw**, and minor **Sxw** comprise the tree layer, with **Oregon-grape**, **snowberry**, and **prickly rose** dominant in the well-developed shrub layer. Understorey herb cover and composition varies, with minor to moderate amounts of pinegrass, **twinflower**, **wild sarsaparilla**, **sweet-scented bedstraw**, and/or **fairybells**.

Differentiating from Other Site Series

Slightly drier sites (101) lack Sxw and have higher cover of pinegrass. Slightly moister sites (111) are Sxw-dominated with less Fd, Lw, and prickly rose, no pinegrass (< 1%), and more wild sarsaparilla, rough-leaved ricegrass, and bunchberry.

Variability

Fd and Lw can both be dominant in the overstorey. Pl may be present but is rarely abundant. Thimbleberry (*Rubus parviflorus*) can be abundant.

Management Issues

The 110 site series includes very productive sites for the IDF. Tree species diversity is relatively high on these sites and should be maintained. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Vegetation competition may be a concern in regenerating stands. Invasive plant species are a serious concern.

111 SxwFd – Snowberry – Sarsaparilla

General Description

SMR 5 (6). The 111 site series occurs on **lower and toe slopes or level sites** where **seepage or subirrigation is prolonged** and typically within 50 cm of the soil surface. Soils are frequently derived from lacustrine or fluvial sources and are usually calcareous with silt loam or silty clay loam textures and low coarse fragment content. **Cold-air** pooling is common. Sites are typically associated with **riparian areas**.

Sxw, along with minor amounts of Fd and Lw, comprise the tree layers. **Wild sarsaparilla** and **bunchberry** are common in the lush understorey along with minor amounts of **rough-leaved ricegrass** and **star-flowered false Solomon's-seal**. Very minor cover (< 3%) of horsetails, sedges, or other moist indicator species is common. Ep and At are often present, and can be abundant, especially in earlier seral stages. Moss cover is variable but usually sparse.

Differentiating from Other Site Series

Slightly drier sites (110) are not dominated by Sxw. They also have more Fd, Lw, prickly rose, snowberry, birch-leaved spirea, and pinegrass and less wild sarsaparilla, bunchberry, and rough-leaved ricegrass. Slightly moister sites (112) have moderate to abundant cover of horsetails and/or sedges and are usually Sxw-dominant with little or no Fd or Lw.

Variability

Seral stands can have high cover of aspen and often have moderate Act or Ep. These stands can be coded as IDFdm2/111$B[3] and differ from the At-dominated Fm07 by having Sxw and/or Fd in the overstorey and/or understorey. Thimbleberry (*Rubus parviflorus*) can be abundant.

Management Issues

When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Vegetation competition, cold air, and frost may limit conifer regeneration. Invasive plant species are a serious concern. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

[3] See section 2.3 for seral coding.

Sxw – Dogwood – Horsetail 112

General Description

SMR 6 (7). The 112 site series occurs on **level sites**, **depressions**, and **gently sloping lower and toe** slopes where the **water table** is within the top 30 cm of the soil profile. It is associated with **riparian areas** where groundwater and/or surface flow results in soils being saturated for extended periods each year. Two site series phases are recognized to differentiate between flood and swamp sites (see Variability section below). On swamp sites, soils are usually Gleysols with prominent mottles or gleying, and sometimes have thick peaty, organic veneers (30–50 cm) overlying the mineral soil. Gleyed Humic Regosols with buried horizons are common on sites that **flood**. **Cold-air pooling** is common.

Open-canopied **Sxw** stands often have minor cover of At or Act. **Horsetails** and/or **sedges** are characteristic, along with various moist-site species such as mitreworts and leafy mosses. **Mountain alder**, **red-osier dogwood**, and roses are usually present and can be abundant.

Differentiating from Other Site Series

Slightly drier sites (111) have little or no horsetails or sedges (< 3% cover) and lack mountain alder. Slightly wetter sites are wetlands—usually swamps or marshes (see Section 6.2). Broadleaf-dominated sites with more dynamic flood regimes are classified in the Flood Group (middle bench Act or At stands, or low bench willow or alder sites) (see Section 6.3).

Variability

The herb layer can be highly variable, but horsetails, and less frequently sedges, are characteristic and diagnostic. Ferns, usually oak fern (*Gymnocarpium dryopteris)* or lady fern (*Athyrium filix-femina*), may be present on these sites, particularly in areas transitional to the ICH. The 112 site series usually occurs on high bench floodplains, with non-wetland soils. Occasionally, sites with very poor drainage and a thick organic veneer occur; these can be classified as treed swamps (Ws07) (see Section 6.2). Vegetation is very similar on both site conditions, and users who require additional information can use phases to differentiate:

> **112a** for **riparian floodplain sites**
>
> **112b** for the **swamp phase**: sites have a thick organic veneer and very poor drainage; swamp sites are equivalent to the Ws07 swamp site association (see Section 6.2)

Minor cover of Act, Ep, or At is often present on flood sites, along with snowberry, wild sarsaparilla, blue wildrye, and oak fern. Swamp sites have higher cover and diversity of mosses, including glow moss, leafy mosses, and occasionally peat-mosses.

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Cold air and frost may limit regeneration. Invasive plant species are a serious concern. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

Other Ecosystems

The following ecosystems occur in the IDFdm2. They are described in detail in Chapter 6.

Wetlands

Marsh (Wm), swamp (Ws), and shallow water (Ww) wetlands are the most common wetland classes in the low-elevation, dry climate of the IDFdm2. Fens (Wf) occur but less frequently. Section 6.2 provides descriptions of wetland ecosystems.

Cottonwood floodplains and other flood ecosystems

The most common cottonwood floodplain (Fm) units in the IDFdm2 are *Fm01 Cottonwood – Snowberry – Rose, Fm02 Cottonwood – Spruce – Dogwood*, and *Fm07 Aspen – Dogwood – Water birch.* These, along with low bench (Fl) and other flood ecosystems, are described in Section 6.3.

Grasslands, brushlands, shrub-steppe, and alkaline/saline meadows

Grassland (Gg), brushland (Gb), shrub-steppe (Gs), and alkaline/saline meadow (Ga) ecosystems are ecologically significant in the dry climate of the IDFdm2. The Grassland Group is described in detail in Section 6.4.

Rock outcrops and talus

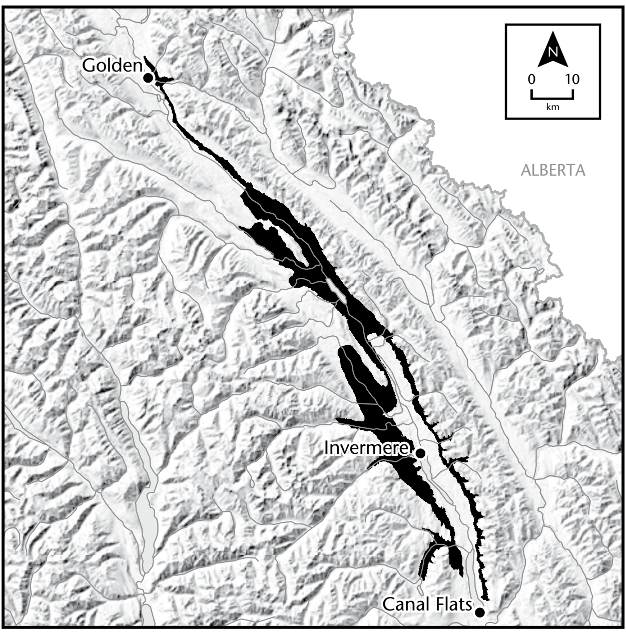
Rock outcrop (Ro) and talus (Rt) ecosystems are common in the IDFdm2, and are described in Section 6.6.

IDFdk5
Columbia Dry Cool Interior Douglas-fir

Geographic Distribution

The IDFdk5 occurs at low elevations in and adjacent to the Rocky Mountain Trench from Columbia Lake to just north of Hospital Creek. In its central extent, it occurs on the bottom and lower sides of the Columbia and Spillimacheen valleys. At its southern extent, it occurs above the IDFxk along the Columbia River and in the valley bottoms of side drainages, including Frances, Horsethief, Toby, and Dutch Creeks in the Purcell Mountains and Shuswap and Windermere Creeks in the Rocky Mountains. At its northern extent, the IDFdk5 forms a narrow band on the warm-aspect slopes above the Columbia River from Parsons to Moberly. The IDFdk5 occurs below the MSdk across most of its range, except where it is adjacent to the ICHmk5. It abuts the IDFdm2 at similar elevations to the south.

Distribution of the IDFdk5



Elevation Range

Throughout most of its range, the IDFdk5 extends to valley bottom. The exception to this is where it is located above the IDFxk. In these areas, lower-elevation limits are generally between 850 and 975 m on cool and neutral aspects, and between 950 and 1025 m on warm aspects. Where the IDFdk5 borders the MSdk or ICHmk5, upper elevations are between 1100 and 1250 m on cool and neutral aspects, and between 1250 and 1350 m on warm aspects, except in the area from Spillimacheen to McMurdo, where the boundary between the IDFdk5 and ICHmk5 is between 1000 and 1100 m on warm aspects.

Climate[1]

The IDFdk5 occurs in the Dry climate subregion. Winters are cool and summers are hot. Spring and fall are intermediate, with mild spring and warm fall temperatures. Soil moisture availability is dry to very dry throughout all seasons, and moisture deficits are common on mesic and drier sites and can affect subhygric sites in drier than normal years. The snowpack is shallow to moderate and generally persists throughout the winter from late November or December through to late February or early March, except on insolated, warm-aspect sites where snow accumulation is lower and of shorter duration. Extreme cold snaps in winter and extreme heat waves in summer are important influences on climate and vegetation in the IDFdk5. Growing-season frosts may occur. The IDFdk5 has similar precipitation to the IDFdm2, but is generally cooler in all seasons.

Forest and Vegetation Characteristics

The IDFdk5 is the most productive IDF subzone/variant for tree growth in the East Kootenay. Fd and Pl are common across the landscape, with Sxw restricted to moist sites. Broadleaf trees are also abundant: At is common in seral stands on both drier and wetter sites, and Ep and Act occur on wetter sites. **Zonal sites** are characterized by Fd, often with Pl, particularly in younger stands, and by abundant pinegrass. Twinflower is usually present with low cover. **Drier sites** are also Fd-dominated and have common juniper and Rocky Mountain juniper, pinegrass, bluebunch wheatgrass, and/or yarrow. **Wetter sites** are Sxw-dominated and have red-osier dogwood, bunchberry, wild sarsaparilla, and/or horsetails. Understorey shrub communities are similar across dry to moist sites, although common juniper and Rocky Mountain juniper are limited to drier than mesic sites, and red-osier dogwood occurs on wetter than mesic sites.

[1] See Section 4.5 for more information on climate variables.

The Spillimacheen area has particularly high productivity for tree growth, as well as cool-air influences; low cover of Sxw often occurs in the understorey on mesic sites in that area, although Fd is dominant in both the overstorey and understorey. Lw is often present at the southern extent of the IDFdk5 and can be abundant from Columbia Lake north to Toby Creek in the Purcell Mountains and to Fairmont in the Rocky Mountains; it is occasionally present as far north as Brisco. Cw can occur on wet sites but is usually a minor component of stands.

Cottonwood and aspen forests are common on floodplains along the Columbia River and its tributaries. Large areas of the internationally recognized **Columbia Wetlands** occur within the IDFdk5. Smaller wetlands also provide important habitat and biodiversity values in side drainages. Grasslands are very uncommon in the IDFdk5 and occur mostly in areas adjacent to the IDFxk. Rock outcrop, talus, and cliff ecosystems are scattered throughout.

Disturbance

Historically, **mixed-severity fire regimes** characterized disturbances in the IDFdk5. This included frequent, low-severity, stand-maintaining fires as well as less frequent stand-replacing fires. **Fire exclusion** has facilitated **forest ingrowth** in some historically open stands. Ecosystem restoration treatments to remove forest ingrowth have been used on drier sites. **Urban and rural development** is extensive throughout lower elevations of the IDFdk5, with towns, rural settlements, farms, and ranches covering large areas.

Bark beetles are important disturbance agents, causing endemic to extensive levels of mortality. Mountain pine beetle and Douglas-fir beetle have affected large areas of mature Pl and Fd, respectively, while spruce beetles have affected isolated areas on moist to wet sites where Sxw is abundant. Western false hemlock looper is cyclical and causes defoliation and mortality of small to large Fd trees. It has generally been restricted to areas south of Radium.

Low levels of **black stain fungus** and **armillaria root rot** occur in stands of all ages and can cause locally significant mortality in mature and regenerating stands, particularly Fd, Lw, and Pl. Other important pathogens that affect growth and form of regenerating trees include western gall rust and atropellis cankers on Pl, rhabdocline needle cast on Fd, and larch needle blight on Lw. Commandra blister rust also commonly kills Pl, while stalactiform blister rust reduces growth and form of Pl, and can kill it. Warren's root collar weevil can interact with pathogens on P1 to limit regeneration success.

Soils, Geology, and Landforms

Geological history is complex in the IDFdk5, with high variability between areas in the Rocky Mountains, the Purcell Mountains, and the bottom of the Rocky Mountain Trench. In the Columbia River valley bottom and the lower slopes of the Rocky Mountains, dominant bedrock types are mudstone, siltstone, and shale with dolomites. Coarse-grained sedimentary rocks, including sandstones, conglomerate, quartzite, and quartz arenite sandstones, are abundant in the Purcell Mountains. Calcareous rocks, including limestone and marble, are locally common in the valley bottom in the central part of the unit and north of Fairmont, and pockets of limestone with slate, phyllite, siltstone, and argillite occur south of Windermere Creek and on the west side of the valley near Parson.

The dominant landforms include morainal and glaciofluvial deposits. Most morainal soils have silt loam to very gravelly silt loam or sandy loam surface textures, and some have clay-enriched (Bt) subsurface horizons. Soils derived from glaciofluvial deposits are typically gravelly with silty to sandy textures. The deposits are usually capped by an eolian veneer with fine sandy loam to silt loam textures and low coarse-fragment content. Glaciolacustrine deposits and fluvial floodplains are common along the Columbia River, while colluvial deposits are common on the valley sides at the upper elevation limits of the IDFdk5, especially in side drainages of the Columbia River.

Many soils in the IDFdk5 are derived from multiple glaciation events that have mixed and remixed parent materials from a variety of geographic areas within the Rocky Mountain Trench. Most soils are developed from calcareous parent materials and have carbonate-enriched (Cca) subsoil horizons that are sometimes cemented.

Wildlife Habitat

The IDFdk5 provides **important ungulate winter range** for significant populations of Rocky Mountain elk, bighorn sheep, mule deer, and moose, and connectivity and linkage corridors for wide-ranging carnivores and furbearers such as **grizzly bear**, **black bear**, **cougar**, **grey wolf**, **Canada lynx**, and **bobcat**.

Abundant lakes and wetlands in the IDFdk5 comprise part of the **Columbia Wetlands** in the **Columbia National Wildlife Area**, which is internationally recognized for high wildlife diversity and **key breeding and staging habitat for waterfowl, shorebirds, and migratory birds.** This includes a number of **at-risk species** such as American bittern, American avocet, American golden-plover, American white pelican, California gull, great blue heron, eared grebe, horned grebe, long-billed curlew, red-necked phalarope, rusty blackbird, sandhill crane, surf scoter, tundra swan, and upland sandpiper. Fast-flowing rivers and streams are also important for **bull trout** and **cutthroat trout**.

The IDFdk5 provides important habitat for **herptiles** (e.g., western toad and reintroduced northern leopard frog), **invertebrates** (e.g., vivid dancer), and **aquatic furbearers** (e.g., otter, beaver, and mink). Several **aerial insectivores** are relatively abundant in the IDFdk5 and feed on insect hatches in wetlands, brushlands, and open forests. These include at-risk barn swallows, bank swallows, common nighthawk, flammulated owl, Lewis's woodpecker, olive-sided flycatcher, little brown myotis, and Townsend's big-eared bat.

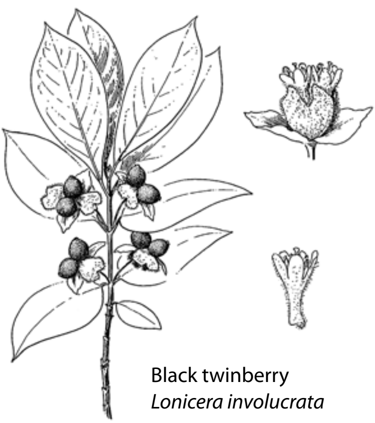
Large forest structure provides key attributes for cavity nesters (e.g., at-risk **Lewis's woodpecker** and **flammulated owl**), open-nesters (e.g., osprey, bald eagle, and at-risk **great blue heron, broad-winged hawk, northern goshawk, olive-sided flycatcher**), waterfowl, and herptiles. Retention of **old-forest structure**, including large wildlife trees in a range of species and decay classes (with cavities, heart rot, broken tops, limbs for perching, etc.), and sparse large coarse woody debris, is required to sustain these species.

Several species in the IDFdk5 require **rocky sites** for breeding (e.g., at-risk peregrine falcon, Townsend's big-eared bat, black swift, and white-throated swift). **Brushlands and open forests maintained by fire** are used by a range of species, including at-risk American badger, Rocky Mountain bighorn sheep, short-eared owl, Lewis's woodpecker, common nighthawk, bobolink, and prairie falcon. Common forest bird species include American robin, Swainson's thrush, dark-eyed junco, chipping sparrow, warbling vireo, western tanager, ruby-crowned kinglet, and yellow-rumped warbler.

The IDFdk5 supports a **diversity of at-risk vascular plants**, and management of livestock grazing, invasive plants, access, and development are key management activities that can help protect this diversity.

Birch-leaved spirea
Spiraea lucida

Tall Oregon-grape
Berberis aquifolium



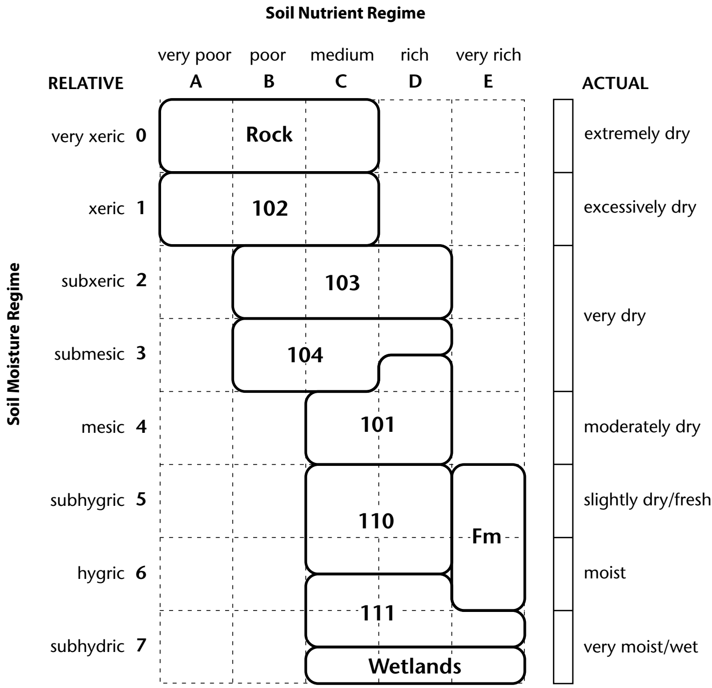
Black twinberry
Lonicera involucrata

Distinguishing the IDFdk5 from Adjacent Biogeoclimatic Units

In the **IDFxk**, most sites have:	- no Pl - more open-structured stands - lower-productivity Fd trees
zonal sites have:	- bluebunch wheatgrass and Rocky Mountain juniper - no Oregon-grape or twinflower - less snowberry and soopolallie
dry sites have:	- common rabbit-brush - more grasslands
In the **IDFdm2**, most sites have:	- Lw or Py - fewer feathermosses - less productive Fd
zonal sites have:	- Lw - less red-stemmed feathermoss and little or no step moss
dry sites have:	- Py
In the **MSdk**, most sites have:	- more Pl and Sxw
zonal sites have:	- Sxw and/or Bl in the overstorey or understorey - bunchberry and little or no pinegrass - grouseberry/low bilberry (frequently) - thimbleberry, Douglas maple, and alder (frequently)
dry sites have:	- less bunchgrass cover - more Pl - Bl or Sxw, often in the understorey
In the **ICHmk5**,[a] most sites have:	- Cw and/or Sxw - less pinegrass
zonal sites have:	- Cw, Sxw, and often Bl - thimbleberry, black huckleberry, and/or false azalea - no pinegrass and showy aster - more twinflower, bunchberry, and wild sarsaparilla
wet sites have:	- devil's club and/or ferns

[a] Described in a future publication.

Edatopic Grid



Site series

101	FdPl – Pinegrass – Feathermoss
102	Fd – Juniper – Pinegrass
103	Fd – Saskatoon – Bluebunch wheatgrass
104	Fd – Spirea – Pinegrass – Kinnikinnick
110	Sxw(Fd) – Dogwood – Bunchberry
111	Sxw – Dogwood – Horsetail
Fm01	Cottonwood – Snowberry - Rose[a]
Fm02	Cottonwood – Spruce – Dogwood[a]
Fm07	Aspen – Dogwood – Water birch[a]

[a] See Section 6.3 for descriptions.

Site Series Flowchart

Forest group	Site characteristics	Site series
VERY DRY to DRY FORESTS • warm aspects • shallow soils and/or extensive rock	• SMR 1 • open Fd stands • exposed bedrock/talus prominent in stands • common and Rocky Mountain juniper • round-leaved alumroot, nodding onion • abundant clad and pelt lichens	**102**
	• SMR 2 • open Fd stands • steep, warm aspects; shallow and/or coarse soils • bluebunch wheatgrass abundant	**103**
SLIGHTLY DRY to MESIC FORESTS • (usually) mid slopes with deep soils • moderate to abundant pinegrass	• SMR 3 • Fd stands • mid-slope, warm aspect; medium to coarse soils • kinnikinnick and pinegrass • may contain minor cover of bluebunch wheatgrass and red-stemmed feathermoss	**104**
	• SMR 4 (3) • Fd (Pl) stands • mid-slope, neutral to cool aspects • pinegrass and showy aster • minor cover of twinflower, rattlesnake plantain, and/or prince's pine • step moss and abundant red-stemmed feathermoss	**101**
MOIST to WET FORESTS • level, lower, and toe slopes • seepage or mottles • riparian; cold air common	• SMR 5 (6) • Sxw (Fd, At, Ep) stands • red-osier dogwood • bunchberry, wild sarsaparilla, and/or ricegrass	**110**
	• SMR 6 (7) • Sxw stands • red-osier dogwood • horsetails and/or sedges abundant	**111**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■	■■■■■	■■■■■	■■■		Douglas-fir
	Pinus contorta			*	□□□	*	*	lodgepole pine
	Populus tremuloides					□□□		trembling aspen
	Picea engelmannii x *glauca*					■■■■	■■■■■	interior spruce
	Betula papyrifera					□□□	*	paper birch
Regen	*Pseudotsuga menziesii*	■■■	■■■	■■■	■■■	□□		Douglas-fir
	Picea engelmannii x *glauca*					■■■	■■■	interior spruce
Shrubs	*Juniperus communis*	■■■	□□	□□				common juniper
	Juniperus scopulorum	■■■	■■■	□□				Rocky Mountain juniper
	Shepherdia canadensis	□□	□□	■■■	■■■	□□		soopolallie
	Spiraea lucida	■■	■■	■■■	□□	□□		birch-leaved spirea
	Rosa acicularis	□□	*	□□	■■	■■	■■	prickly rose
	Amelanchier alnifolia	□□	■■■	*	■■	■■		saskatoon
	Symphoricarpos spp.	*	■■■	□□□	■■■	■■■	□□	snowberry
	Berberis spp.	*	*	■■	■■	□		Oregon-grape
	Cornus stolonifera					■■■	■■■	red-osier dogwood
	Lonicera involucrata					□	■	black twinberry
	Viburnum edule					*	□	highbush-cranberry
	Alnus incana						□□□	mountain alder

Layer	Scientific name	102	103	104	101	110	111	Common name
Herbs	*Arctostaphylos uva-ursi*	■■■	□□	■■■	*			kinnikinnick
	Calamagrostis rubescens	■■■	□□□	■■■■■	■■■■	□□		pinegrass
	Pseudoroegneria spicata	■■	■■■■	*				bluebunch wheatgrass
	Antennaria spp.	□	□	□□				pussytoes
	Achillea spp.	■	■	■				yarrow
	Allium cernuum	■	*					nodding onion
	Heuchera cylindrica	■						round-leaved alumroot
	Balsamorhiza sagittata		□□					arrowleaf balsamroot
	Eurybia conspicua			□□□	■■■	□□		showy aster
	Astragalus miser			□				timber milk-vetch
	Linnaea borealis				■■	■■	■■	twinflower
	Goodyera oblongifolia				□			rattlesnake-plantain
	Cornus canadensis					■■■	■■■	bunchberry
	Aralia nudicaulis					■■■	□□	wild sarsaparilla
	Oryzopsis asperifolia					■■		rough-leaved ricegrass
	Rubus pubescens					□	■■	dwarf red raspberry
	Equisetum spp.						■■■■■	horsetails
	Carex spp.						□□□	sedges
	Petasites frigidus						■■	sweet coltsfoot
Moss layer	*Pleurozium schreberi*	□□□		■■■	■■■■	■■■■	■■■	red-stemmed feathermoss
	Peltigera spp.	■■■	■	■■■	■■	□		pelt lichens
	Cladonia spp.	■■■	*	□□□				clad lichens
	Syntrichia ruralis	□□	*					sidewalk screw-moss
	Brachythecium spp.	□□					□□	ragged-mosses
	Hylocomium splendens			□	■■■	□□□		step 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
No. of plots	11	13	15	32	19	7
SMR	1	2	3	4 (3)	5 (6)	6 (7)
SNR	B–C	C–D (B)	C–D (B)	C–D	D (C –E)	D–E (C)
Slope position	CR–UP	UP, MD, CR	MD (UP)	MD (LV)	TO, LV, LW	LV (DP, TO)
Typical slope/ aspect	Warm	Steep/warm	Moderate/ warm	Moderate/ neutral (cool)	Gentle (level)	Gentle or level
Common compensating conditions		Insolated crests	Upper/cool; lower/warm/ coarse	Lower/ moderately coarse; mid/ warm/gentle	Steep/cool receiving sites	
Surficial materials	Cxv/R, Mx/R	Cv (Cb)	M, C, FG (Ev common)	M (Ev/FG, C)	F, FG, M (L)	F, Ov
Soil texture	SL (L, LS, SiL)	SiL, SL (LS, SiCL)	SiL, SL (L)	SiL, L (SiCL, SL)	SiL (SiCL, L, FSL)	SiL (FSL, SiCL)
Coarse fragment content	High (moderate)	Moderate–high	Moderate–high	Variable	Usually sparse, increasing at depth	Sparse; may increase at depth
Important features	Dominated by (bed)rock	Insolation			Mottles within top 50 cm; cold air	Water table within 30 cm; riparian; cold air

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

FdPl – Pinegrass – Feathermoss **101**

General Description

SMR 4 (3). 101 sites occur on **mid slopes** of **neutral to cool** aspects with **moderate-textured soils** and, occasionally, on lower or gentle (< 15%) slopes on warm aspects. Soils are typically Eutric Brunisols derived from deep morainal deposits, and less frequently from colluvium or from eolian veneers over coarser glaciofluvial materials. Textures are primarily silt loam or loam, sometimes with either a cemented calcareous layer or a coarser sandy loam layer at depth.

Fd forms **closed forest canopies**, often with minor amounts of Pl. The shrub layer is generally well-developed with moderate to high cover of **snowberry**, rose, saskatoon, soopolallie, and birch-leaved spirea. **Pinegrass** is abundant with moderate amounts of **showy aster** and low cover of twinflower and/or rattlesnake plantain. 101 sites also have minor cover of heart-leaved arnica (*Arnica cordifolia*) and/or prince's pine (*Chimaphilla umbellata*). The moss layer generally includes abundant **step moss** and red-stemmed feathermoss with minor cover of pelt lichens.

Differentiating from Other Site Series

Slightly drier sites (104) have abundant kinnikinnick and minor cover of pussytoes, yarrow, and/or timber milk-vetch, and lack twinflower, prince's pine, rattlesnake plantain, and heart-leaved arnica. Slightly moister sites (110) have Sxw, red-osier dogwood, wild sarsaparilla, bunchberry, and/or rough-leaved ricegrass.

Variability

Lw is often present at the southern extent of the IDFdk5 from Columbia Lake north to Toby Creek. Pl and At can be abundant in younger stands. Common juniper and kinnikinnick occasionally occur with very low cover (< 2%), mostly in very young stands with high light levels and only when other plant indicators of the 101 are present.

Management Issues

Ungulate browsing and vegetation competition may limit tree growth and establishment. Where machinery is active, conserve surface soils and avoid exposure of unfavourable subsoils. Invasive plant species are a serious concern.

102 Fd – Juniper – Pinegrass

General Description

SMR 1 (2). 102 forests occur where exposed **bedrock or talus** is extensive. Solar radiation is usually high, and stands often occur in larger complexes with open, non-forested rock outcrops and 103 forested sites. Soil, where present between rocks, is typically shallow, often with high or fragmental coarse fragment content.

Moss and lichen cover is generally high on bedrock or talus under an **open Fd** canopy. **Juniper**, both common and Rocky Mountain, is typically abundant, usually with minor cover of soopolallie, birch-leaved spirea, and prickly rose. Pinegrass and kinnikinnick are usually present and often moderately abundant (< 15% cover). Minor cover of bluebunch wheatgrass, round-leaved alumroot, and a diversity of understorey herbs, including yarrow, nodding onion, and pussytoes, is typical. Clad lichen and pelt lichens are usually common, with variable cover of sidewalk screw-moss, red-stemmed feathermoss, ragged-mosses, and heron's-bill mosses (*Dicranum* spp.)

Differentiating from Other Site Series

Drier sites are non-forested rock outcrops (Ro), talus (Rt), brushlands (Gb), or grasslands (Gg) with < 10% tree cover. Slightly moister forested sites (103) lack prominent bedrock or talus and have less moss and more bluebunch wheatgrass, arrowleaf balsamroot, and other grassland-associated species.

Variability

Vegetation varies considerably based on bedrock characteristics and the depth of soil pockets between rocks. Grasses, including bluebunch wheatgrass, pinegrass, fescues (*Festuca* spp.), and junegrass (*Koeleria macrantha*), are often present in patches of soil. Pl may occur, but usually at low densities.

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. Drought stress can increase the susceptibility of trees to insects and disease. Invasive plant species are a serious concern.

Fd – Saskatoon – Bluebunch wheatgrass 103

General Description

SMR 2. The 103 site series occurs on **steep, warm-aspect** sites, typically with **coarse, rocky,** and/or **shallow** soils, and on **gentle, warm crests**. It occasionally occurs on neutral-aspect sites with extensive sun exposure or very coarse soils. Soils are usually rapidly to well-drained Eutric Brunisols derived from colluvial materials with textures ranging from silt loam to sandy loam. Coarse fragment content is usually high, and exposed mineral soil is common. A thick Ah layer (> 10 cm) may be present in open stands with high bunchgrass cover. Sites often occur in a mosaic with 102 forests and non-forested rock outcrops, talus, or grassland ecosystems.

Stands are characterized by widely spaced, **open Fd** with scattered shrubs and bunchgrasses. **Bluebunch wheatgrass** is usually present and can be relatively abundant (> 10% cover). Pinegrass is also present but not dominant. Arrowleaf balsamroot often occurs with minor cover of pussytoes, yarrow, nodding onion, and/or spreading dogbane (*Apocynum androsaemifolium*). Minor cover of kinnikinnick is common. Moss cover is typically sparse, and exposed mineral soil often covers more of the site.

Differentiating from Other Site Series

Slightly drier sites (102) occur where exposed bedrock or talus are prominent, and they have more mosses, lichens, and juniper and less bunchgrass cover. Slightly moister sites (104) have more soopolallie, pinegrass, and kinnikinnick, are usually closed-canopy stands, and often have minor cover of Pl.

Variability

These sites often have many species with very low cover of each.

Management Issues

Ungulate browsing, drought, and grass competition may limit tree growth and establishment. Sites with large trees, lower snow depths, and high forage availability provide important ungulate winter range. Where fire exclusion and forest ingrowth have increased understorey density, ecosystem restoration treatments may enhance habitat and ecosystem values. Care should be taken during harvesting and ecosystem restoration activities to conserve limited organic matter and to avoid soil disturbance. Invasive plant species are a serious concern.

104 Fd – Spirea – Pinegrass – Kinnikinnick

General Description

SMR 3. The 104 site series typically occurs on **mid slopes** of **warm aspects** with **medium- to coarse-textured soils**. It also occurs on **cool- to neutral-**aspect sites on upper slopes that are **moisture-shedding** or that have coarse- to very **coarse-textured soils**. Well-drained Eutric Brunisols are common and typically have silt loam or sandy loam textures and moderate to high coarse fragment content. A clay-enriched layer and/or cemented, calcareous subsurface horizons are often present, particularly at lower elevations in the Rocky Mountain Trench.

Fd is the dominant tree. Pl or At may be present in minor amounts in mature stands and can be more abundant in earlier seral stages. Shrub cover is diverse and abundant, with soopolallie, birch-leaved spirea, and Oregon-grape typically dominant. Low cover (< 5%) of common and/or Rocky Mountain juniper is usually present. **Pinegrass** and **kinnikinnick** are prominent, along with showy aster and minor cover of pussytoes, yarrow, and/or timber milk-vetch. Red-stemmed feathermoss, pelt lichens, and clad lichens commonly occur with moderate cover (< 15%). Step moss is usually sparse or absent.

Differentiating from Other Site Series

Drier sites (103) typically have a more open canopy structure with more saskatoon, juniper, and bluebunch wheatgrass and less kinnikinnick, pinegrass, showy aster, and soopolallie. Slightly moister sites (101) have little or no kinnikinnick, yarrow, and pussytoes and have minor cover of twinflower, rattlesnake-plantain, heart-leaved arnica, and/or prince's pine. 101 sites usually have more abundant red-stemmed feathermoss and/or step moss.

Variability

Minor amounts of bluebunch wheatgrass or rough fescue (< 2%) may be present. Some sites have a thin eolian veneer over a gravelly glaciofluvial or coarser-textured morainal soil.

Management Issues

Ungulate browsing, drought, and grass competition may limit tree growth and establishment. Sites on warm aspects with large trees, lower snow depths, and high forage availability can provide important ungulate winter range. Where fire exclusion and forest ingrowth have increased understorey density, ecosystem restoration treatments may enhance habitat and ecosystem values. Care should be taken during harvesting and ecosystem restoration activities to conserve limited organic matter and to avoid soil disturbance. Invasive plant species are a serious concern.

Sxw(Fd) – Dogwood – Bunchberry 110

General Description

SMR 5 (6). 110 sites typically occur on gentle (< 15%) **lower and toe slopes** or **level sites** with **seepage**, often at depth. They also occur in moderately steep to steep gullies or lower slopes with seepage. Soils are usually Gleyed Eutric or Melanic Brunisols with silt loam or silty clay loam textures, moderate coarse fragment content, and Mor or Moder humus forms. Calcareous subsurface horizons are commonly present. **Cold-air** pooling is common. Sites are typically associated with **riparian areas**.

Mixed **Sxw**, **Fd**, **At**, and **Ep** comprise the tree layer, with mixed **red-osier dogwood**, **snowberry**, and **prickly rose** dominant in the well-developed shrub layer. Understorey herb cover and composition varies, with **bunchberry**, **wild sarsaparilla**, **rough-leaved ricegrass**, and/or **twinflower** most common and abundant. Minor amounts of pinegrass (< 5%) are often present.

Differentiating from Other Site Series

Slightly drier sites (101) lack Sxw and have higher cover of pinegrass. Slightly moister sites (111) are Sxw-dominated with abundant horsetails.

Variability

Earlier seral stands are common and usually have high cover of broadleaf trees mixed with conifers. At and Ep can be dominant, often with minor Act. Pl may be present but is rarely abundant. Lw may be present at the southern extent of the IDFdk5. Thimbleberry (*Rubus parviflorus*) can be abundant. Cw is rarely present.

Management Issues

The 110 site series includes very productive sites for the IDF. Tree species diversity is also relatively high on these sites and should be maintained. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Vegetation competition, cold air, and frost may limit conifer regeneration. Invasive plant species are a serious concern. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

111 Sxw – Dogwood – Horsetail

General Description

SMR 6 (7). The 111 site series occurs on **level sites**, **depressions**, and **gently sloping toe** slopes where the **water table** is within the top 30 cm of the soil profile. Sites are usually associated with **riparian areas** where groundwater and/or surface flow create temporarily saturated soils each year. **Flooding** is typical, and Humic Gleysols and Gleyed Humic Regosols with buried horizons are common. **Cold air** usually pools on these sites.

Horsetails and/or **sedges** are characteristic, along with various moist species such as dwarf red raspberry, rein orchids (*Platanthera* spp.), sweet coltsfoot, violets (*Viola* spp.), and bedstraw (*Galium* spp.). Mountain alder and red-osier dogwood are usually present and can be abundant with minor cover of black twinberry or highbush-cranberry. The moss layer is often poorly developed due to flooding but may have small amounts of leafy mosses.

Differentiating from Other Site Series

The herb layer can be highly variable, but horsetails and, less frequently, sedges are characteristic and diagnostic. Slightly drier sites (110) have little or no horsetail or sedge cover (< 3%) and lack mountain alder; Fd is usually present. Slightly wetter sites are wetlands—usually swamps or marshes (see Section 6.2). Broadleaf-dominated sites with more dynamic flood regimes are classified in the Flood Group (middle bench Act or At stands or low bench willow or alder sites) (see Section 6.3).

Variability

111 sites occur usually on high bench floodplains, with non-wetland soils. Occasionally, sites with very poor drainage and a thick organic veneer occur; these can be classified as treed swamps (Ws07) (see Section 6.2). Vegetation is very similar on both site conditions, and those who require additional information can use phases to differentiate:

> **111a** for **riparian flood sites**
> **111b** for the **swamp phase**, with a thick organic veneer and very poor drainage (Ws07)

Swamp sites have higher cover and diversity of mosses.

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Vegetation competition, cold air, and frost may limit conifer regeneration. Invasive plant species are a serious concern. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

Other Ecosystems

The following ecosystems occur within the IDFdk5. They are described in detail in Chapter 6.

Wetlands

The IDFdk5 includes large areas in the Columbia Wetlands, a Ramsar Wetland of International Importance that is the largest river valley wetland system in British Columbia. It includes a variety of marsh (Wm), fen (Wf), swamp (Ws), and shallow open water (Ww) ecosystems that are described in Section 6.2.

Cottonwood floodplains and other flood ecosystems

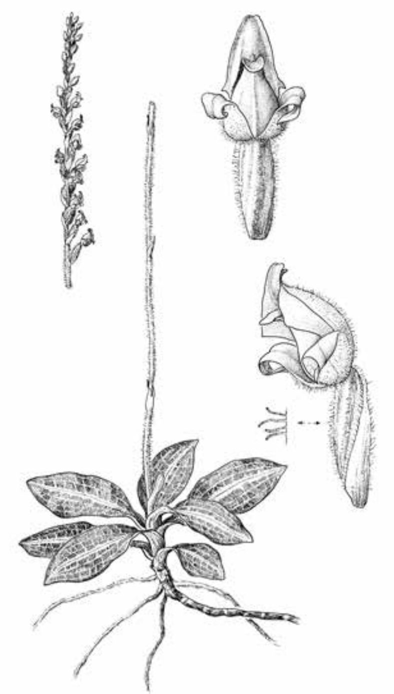
Cottonwood and aspen floodplain forests provide important habitat in the Columbia Valley and its tributaries. The most common cottonwood middle bench floodplain (Fm) units are *Fm01 Cottonwood – Snowberry – Rose*, *Fm02 Cottonwood – Spruce – Dogwood*, and *Fm07 Aspen – Dogwood – Rose*. These, along with shrub-dominated low bench (Fl) and other flood ecosystems, are described in Section 6.3.

Grasslands and brushlands

Grassland (Gg) and brushland (Gb) ecosystems occur but are uncommon in the IDFdk5. The Grassland Group is described in Section 6.4.

Rock outcrops and talus

Rock outcrop (Ro) and talus (Rt) ecosystems are common in the IDFdk5, and are described in Section 6.6.



Rattlesnake-plantain
Goodyera oblongifolia

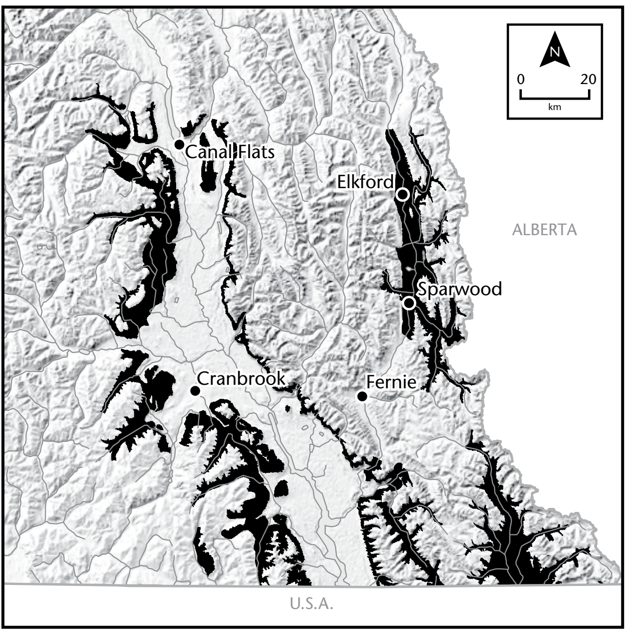
One-sided wintergreen
Orthilia secunda

MSdw
Dry Warm
Montane Spruce

Geographic Distribution

The MSdw covers a large area. In the Purcell Mountains, it occurs from the Dutch Creek drainage south to the U.S. border, and includes major river and creek drainages such as Findlay, Skookumchuck, Lost Dog, Gold, Perry, Moyie, Yahk, and Linklater. In the Rocky Mountains, it occurs from Bingay Creek in the Elk Valley, to the Flathead and Wigwam Rivers in the south, and the Alberta border to the east. On the west side of the Rocky Mountains, it occurs from Canal Flats south to the U.S. border. The MSdw occurs above the IDFdm2 except in the Elk, Flathead, and Wigwam river drainages, and at the upper reaches of most other drainages, where it extends to valley bottom. The ESSFdk1 occurs above the MSdw. The MSdw abuts the MSdk at similar elevations to the north.

Distribution of the MSdw



Elevation Range

The MSdw often extends to valley bottom. Where it occurs above the IDFdm2, lower elevations range from 1050 to 1250 m on cool aspects and from 1225 to 1350 m on warm aspects. At the upper limits, the MSdw generally extends to 1500 m on cool aspects, 1550 m on neutral aspects, and 1650 m on warm aspects.

Climate[1]

The MSdw occurs in the Dry climate subregion and is characterized by dry, cool winters and dry, warm summers and falls. Winter snowpacks are moderately deep and persist from late November or December through March. Growing-season moisture deficits typically occur on subxeric and drier sites, and on submesic to mesic sites in dry years. Frost is a common limiting factor. At the eastern extent, the MSdw can be influenced by chinook and other weather phenomena that are common to the eastern slopes of the Rocky Mountains. Northern air masses with cold air also influence the MSdw, often bringing extreme cold temperatures.

Forest and Vegetation Characteristics

The MSdw covers a wide range of ecosystems from grasslands to rock outcrops and cliffs, wetlands, and forests. Common tree species are Sxw, Fd, Pl, Bl, Lw, At, Act, and Ep. Productive stands of Sxw, Fd, Pl, and Lw occur on **zonal sites** with low to moderate cover of arnica, bunchberry, grouseberry/low bilberry, and pinegrass. Minor cover of Bl is common. **Submesic** and drier sites have moderate to abundant Fd, pinegrass, soopolallie, birch-leaved spirea, and saskatoon, often with abundant Lw. Pl is common on earlier seral stands, particularly on drier glaciofluvial flats where seral stands are common. Grouseberry/low bilberry is often most abundant on these sites. Juniper, Oregon grape, and kinnikinnick are typically present on the **driest sites** where stands of open Fd dominate. **Wetter sites** have Sxw and Bl with little or no Fd and Lw, lack pinegrass, and typically have moister shrub and herb species such as black gooseberry, red-osier dogwood, black twinberry, sweet-scented bedstraw, baneberry, and horsetails.

Several uncommon forested ecosystems provide diverse habitats in the MSdw. Forested bogs with Sxw, Pl, scrub birch, trapper's tea, and/or Labrador tea occur infrequently. Cottonwood floodplain forests occur at lower elevations. **Pf**[2] is an at-risk tree species that is scattered infrequently throughout the MSdw, usually on dry, rocky sites. Cw is scattered across the

[1] See Section 4.5 for more information on climate variables.
[2] *Pinus flexilis* (limber pine).

MSdw landscape where it is restricted to moist riparian sites (see 110.2 site series variation on page 173) and adjacent upland areas. Maintaining Cw on these sites provides important species and habitat variability for biodiversity.

Bl and Sxw are more abundant on mesic sites at upper elevations where the MSdw is transitional to the ESSFdk1, and Fd and Lw are more abundant closer to the IDFdm2. Understorey plants also vary with elevation: grouseberry/low bilberry, black huckleberry, and false azalea are more common at upper elevations, while pinegrass, Oregon-grape, and saskatoon are more common at lower elevations. Bear-grass (*Xerophyllum tenax*) can be abundant in the MSdw, particularly in the Flathead and Wigwam valleys. Step moss and knight's plume are uncommon across most site series in the MSdw, except in areas that are transitional to the MSdk and in the Elk and Bull River valleys. Red-stemmed feathermoss occurs throughout the MSdw but typically with low to moderate cover. Pipecleaner moss (*Rhytidiopsis robusta*) is often present and can have high cover.

Non-forested ecosystems are common in the MSdw. Grassland and brushland communities often extend into the adjacent IDFdm2 or ESSFdk1. The Elk Valley has a particularly high concentration of grassland and brushland communities, although smaller grass- and shrub-dominated areas are common throughout the range of the MSdw. Avalanche paths frequently extend into the MSdw, particularly the lower portions and run-out zones. Wetlands are typically small and relatively uncommon but provide important landscape variability. Rock outcrops, talus, and cliffs are abundant.

Disturbance

Historically, frequent stand-initiating **wildfires** in the MSdw maintained a **mosaic of even-aged stands** in patches of different ages across the landscape, including some open grassland habitats, and some patches of old forest that were skipped over by fire. While stand-replacing fires dominate much of the land base, **mixed-severity fires**, including frequent low-severity burns, were historically common. Fire history studies in the MSdw have repeatedly found evidence of stand-maintaining fire with landscape-scale intervals ranging on average from 15 to 75 years (with a range of 5–138 years between individual fires on any given site) (Cochrane 2007). These occurred primarily on warm and cool aspects connected to lower-elevation fire-prone sites (Cochrane 2007), and steep, warm-aspect sites often experience higher fire frequencies (Da Silva 2009). Fd and Lw are the most common remnant trees in the MS, occurring as single veteran trees and as clumps, patches, and islands ranging in area from 1 to 100 ha (Stuart-Smith and Hendry 1998).[3] On these warmer-aspect sites, which had stand-maintaining fires, **forest ingrowth and encroachment** due to fire suppression have led to dense, closed forest in many stands. Seral Pl stands are also extensive in the MSdw where wildfires have burned large areas over the past century.

Mountain pine beetle epidemics, including a prolonged outbreak in the Flathead and Wigwam valleys that peaked in 1979–1980 have had a large influence on the current landscape by creating diverse stand- and landscape-level structure and species composition (Dykstra and Braumandl 2006; Amoroso et al. 2013). Recent outbreaks have continued to inflict high mortality on Pl stands. Douglas-fir beetle has more isolated effects in stands with high Fd cover. Balsam bark beetle can be a key driver of regeneration and development of multi-storeyed stands where Bl is abundant, especially at higher elevations in the MSdw. A number of insects affect Sxw. **Spruce beetle** can cause high mortality in mature stands, especially following fire or blowdown, or where slash retention is high after harvest. Spruce terminal weevil is an impediment to regenerating Sxw. Western spruce budworm outbreaks have caused serious mortality and growth loss in the Flathead and Wigwam valleys and the Galton Range.

Several **pathogens** influence survival and growth of mature and regenerating stands. Armillaria root rot creates gaps in mature stands and can be a major impediment to tree regeneration. Western gall rust reduces growth in regenerating Pl, while rhabdocline needle cast can cause growth losses in Fd on warmer sites; larch needle blight has similar effects on Lw.

Historic **harvesting** for railway ties in the early 1900s removed many large, old, often fire-scarred Lw and Fd from the MSdw. Evidence of old "bush mills" can still be seen in areas far from towns and settlements. More recently, forest harvesting activity has been extensive since the late 1970s. Urban and rural development is limited, although the towns of Sparwood, Elkford, and Kimberly are within the MSdw. **Mining** has also disturbed large areas around these towns.

Soils, Geology, and Landforms

The Purcell Mountains and Rocky Mountains are dominated by a mixture of sedimentary rocks, including sandstone, siltstone, shale, argillite, conglomerates, and dolomite. Finer-textured bedrock types such as mudstone, shale, and, in places, coal are common in the Elk Valley. Limestone is found

[3] Data include fires from the MSdk, MSdw, and adjacent ESSF. Mean size of remnant patches within burn perimeters was 10.4 ha (± 6.2 ha) for islands and 13.5 ha (± 7.7 ha) for skips.

throughout the MSdw, but is most common in the Lussier River drainage and on both sides of the Koocanusa Reservoir.

Soils derived from colluvium and morainal materials typically have surface textures ranging from silty clay loam to silt loam or sandy loam and are often calcareous in both the Purcell Mountains and Rocky Mountains. Carbonate-enriched subsoil layers (Cca) are often present in calcareous soils, particularly at lower elevations closer to the IDF. Some of these soils are cemented and/or have a weakly developed clay-enriched (Bt) layer. These subsoil layers can restrict water and root penetration.

Glaciofluvial and fluvial features are common in major river and creek valleys including the Elk, Flathead, Wigwam, and Upper Moyie Rivers, as well as Mather and Mark Creeks west of Wasa. These soils have high gravel content, and loam, loamy sand, or sand textures. Several areas of glaciolacustrine plains and terraces occur in the Elk River and Michel Creek valleys near Sparwood and in the Upper Moyie River valley. Fine-textured fluvial or eolian veneers often occur on these valley-bottom features.

Brunisols are the dominant soil type: Eutric Brunisols are found in areas of calcareous bedrock types and on warmer, drier sites, while Dystric Brunisols are common in soil derived from non-calcareous bedrock. Organic-enriched (Ah) surface horizons are found in grassland environments of the MSdw, although these are sparse across the landscape and primarily on warm-aspect sites.

Wildlife Habitat

The MSdw provides diverse habitat for a number of key wildlife species. Open forests, brushlands, and grasslands in the MSdw, as found within the Flathead, Elk, and Wigwam drainages and some of the side tributaries of the Kootenay, provide key winter ranges for abundant populations of **Rocky Mountain elk** and **bighorn sheep**, as well as **mule deer**, **white-tailed deer**, and **moose**. The MSdw provides important early-season foraging habitat for **grizzly bear** and **black bear**, as well as connectivity and linkage habitat for bears and other wide-ranging carnivores, including **wolverine**, **Canada lynx**, and **grey wolf**. Terrestrial and aquatic furbearers, such as bobcat, snowshoe hare, American beaver, North American river otter, and American mink, also occur in the MSdw.

Dry, open grasslands and forests are important for **American badger** and other **at-risk species**, including **common nighthawk** and **barn swallow**. Cliffs, talus, and rock outcrops, and/or sandy substrates are key features used for nesting, denning, roosting, and cover by at-risk **peregrine falcon**, **black swift**, **northern rubber boa**, **bank swallow**, and other species.

Old-growth forests and mature forests are important in the MSdw for many species that nest, roost, den, or perch in wildlife trees, including at-risk **southern red-backed vole**, **Lewis's woodpecker**, **Williamson's sapsucker**, **flammulated owl**, **northern goshawk**, **great blue heron**, **olive-sided flycatcher**, and **little brown myotis**, as well as American marten, red squirrel, pileated woodpecker, three-toed woodpecker, black-backed woodpecker, Vaux's swift, red-breasted nuthatch, and chickadees. Many of these species are important predators of forest insects, and retention of large structures (live trees, wildlife trees with heart rot, cavities, hollow logs, and other coarse woody debris) is key to sustaining their populations.

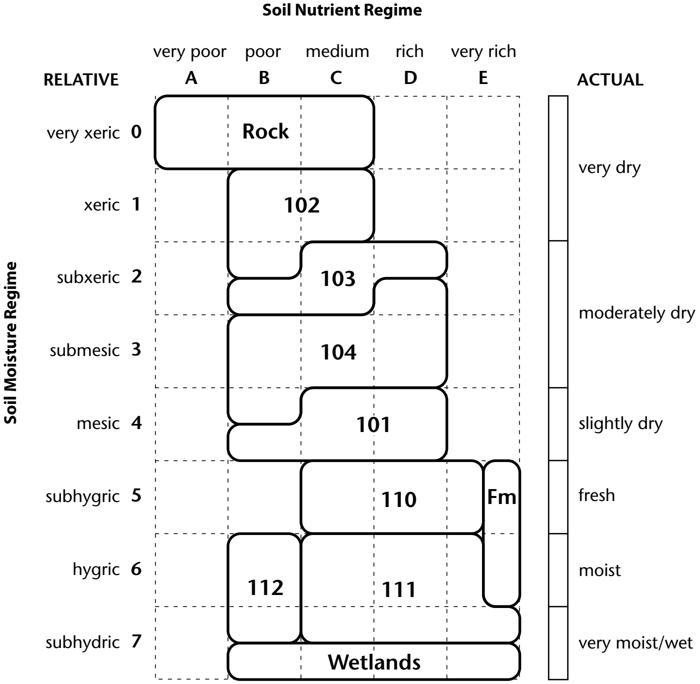
Wetland and riparian habitats in the MSdw are breeding and staging habitats for selected amphibian, bird, and mammal species, including at-risk western toad, short-eared owl, great blue heron, and, occasionally, American avocet. Cottonwood stands support several species, including western screech-owls. At-risk **Rocky Mountain tailed frog** (mainly in the Yahk and Flathead drainages), as well as **bull trout**, **westslope cutthroat trout**, **Rocky Mountain sculpin**, and **harlequin duck** breed in clear, cold, swift-moving mountain streams that have coarse substrates; these microhabitat conditions are generally associated with older forests and intact streamside habitats. **At-risk invertebrates** are also associated with riparian and wet areas in the MSdw: vivid dancer (a dragonfly associated with cold/hot springs), Gillette's checkerspot (a butterfly found in open wooded areas, often near streams), and bronze copper (a butterfly that breeds in wetlands and riparian zones).

The MSdw supports a **high diversity of at-risk vascular plant species** that are associated with montane habitats, including Pf. Some of the more common bird species in the MSdw include Swainson's thrush, warbling vireo, yellow-rumped warbler, pine siskin, and American robin.

Distinguishing the MSdw from Adjacent Biogeoclimatic Units

In the **IDFdm2**, most sites have:	- no Bl or Sxw
zonal sites have:	- abundant pinegrass - no alder or bunchberry - less arnica - shrubbier understoreys with more Oregon-grape, snowberry, and soopolallie
dry sites have:	- Py - more bunchgrasses - more Rocky Mountain juniper
In the **MSdk**, most sites have:	- very limited grasslands - knight's plume moss and step moss - more red-stemmed feathermoss - no Lw (except in the transition between MSdw and MSdk, particularly along Windermere Lake)
zonal sites have:	- more Fd and false azalea - less pinegrass, grouseberry/low bilberry, and arnica - more feathermosses
In the **ICHmk4**, most sites have:	- less Pl - little or no pinegrass
zonal sites have:	- Cw - falsebox, Douglas maple, black huckleberry, and/or queen's cup - no pinegrass
dry sites have:	- more falsebox, Douglas maple, and snowberry - little or no bluebunch wheatgrass
wet sites have:	- lady fern, oak fern, and/or devil's club
In the **ESSFdk1**, most sites have:	- little or no Lw - no Fd (except on driest sites) - more Bl - occasional white-flowered rhododendron
zonal sites have:	- abundant false azalea - no pinegrass - less twinflower and very little bunchberry
dry sites have:	- more grouseberry/low bilberry
wet sites have:	- false-hellebore and/or arrow-leaved groundsel - little or no bunchberry

Edatopic Grid



Site series

101	Sxw – Arnica – Pinegrass
102	Fd – Juniper
103	Fd(LwPl) – Pinegrass
104	Pl(Lw) – Pinegrass – Twinflower
110	SxwBl – Azalea – Bunchberry
111	Sxw – Horsetail
112	Sxw – Trapper's tea – Peat-moss[a]
Fm01	Cottonwood – Snowberry – Rose[b]
Fm02	Cottonwood – Spruce – Dogwood[b]

[a] Sites can also be classified as bogs (see Section 6.2) and may have Labrador tea instead of trapper's tea.
[b] See Section 6.3 for descriptions.

Site Series Flowchart

VERY DRY to DRY FORESTS

- warm aspects
- shallow soils and/or extensive rock/ bedrock

→
- SMR 1
- Fd (Pl) stands
- bedrock or talus prominent
- saskatoon, common juniper, and pinegrass with moderate to abundant cover
- bluebunch wheatgrass may occur

→ **102**

→
- SMR 2 (3)
- Fd (Lw, Pl) stands
- steep, warm aspect; shallow and/or coarse soils
- Oregon-grape and birch-leaved spirea with moderate cover
- pinegrass abundant
- juniper and/or kinnikinnick often present

→ **103**

SLIGHTLY DRY to MESIC FORESTS

- mid slopes (usually) with deep soils

→
- SMR 3 (2)
- Fd, Pl (Lw) stands with Fd, Sxw, and Bl regen
- mid-slope, warm aspect; medium to coarse deep soils
- pinegrass and soopolallie abundant
- showy aster, twinflower, and arnica
- grouseberry/low bilberry can be abundant

→ **104**

→
- SMR 4
- Sxw, Lw, Bl (Pl, Fd) stands with Bl and Sxw regen
- arnica, grouseberry, bunchberry, showy aster, and/ or pinegrass common with < 10% cover each
- Pl can be abundant in younger stands

→ **101**

MOIST to WET FORESTS

- lower, level, or toe slopes
- seepage, water table, or mottles present

→
- SMR 5
- Sxw, Bl (Pl, Fd, Lw) stands
- receiving sites, seepage > 50 cm
- Cw can be present and abundant, often in the understorey (110.2 variation)
- false azalea, twinberry, and gooseberry with moderate cover
- bunchberry, arnica, and grouseberry abundant

→ **110**

→
- SMR 6 (7)
- Sxw stands
- very wet sites, water table at or near surface
- riparian; cold air common
- horsetails are abundant

→ **111**

→
- SMR 7 (6)
- Sxw, Bl stands
- very wet sites; cold air
- abundant sedges and peat-mosses

→
- abundant trapper's tea

→ **112.1 (Wb16)**

→
- abundant Labrador tea

→ **112.2 (Wb15)**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■	■■■	□□	□□			Douglas-fir
	Pinus contorta	□□□	■■■	■■■■	■■■	□□□		■■■	lodgepole pine
	Larix occidentalis		□□□	□□□	■■■	*			western larch
	Picea engelmannii x *glauca*			*	■■■■	■■■■	■■■■■	■■■■	interior spruce
	Abies lasiocarpa				■■■	■■■	*	*	subalpine fir
Regen	*Pseudotsuga menziesii*	■■■	■■■	□□					Douglas-fir
	Abies lasiocarpa		*	□□	■■■	■■■	□□	□□	subalpine fir
	Picea engelmannii x *glauca*			□□	■■■	■■	■■■	■■■	interior spruce
Shrubs	*Amelanchier alnifolia*	■■■	■■	■■					saskatoon
	Juniperus communis	■■■	■■						common juniper
	Berberis aquifolium	□□	■■	□□					tall Oregon-grape
	Symphoricarpos spp.	□□				□□	*		snowberry
	Spiraea lucida	□	■■■	■■■	■■	■			birch-leaved spirea
	Shepherdia canadensis	□	□□	■■■■	□□				soopolallie
	Rubus parviflorus				□□	■■■	*		thimbleberry
	Menziesia ferruginea				■	□□□	□	□	false azalea
	Lonicera involucrata				□	■■	■■■	□	black twinberry
	Ribes lacustre					■■	■		black gooseberry
	Cornus stolonifera					*	□□□		red-osier dogwood
	Viburnum edule						□		highbush-cranberry
	Rhododendron columbianum/ groenlandicum							■■■■	trapper's tea/Labrador tea
	Betula nana							■■■	scrub birch

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Herbs	*Calamagrostis rubescens*	■■■	■■■■■	■■■■■	■■■				pinegrass
	Arctostaphylos uva-ursi	□□	□□	*					kinnikinnick
	Pseudoroegneria spicata	□□	*						bluebunch wheatgrass
	Antennaria spp.	□	□						round-leaved alumroot
	Fragaria spp.	□	□□	□	*				strawberry
	Eurybia conspicua		□□	■■■	□□				showy aster
	Vaccinium scoparium/myrtillus			□□□□	■■■	■■■		■■	grouseberry/low bilberry
	Linnaea borealis			■■■	□□	□□	■■	□□□	twinflower
	Arnica spp.			■■	■■■	■■■	*		arnicas
	Chimaphila umbellata			□□	□				prince's pine
	Cornus canadensis			*	■■■	■■■	■■■■	■■	bunchberry
	Thalictrum spp.				□	■■	*	□	meadowrues
	Galium triflorum					■	■		sweet-scented bedstraw
	Actaea rubra					■	□		baneberry
	Streptopus amplexifolius					□	■		clasping twistedstalk
	Equisetum spp.						■■■■	■■	horsetails
	Gymnocarpium dryopteris						□□		oak fern
	Rubus pubescens						□	*	dwarf red raspberry
	Heracleum maximum						■		cow-parsnip
Moss layer	*Cladonia* spp.	□□□							clad lichens
	Peltigera spp.	□□□	□□						pelt lichens
	Polytrichum spp.	□□							haircap mosses
	Brachythecium spp.		□□	*	*	□□□	□□□		ragged-mosses
	Pleurozium schreberi			□□□	■■■■	□□□	□□□	□□□	red-stemmed feathermoss
	"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	12	12	28	10	17	10	8[b]
SMR	1 (2)	2	3 (2)	4	5	6 (7)	6–7
SNR	B (A, C)	B–C	C (B, D)	D (B, C)	C–D	D–E (C)	A–B
Slope position	UP (MD, CR)	MD–UP	MD (LW, UP)	MD	LW, TO (LV)	LV, TO (LW)	LV, DP
Typical slope/ aspect	Steep–moderately steep/warm	Steep/warm	Moderate (gentle)/ warm	Moderate/ neutral (cool)	Gentle (moderate)	Gentle (moderate)	Level (gentle)
Common compensating conditions		Neutral aspects with high sun exposure	Upper/cool, shedding; shallow or coarse on neutral, cool, or lower	Lower/coarse; gentle/warm	Mid-slope receiving sites; moderately coarse toe slopes		
Surficial materials	Cxv/R, Mx/R	Cb (FG)	Mb (FG, Cb)	Mb (Cb)	F (L, M)	F (L, Ov)	Ob, Ov/F
Soil texture	SiL (L, SL)	SiL, SL	SiL, SL (SCL)	SiL, L (SL)	SiL, SL (FSL, SiCL)	SiL, SL, S, SCL	SiL, SCL
Coarse fragment content	High–fragmental (moderately high)	High (moderate)	Moderate (high)	Variable	Moderate (high)	Low; often increasing at depth	Low; often increasing at depth
Important features	(Bed)rock is prominent and abundant; soils are often fragmental	Insolation			Seasonal seepage at depth	Moisture near surface; can have an organic veneer; cold air associated with riparian areas, swamp sites are also classified as Ws07	Typically wetland soils; most sites are also classified as Wb16 (or Wb15) bogs

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.
[b] Includes plots from the same site association in other areas of southern British Columbia.

Sxw – Arnica – Pinegrass 101

General Description

SMR 4. The 101 typically occurs on **mid slopes** of **neutral to cool** aspects and on gentle sites with deep, **medium-textured soils**. Due to compensating factors, it also occurs on lower, warm-aspect slopes. Soils are typically moderately well drained with silt loam, sandy loam, or loam textures. Eutric Brunisols are common where soils are derived from calcareous parent materials, and Orthic Humo-Ferric Podzols are typical in non-calcareous materials. Coarse fragment content is generally low to moderate.

Sxw is typically present and abundant in mature stands, with moderate amounts of **Lw** and **Bl**, and varying amounts of Fd and Pl. Shrub cover is variable with low to moderate cover of a range of species, including thimbleberry, birch-leaved spirea, and Sxw and Bl regeneration. **Arnica, bunchberry, grouseberry**, **low bilberry**, and/or **pinegrass** are usually present with < 10% cover each. Moss cover is variable, with low to moderately high cover of red-stemmed feathermoss being common.

Differentiating from Other Site Series

Slightly drier sites (104) have more grouseberry/low bilberry, pinegrass, soopolallie, and Pl, and less Sxw, Bl, bunchberry, and arnica. Slightly moister sites (110) lack pinegrass and have minor cover of moist indicators such as baneberry and sweet-scented bedstraw. They also have less Lw and more thimbleberry, black gooseberry, and black twinberry.

Variability

Sxw and Bl can be limited to the understorey, particularly at lower elevations where Fd, Lw, and Pl are more abundant. Lw can range from dominant to sparse or absent, and is often less abundant at upper elevations. Mid-seral 101 stands are common across the MSdw and often have higher cover of Pl, Lw, and Fd. Pinegrass cover is also generally higher in mid-seral stands, particularly where Pl is dominant and light availability is higher. In the upper half of the MSdw, false azalea is often present with minor cover. Bear-grass may be present and abundant in the southeast portion of the MSdw in the Wigwam and Flathead valleys.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be maintained. Forest productivity is high for the MS. Brush competition and ungulate browsing can limit tree growth and establishment.

102 Fd – Juniper

General Description

SMR 1 (2). The 102 site series occurs on **warm**-aspect sites where soils are **very shallow and/or coarse**. Sites usually have extensive **talus and/or exposed bedrock** and occur on convex mid- to upper-slope positions or crests. Soil textures are variable, depending on bedrock geology, but are usually silt loam to sandy loam.

Fd dominates the tree layers, although Pl is often present. Shrub cover varies, with saskatoon and juniper commonly present, often with snowberry and/or Oregon-grape. Pinegrass is usually present, along with minor cover of a variety of dry-site herb species such as kinnikinnick, yarrow (*Achillea* spp.), small-flowered penstemon (*Penstemon procerus*), pussytoes, stonecrops (*Sedum* spp.), and round-leaved alumroot (*Heuchera cylindrica*). Bluebunch wheatgrass is often present with minor cover (< 5%). Clad and pelt lichens are typically present, with a variety of mosses, including hair-cap mosses and heron's-bill mosses (*Dicranum* spp.).

Differentiating from Other Site Series

The 102 is the driest forested site series in the MSdw. Drier sites are non-forested and are either rock outcrops (Ro), talus (Rt), grasslands (Gg), or brushlands (Gb). Slightly moister sites (103) have little to no exposed bedrock or talus and are pinegrass-dominated, usually with more Lw, tall Oregon-grape, birch-leaved spirea, and showy aster.

Variability

Vegetation can be highly variable on these very dry sites. Py and arrowleaf balsamroot (*Balsamorhiza sagittata*) may be present in minor amounts, particularly at lower elevations adjacent to the IDFdm2. Pl is often a minor component of stands, particularly at upper elevations.

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. Drought stress can increase the susceptibility of trees to insects and disease.

Fd(LwPl) – Pinegrass 103

General Description

SMR 2. 103 sites occur on upper to mid slopes on moderately steep to steep, **warm aspects**, typically with **coarse**, **deep soils**, and occasionally on warm, shallow crests. Soils are typically Eutric Brunisols with silt loam or sandy loam textures and high to moderate coarse fragment content.

Fd is typically the leading species and is often also present in the understorey. Lw and Pl are typically present, but Pl is rarely dominant in mature stands. Sxw and Bl are usually sparse or absent. Shrub cover is typically high, with birch-leaved spirea, saskatoon, tall Oregon-grape, and common juniper most abundant. **Pinegrass** typically dominates the understorey, with small amounts of kinnikinnick, pussytoes, strawberry, and/or showy aster.

Differentiating from Other Site Series

Drier (102) sites have similar shrub composition, but sites are characterized by abundant bedrock and usually have clad lichens, bluebunch wheatgrass, and species typically associated with drier conditions, such as small-flowered penstemon, round-leaved alumroot, and rock ferns. Slightly moister (104) sites have less Fd and more soopolallie, twinflower, arnica, and prince's pine.

Variability

Falsebox can be abundant. Py may be present, especially at lower elevations. Lw and Pl are often more abundant at higher elevations.

Management Issues

Drought may limit tree productivity and cause mortality, especially during dry growing seasons. Ungulate browsing and vegetation competition can also limit tree establishment and growth. Soil erosion may be a concern following harvesting on steep slopes. Sites with large trees, lower snow depths, and high forage availability may provide important ungulate winter range.

104 Pl(Lw) – Pinegrass – Twinflower

General Description

SMR 3 (2). 104 sites are common and typically occur on **gentle to moderately sloped warm-aspect sites** with medium- to coarse-textured soils. Due to compensating factors, this unit also occurs on **cool to neutral** aspects that are on **upper, shedding** sites, or have **coarse- to very coarse-textured soils**. Soils are generally Eutric or Dystric Brunisols, but can be Gray Luvisols where subsurface horizons are clay enriched.

Pl is common, along with varying cover of Fd and Lw. **Soopolallie**, birch-leaved spirea, and saskatoon are common shrubs, while **pinegrass** is typically dominant in the herb layer. **Grouseberry and/or low bilberry** can be abundant, although cover varies (see Variability section below). **Twinflower** and showy aster usually have moderate cover, with minor amounts of arnica and prince's pine.

Differentiating from Other Site Series

Slightly drier sites (103) have less Pl, more Fd and pinegrass, and little or no grouseberry/low bilberry, twinflower, and arnica. Slightly moister sites (101) have more Sxw, Bl, bunchberry, and red-stemmed feathermoss, and less pinegrass, Pl, and soopolallie.

Variability

Mature Pl stands on coarser-textured glaciofluvial sites often have abundant kinnikinnick and/or twinflower. Bear-grass may be present and abundant in the southeast portion of the MSdw, particularly in the Wigwam and Flathead valleys. Grouseberry and/or low bilberry cover can be highly variable on 104 sites, ranging from dominant to absent. Two site series variations are described for the 104:

> **104.1 Pl(Lw) – Pinegrass – Twinflower**
> sites with little to no grouseberry and/or low bilberry (< 10% cover); showy aster, prince's pine, and soopolallie often have higher cover
> **104.2 Pl(Lw) – Pinegrass – Grouseberry**
> sites with > 10% cover of grouseberry and/or low bilberry

Management Issues

This site series is common across the landscape, and maintaining tree species diversity at stand and landscape scales is important. Soil erosion may be a concern following harvesting on steep slopes. Ungulate browsing and grass competition may limit tree establishment and growth.

SxwBl – Azalea – Bunchberry 110

General Description

SMR 5. 110 sites occur on toe and lower slopes in moist sites with **seasonal seepage** or subirrigation. They are often associated with **riparian areas**. Soils are usually deep with silt loam or sandy loam soil textures and variable coarse fragment content. Gleyed brunisols and podzols are common.

Sxw and **Bl** dominate the canopy, although minor amounts of Pl, Fd, and Lw may be present. **Cw** can be abundant (see Variability section below). Black gooseberry, thimbleberry, false azalea, and/or black twinberry are usually present, along with **bunchberry**, arnica, meadowrues, and minor amounts of sweet-scented bedstraw, baneberry, and/or clasping twisted-stalk.

Differentiating from Other Site Series

Slightly drier sites (101) usually have more Lw, minor cover of pinegrass, less black twinberry and black gooseberry, and little to no moist-associated species, such as baneberry, oak fern, and sweet-scented bedstraw. Slightly moister sites (111) have moderate to high cover of horsetails, and generally lack Fd, Pl, and Lw. Moist to wet, poor sites (112) have trapper's tea and/or Labrador tea.

Variability

Cw can be present and dominant on 110 sites in riparian areas of the MSdw, and site series variations are described:

110.1 SxwBl – Azalea – Bunchberry
sites lacking Cw

110.2 CwSxw – Bunchberry – Mitrewort
sites where Cw is abundant, often with Bl and Sxw; thimbleberry, red-osier dogwood, and/or highbush-cranberry often occur with bunchberry, queen's cup (*Clintonia uniflora*), and arnicas, as well as lady fern (*Athyrium felix-femina*), oak fern, and devil's club (*Oplopanax horridus*)

Small amounts of oak fern and devil's club may occur on both variations.

Management Issues

Tree productivity is high on these sites, and vegetation competition may impede regeneration following harvest. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Frost may limit regeneration, particularly in areas where cold air pools. Maintaining Cw on sites where it is dominant or codominant will contribute to stand and landscape biodiversity and habitat values.

111 Sxw – Horsetail

General Description

SMR 6 (7). 111 sites occur on **gentle to level receiving sites** with the **water table** typically **near the surface** or within the top 30 cm of the soil profile. Sites are usually associated with **riparian floodplains** and have a thin (< 20 cm) to thick, peaty, organic veneer over mineral soils. Soils are typically sandy to silt-textured Gleysols or Gleyed Regosols and are derived from fluvial materials. Coarse fragment content is usually sparse to absent but may be high at depth.

Sxw is dominant in the overstorey, while **horsetails** characterize the understorey. Red-osier dogwood may be present in the shrub layer with black twinberry and highbush-cranberry. Minor cover of willows (*Salix* spp.) is also common. Bunchberry, dwarf red raspberry, cow-parsnip, and clasping twistedstalk are often present. A wide variety of other herb species, each with minor cover, is also typical of these sites.

Differentiating from Other Site Series

Slightly drier sites (110) have little to no horsetails (< 2%). Wet sites with poorer nutrient availability (112) are dominated by trapper's tea and/or Labrador tea, with abundant peat-mosses. Other wetter sites are non-forested wetlands (see Section 6.2)

Variability

111 sites usually occur on high bench floodplains, with non-wetland soils. Occasionally, sites with very poor drainage and a thick organic veneer occur; these can be classified as treed swamps (Ws07). Vegetation is very similar on both site conditions, and two phases are described to reflect the site variability:

111a for **riparian flood sites**
111b for the **swamp phase** (Ws07) (see Section 6.2)

Bluejoint reedgrass (*Calamagrostis canadensis*) can be prominent, especially in open stands.

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Sites have high productivity, and vegetation competition may be a concern in regenerating stands. Cold air and frost may limit regeneration. Windthrow hazard should be a consideration in areas adjacent to harvesting due to shallow rooting. These sites provide forage for wildlife and are often part of travel corridors in steep terrain.

Sxw – Trapper's tea – Peat-moss 112

General Description

SMR 7. The 112 site series occurs on **level to gently sloping sites**, usually **adjacent to wetlands or water bodies** and typically where **cold air** accumulates. Soils are organic with a deep, peaty layer at the surface (often > 1 m thick), and the surface is saturated for much of the year. These sites are also classified as **bogs (Wb)** in the non-forested and related ecosystem classification (see Section 6.2).

Sxw typically dominates the overstorey, although Pl can be present and abundant. Bl often occurs with minor cover in the overstorey and/or understorey. **Trapper's tea** (occasionally Labrador tea) is always abundant (> 10% cover). Other common species include bunchberry, dwarf red raspberry, sedges (*Carex* spp.), and bluejoint reedgrass. Minor cover of scrub birch, alders (*Alnus* spp.), and willows (*Salix* spp.) is also common. Peat-mosses and red-stemmed feathermoss are usually abundant.

Differentiating from Other Site Series

The 112 is characterized by abundant trapper's tea (or occasionally Labrador tea). Slightly richer, moist to wet sites (111) are dominated by horsetails, with little or no trapper's tea or Labrador tea. Richer, drier sites (110) also lack trapper's tea and Labrador tea, and have more arnicas, thimbleberry, and (often) ferns.

A separate site series is described in the MSdk for submesic to subhygric sites dominated by Labrador tea. These sites are very uncommon in the MSdw and are not recognized as a separate site series. If encountered, users can manage these sites following guidance for the MSdk/104.

Variability

Species diversity can be high, with a number of understorey species often present with low cover. Sxw is usually dominant, although Pl often occurs and can be abundant. Although trapper's tea is most common, Labrador tea can be dominant on these sites. This site series has two variations that can also be classified as separate treed bog site associations:

112.1 Sxw – Trapper's tea – Peat-moss (Wb16)
Trapper's tea is abundant (most common bog in the MSdw)

112.2 Sxw – Labrador tea – Peat-moss (Wb15)
Labrador tea is abundant (typically restricted to the northern extent of the MSdw)

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Cold air, frost, and deep organic soils may limit tree regeneration. Windthrow hazard may be a concern in areas adjacent to harvesting due to shallow rooting.

Other Ecosystems

The following ecosystems occur in the MSdw; they are described in detail in Chapter 6.

Wetlands

Wetland diversity is high in the MSdw, with bogs (Wb), fens (Wf), swamps (Ws), marshes (Wm), and shallow water wetlands (Ww) occurring. Wetland site associations are described in Section 6.2.

Cottonwood forests and other flood ecosystems

Cottonwood floodplain forests (Fm) are moderately common in the MSdw. The most common Fm site associations in the MSdw are *Fm01 – Cottonwood – Snowberry – Rose* and *Fm02 Cottonwood – Spruce – Dogwood*. Low bench (Fl) site associations are dominated by willows or alders. Flood ecosystems are described in Section 6.3.

Grasslands and brushlands

Grasslands and brushlands occur infrequently throughout the MSdw, and are most common in the Elk and Flathead valleys or in areas contiguous with grasslands in the IDF. Section 6.4 describes the grassland and brushland site associations that are most common in the MSdw.

Avalanche features

Avalanche ecosystems are moderately common in the MSdw and consist mostly of herb-dominated (Vh) and shrub-dominated (Vs) types in run-out zones and the lower portions of slide paths that initiate in higher-elevation ESSF subzones. Descriptions of avalanche ecosystems are provided in Section 6.5.

Rock outcrops and talus

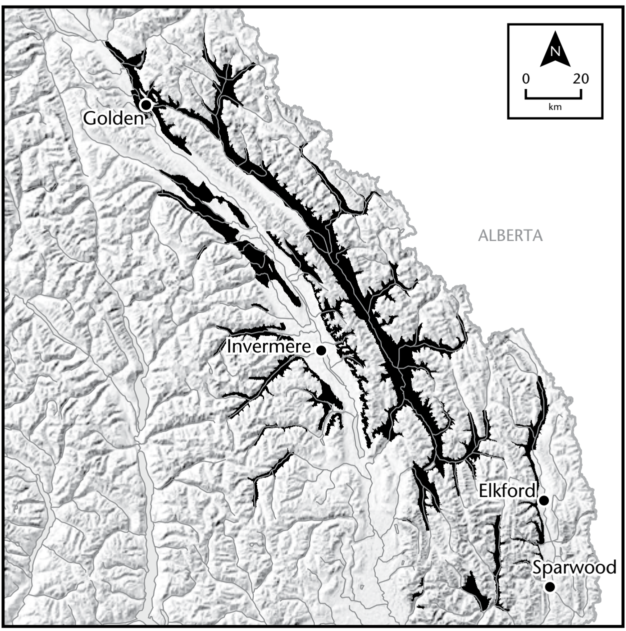
Rock outcrop (Ro) and talus (Rt) ecosystems are common in the MSdw. See Section 6.6 for descriptions of rock ecosystems.

MSdk
Dry Cool
Montane Spruce

Geographic Distribution

The MSdk occurs at low to mid elevations in the Kootenay and Columbia River valleys and along their tributaries from Donald south to the upper Bull and Elk Rivers. It includes major tributaries such as the Spillimacheen River and Horsethief, Toby, Dutch, Brewer, and Findlay Creeks in the Purcell Mountains and the Kicking Horse, Beaverfoot, Vermillion, Cross, Palliser, Bull, and Elk Rivers in the Rocky Mountains. Throughout most of its range, the MSdk occurs below the ESSFdk2, either to valley bottom or above the IDFdk5. Occasionally, it occurs adjacent to the ICHmk5. The MSdk abuts the MSdw at similar elevations to the south and the ICHmw1 at similar elevations to the north.

Distribution of the MSdk



Elevation Range

The MSdk often extends to valley bottom. Where it occurs above the IDFdk5, lower elevations range from 1100 to 1250 m on cool and neutral aspects and from 1250 to 1350 m on warm aspects. Upper elevation limits are generally 1575 m on cool aspects, 1650 m on neutral aspects, and 1700 m on warm aspects. Where the MSdk occurs adjacent to the ICHmk5, elevation limits vary depending on the distribution of Cw.

Climate[1]

The MSdk occurs in the Dry climate subregion and is characterized by dry, cold winters and dry, warm summers. Winter snowpacks are moderately deep and persist from December or early January through March. Growing-season moisture deficits typically occur on subxeric and drier sites, and on submesic to mesic sites in dry years. Frost is a common limiting factor. Northern air masses with cold air influence the MSdk, often bringing extreme cold temperatures. The MSdk is colder and slightly moister than the MSdw.

Forest and Vegetation Characteristics

The MSdk is very diverse and productive for the MS zone. Common tree species are Sxw, Fd, Pl, Bl, At, Act, and Ep. **Zonal sites** are characterized by Fd and Sxw with bunchberry and abundant feathermosses. **Drier sites** have more Fd and/or Pl, less Sxw, and (usually) abundant pinegrass. **Moist sites** have more Sxw and Bl, and little or no Fd or Pl. False azalea can be abundant on mesic and moister sites. Sites with **lower nutrient availability** have abundant Pl and Labrador tea. These include circum-mesic sites (104) and wetter sites (112); the wetter sites often have a thick peaty organic layer, and many can also be classified as forested bogs (Wb15) (see Section 6.2). **Wet sites** with higher nutrient availability are spruce- and horsetail-dominated and lack Pl.

Lw, Cw, and Pf (limber pine) also occur in the MSdk but with limited distributions. **Lw** is restricted to the southern half of the MSdk, where it often forms a minor component of forests on submesic to subhygric sites. It is generally absent at latitudes north of Brisco. **Cw** occurs within the MSdk, but is scattered across the landscape and is usually restricted to moist riparian sites (see 110.2 site series variation on page 194) and adjacent upland areas. Maintaining Cw on these sites provides important species and habitat variability for biodiversity. **Pf**[2] is an at-risk tree species that is scattered infrequently throughout the MSdk; it usually occurs on dry, rocky sites.

[1] See Section 4.5 for more information on climate variables.

[2] *Pinus flexilis* (limber pine).

The MSdk covers a broad geographic area in the Rocky Mountains and the Purcell Mountains. At lower elevations in the MSdk, Fd and pinegrass are common on mesic and drier sites. This includes valley-bottom areas in large valleys, including the upper Kootenay. At upper elevations and on cooler sites in the MSdk, Bl, false azalea, and grouseberry/low bilberry often become more common and abundant.

Avalanche paths frequently extend into the MSdk, particularly the lower portions and run-out zones and lower portions of avalanche tracks. Wetlands are typically small and uncommon but provide important landscape variability. The exception to this is in the Columbia Valley and in areas of the upper Kootenay and Elk Rivers where wetlands are more frequent and extensive along the valley bottoms. Cottonwood floodplains are limited in distribution but provide critical habitat where present at lower elevations in larger river valleys. Grasslands are very uncommon, and brushlands occasionally occur on warm, rocky sites. Rock outcrops, talus, and cliffs are abundant.

Disturbance

Historically, frequent stand-initiating **wildfires** in the MSdk maintained a **mosaic of even-aged forest stands** in patches of different ages across the landscape, as well as some patches of old forest that were skipped over by fire. While stand-replacing fires dominate much of the land base, **mixed-severity fires**, including frequent low-severity burns, were historically common. Fire history studies in the MSdk and MSdw have found evidence of stand-maintaining fire with intervals ranging on average from 15 to 75 years (range 5–138 years between fires) (Cochrane 2007). These occurred primarily on warm and cool aspects connected to lower-elevation, fire-prone sites (Cochrane 2007). Fd and Lw are the most common remnant trees in the MS, occurring as single veteran trees and as clumps, patches, and islands ranging in area from 1 to 100 ha (Stuart-Smith and Hendry 1998).[3] On sites that had stand maintaining fires, **forest ingrowth and encroachment** have created dense, closed stands. Seral Pl stands are also extensive in the MSdk where stand-replacing wildfires have burned large areas over the past century. Extensive **timber harvesting** has increased the area dominated by early to mid seral mixed coniferous forests.

Bark beetles are important disturbance agents, particularly **mountain pine beetle**, but also Douglas-fir beetle in stands with high Fd cover. Balsam

[3] Data include fires from the MSdk, MSdw, and adjacent ESSF. Mean size of remnant patches within burn perimeters was 10.4 ha (± 6.2 ha) for islands and 13.5 ha (± 7.7 ha) for skips.

bark beetle can be a key driver of regeneration and development of multi-storeyed stands where Bl is abundant. Spruce beetle can cause high mortality in mature stands, especially following fire or blowdown, or where slash retention is high after harvest. Spruce terminal weevil is an impediment to regenerating Sxw. Defoliation from 2-year-cycle spruce budworm can cause both growth loss and mortality of Sxw and Bl, and outbreaks have been recorded in the MSdk. Insect infestations create diverse stand- and landscape-level structure and species composition through partial disturbances that leave legacies (veteran trees, snags, CWD) and stimulate understorey vegetation growth (Dykstra and Braumandl 2006; Amoroso et al. 2013).

Pathogens are also important influences on growth and survival of mature and regenerating stands. Armillaria root rot creates gaps in mature stands and can be a major impediment to tree regeneration. Several rusts and fungi also affect regenerating trees, particularly Pl. Commandra blister rust commonly kills Pl, while stalactiform blister rust reduces growth and form and sometimes kills Pl. Western gall rust and atropellis cankers rarely kill Pl but cause growth loss and deformity. In other conifers, rhabdocline needle cast can cause growth losses in Fd on warmer sites, while larch needle blight has similar effects on Lw at the southern extent of the MSdk where Lw is abundant.

Soils, Geology, and Landforms

The MSdk covers diverse geological areas in the Purcell Mountains and Rocky Mountains. Dominant bedrock types across the Rocky Mountains include limestone, slate, phyllite, siltstone, argillite, and dolomitic carbonate rocks. Areas of finer-textured mudstone, siltstone, and shale are found in the upper Kootenay River valley north of the Vermillion River and in the Columbia River valley north of Parsons. In the Purcell Mountains, dominant bedrock types are phyllite, siltstone, dolomite, quartzite, and conglomerate. Calcareous bedrock types cover much of the MSdk but are far less common in the Purcell Mountains than in the Rocky Mountains. Finer-textured, non-calcareous bedrock types in both the Purcell Mountains and Rocky Mountains are generally nutrient rich.

Morainal and colluvial soils in this subzone often have textures ranging from silt loam to sandy loam, and often have weakly clay-enriched (Bt) subsurface horizons. Where soils are derived from calcareous bedrock, they usually have carbonate-enriched (Cca) subsoil layers that may be cemented. Soils derived from calcareous and other fine-textured bedrock are primarily Eutric Brunisols or Brunisolic Gray Luvisols. Dystric Brunisols and Orthic Humo-Ferric Podzols are common, particularly where parent materials are non-calcareous. Colluvial veneers and large areas of exposed bedrock are scattered throughout the MSdk. Glaciofluvial and fluvial terraces are common in the Kootenay and White River drainages, while fluvial or eolian veneers over glaciofluvial features are more common south of Parsons.

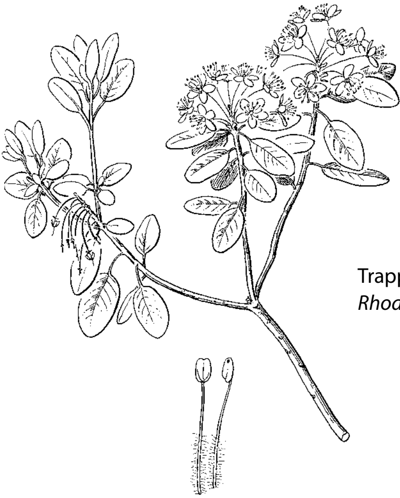
Wildlife Habitat

Forests in the MSdk provide high-value winter ranges for abundant populations of **Rocky Mountain elk**, **bighorn sheep**, **mule deer**, and **moose**. The unit provides important early-season foraging habitat for **grizzly bear** and **black bear**, as well as connectivity and linkage habitat for bears and other wide-ranging carnivores, including **wolverine** and **Canada lynx**. Furbearers, such as American marten, bobcat, and snowshoe hare are abundant, and the at-risk **southern red-backed vole** also occurs here. Drier open forests are used by **American badger**, and rocky habitats provide breeding sites for species such as white-throated swift, peregrine falcon, and little brown myotis.

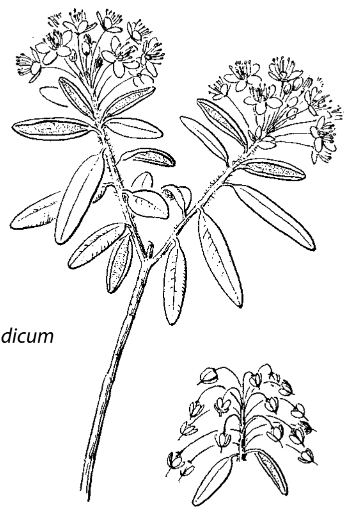
The MSdk covers areas within the northern extent of the **Columbia Wetlands** and is adjacent to these wetlands throughout much of the Rocky Mountain Trench. The Columbia Wetlands and several major tributaries in the MSdk support aquatic furbearers, including **American beaver**, **North American river otter**, and **American mink**. Wetlands and lakes throughout the MSdk are important for a variety of bird, mammal and amphibian species including at-risk **American avocet**, **common nighthawk**, **great blue heron**, **rusty blackbird**, **short-eared owl**, and **western toad**, and upland areas adjacent to the wetlands are important connectivity habitat for broad-ranging species. **Harlequin ducks**, **bull trout**, and **cutthroat trout** also breed along some streams in the MSdk.

The MSdk provides important habitat for species that require **old- and mature-forest structures** for breeding, feeding, or perching. Such species include **northern goshawk**, **broad-winged hawk**, **flammulated owl**, **Lewis's woodpecker**, **Williamson's sapsucker**, and **olive-sided flycatcher**, as well as pileated woodpecker, hairy woodpecker, northern flicker, brown creeper, red-breasted nuthatch, mountain chickadee, Pacific wren, and red squirrel. These species require retention of large structures such as live trees, wildlife trees with heart rot and cavities, hollow logs, and insect host trees.

The MSdk supports a variety of **at-risk vascular plant species** that are associated with montane habitats, including Pf. Two invertebrates of concern are also known to occur: **vivid dancer** (a dragonfly associated with cold/hot springs) and **Gillette's checkerspot** (a butterfly found in open wooded areas, often near streams). Some of the more common bird species include yellow-rumped warbler, Swainson's thrush, American robin, dark-eyed junco, and Townsend's warbler.



Trapper's tea
Rhododendron columbianum

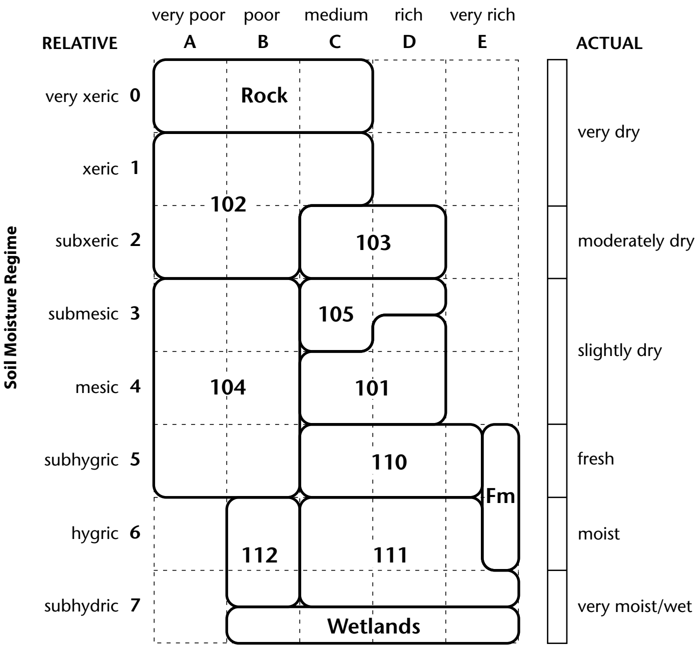


Labrador tea
Rhododendron groenlandicum

Distinguishing the MSdk from Adjacent Biogeoclimatic Units

In the **IDFdk5**, most sites have:	- more Fd, less Pl and Sxw - no Bl or grouseberry/low bilberry - less Douglas maple, Sitka alder, and thimbleberry
zonal sites have:	- no Sxw or Bl in the understorey or overstorey - more pinegrass - little or no bunchberry
dry sites have:	- bluebunch wheatgrass - more Rocky Mountain juniper
In the **ICHmk4** and **ICHmk5**, most sites have:	- Cw across the landscape, not just restricted to riparian and adjacent areas - little or no grouseberry/low bilberry
zonal sites have:	- Cw - more Douglas maple and Ep
wet sites have:	- more ferns and devil's club
In the **MSdw**, most sites have:	- Lw - no knight's plume or step moss
zonal sites have:	- less bunchberry - more arnica and pinegrass
dry sites have:	- more saskatoon and bluebunch wheatgrass - more grasslands
In the **ESSFdk2**, most sites have:	- more Bl - more false azalea and/or white-flowered rhododendron - higher cover of grouseberry and/or low bilberry
zonal sites have:	- no Fd, less Pl - no pinegrass, less twinflower
dry sites have:	- less Fd, pinegrass, and saskatoon - no Rocky Mountain juniper
wet sites have:	- no highbush-cranberry - cow-parsnip, arrow-leaved groundsel, valerian, or false-hellebore

Edatopic Grid



Site series

101	SxwFd – Bunchberry – Feathermoss
102	Fd – Juniper – Douglas maple
103	FdPl – Juniper – Pinegrass
104	SxwPl – Labrador tea – Feathermoss
105	FdPl – Pinegrass – Twinflower
110	SxwBl – Azalea – Bunchberry
111	SxwBl – Horsetail
112	Sxw – Labrador tea – Peat-moss
Fm01	Cottonwood – Snowberry – Rose[a]
Fm02	Cottonwood – Spruce – Dogwood[a]

[a] See Section 6.3 for descriptions.

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects
- shallow soils and/or extensive bedrock

→
- SMR 1 (2)
- Fd stands
- bedrock or talus prominent
- Rocky Mountain and common juniper
- saskatoon and kinnikinnick may occur

→ **102**

→
- SMR 2
- Fd (Pl) stands
- steep, coarse, or shallow; warm aspects
- juniper saskatoon, soopolallie, birch-leaved spirea
- kinnikinnick and pinegrass abundant

→ **103**

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

→
- SMR 3–5; nutrient-poor sites
- Sxw, Pl stands
- coarse-textured FG or F; often with cold air
- Labrador tea is abundant
- stiff club-moss, rough-leaved ricegrass

→ **104**

→
- SMR 3 (2)
- Fd, Pl (Sxw)
- gentle to moderately steep, warm aspects
- soopolallie with birch-leaved spirea and rose
- pinegrass and twinflower abundant
- Fd regen

→ **105**

→
- SMR 4
- Fd, Sxw (Pl, Bl) stands with Bl regen
- mid-slope, neutral to cool aspects
- moderate false azalea and Utah honeysuckle
- bunchberry, twinflower, and arnica common
- Bl regen

→ **101**

MOIST to WET FORESTS
- lower, level, or toe slopes
- seepage, water table, or mottles present

→
- SMR 5
- Sxw (Pl, Bl) stands
- receiving sites, seepage > 50 cm
- Cw can be abundant, often in the understorey (110.2)
- black twinberry, bunchberry, mitreworts, bedstraw

→ **110**

→
- SMR 6 (7)
- Sxw (Bl) stands
- very wet sites, water table at or near surface
- horsetails are abundant

→ **111**

→
- SMR 7
- Sxw (Bl, Pl) stands
- very wet sites, water table at or near surface
- Labrador tea and peat-mosses abundant

→ **112**

Vegetation Table

Layer	Scientific name	102	103	104	105	101	110	111	112	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■		■■■■	■■■■	*			Douglas-fir
	Pinus contorta		□□□	■■■■	■■■	□□□	□□		■■■	lodgepole pine
	Picea engelmannii x *glauca*			■■■■	□□□	■■■■	■■■■■	■■■■■	■■■■	interior spruce
	Abies lasiocarpa					□□□	□□□	□□□	*	subalpine fir
Regen	*Pseudotsuga menziesii*	■■■	■■■		□□□	*				Douglas-fir
	Picea engelmannii x *glauca*			■■■	□□	□□□	■■■	■■■	■■■	interior spruce
	Abies lasiocarpa					■■■	■■■	□□	□□	subalpine fir
Shrubs	*Acer glabrum*	■■■	□□		*	*	*			Douglas maple
	Juniperus communis	■■■	■■■■	□□	□□				□□	common juniper
	Juniperus scopulorum	■■■	□□							Rocky Mountain juniper
	Amelanchier alnifolia	■■	■■	□□	□	□	*			saskatoon
	Symphoricarpos spp.	*	□□		□□					snowberry
	Shepherdia canadensis		■■■	■■■■	■■■■	□				soopolallie
	Rosa acicularis		■■	□	■■	□	□	□□	□	prickly rose
	Spiraea lucida		■■	□□	■■	□	□			birch-leaved spirea
	Rhododendron groenlandicum			■■■■■					■■■■	Labrador tea
	Menziesia ferruginea			■■■		□□□	■■■	*	□	false azalea
	Lonicera involucrata			□□			■■	■■■	□	black twinberry
	Lonicera utahensis			□	□	■■	□□			Utah honeysuckle
	Ribes lacustre					□	□	□		black gooseberry
	Rubus parviflorus						□□			thimbleberry
	Cornus stolonifera						□□	□□		red-osier dogwood
	Viburnum edule						□	*		highbush-cranberry
	Betula nana								■■■■	scrub birch
	Salix spp.								■■■	willows
	Dasiphora fruticosa								■■■	shrubby cinquefoil

Layer	Scientific name	102	103	104	105	101	110	111	112	Common name
Herbs	*Arctostaphylos uva-ursi*	□□□	■■■		□					kinnikinnick
	Calamagrostis rubescens	*	■■■■	□□□	■■■■■	*				pinegrass
	Fragaria spp.	*	■	□	■					strawberry
	Eurybia conspicua		■■	□□□	■■■	□				showy aster
	Linnaea borealis		*	■■	■■■	■■	■■	□□	■■■	twinflower
	Vaccinium scoparium/myrtillus			□□□		□□			□□	grouseberry/low bilberry
	Cornus canadensis			■■■	*	■■■	■■■	■■■	■■	bunchberry
	Arnica cordifolia			□	□	□□	□□			heart-leaved arnica
	Chimaphila umbellata				□	□				prince's pine
	Goodyera oblongifolia				□	□				rattlesnake-plantain
	Vaccinium caespitosum			■■						dwarf blueberry
	Lycopodium annotinum			■■						stiff club-moss
	"mitreworts"[a]			□			■	■■	□□	mitreworts
	Rubus pubescens						□□	□□	*	dwarf red raspberry
	Equisetum spp.						□	■■■■■	■■	horsetails
	Galium triflorum						□	□		sweet-scented bedstraw
	Petasites frigidus							□□	□□□	sweet coltsfoot
	Calamagrostis canadensis							□□	*	bluejoint reedgrass
	Carex spp.							*	□□□	sedges
Moss layer	*Peltigera* spp.	□□	■■	□	□□	□□	□□			pelt lichens
	Pleurozium schreberi		*	■■■■	■■■■	■■■■■	■■■■■	■■■■	■■■	red-stemmed feathermoss
	Hylocomium splendens			□□□□□	□□□	■■■■	□□□□	□□□□	□□□	step moss
	Ptilium crista-castrensis			□□□□	*	□□□	■■■■	□□		knight's plume
	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	105	101	110	111	112
No. of plots	13	22	6	39	25	41	27	5
SMR	1 (2)	2	3 – 5	3	4	5	6 (7)	7 (6)
SNR	B (A, C)	C–D	B–C (A)	C–D	C–D	C–D (E)	D–E (C)	A–B (C–D)
Slope position	UP (MD, CR)	MD–UP	LV, LW (DP)	MD (UP)	MD	LW, TO, LV	LV (TO)	LV, DP
Typical slope/ aspect	Steep– moderately steep/ warm	Steep/warm	Level– gentle	Gentle– moderately steep/warm	Moderate/ neutral (cool)	Gentle, level (moderate)	Level (gentle)	Level (gentle)
Common compensating conditions		Neutral aspects with high sun exposure		Steep and/or coarse neutral to cool aspects	Lower/ coarse; gentle/ warm	Mid-slope receiving sites; moderately coarse toe slopes		
Surficial materials	Cxv/R, Mv/R (Cb)	Cb, Cv (Mb, FG)	F, FG	Mb (FG, Cb)	Mb (Cb, FG)	F (C, M)	Ov/F (F)	Ob, Ov/F (F)
Soil Texture	SiL (SL, L)	SiL (SL, L)	SiL, SL	SiL, SL (SCL, CL)	SiL, SL (L)	SiL, SL (LS, SiCL)	SiL (SiCL, SL)	O (Sil, S)
Coarse fragment content	High– fragmental (moderately high)	Moderately high (moderate, high)	High	Moderate (variable)	Moderate (variable)	Low–moderate (high)	Low; often increasing at depth	Nil
Important features	Rock is prominent and abundant; soils are often fragmental	Insolation	Low nutrient availability; coarser-textured soils; cold air			Seasonal seepage	Water table near surface; cold air; often riparian areas or swamp (Ws07)	Usually a bog (Wb15); cold air; low nutrient availability

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

SxwFd – Bunchberry – Feathermoss 101

General Description

SMR 4. Typical site conditions for the 101 site series are **mid slopes** of **neutral aspects** or **deep**, **level** areas with **medium-textured soils**. Soils are typically moderately well-drained with silt loam, sandy loam, or loam textures. Eutric Brunisols are common where soils are derived from calcareous parent materials, and Orthic Humo-Ferric Podzols are typical in non-calcareous materials. Coarse fragment content is generally low to moderate.

Sxw and **Fd** are typically present and abundant in mature stands, with minor amounts of Pl and/or low to moderate cover of Bl. Shrub cover typically includes Utah honeysuckle and/or false azalea, with minor cover of Douglas maple, black gooseberry, or prickly rose. **Bunchberry** and **twinflower** are typically present with low to moderate cover (usually < 8%), usually with varying amounts of arnica (< 10% cover) and minor cover of prince's pine, one-sided wintergreen (*Orthilia secunda*), and rattlesnake plantain. Pinegrass is frequently present, although cover is typically < 5%. The well-developed moss layer consists of red-stemmed feathermoss, step moss, and knight's plume.

Differentiating from Other Site Series

Slightly drier sites (105) are dominated by pinegrass and soopolallie, and have higher cover of showy aster and twinflower along with minor amounts of common juniper. Fd regeneration is common in the understorey. Slightly moister sites (110) have black twinberry, red-osier dogwood, highbush-cranberry, dwarf red raspberry, and/or mitreworts. Sites with poorer nutrient availability (104) have abundant (> 5% cover) Labrador tea and lack Fd.

Variability

Shrub cover and composition are variable. False azalea is usually sparse or absent in the lower half of the MSdk, and ranges from absent to dominant in the shrub layer (> 20% cover) in the upper half. Across the elevation range, Douglas maple and Sitka alder (*Alnus viridis* ssp. *sinuata*) commonly range from absent to > 15% cover. Lw is often present in the southern portion of the MSdk, and younger stands often have higher Pl and Fd cover. Soopolallie can be abundant, particularly in seral Pl stands of the 101; these sites are differentiated from drier (105) sites by the abundance of bunchberry, false azalea, and considerably less pinegrass. Grouseberry and/or low bilberry frequently occur but are not dominant.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be maintained. Forest productivity is high for the MS. Brush competition and ungulate browsing can limit tree growth and establishment.

102 Fd – Juniper – Douglas maple

General Description

SMR 1 (2). The 102 site series occurs on **warm** aspects where soils are **very shallow and/or rocky.** Sites usually have extensive **talus and/or exposed bedrock** and occur on convex mid- to upper-slope positions or crests. Soil textures are variable, depending on bedrock geology, but are most commonly silt loam or sandy loam, with high or very high coarse fragment content.

Fd dominates the tree layers, although Pl may be present, particularly in earlier seral stands. **Common juniper** and **Rocky Mountain juniper** are usually present, along with Douglas maple, saskatoon, kinnikinnick, and minor cover of a variety of dry herbs such as yarrow (*Achillea* spp.), pussytoes (*Antennaria* spp.), common harebell (*Campanula rotundifolia*), shrubby penstemon (*Penstemon fruticosus*), saxifrages (*Saxifraga* spp. and *Micranthes* spp.), and rock ferns. The moss layer is usually poorly developed, particularly on talus sites. Pelt lichens and clad lichens (*Cladonia* spp.) are usually present with variable cover.

Differentiating from Other Site Series

Drier sites are non-forested talus (Rt) or rock outcrops (Ro) (see Section 6.6) or brushlands (Gb) (see Section 6.4) with < 10% tree cover at maturity. Slightly moister sites (103) have deeper soils with soopolallie, birch-leaved spirea, prickly rose, pinegrass, and/or showy aster.

Variability

Plant species vary across these sites based on soil depth in small microsites; occasionally, species associated with moister conditions will occur in deeper pockets of soil. Pf, an at-risk tree species, and At may be present with minor cover.

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. Drought stress can increase the susceptibility of trees to insects and disease.

FdPl – Juniper – Pinegrass 103

General Description

SMR 2. 103 forests occur on **upper** to **mid** slopes of moderately steep to **steep**, **warm-aspect** sites, typically with **coarse**, **deep soils**. They also occur on coarse, dry crests and deep, coarse-textured glaciofluvial terraces. Soils typically have silt loam or sandy loam textures with high or very high coarse fragment content and are commonly Eutric or Melanic Brunisols.

Fd typically dominates the tree layers, often with minor amounts of Pl or Sxw. Shrub cover is usually high, with **common juniper**, birch-leaved spirea, saskatoon, prickly rose, and soopolallie being most common. **Pinegrass** and **kinnikinnick** typically dominate the understorey, with small amounts of strawberry and showy aster. The moss layer is usually poorly developed with minor cover of pelt lichens and clad lichens.

Differentiating from Other Site Series

Slightly drier sites (102) have shallow soils with exposed bedrock or talus and typically have little or no pinegrass, showy aster, soopolallie, prickly rose, or birch-leaved spirea. The lack of twinflower and the abundance of common juniper and kinnikinnick differentiate the 103 from the slightly moister 105.

Variability

Kinnikinnick is usually present and often abundant (> 25% cover). Pinegrass cover varies from absent to very high (> 20%). Sites with higher shrub cover tend to have lower cover of pinegrass, showy aster, and other herbs. Lw may be present on these sites at the southern extent of the MSdk. Pl is frequently present but rarely dominant, even in earlier seral stands.

Management Issues

Drought may limit tree productivity and cause mortality, especially during dry growing seasons. Ungulate browsing and vegetation competition can also limit tree establishment and growth. Soil erosion may be a concern following harvesting on steep slopes. Sites with large trees, lower snow depths, and high forage availability may provide important ungulate winter range.

104 SxwPl – Labrador tea – Feathermoss

General Description

SMR 4–5 (3). The 104 site series is uncommon and occurs on level to gentle sites, typically associated with nutrient-poor, **coarse-textured glaciofluvial or fluvial** sites with **cold-air pooling**. Soils usually have coarse sandy loam or loamy sand textures, often at depth, with a thin, finer-textured silt loam capping.

Pl and Sxw characterize the tree layers, while **Labrador tea** is abundant in the shrub layer. Bunchberry, **dwarf blueberry**, **stiff club-moss**, and rough-leaved ricegrass (*Oryzopsis asperifolia*) are common, along with minor amounts of twinflower, showy aster, grouseberry/low bilberry, and pinegrass.

Differentiating from Other Site Series

Labrador tea–dominated sites also occur on wet sites in the MSdk (112). On these sites, the water table is near the surface, and many sites have a thick organic layer. Scrub birch, shrubby cinquefoil, willows, and sedges are typically present, while drier species such as soopolallie, showy aster, and pinegrass are not. Sites with similar moisture regimes and higher nutrient availability (105, 101, 110) have more Fd and no Labrador tea.

Variability

Most sites have mesic or subhygric moisture regimes, although drier, submesic sites can also occur. The 104 can occur on drier areas adjacent to 112 sites, or independently. Trapper's tea can occur on 104 sites, especially at the southern extent of the MSdk.

Management Issues

104 sites have lower productivity than other circum-mesic sites in the MSdk. Cold-air pooling is common, and frost may limit regeneration.

FdPl – Pinegrass – Twinflower 105

General Description

SMR 3. The 105 site series typically occurs on gentle to moderately steep, **warm-aspect** sites with medium- to coarse-textured soils. It also occurs on **cool to neutral** aspects on **upper**, **shedding sites**, or on sites with coarse- to very coarse-textured soils. Soils are typically deep and well drained with sandy loam or silt loam textures and moderate to high coarse fragment content.

Fd and **Pl** are common, along with varying amounts of Sxw. **Soopolallie** and **pinegrass** are typically the dominant understorey species. Minor amounts of birch-leaved spirea, common juniper, prickly rose, and snowberry are usually present, with moderate cover (~ 5–15%) of **twinflower** and **showy aster.** Minor amounts of arnica, prince's pine, and/or kinnikinnick may occur (< 3% cover).

Differentiating from Other Site Series

Slightly drier sites (103) have more kinnikinnick, juniper, and red-stemmed feathermoss, and little or no Sxw, twinflower, or prince's pine. Slightly moister sites (101) have more Sxw, Bl, and bunchberry, and little or no soopolallie, juniper, pinegrass, or showy aster. Bl regeneration is common in the understorey. Sites with poorer nutrient availability (104) have Labrador tea and lack Fd.

Variability

Tree species diversity is usually high on these sites, although nearly pure Pl stands can occur after a stand-replacing fire. Lw is often present on these sites at the southern extent of the MSdk. Warm-aspect sites frequently have At in earlier seral stages. Tall Oregon-grape (*Berberis aquifolium*) usually occurs, particularly at lower elevations. Bunchberry is occasionally present with abundant pinegrass and soopolallie, particularly on cool- and neutral-aspect sites with coarse soils.

Management Issues

This site series is common across the landscape, and maintaining tree species diversity at stand and landscape scales is important. Soil erosion may be a concern following harvesting on steep slopes. Ungulate browsing and grass competition may limit tree establishment and growth.

110 SxwBl – Azalea – Bunchberry

General Description

SMR 5. 110 forests occur on **moist lower**, **toe**, and level sites with **seasonal seepage** or subirrigation within the upper 30–60 cm of the soil profile. Sites are usually associated with **riparian areas**, and occasional flooding is common in many stands. Soils have variable textures and coarse fragment content. Soils with subsurface moisture are usually Gleysols or Gleyed Eutric or Dystric Brunisols, while soils on high bench flood sites are often Cumulic Regosols or Orthic Humic Regosols with multiple buried horizons.

Sxw dominates the canopy with minor amounts of Bl, Ep, Pl, and Fd. Cw can be abundant (see Variability section below). **Highbush-cranberry**, thimbleberry, false azalea, and/or **black twinberry** are usually present, along with **bunchberry**, and minor amounts of **dwarf red raspberry** and mitreworts. Red-osier dogwood, wild sarsaparilla (*Aralia nudicaulis*), baneberry (*Actaea rubra*), five-leaved bramble (*Rubus pedatus*), and clasping twistedstalk (*Streptopus amplexifolius*) may also occur.

Differentiating from Other Site Series

Slightly drier sites (101) have more Fd, pinegrass, grouseberry/low bilberry, and lack highbush-cranberry, red-osier dogwood, dwarf red raspberry, wild sarsaparilla, baneberry, clasping twistedstalk, and other moist indicators. Slightly moister sites (111) have abundant horsetails, sedges, and/or bluejoint reedgrass. Sites with lower nutrient availability (104, 112) have abundant Labrador tea.

Variability

Cw can be present and dominant, and two site series variations are described:

110.1 SxwBl – Azalea – Bunchberry
sites lacking Cw

110.2 CwSxw – Bunchberry – Mitreworts
sites with abundant Cw (> 10% in the canopy and/or regeneration)

Oak fern (*Gymnocarpium dryopteris*), spiny wood fern (*Dryopteris expansa*), and/or devil's club (*Oplopanax horridus*) may occur on both variations.

Management Issues

Tree productivity is high on these sites, and vegetation competition may impede regeneration following harvest. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Frost may limit regeneration, particularly in areas where cold air pools. Maintaining Cw on sites where it is dominant or codominant will contribute to stand and landscape biodiversity and habitat values.

SxwBl – Horsetail **111**

General Description

SMR 6 (7). 111 sites occur on **gentle to level receiving sites** with the **water table** typically **near the surface** or within the top 30 cm of the soil profile. Sites are usually associated with **riparian areas** and have a thin (< 20 cm) to thick, peaty, organic veneer over mineral soil. Soils are typically sandy to silt-textured Gleysols or, where flooding is common, Gleyed Regosols derived from fluvial materials.

Sxw is dominant in the overstorey, often with minor cover of Bl. Abundant cover of **horsetails** typifies the herb layer, while bunchberry, bluejoint reedgrass, dwarf red raspberry, and sweet coltsfoot are usually present. Black twinberry, black gooseberry, and Sitka alder may occur, typically with low cover. The moss layer is variable, with feathermosses and leafy mosses (*Rhizomnium* spp. and *Plagiomnium* spp.) being the most common.

Differentiating from Other Site Series

Slightly drier sites (110) have little or no horsetails, sedges, and/or bluejoint reedgrass. Sites with lower nutrient availability (112) have abundant Labrador tea, with scrub birch and shrubby cinquefoil. Moister sites are non-forested wetlands (see Section 6.2).

Variability

111 sites are typically riparian-associated high bench floodplains with non-wetland soils. Occasionally, sites with very poor drainage and a thick organic veneer occur; these can be classified as treed swamps (Ws). Two site series phases are described to differentiate between these site conditions:

111a for **riparian flood sites**
111b for the **swamp phase** (Ws07) (see Section 6.2)

Vegetation is very similar on both site conditions. Devil's club and ferns may occur, especially on the flood sites.

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Sites have high productivity, and vegetation competition may be a concern in regenerating stands. Cold air and frost may limit regeneration. Windthrow hazard should be a consideration in areas adjacent to harvesting due to shallow rooting. These sites provide forage for wildlife and are often part of travel corridors in steep terrain.

112 Sxw – Labrador tea – Peat-moss

General Description

SMR 7 (6). The 112 site series is uncommon. It occurs on **level to gently sloping sites**, usually **adjacent to wetlands or water bodies**, and typically where **cold air** accumulates. Soils are typically organic with a deep, peaty layer at the surface (often > 1 m thick). The surface is water-saturated for much of the year. These sites are also classified as bogs (Wb15) in the non-forested and related ecosystem classification (see Section 6.2).

Sxw typically dominates the overstorey, although Pl is often a minor component. Bl may occur with minor cover in the overstorey and/or understorey. **Labrador tea** is always abundant (> 10% cover). Other common species include bunchberry, dwarf red raspberry, rough-leaved ricegrass, sedges, and bluejoint reedgrass. Minor cover of scrub birch (*Betula nana*), alders (*Alnus* spp.), and willows (*Salix* spp.) is common. Peat-mosses and red-stemmed feathermoss are usually abundant.

Differentiating from other site series

The 112 is characterized by abundant Labrador tea. Moist sites with higher nutrient availability (111) are dominated by horsetails with little or no Labrador tea. Drier sites with poor nutrient availability (104) also have abundant Labrador tea but lack scrub birch, sedges, and bluejoint reedgrass and have stiff club-moss, often with pinegrass and showy aster. 104 sites also lack a peaty organic veneer at the soil surface. Forested bogs dominated by trapper's tea are classified as Wb16 (see Section 6.2). Other moister or richer sites are non-forested wetlands (see Section 6.2).

Variability

Species diversity is often high, with a number of different understorey species present, each with low cover. Sxw is usually dominant, although Pl is frequently present and can be the leading species. Occasionally, sites with a high water table and abundant Labrador tea occur on mineral soils in the MSdk; these sites are a poor fit to the Wb15 and are considered a riparian phase of the 112:

112a for **riparian** sites on **mineral soils**; peat-mosses are absent; this site series phase is very uncommon

112b for the **bog phase (Wb15)** on sites with **organic soils** (thick peaty layer); peat-mosses are typically abundant

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Cold air, frost, and deep organic soils may limit tree regeneration. Windthrow hazard may be a concern in areas adjacent to harvesting due to shallow rooting.

Other Ecosystems

The following ecosystems occur in the MSdk. They are described in detail in Chapter 6.

Wetlands

Wetland diversity is very high in the MSdk, particularly in the Columbia Wetlands. Across the MSdk, there are bogs (Wb), fens (Wf), swamps (Ws), marshes (Wm), and shallow water wetlands (Ww). Wetland ecosystems are described in Section 6.2.

Cottonwood forests and other flood ecosystems

Cottonwood floodplain forests (Fm) are moderately common in the MSdk. The most common Fm site associations in the MSdk are *Fm01 – Cottonwood – Snowberry – Rose* and *Fm02 Cottonwood – Spruce – Dogwood*. Low bench (Fl) site associations are dominated by willows or alders. Flood ecosystems are described in Section 6.3.

Grasslands and brushlands

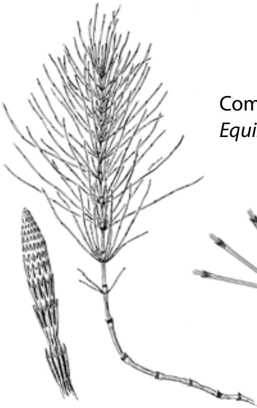
Grasslands and brushlands are uncommon in the MSdk and generally occur as small, isolated patches on warm-aspect sites within forested landscapes. Section 6.4 provides detailed descriptions of the Grassland Group.

Avalanche features

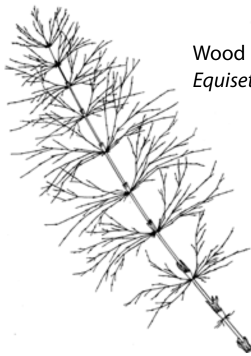
Avalanche ecosystems are moderately common in the MSdk and consist mostly of herb-dominated (Vh) and shrub-dominated (Vs) types in run-out zones and the lower portion of slide paths that initiate in higher-elevation ESSF subzones. Descriptions of avalanche ecosystems are provided in Section 6.5.

Rock outcrops and talus

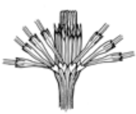
Rock outcrop (Ro) and talus (Rt) ecosystems are common in the MSdw. See Section 6.6 for descriptions of rock ecosystems.



Common horsetail
Equisetum arvense



Wood horsetail
Equisetum sylvaticum



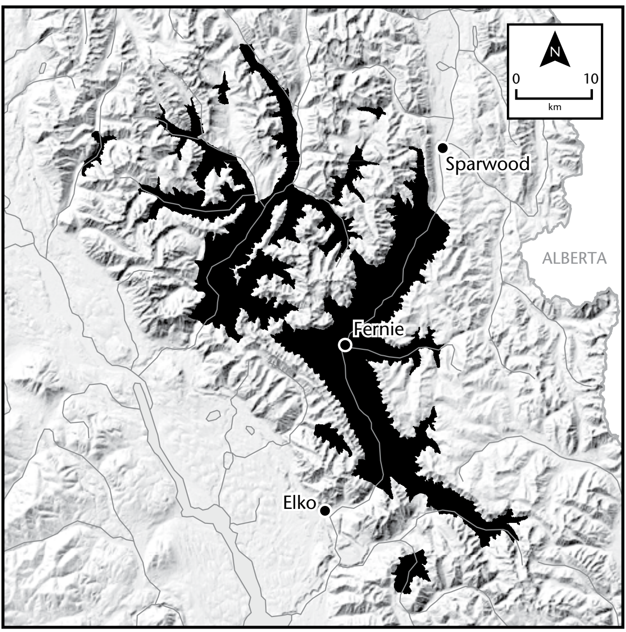
Meadow horsetail
Equisetum pratense

ICHmk4
Elk Moist Cool
Interior Cedar – Hemlock

Geographic Distribution

The ICHmk4 is restricted to the valley bottoms and mid slopes of the Rocky Mountains, primarily in the Elk and Bull River drainages. It occurs along the lower Elk River and its tributaries, including McCool, Hartley, Coal, Lizzard, Morrissey, Lodgepole, and Tunnel Creeks, and along the Bull River and its tributaries, including Quinn, Sulphur, Galbraith, Tanglefoot, and Iron Creeks. Small areas also occur in the Wigwam, Wild Horse, McDermid, and Telford drainages. The area in the Elk Valley includes the City of Fernie and much of the nearby ski hill. The ICHmk4 occurs below the ESSFwm1 and abuts the MSdw to the south and northeast (Elk Valley), the MSdk to the north, and the ICHdm in isolated areas to the west.

Distribution of the ICHmk4



Elevation Range

Across most of its range, the ICHmk4 covers a wide elevation band from valley bottom to approximately 1500 m on cool and neutral aspects and to 1650 m on warm aspects.

Climate[1]

The ICHmk4 occurs in the Moist climate subregion but is surrounded by ecosystems in the Dry climate subregion. Summers are warm and moist, while spring months are wet with substantial rain falling in June. Winters are cool (cold relative to other southern ICH subzones) with moderately deep to deep snowpacks that persist from November through April. Large fluctuations in weather are common. Arctic air masses from the north result in cold snaps throughout the winter, although rain-on-snow events also commonly occur several times throughout the winter. Growing-season moisture deficits typically occur on subxeric and drier sites, and on submesic to mesic sites in dry years.

Forest and Vegetation Characteristics

The ICHmk4 is in a unique geographic position within the southern Rocky Mountains, where it occurs in a moist climate with snowy winters but is surrounded by drier biogeoclimatic units. As a result, plant communities are similar to those of other moist variants of the ICH, but a number of species that are more common in the drier, colder continental climates of the Rocky Mountains also occur.

The ICHmk is also an unusual subzone within the ICH in that Hw is absent and, instead, **Cw is codominant with Sxw**. In the ICHmk4, Cw is consistently present on mesic and wetter sites and is uncommon on drier than mesic sites where Fd, Lw, and Sxw are abundant, sometimes with Pl. Pl and Lw are most common in younger stands. Bl is present across the ICHmk4 but increases at upper elevations. Ep, At, and Act also occur and provide important broadleaf-dominated habitats.

Mesic sites are characterized by arnicas and queen's cup in the understorey. **Drier sites** tend to have high shrub cover with abundant saskatoon, Oregon-grape, soopolallie, and snowberry, and pinegrass in the herb layer, while **wetter sites** have devil's club, Sitka alder, foamflower, and abundant ferns. Falsebox, thimbleberry, and Douglas-maple are common across the ICHmk4. However, the ICHmk4 covers a broad elevation range, and this is reflected in the variability in vegetation. At **lower elevations**, snowberry, fairybells, twinflower, and bunchberry are most common, while Bl, false azalea, and one-leaved foamflower are more common at **higher elevations**.

[1] See Section 4.5 for more information on climate variables.

Although usually present on mesic and wetter sites, Cw can be restricted to the understorey at elevations above ~ 1350 m.

Cottonwood forests provide important habitat and riparian function, particularly at valley bottom along the Elk and Bull Rivers. Wetlands, avalanche features, rock outcrops, and talus also provide critical habitat and landscape diversity within an otherwise forest-dominated landscape.

Disturbance

Stand-replacing fires and **mixed-severity fires** were historically widespread in the ICHmk4. Evidence of mixed-severity fires is most often found on warm-aspect sites where fire-scarred Fd, Lw, and occasionally Cw are common. Old-growth forests are uncommon due to **timber harvesting** combined with both natural and human-caused fire (particularly during the mining era of the early 20th century). The current landscape is dominated by early- to mid-seral mixed coniferous stands, although prior to European settlement, old and mature forest would have been more common.

Bark beetles are important disturbance agents, particularly **mountain pine beetle** in localized areas where Pl is abundant, and **spruce beetle** following fire, blowdown, or where logging slash retention is high following harvest. **Douglas-fir beetle** is also important in isolated stands with high cover of Fd. **Armillaria root rot** creates small gaps in mature stands and can be a major impediment to tree regeneration. **Birch decline**, caused by a combination of factors, has had large effects on Ep. **Gall rusts** affect growth of regenerating Pl, while **black stain root disease** poses a moderate threat to its most common hosts, Fd and Pl. **Spruce weevil** can be an impediment to planted stands. **Animal damage** can also be extensive, particularly in Cw, Pl, and Lw plantations.

Human settlements and activities have also affected ecosystems and habitats in the ICHmk4. The City of Fernie, associated rural settlements, and the Fernie ski resort are all located within the ICHmk4.

Soils, Geology, and Landforms

A mixture of sedimentary rocks, including shale, siltstone, sandstone, and limestone, are the dominant bedrock types underlying the Elk River valley and the northern extent of the Wigwam River drainage. Dolomitic carbonate rocks and mudstone, siltstone, and shale are dominant in areas just south of Sparwood, south of Morrissey, and in the Bull River drainage. Areas of limestone with slate, siltstone, argillite, marble, and other calcareous rocks are also common in the Bull River area. With calcareous parent materials abundant, Eutric Brunisols are very common. In areas of non-calcareous soils, Dystric Brunisols are common.

Glacial deposits (morainal blankets and veneers) cover most of the moderate terrain in the area, while colluvial deposits are dominant on steep valley side slopes. Glaciofluvial and fluvial plains, terraces, and fans are common in the valley bottoms of the Elk, Wigwam, and Bull River drainages. The gravelly deposits have loam to loamy sand textures and are often capped by silty or fine sandy veneers. Small glaciolacustrine deposits occur in several locations in the Elk Valley south of Sparwood, between Fernie and Morrissey, in the Lodgepole valley east of Mount Broadwood. Finer-textured morainal soils and glaciolacustrine deposits have silty clay loam and silt loam textures and may have weakly developed, clay-enriched (Bt) subsurface horizons. Soils derived from calcareous bedrock are common and often have carbonate-enriched (Cca) subsoil layers that may be cemented. Both the Bt and Cca layers can be root-restricting.

Wildlife Habitat

The ICHmk4 provides high-value habitat for several ungulate species, including **moose** and **mule deer**. Drier sites are particularly important for **Rocky Mountain elk** and **bighorn sheep**, and warm-aspect forests often provide valuable **ungulate winter range**. The ICHmk4 also provides important **habitat connectivity** and **linkage zones** for many wide-ranging species including **black bear**, **Canada lynx**, **grey wolf**, and **bobcat**, as well as at-risk **wolverine**, **American badger**, and **grizzly bear**. **Grizzly bear** also forage in avalanche run-out zones in spring and feed on black huckleberries in late summer. **Cutthroat trout** and **bull trout** breed in cold, fast-moving streams with coarse substrates, and are more productive with intact streamside habitats and hydrologically stable watersheds.

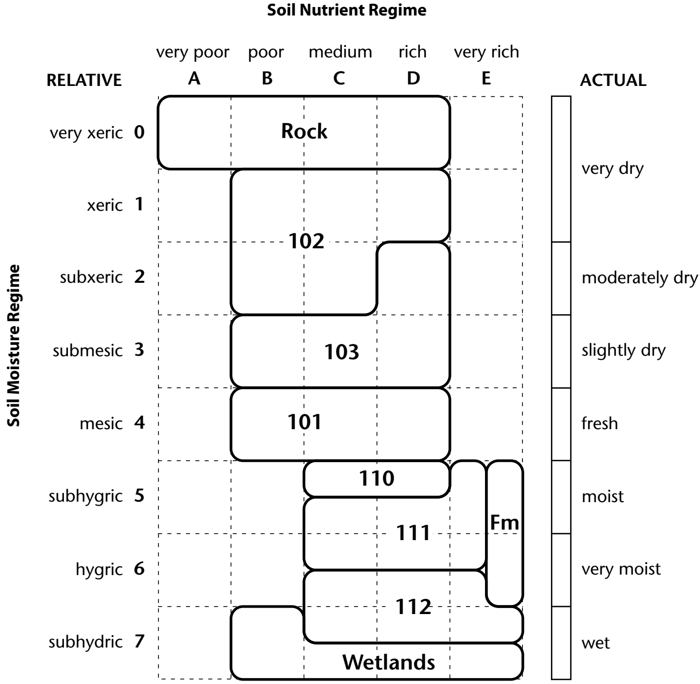
The relatively high productivity of the ICHmk4 promotes the development of large, **old-forest structure**, including veteran and large-sized trees, wildlife trees with heart rot and cavities, hollow logs, root wads, and multi-layered canopies with lichens and epiphytes. These structures are highly important for a range of nesting, roosting, denning, and perching guilds (e.g., **bats**, **furbearers**, and small mammals). **Large patches of old and mature forest** are particularly important for **northern goshawk**, **fisher**, and other wildlife species associated with **interior forest** conditions. Several at-risk insectivorous species, including **olive-sided flycatcher**, **little brown myotis**, **barn swallow**, and **common nighthawk**, also use the ICHmk4.

The ICHmk4 supports a number of at-risk plant species, including Pf. Extensive stands of intact, mature riparian cottonwood are used year-round or seasonally by a variety of raptors, owls, bats, furbearers, songbirds, waterfowl, and other bird species. Wetland and riparian habitats are important breeding and foraging sites for at-risk **western screech-owl**, **great blue heron**, and **western toad**, and also provide staging and stopover areas for migrant birds. **Peregrine falcon** breed along cliffs in the ICHmk4, and some of the common songbirds include Swainson's thrush, Hammond's flycatcher, warbling vireo, American robin, and ruby-crowned kinglet.

Distinguishing the ICHmk4 from Adjacent Biogeoclimatic Units

In the **ICHdm**, mesic and moister sites have:	- Hw
In the **MSdw** and **MSdk**, most sites have:	- no Cw - more Pl - more pinegrass and/or some grouseberry/low bilberry
zonal sites have:	- no Cw - Pl and pinegrass
dry sites have:	- some bluebunch wheatgrass - little or no falsebox, Douglas maple, or snowberry - more juniper
wet sites have:	- sporadic Cw within broader landscapes that do not have abundant Cw on mesic sites
In the **ESSFwm1**, most sites have:	- no Cw or Lw - abundant false azalea and/or white-flowered rhododendron - more black huckleberry
zonal sites have:	- abundant false azalea and white-flowered rhododendron - false-hellebore, wood-rushes, and one-leaved foamflower - no thimbleberry or Douglas maple
dry sites have:	- more black huckleberry - no snowberry, Oregon-grape, or soopolallie - Bl, Sxw, and less Fd
wet sites have:	- abundant Bl - Canby's lovage, arrow-leaved groundsel, and more false-hellebore

Edatopic Grid



Site series

101	CwSxw – Falsebox
102	Fd – Snowberry – Oregon-grape
103	Fd – Douglas maple – Falsebox
110	CwSxw – Oak fern
111	CwSxw – Devil's club
112	SxwBl – Horsetail
Fm01	Cottonwood – Snowberry – Rose[a]
Fm02	Cottonwood – Spruce – Dogwood[a]

[a] See Section 6.3 for descriptions.

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects
- shallow and/or coarse soils

→
- SMR 1–2
- Fd stands
- may contain exposed bedrock or talus
- juniper with diverse and abundant dry-site shrubs
- pinegrass, round-leaved alumroot, rock ferns, stonecrops , and/or pussytoes

→ **102**

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

→
- SMR 3 (2)
- mixed Fd (Pl, Lw, Sxw) stands
- abundant shrubs: saskatoon, Oregon-grape, soopolallie, and/or snowberry
- pinegrass, showy aster, and/or strawberry

→ **103**

→
- SMR 4
- Cw, Sxw (Lw, Fd, Bl) stands
- black huckleberry, falsebox, thimbleberry, and Douglas maple
- queen's cup and arnica

→ **101**

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

→
- SMR 5
- Cw, Sxw (Bl) stands
- one-leaved foamflower and oak fern
- lady fern often present (up to ~ 5% cover)
- devil's club absent or < 2%
- growing-season seepage at depth (> 50 cm)

→ **110**

→
- SMR 6 (5)
- Cw, Sxw (Bl) stands
- devil's club and lady fern abundant
- seepage and/or mottles within 30–50 cm of surface

→ **111**

→
- SMR 6 (7)
- Sxw (Cw) stands
- horsetails abundant
- level or gentle sites with water table at or near surface

→ **112**

Vegetation Table

Layer	Scientific name	102	103	101	110	111	112	Common name
Trees	*Pseudotsuga menziesii*	■■■■	■■■■	□□□				Douglas-fir
	Pinus contorta		□□□					lodgepole pine
	Picea engelmannii x glauca		□□□	■■■■	■■■■	■■■■	■■■■	interior spruce
	Larix occidentalis		□□	□□□				western larch
	Thuja plicata		*	■■■■	■■■■■	■■■■	□□□	western redcedar
	Abies lasiocarpa		*	□□□	□□□	□□□	*	subalpine fir
	Populus trichocarpa						□□□	black cottonwood
Regen	*Pseudotsuga menziesii*	□□	□□					Douglas-fir
	Thuja plicata		□	■■■	■■■	□□□	□	western redcedar
	Abies lasiocarpa		*	□□□	*	*		subalpine fir
	Picea engelmannii x glauca		*	*	*	□□	□□	interior spruce
Shrubs	*Symphoricarpos* spp.	■■■	■■■		□		■■■■	snowberry
	Amelanchier alnifolia	■■■	■■■					saskatoon
	Berberis spp.	■■■	■■					Oregon-grape
	Shepherdia canadensis	■■■	□□					soopolallie
	Acer glabrum	■■	■■■	■■	■■	□□	□	Douglas maple
	Spiraea lucida	■■	■■■	□□				birch-leaved spirea
	Juniperus spp.	■■						juniper
	Paxistima myrsinites	■	■■	■■	*			falsebox
	Rubus parviflorus		■■■	■■■	■■■	■■■	□□	thimbleberry
	Vaccinium membranaceum		*	■■	*			black huckleberry
	Menziesia ferruginea			□	□□	*		false azalea
	Ribes lacustre			*	□	■■	□	black gooseberry
	Oplopanax horridus				□	■■■■		devil's club

Layer	Scientific name	102	103	101	110	111	112	Common name
Herbs	*Calamagrostis rubescens*	■■■	□□					pinegrass
	Heuchera cylindrica	■■						round-leaved alumroot
	Fragaria spp.	■	■■					strawberry
	Achillea spp.	■						yarrow
	Antennaria spp.	■						pussytoes
	Sedum spp.	■						stonecrops
	Eurybia conspicua	*	■■					showy aster
	Arnica spp.		■■	■■■	*	*		arnicas
	Clintonia uniflora			■■	■■■	■■		queen's cup
	Tiarella trifoliata var. *unifoliata*				■■■	■■■■	□□	one-leaved foamflower
	Gymnocarpium dryopteris				■■■	■■■	□□	oak fern
	Athyrium filix-femina				■■	■■■■	□	lady fern
	Galium triflorum				■	■	■■	sweet-scented bedstraw
	Urtica dioica					□□		stinging nettle
	Veratrum viride					□□		false-hellebore
	Equisetum spp.						■■■■	horsetails
	Viola canadensis						□□□	Canada violet
Moss layer	*Dicranum* spp.	□□	*	*				heron's-bill mosses
	Brachythecium spp.	*	■■■	□□□		□□□□	□□	ragged-mosses
	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

Environment Table[a]

Site series	102[b]	103	101	110	111	112
No. of plots	3	12	16	9	8	6
SMR	1–2	3 (2)	4	5	6 (5)	6 (7)
SNR	B–C (D)	B–D	D (B–C)	C–D	D–E (C)	D–E (C)
Slope position	UP (MD)	MD–UP	MD	LW (MD, TO)	LV, TO (LW)	LV, TO (LW)
Typical slope/ aspect	Steep–moderately steep/warm	Moderate–moderately steep/ warm	Moderate/neutral (cool)	Gentle (moderate)	Gentle–level	Gentle–level
Common compensating conditions		Cool aspects with coarse or shallow soils	Lower/coarse; gentle or shaded/ warm	Mid-slope receiving sites; moderately coarse toe slopes		
Surficial materials	Cxv (Mv, Cb, FG)	Cb, Mb (FG, Mv)	Mb (FG)	F, Mb (Cb)	F, FG (Mb)	F (Ov/F)
Soil texture	SL, SiL	SiL, SL	SiL, L (SL, CL)	SiL, L (SiCL)	SiL, SL, S, SCL	SiL, SL, S, SiCL
Coarse fragment content	High	Moderate (high)	Variable	Low–moderate	Low–moderate	Low
Important features	Insolation; shallow and/or fragmental soils; exposed bedrock may be present			Seasonal seepage at depth	Seepage and/ or mottles in upper 30–50 cm of soil; typically associated with riparian areas	Water table at or near surface; can have an organic veneer; cold air is common; associated with riparian areas

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.
[b] Two phases are presented: 102a (xeric phase) occurs where bedrock or talus are present; 102b (subxeric phase) occurs on shallow and/or coarse Cb and FG soils.

CwSxw – Falsebox 101

General Description

SMR 4. The 101 site series occurs on **mid slopes** with **cool or neutral aspects**. It is also common on lower slopes where soils are coarse, and on warm-aspect sites with extensive shading from adjacent mountains. Soils typically have silt loam or loam textures, often with low to moderate coarse fragment content and Mor humus forms.

Tree species diversity is generally high, with **Sxw and Cw** typically dominant along with Fd, Lw, and/or Bl. Shrub cover varies, but there is usually a moderate amount of **black huckleberry**, thimbleberry, and minor amounts of Douglas-maple and/or falsebox. **Arnicas** and **queen's cup** are present in the understorey herb layer, often with minor cover (< 1%) of one-sided wintergreen (*Orthilia secunda*), bunchberry (*Cornus canadensis*), and rattlesnake-plantain (*Goodyera oblongifolia*). Ragged-mosses and red-stemmed feathermoss are common in the moss layer.

Differentiating from Other Site Series

Slightly drier sites (103) have more Fd, less Cw, higher shrub cover with snowberry, saskatoon, Oregon-grape, and/or soopolallie, and (usually) more Douglas maple; pinegrass, showy aster, and/or strawberry are distinctive in the herb layer. Slightly moister sites (110) have oak fern, lady fern, foamflower, and/or devil's club.

Variability

The ICHmk4 covers a wide elevation band, and there is considerable variability from low to higher elevations across the unit. Cw is typically present across all elevations but is more abundant at lower elevations where overstorey cover is often equal to that of Sxw. At upper elevations, Cw is often present in the understorey but may be absent in the overstorey. Bl is most abundant at upper elevations (> 1350 m), while Fd and Lw are more commonly present in stands at lower elevations. Minor cover (< 3%) of false azalea often occurs at upper elevations, while twinflower (*Linnea borealis*), fairybells (*Prosartes* spp.), and wild sarsaparilla (*Aralia nudicaulis*) are commonly abundant at lower elevations.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be maintained. Forest productivity is high, and brush competition may inhibit regeneration.

102 Fd – Snowberry – Oregon-grape

General Description

SMR 1–2. 102 sites occur on **upper and mid slopes** where **soils are shallow and/or very coarse** and slopes are **steep.** Exposed bedrock, talus, or very rocky (fragmental) soils are common.

Forests are typically open-canopied Fd stands. Shrub cover is usually high with snowberry, saskatoon, Oregon-grape, soopolallie, and/or **juniper** (Rocky Mountain [*Juniperus scopulorum*] and common [*J. communis*]). **Pinegrass** is typically present with low to moderate cover. Minor amounts of round-leaved alumroot, stonecrops, rock ferns, wild strawberry, pussy-toes, and/or other dry-site species are present. Bunchgrasses, including bluebunch wheatgrass (*Pseudoroegnaria spicata*) and fescues (*Festuca* spp.) may be present. The moss layer is highly variable and often contains pelt (*Peltigera* spp.) or clad (*Cladonia* spp.) lichens, haircap mosses (*Polytrichum* spp.), and heron's-bill mosses.

Differentiating from Other Site Series

The 102 is the driest forested site series in the ICHmk4. Drier sites are non-forested rock outcrops and talus (Ro, Rt; see Section 6.6) with < 10% tree cover. Slightly moister sites (103) occur on deeper soils with less coarse textures and typically have higher tree species diversity, including Lw, Pl, Sxw, and sometimes Bl and/or Cw. Thimbleberry, showy aster, and arnicas are also common on 103 sites.

Variability

The 102 includes sites with and without exposed bedrock or talus. Two site series phases are presented to differentiate between these site conditions:

102a for sites with prominent exposed bedrock/talus (**xeric phase**)
102b for sites on shallow and/or coarse soils (**subxeric phase**)

Vegetation is similar on both phases, although understorey species vary depending on the nutrient status of the bedrock and/or surficial materials. Higher diversity is common where calcareous soils and rock are present.

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. There are several challenges for sites with shallow, coarse soils (102b): snow creep may cause damage to regenerating trees on steep slopes, soil erosion can be a concern during the snow-free seasons, and drought or brush competition may limit the success of regenerating trees. Sites with large Fd trees, lower snow depths, and high forage availability may provide important ungulate winter range.

Fd – Douglas maple – Falsebox 103

General Description

SMR 3 (2). 103 sites typically occur where soils are **medium- to moderately coarse-textured** on **mid slopes** of **warm aspects**. They are also common on **coarse and/or shallow soils or shedding sites** on **cool and neutral aspects**, and can occur on moderate upper slopes and gentle crests. Soils are usually well-drained Eutric Brunisols derived from colluvial or morainal surficial materials with silt loam or sandy loam textures. This site series also often occurs on drier (SMR 2) sites with richer soils (SNR D).

Stands are typically Fd-leading, but tree species can be diverse, with Pl, Sxw, Lw, and Bl as common secondary species. Cw is frequently present with low cover and is often restricted to the understorey. Shrub cover is usually high with **saskatoon**, **snowberry**, **birch-leaved spirea**, **Oregon-grape**, **soopolallie**, Douglas-maple, falsebox, and thimbleberry. **Showy aster**, **pinegrass**, **wild strawberry**, arnica, and minor amounts of fairybells are common. Ragged-mosses are the most common species in the moss layer and may occur with minor cover of haircap mosses, pelt lichens, and/or clad lichens.

Differentiating from Other Site Series

Slightly drier sites (102) are Fd-dominated with little or no other tree species present. Juniper, rock ferns, round-leaved alumroot, stonecrops, and/or other dry-site species are present, and exposed rock is common. Slightly moister sites (101) have more Cw, no Pl or pinegrass, and fewer shrubs with little or no snowberry, saskatoon, Oregon-grape, or soopolallie.

Variability

Bl is more common at upper elevations in the ICHmk4, while twinflower, fairybells, and wild sarsaparilla may occur at lower elevations. Pl, At, and Ep are more abundant in earlier seral stands.

Management Issues

This site series is amenable to the growth of a wide variety of species, and species diversity should be maintained. Forest productivity is high, but moisture deficits can limit tree growth, particularly during dry years. Shrub competition may also inhibit conifer regeneration. Soil erosion may be a concern on steep slopes. Warm-aspect sites with large Fd trees, lower snow depths, and high forage availability may provide important ungulate winter range.

110 CwSxw – Oak fern

General Description

SMR 5. 110 forests occur on receiving sites with seasonal seepage and/or moisture at depth. These forests usually occur on **lower slopes** with seepage or mottles within 70–100 cm of the surface, and occasionally occur on mid-slope seepage sites. Soils are imperfectly to moderately well drained, usually with silty loam and loam textures and low to moderate coarse fragment content.

Stands are dominated by **Cw and Sxw**, often with minor cover of Bl. Thimbleberry is usually present, often occurring with minor cover of Douglas maple, snowberry, false azalea, and/or black gooseberry. **Oak fern**, queen's cup, and **one-leaved foamflower** are abundant; lady fern is often present with low cover (< 5%). Herb diversity can be high: sweet-cicely (*Osmorhiza* spp.), sweet-scented bedstraw, mitreworts (*Pectiantia* spp. and *Mitella* spp.), and pathfinder (*Adenocaulon bicolor*) commonly occur with low cover. Leafy mosses are usually the most consistently present species in the sparse moss layer.

Differentiating from Other Site Series

Slightly drier sites (101) often have higher tree species diversity with Fd and/or Lw present along with Cw, Sxw, and Bl. 101 sites also have little or no oak fern, foamflower, or lady fern, and more falsebox, black huckleberry, and/or arnicas. Slightly moister sites (110) have more devil's club and lady fern, and often have some false-hellebore and/or stinging nettle.

Variability

Devil's club is usually absent but may be present with < 2% cover. Cw is usually the dominant tree species in the overstorey but can be restricted to the understorey with Sxw dominant. Bl is most common at upper elevations in the ICHmk4.

Management Issues

Tree productivity is high on these sites, and vegetation competition may impede regeneration following harvest. Frost may also limit regeneration, particularly in areas where cold air pools. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

CwSxw – Devil's club **111**

General Description

SMR 6 (5). 111 stands usually occur on **level** and **gentle toe and lower slope positions** (< 20% slope) with **seepage** or the **water table** within the top 30–50 cm of the soil profile. Soils are typically Gleysols or Gleyed Brunisols derived from finer-textured fluvial or glaciofluvial materials. Sites are usually associated with **riparian areas**.

Sxw and Cw are the dominant overstorey trees, often with Bl. In the understoreys, **devil's club** and/or **lady fern** are typically abundant (> 10%). Black gooseberry, thimbleberry, oak fern, and one-leaved foamflower are also common, along with minor cover of false-hellebore (particularly on colder sites) and stinging nettle. Leafy mosses and ragged-mosses are usually common and can be abundant.

Differentiating from Other Site Series

Slightly drier sites (110) have little or no devil's club (< 3%) and lady fern (< 5%). Slightly moister sites (112) have abundant horsetails.

Variability

Bl and false azalea are more abundant at upper elevations where Cw is often more abundant in the understorey. Herb diversity can be high: sweet-scented bedstraw, baneberry(*Actaea rubra*), and clasping twistedstalk (*Streptopus amplexifolius*) often occur with low covers.

Management Issues

Tree productivity is high on these sites, and vegetation competition may impede regeneration following harvest. Frost may also limit regeneration, particularly in areas where cold air pools. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

112 SxwBl – Horsetail

General Description

SMR 6 (7). The 112 site series is uncommon in the ICHmk4, and is restricted to gentle and level (< 5% slope) floodplain sites where the water table is at or near the soil surface. Thin organic veneers are often present over Humic Gleysols derived from fluvial materials. Sites are associated with riparian areas; open water can be present as slow-moving streams or seeps within stands, and flooding is occasional to rare. Cold-air accumulation is common.

Stands typically have an open canopy of Sxw with minor amounts of Cw, Bl, and sometimes Act. Herb cover is abundant and diverse: horsetails are characteristic, although other commonly present species with minor cover include oak fern, lady fern, wild sarsaparilla, foamflower, mitreworts, sweet-cicely, and sweet-scented bedstraw.

Differentiating from Other Site Series

Slightly drier sites (111) have little or no horsetails (< 2%) and are instead dominated by devil's club and lady fern. Slightly moister sites are wetland and flood sites. Although Act may be present on these sites, the 112 differs from the Fm02 site association in that the 112 is conifer-dominated and the Fm02 is Act-dominated with a lesser component of conifers. The Fm02 and 112 site units often occur together and/or adjacent to the Fm01. The 112 occurs on high bench flood sites, and the Fm01 and Fm02 units occur on mid bench flood sites (see Section 6.3). Forested swamp or bog phases of the 112 have not been sampled in the ICHmk4 as in other units; if encountered, users can refer to the Ws07, Wb15, and Wb16 units described in Section 6.2.

Variability

Given the steep terrain of the ICHmk4, most 112 sites occur on the broad valley bottom at lower elevations (< 1000 m) along the Elk and Bull Rivers. Sites also occur at upper elevations but are generally smaller and often have higher cover of Bl. Common horsetail (*Equisetum arvense*) is the most abundant horsetail present on these sites, although meadow horsetail (*E. pratense*) is also known to occur.

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential hazards, and the water table may rise once trees are removed. Cold air, frost, and brush competition may limit tree regeneration following harvest. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

Other Ecosystems

The following ecosystems are known to occur in the ICHmk4. They are described in detail in Chapter 6.

Wetlands

Wetlands are most common in the valley bottom but rural and urban development have reduced their abundance. Fens (Wf), swamps (Ws), marshes (Wm), and shallow water wetlands (Ww) are the most common wetland classes in the ICHmk4, although bogs (Wb) may also occur. Wetland ecosystems are described in Section 6.2.

Cottonwood forests and other flood ecosystems

Cottonwood forests (Fm) and other flood ecosystems (Fl and Fa) are very important in the ICHmk4, particularly in the Elk and Bull valleys, where they provide shade and nutrient inputs to streams, and critical habitat for a number of wildlife and plant species. Both the *Fm01 Cottonwood – Snowberry – Rose* and *Fm02 Cottonwood – Spruce – Dogwood* units occur in the ICHmk4. One of the oldest known cottonwood stands in the province occurs in the ICHmk4 near Morrissey, with individual cottonwood trees that are more than 450 years old. The Flood Group is described in Section 6.3.

Grasslands and brushlands

Grasslands (Gg) and brushlands (Gb) are very uncommon in the ICHmk4, occasionally occurring on steep, warm-aspect, sun- or wind-exposed sites. The Grassland Group is described in Section 6.4.

Avalanche features

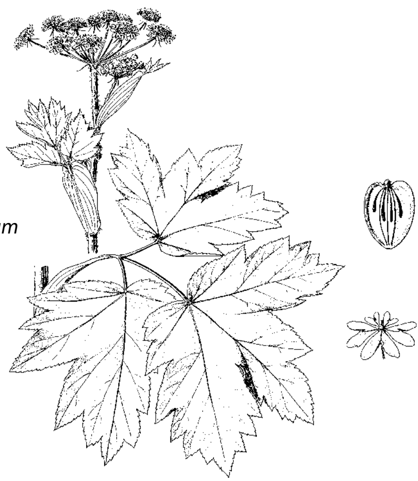
Avalanche paths are common in the ICHmk4, with most start zones initiating high above in the ESSF. Herb meadow (Vh), shrub-thicket (Vs), and treed (Vt) avalanche ecosystems are very common. The Avalanche Group is described in Section 6.5.

Rock outcrops and talus

Several rock outcrop (Ro) and talus (Rt) ecosystems occur in the ICHmk4 and are commonly found adjacent to the driest forested ecosystems. The Rock Group is described in Section 6.6.

Dawson's angelica
Angelica dawsonii

Cow-parsnip
Heracleum maximum

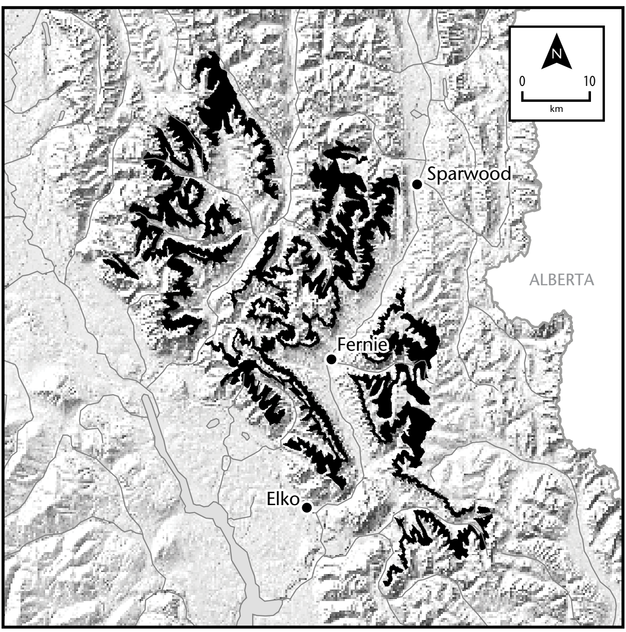


ESSFwm1
Fernie Wet Mild
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFwm1 is restricted to the Rocky Mountains, primarily in the Elk and Bull River drainages. In the lower Elk River valley, it occurs along tributaries, including McCool, Hartley, Coal, Lizard, Morrissey, Lodgepole, and Tunnel Creeks. In the lower Bull River valley, it occurs along tributaries, including Quinn, Sulphur, Galbraith, Tanglefoot, Van, and Iron Creeks. It is also extensive along Sand and McDermid Creeks, and a small area occurs in the Wigwam valley. The ESSFwm1 occurs below the ESSFwmw and above the ICHmk4, except in the Sand Creek valley and from Van to Dibble Creek in the lower Bull River valley, where it occurs above the ICHdm. At similar elevations, the ESSFwm1 is bordered by the ESSFdk2 to the north and the ESSFdk1 in all other directions.

Distribution of the ESSFwm1



Elevation Range

Upper elevations of the ESSFwm1 range from 1925 to 2050 m on cool and neutral aspects and from 1950 to 2100 m on warm aspects. At lower elevations, the ESSFwm1 borders the ICH at approximately 1500 m on cool and neutral aspects and at approximately 1650 m on warm aspects.

Climate[1]

The ESSFwm1 occurs in the Moist climate subregion but is surrounded by ecosystems in the Dry climate subregion. The climate is characterized by cool, moist summers and cold, moist winters with a deep snowpack that typically persists from October or November through May. Rain-on-snow events occur infrequently during many winters. Growing-season moisture deficits are uncommon on all but the driest sites. The ESSFwm1 has higher precipitation and a deeper snowpack than the ESSFdk1 and ESSFdk2.

Forest and Vegetation Characteristics

The ESSFwm1 is in a unique geographic position in the southern Rocky Mountains, where it occurs in a moist climate with snowy winters but is surrounded by drier biogeoclimatic units. As a result, plant communities are similar to those of other moist to wet variants of the ESSF, but a number of species that are more common in the drier, colder continental climates of the Rocky Mountains also occur.

Se and Bl are the most common tree species across the ESSFwm1. Pl is often a minor component of mesic and drier sites. Other tree species include the occasional Fd at lower elevations, as well as Pa and La[2] at upper elevations on dry sites. Minor cover of Cw may be present in the understorey or overstorey on circum-mesic sites at low elevations. **False azalea** and **white-flowered rhododendron** co-occur across all but the driest site series in the ESSFwm1, usually with abundant **black huckleberry**. On dry sites, shrubby understoreys include Douglas maple, falsebox, and birch-leaved spirea.

Mesic sites are characterized by abundant false azalea, white-flowered rhododendron, and black huckleberry, with foamflower, false-hellebore, wood-rushes, and mitreworts in the understorey. **Submesic sites** have similar shrubs but with less diverse herb communities characterized by arnica and, frequently, grouseberry/low bilberry. Canby's lovage, arrow-leaved groundsel, and globeflower are common on **wetter-than-mesic sites**. Ferns, including oak fern, lady fern, and sometimes spiny wood fern (*Dryopteris*

[1] See Section 4.5 for more information on climate variables.

[2] Pa refers to *Pinus albicaulis* (whitebark pine), an at-risk species, and La to *Larix lyallii* (subalpine larch).

expansa), also occur on moist to wet sites. The wettest forested site series are characterized by horsetails.

Plant diversity is relatively high for the ESSF, and a number of regionally specific plant species are also present. Bear-grass (*Xerophyllum tenax*) occurs on subxeric to xeric sites but is not consistently present. Dawson's angelica (*Angelica dawsonii*), a species uncommon elsewhere in British Columbia, is relatively common in the ESSFwm1, especially on open moist sites, including avalanche run-out zones, meadows, and riparian areas. Both species of valerian are also common in the ESSFwm1: *Valeriana sitchensis* (Sitka valerian) and *V. dioica* (wood valerian). Common species that frequently occur across most site series include western meadowrue (*Thalictrum occidentalis*), Utah honeysuckle (*Lonicera utahensis*), and mountain-ash (*Sorbus* spp.).

Avalanche tracks and rock outcrops are the most common non-forested ecosystems in the ESSFwm1. Grasslands and wetlands are uncommon.

Disturbance

Fire is the dominant broad-scale natural disturbance in the ESSFwm1, with infrequent stand-replacing fires along with occasional mixed-severity fires, particularly on warmer aspects adjacent to the ICH. Pl is generally restricted to drier sites in the ESSFwm1, and **mountain pine beetle** has had significant effects on some Pl stands in localized areas. Small-scale **forest gap dynamics** driven by windthrow, insects, and pathogens are important for creating stand structural complexity between stand-replacing fires. Endemic levels of **western balsam bark beetle** kill Bl trees and create small canopy openings that facilitate development of multi-aged stands. **Spruce bark beetles** are known to inflict high mortality in some areas, 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 Pa. Western gall rust can also limit the growth and form of regenerating Pl. The combination of deep snowpacks and steep terrain results in widespread avalanche tracks and a high risk of snowpress in regenerating stands on steep slopes. Timber harvesting has been extensive in many areas of the ESSFwm1, and old-growth forests are uncommon across the landscape.

Soils, Geology, and Landforms

Bedrock geology in the ESSFwm1 is characterized by a mixture of sedimentary and metamorphic rocks that have created both fine- and coarse-textured surficial materials. Soils derived from calcareous parent materials are common. Dolomite, mudstone, siltstone, and shale are the dominant bedrock types across much of the ESSFwm1, including the Bull River drainage, the Lodgepole valley, and the west side of the Elk Valley. Limestone, slate, siltstone, and argillite are also common, especially in the lower Bull River drainage. These fine- to medium-grained bedrock types result in an abundance of soils with finer textures ranging from silty clay loam to silt loam. Coarse-grained sandstones and conglomerates, with a mix of finer-grained sedimentary rocks, are common in the Morrissey and Coal Creek drainages and in the upper drainages of Lodgepole, Sand, Van, and Tanglefoot Creeks. Soils associated with medium- to coarse-grained bedrock types have surface textures ranging from sandy loam to loamy sand with moderate to very high coarse fragment content. Colluvial and morainal materials are dominant in the mountainous terrain of the ESSFwm1. Areas of rock outcrops associated with very shallow soil veneers are also relatively common.

Wildlife Habitat

The ESSFwm1 provides valuable summer range for **Rocky Mountain elk**, **bighorn sheep**, **mule deer**, **mountain goat**, and **moose**. Avalanche paths provide high-value spring forage for **grizzly bears** and **black bears**, and early seral patches dominated by huckleberries are important bear feeding areas in summer. The ESSFwm1 provides highly suitable habitat for other wide-ranging carnivores such as **wolverine** and **Canada lynx**.

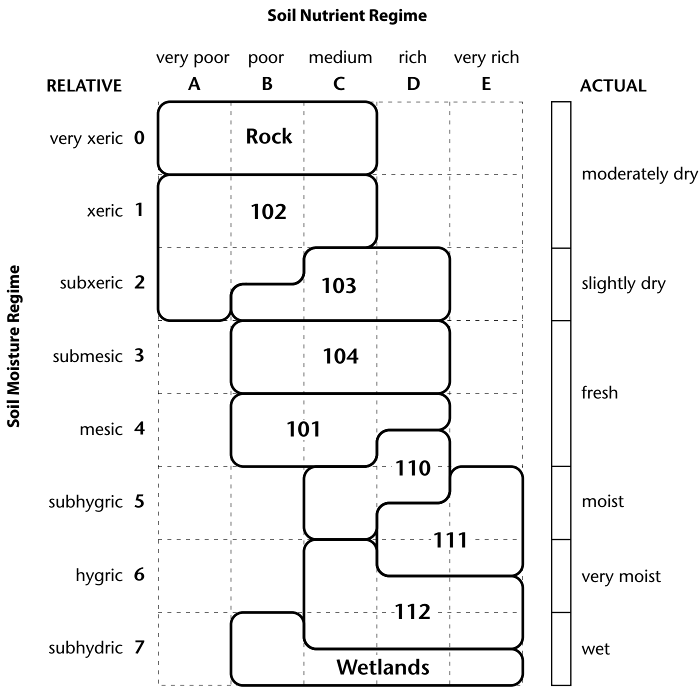
Old-forest patches provide important structure for **cavity-nesting, roosting, and denning species** that are dependent on multi-layered canopies, large live and dead trees (including wildlife trees), and/or coarse woody debris. At lower elevations, this includes at-risk **northern goshawk**, **Swainson's hawk**, and **olive-sided flycatcher**. Other species reliant on these structures include **American marten**, **American three-toed woodpecker**, **red-breasted nuthatch**, **golden-crowned kinglet**, and **ruby-crowned kinglet**.

Rocky habitats in the ESSFwm1 provide escape terrain for **mountain goat** and have potential to support at-risk **red-tailed chipmunk** and **least chipmunk**. Less common **wetland and riparian sites** provide habitat for at-risk **western toad** and stopover sites for migratory bird species. Several **at-risk plant species** occur in the ESSFwm1, including Pf and Pa. Common bird species include Townsend's warbler, Swainson's thrush, hermit thrush, MacGillivray's warbler, yellow-rumped warbler, and fox sparrow.

Distinguishing the ESSFwm1 from Adjacent Biogeoclimatic Units

In the **ICHmk4**, most sites have:	- Cw or Lw - little or no false azalea and white-flowered rhododendron
zonal sites have:	- queen's cup, thimbleberry, falsebox, and Douglas maple - no false-hellebore, mitreworts, or wood-rushes
dry sites have:	- no Bl or Sxw - more Fd - snowberry, Oregon-grape
wet sites have:	- no Canby's lovage or arrow-leaved groundsel
In the **ESSFwmw**, most sites have:	- lower tree and site productivity - some high-elevation understorey species, such as mountain-heathers and anemones, and more wood-rushes
zonal sites have:	- less Se and false azalea - little or no false-hellebore or one-leaved foamflower
dry sites have:	- Pa and/or La - no Douglas maple or saskatoon
wet sites have:	- little or no oak fern, lady fern, or horsetails - more arrow-leaved groundsel, globeflower, and valerian
In the **ESSFdk1**, most sites have:	- less black huckleberry and white-flowered rhododendron - more grassland and brushland ecosystems - more Pl and grouseberry/low bilberry
zonal sites have:	- little or no foamflower - grouseberry/low bilberry
dry sites have:	- more soopolallie and juniper - more Fd
wet sites have:	- no oak fern or lady fern
In the **ESSFdk2**, most sites have:	- less black huckleberry and white-flowered rhododendron - more feathermosses and fewer ragged-mosses - more Pl and grouseberry/low bilberry
zonal sites have:	- grouseberry/low bilberry - Pl in mixed-species stands
dry sites have:	- more soopolallie and juniper - more Fd
wet sites have:	- black twinberry - little or no Canby's lovage - usually no oak fern or lady fern

Edatopic Grid



Site series

101 Bl – Rhododendron – Azalea – Foamflower
102 BlFd – Douglas maple
103 Bl – Huckleberry – Falsebox
104 Bl – Rhododendron – Azalea
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
- shallow soils

→
- SMR 1 (2)
- exposed rock prominent
- Fd, Se, Bl stands
- Douglas maple and saskatoon
- pussytoes, stonecrop, pinegrass, and/or other dry-site species

→ **102**

→
- SMR 2
- Se, Bl (Fd, Pl) stands
- birch-leaved spirea, showy aster, and/or white hawkweed
- little or no rhododendron and false azalea
- may have grouseberry/low bilberry, pinegrass, or bear-grass

→ **103**

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

→
- SMR 3
- Se, Bl (Pl) stands
- abundant black huckleberry, rhododendron, and false azalea
- arnica
- may have grouseberry/low bilberry or bear-grass

→ **104**

→
- SMR 4
- Se, Bl stands
- abundant black huckleberry, rhododendron, and false azalea
- foamflower, wood-rushes, mitreworts, false-hellebore, and arnica

→ **101**

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

→
- SMR 5 (4)
- Se, Bl stands
- oak fern abundant
- lady fern and/or spiny wood fern often present

→ **110**

→
- SMR 5 (6)
- Se, Bl stands
- Canby's lovage, false-hellebore, and arrow-leaved groundsel

→ **111**

→
- SMR 6 (7)
- Se, Bl stands
- horsetails abundant
- arrow-leaved groundsel and globeflower

→ **112**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Trees	*Pseudotsuga menziesii*	□□□	*						Douglas-fir
	Abies lasiocarpa	□□□	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	subalpine fir
	Picea engelmannii	□□	■■■	■■■	■■■	■■■■	■■■	■■■■	Engelmann spruce
Regen	*Abies lasiocarpa*	□□□	■■■	■■■	■■■	■■■	■■■	■■■	subalpine fir
	Picea engelmannii	*	□□	*	*	■■	□	■■	Engelmann spruce
Shrubs	*Acer glabrum*	■■■	*						Douglas maple
	Amelanchier alnifolia	■■	□						saskatoon
	Paxistima myrsinites	■■	□□						falsebox
	Spiraea lucida	□□	■■■						birch-leaved spirea
	Sorbus spp.	□□	■	□	■■	*	*	*	mountain-ash
	Vaccinium membranaceum	□□	■■■	■■■■	■■■■	■■■	■■■	■■■	black huckleberry
	Menziesia ferruginea		*	■■■■	■■■■	■■■■	■■■	■■■	false azalea
	Rhododendron albiflorum		*	■■■■	■■■■	□□	■■	■■	white-flowered rhododendron
	Ribes lacustre					■■	■■	□	black gooseberry
Herbs	*Antennaria* spp.	■■■							pussytoes
	Calamagrostis rubescens	□□	□□						pinegrass
	Erythronium grandiflorum	■■							yellow glacier lily
	Fragaria spp.	■■	■						strawberry
	Achillea spp.	■							yarrow
	Sedum spp.	■							stonecrops
	Allium cernuum	□							nodding onion
	Campanula rotundifolia	■							common harebell
	Eremogone capillaris	■							thread-leaved sandwort
	Heuchera cylindrica	■							round-leaved alumroot

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Herbs	*Arnica* spp.	*	■■	■■■	■■■	■■■	■■■	□	arnicas
	Vaccinium scoparium/myrtillus		□□	□□□	*				grouseberry/low bilberry
	Eurybia conspicua		□□						showy aster
	Hieracium albiflorum		■						white hawkweed
	Tiarella trifoliata var. *unifoliata*				■■■	■■■	■■	■■	one-leaved foamflower
	Veratrum viride				■■	■■	■■■	■	false-hellebore
	"mitreworts"[a]				■■	□□	■■■	■■■	mitreworts
	Luzula spp.				■■		□		wood-rushes
	Clintonia uniflora				□□	■■			queen's cup
	Streptopus amplexifolius					■■	□	■■	clasping twistedstalk
	Ligusticum canbyi					*	■■■	■■	Canby's lovage
	Senecio triangularis						■■	■■■	arrow-leaved groundsel
	Gymnocarpium dryopteris					■■■■		□□	oak fern
	Athyrium filix-femina					□□		□□	lady fern
	Trollius albiflorus						□□□	■■	globeflower
	Equisetum spp.							■■■■	horsetails
	Leptarrhena pyrolifolia							■	leatherleaf saxifrage
	Platanthera spp.							■	rein orchids
Moss layer	*Dicranum* spp.	□□□	□	□□	□□	*			heron's-bill mosses
	Brachythecium spp.	■■■	■■	■■■	■■■	■■■	■■■	□□	ragged-mosses
	Cladonia spp.	□□	□□						clad lichens
	Peltigera spp.	■	■						pelt lichens
	"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	101	110	111	112
No. of plots	5	7	13	22	17	9	4
SMR	1 (2)	2	3	4	5 (4)	5 (6)	6 (7)
SNR	B (A, C)	B–C (D)	C (B, D)	C–D (B)	C–D	D–E	D–E (C)
Slope position	UP, CR (MD)	MD, UP (CR)	MD (UP)	MD	LW (MD, TO)	TO (LW)	TO, DP (LW, LV)
Typical slope/ aspect	Steep–moderately steep/warm	Steep/warm	Moderate (gentle)/warm	Moderate/ neutral (cool)	Gentle (moderate)	Gentle (moderate)	Gentle (level)
Common compensating conditions	Very shallow, gentle crests	Neutral aspects with high sun exposure	Upper/cool, shedding; shallow/ coarse on neutral or cool aspects or lower slopes	Lower/coarse; gentle/warm	Mid-slope receiving sites; moderately coarse toe slopes		
Surficial materials	Cx/R, Mx/R (Cvb)	Cv, Cb	Mb (Cb)	Mb (Cb)	Mb, F	Mb, Lb, F	F (L, Ov)
Soil texture	SiL, SL	SiL, SL	SiL, L (SL)	SiL, L (FSL, SiCL)	SiL, L (FSL, SiCL)	SiL, CL, SiCL	SiL, CL, SiCL
Coarse fragment content	High	High	Moderate (warm)–high (cool)	Moderate	Low–moderate	Low–moderate	Low–moderately high
Important features	(Bed)rock is prominent and abundant; soils are often fragmental	Insolation; coarse to fragmental soils			Seepage at depth	Seepage or mottles within upper 30–50 cm of soil; usually associated with riparian areas	Water table near surface; can have an organic veneer; cold air is common; associated with riparian areas

[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). The 101 site series occurs on **mid slopes** with **cool or neutral** aspects, and occasionally on lower slopes with warm aspects and coarse soils or extensive shading from adjacent mountains. Soils are typically Eutric or Dystric Brunisols or Orthic Humo-Ferric Podzols with Mor humus forms, with silt loam textures and moderate coarse fragment content, and are moderately well drained.

Bl and Se occupy the overstorey and understorey tree layers. Shrub cover is usually high, with **false azalea**, **white-flowered rhododendron**, and **black huckleberry** dominant. Arnicas, **foamflower**, **false-hellebore**, mitreworts, and **wood-rushes** are typically present with low to moderate cover. Ragged-mosses are usually abundant, often with leafy liverworts and heron's-bill mosses.

Differentiating from Other Site Series

Slightly drier sites (104) lack foamflower, false-hellebore, and mitreworts, and often have grouseberry/low bilberry. Slightly moister sites (110) have oak fern, lady fern, clasping twistedstalk, and/or black gooseberry.

Variability

Pl may be present in earlier seral stages in mixed-species stands but is not abundant in mature stands. Minor cover of bear-grass (< 2%) or grouseberry/low bilberry (< 1%) may be present. False-hellebore, wood-rushes, and white-flowered rhododendron are more common at upper elevations, while queen's cup is often restricted to lower-elevation sites.

Management Issues

Snow creep and avalanching can damage regenerating trees on steeper slopes. High cover of shrubs can compete with regenerating conifers.

102 BlFd – Douglas maple

General Description

SMR 1 (2). The 102 site series occurs on sites with prominent **exposed 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 based on the underlying bedrock type but are typically silt loam or sandy loam with high coarse fragment content. Eutric and Dystric Brunisols are common. This site series often occurs adjacent to non-forested rock outcrops and shallow, warm-aspect 103 sites.

Tree canopies are typically comprised of open Bl and Se. **Fd** is common in the lower half of the subzone, while **Pl** and/or **Pa** are common in the upper half. Shrub cover is typically low to moderate, with **saskatoon**, **falsebox**, **Douglas-maple**, and often black huckleberry as the most common species. Understorey herbs vary but are typically present with low to moderate cover of **pussytoes**, **stonecrops**, pinegrass, saxifrages (*Micranthes* spp. and *Saxifraga* spp.), wild strawberry, and other dry-site species.

Differentiating from Other Site Series

The 102 is the driest forested (> 10% tree cover) site series in the ESSFwm1. Drier sites are non-forested rock outcrops (Ro) and talus (Rt). Slightly moister sites (103) do not have exposed bedrock and usually have less Fd, more Bl, Se, and little or no pussytoes, stonecrops, thread-leaved sandwort, and other rock outcrop–associated species. La may be present with minor cover on 102 sites, but a separate talus unit (Rt21) describes La-leading stands that occur on blocky talus sites with cold-air ponding (see Section 6.6).

Variability

Where limestone forms the bedrock, sites can have more diverse herb communities, including some species that are typically associated with moister sites. Species distribution and composition can vary in small microsites with deeper and shallower soils. Abundant yellow glacier lily often occurs on 102 sites in the early spring. Pa is more common at upper elevations.

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 species (e.g., Pa).

Bl – Huckleberry – Falsebox **103**

General Description

SMR 2. The 103 site series occurs on **steep**, **warm-aspect** sites with **coarse, rocky, and/or shallow soils**. It can also occur on neutral aspects with extensive sun exposure (e.g., in large valleys) or with very coarse soils, and occasionally on shallow crests. Soils are typically rapidly drained Eutric Brunisols with high to fragmental coarse fragment content.

Bl and Se are typically dominant in the tree layers, often with minor cover of Fd or Pl. **Birch-leaved spirea**, **falsebox**, and black huckleberry have minor to moderate covers, while white-flowered rhododendron and false azalea are typically sparse to absent. Understorey herbs are typically sparse, with low cover of **white hawkweed**, **wild strawberries**, **showy aster**, pinegrass, fireweed (*Chamerion angustifolium*), and arnica.

Differentiating from Other Site Series

Slightly drier sites (102) have prominently exposed bedrock with higher cover of Douglas maple, saskatoon, pussytoes, and/or stonecrops. Slightly moister sites (104) have high cover of black huckleberry, white-flowered rhododendron, and/or false azalea, and lack species associated with drier conditions, such as birch-leaved spirea, pinegrass, and strawberries.

Variability

Grouseberry/low bilberry may be present, particularly near the ESSFdk1 or ESSFdk2 boundaries. Bear-grass can be abundant, particularly in the southern half of the ESSFwm1. Thimbleberry often occurs with low cover, usually on sites with an open tree canopy. Western meadowrue can be abundant (> 5% cover). Sites with calcareous soils often have higher cover of herbaceous plants.

Management Issues

Drought may limit conifer regeneration, particularly during drier than average growing seasons. On steep slopes, avalanching and snowpress can damage regenerating trees in winter, while soil erosion can be a concern during the growing season. Pa stands and individual trees are not recommended for harvest.

104 Bl – Rhododendron – Azalea

General Description

SMR 3. 104 sites typically occur on **warm-aspect sites** with **deep**, **medium-textured soils** in mid-slope positions**.** They also occur on **cool-aspect sites** with **coarse or shallow soils**. Soils are usually moderately well- to well-drained Dystric Brunisols, Eutric Brunisols, or Humo-Ferric Podzols with silt loam or loam textures. They tend to have higher coarse fragment content on cool aspects compared to warm-aspect sites.

Bl is usually abundant in the overstorey and understorey, with moderate amounts of Se in the overstorey. The well-developed shrub layer has high cover of **white-flowered rhododendron**, **false azalea**, and **black huckleberry**. Understorey herb cover is variable, with **arnica** (heart-leaved [*Arnica cordifolia*] and mountain [*A. latifolia*]) and (often) **grouseberry/low bilberry** most common. Moss cover is usually high, often with abundant **leafy liverworts**, **heron's-bill mosses**, and/or **ragged-mosses**.

Differentiating from Other Site Series

Slightly drier sites (103) have little or no white-flowered rhododendron or false azalea and typically have birch-leaved spirea, falsebox, saskatoon, pinegrass, showy aster, and/or white hawkweed. Fd may also occur in mixed stands, particularly at lower elevations. Slightly moister sites (101) have foamflower, false-hellebore, and/or mitreworts, and Pl is less common in younger stands.

Variability

Pl is often abundant in earlier seral stands but is not dominant in mature forests. Grouseberry/low bilberry cover varies from absent to dominant on these sites. Bear-grass may be present, particularly in the southern half of the ESSFwm1.

Management Issues

On steep slopes, avalanching and snowpress can damage regenerating trees in winter, while soil erosion can be a concern during the growing season. High cover of shrubs can compete with conifer regeneration.

BlSe – Azalea – Oak fern **110**

General Description

SMR 5 (4). 110 forests typically occur on **moisture-receiving** sites in **lower-slope positions** and sometimes on mid slopes where **seepage** is present at depth. Mottles or seepage are present within the top 75–100 cm. Soils are usually Gleyed Dystric Brunisols or Humo-Ferric Podzols. Sites occur adjacent to or in association with **riparian areas**.

Se is typically the dominant tree species, while Bl is usually abundant in the codominant and regeneration layers. False azalea is common, but white-flowered rhododendron is usually sparse or absent. Oak fern is the most distinctive herb species. **Foamflower**, false-hellebore, mitreworts, **clasping twistedstalk**, **lady fern**, and black gooseberry are usually present with low to moderate cover. The moss layer is variable, typically with **ragged-mosses** and **leafy mosses**.

Differentiating from Other Site Series

Slightly drier sites (101) have little or no oak fern (< 1%) and leafy mosses, lack black gooseberry, lady fern and/or spiny wood fern, and have more white-flowered rhododendron. Slightly moister sites (111) also have little or no oak fern, and instead have Canby's lovage, arrow-leaved groundsel, and globeflower. The 110 site series is more common than the 111 at lower elevations in the ESSFwm1.

Variability

Lady fern and spiny wood fern are more common at lower elevations and moister sites. Black elderberry (*Sambucus racemosa*) and devil's club (*Oplopanax horridus*) may occur, but are not consistently present.

Management Issues

Brush competition is often a concern in regenerating stands. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

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

General Description

SMR 5 (6). The 111 site series occurs on **gentle, lower- and toe-slope positions** where **seepage** occurs within the top 30–70 cm. Soils are usually imperfectly drained Gleyed Eutric or Dystric Brunisols or, occasionally, Humic Gleysols. Moder and Mormoder humus forms are common. Sites are typically associated with **riparian areas**.

Stands usually have open canopies of Bl and Se with abundant and diverse herb cover. Shrub cover is typically low to moderate (< 20%) and includes false azalea, black huckleberry, and white-flowered rhododendron. **Arrow-leaved groundsel**, **Canby's lovage**, **false-hellebore**, **mitreworts**, **globeflower**, western meadowrue, and/or valerian (*Valeriana sitchensis* and *V. dioica*) are typical in the herb layer, while ragged-mosses and leafy mosses are common in the moss layer.

Differentiating from Other Site Series

Slightly drier sites (110) have abundant oak fern and little or no Canby's lovage, arrow-leaved groundsel, or globeflower. The 111 site series is more common than the 110 at upper elevations in the ESSFwm1 (most common above 1800 m). Slightly moister sites (112) have abundant horsetails.

Variability

Minor amounts of lady fern and clasping twistedstalk often occur, especially at lower elevations or on warmer sites.

Management Issues

Brush competition is often a concern in regenerating stands. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should occur when soils are dry or frozen. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

SeBl – Horsetail – Canby's lovage 112

General Description

SMR 6 (7). The 112 site series is uncommon in the ESSFwm1. It occurs on **gentle toe slopes**, in **depressions**, and on **level sites** where the water table is within the top 0–50 cm. Open water is frequently present as slow-moving streams or seeps. Soils are usually Gleysols or, where flooding occurs, Cumulic Humic Regosols. Thin organic veneers are often present. Sites are typically associated with **riparian areas** where there is frequent to rare flooding.

Stands have an open canopy of Bl and Se. **Horsetails** are always present and often abundant, usually with **globeflower**, **leatherleaf saxifrage**, and **rein orchids**, along with arrow-leaved groundsel, mitreworts, and Canby's lovage. Leafy mosses, hook-mosses, and ragged-mosses are common.

Differentiating from Other Site Series

The 112 is the wettest forested site series described. Slightly drier sites (111) are characterized by false-hellebore, Canby's lovage, and/or arrow-leaved groundsel and have few or no horsetails (< 5% cover). Wetter sites include non-forested wetlands, which are described in Section 6.2.

Variability

Plant species diversity is often high on these sites, with many species occurring with low cover. Sites are often hummocky, with trees and drier indicator species growing on elevated sites, and wetter indicator species, including horsetails, leatherleaf saxifrage, small willowherbs (*Epilobium* spp.), bluejoint reedgrass (*Calamagrostis canadensis*), and peat-mosses (*Sphagnum* spp.), growing in hollows. Minor cover of oak fern, lady fern, or false-hellebore is common. Although not formally recognized, some 112 sites may also fit the definition of the *Ws08.2 Engelmann spruce – Subalpine fir – Horsetail – Canby's lovage* treed swamp site association (see LMH 70 [MacKillop and Ehman 2016]).

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential hazards, and the water table may rise once trees are removed. Cold air, frost, and brush competition may limit tree regeneration following harvest. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

Other Ecosystems

The following ecosystems are also known to occur in the ESSFwm1. They are described in detail in Chapter 6.

Wetlands

Wetlands are uncommon and scattered across the ESSFwm1. The most common wetlands are fens (Wf), although marshes (Wm), swamps (Ws), and, on cold sites at upper elevations, alpine wetlands (Wa) also occur. Wetland ecosystems are described in Section 6.2.

Flood ecosystems

Low bench flood ecosystems are uncommon along the edges of streams and rivers in the ESSFwm1. They are described in Section 6.3.

Grasslands and brushlands

Grasslands (Gg) and brushlands (Gb) are uncommon in the ESSFwm1 and are restricted to the warmest, driest sites. Where they occur, they provide important habitat and structural diversity. The Grassland Group is described in Section 6.4.

Avalanche features

Avalanche tracks are common in the steep, snowy mountains of the ESSFwm1 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

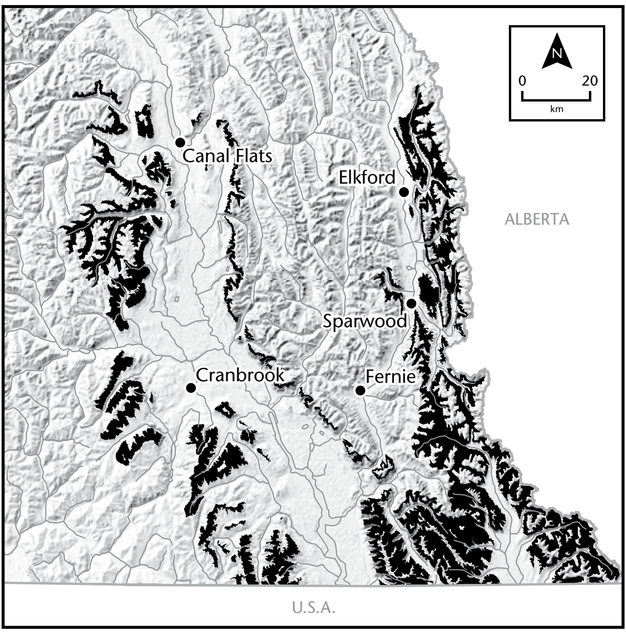
Rock outcrops (Ro) and talus slopes (Rt) commonly occur throughout the ESSFwm1. They are described in Section 6.6.

ESSFdk1
Elk Dry Cool
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFdk1 occurs at upper elevations in the southern Purcell and Rocky Mountains. In the Rocky Mountains, it occurs east and south of the Elk River from the Upper Fording River south to the United States border and includes much of the Elk, Wigwam, and Flathead River drainages. It also occurs on the western slopes of the Kootenay and Galton Ranges, adjacent to the Rocky Mountain Trench. In the Purcell Mountains, it occurs from Dutch Creek south to the McGillivary Range at the United States border. Throughout its range, the ESSFdk1 occurs between the MSdw and ESSFdkw. The ESSFdk1 is adjacent to the ESSFwm1 in the mountains around the Fernie area and abuts the ESSFwm4 in the southern Purcell Mountains. The ESSFdk2 occurs to the north of the ESSFdk1 in both the Purcell and Rocky Mountains.

Distribution of the ESSFdk1



Elevation Range

The ESSFdk1 generally extends from 1500–1600 m to 1900–2050 m on cool and neutral aspects and from 1600–1700 m to 2000–2100 m on warm aspects.

Climate[1]

The ESSFdk1 occurs in the Dry climate subregion. Winters are cold and moist, while spring, summer, and fall are cool and dry to moist. Snowfall is moderately deep to deep, and the snowpack generally persists from October or November through May. Growing-season moisture deficits typically occur on subxeric and drier sites, and on submesic to mesic sites in dry years. At the eastern extent, the ESSFdk1 can be influenced by chinook and other weather phenomena, which are common to the eastern slopes of the Rocky Mountains. The ESSFdk1 is slightly warmer than the ESSFdk2 and drier than the ESSFwm1 and ESSFwm4.

Forest and Vegetation Characteristics

Bl, Se, and Pl are extensive across the ESSFdk1. **Mesic sites** are dominated by Se and Bl, and have lesser amounts of Pl, while **submesic and drier sites** are often Pl-dominated with Bl and Se. Fd can extend to very high elevations in the ESSFdk1, particularly on warm-aspect sites with rocky, calcareous soils. Pa and La[2] also occur on drier, colder, high-elevation sites. **Moist to wet sites** are dominated by Se and Bl.

False azalea, **grouseberry/low bilberry**, **arnicas**, **ragged-mosses**, and **heron's-bill mosses** are the most commonly occurring understorey species across most sites. White-flowered rhododendron is often present, particularly on circum-mesic sites. Black huckleberry can be abundant but has a varied distribution across the ESSFdk1. On any given site series, cover can vary from absent to > 20%. Huckleberry variability may be linked to soils, canopy openness, and disturbance history. Black gooseberry and black twinberry often occur on the wettest sites.

Understorey species on mesic sites are characterized by false azalea, arnicas, and low to moderate cover of grouseberry/low bilberry (< 10%). Grouseberry/low bilberry are usually dominant (> 25% cover) on drier than mesic sites, and pinegrass, common juniper, and birch-leaved spirea occur on the **driest sites**. One-leaved foamflower, mitreworts, false-hellebore, and arrow-leaved groundsel are typical of **moist to wet sites**, and horsetails are abundant on the **wettest sites**.

1 See Section 4.5 for more information on climate variables.

2 Pa refers to *Pinus albicaulis* (whitebark pine), an at-risk conifer, and La to *Larix lyallii* (subalpine larch).

Bear-grass (*Xerophyllum tenax*) is often abundant on sites in the Flathead and Wigwam valleys and is occasionally present where the ESSFdk1 is close to the ESSFwm4. Bear-grass is most common on the 104 site series, but where it is geographically abundant, it can also have high cover on drier sites and on the 101 site series.

Grasslands are uncommon throughout the ESSFdk1, and are usually restricted to warm-aspect sites. In the Elk and Flathead valleys, they are locally more abundant and provide important habitat for a diversity of species (see Section 6.4). Other non-forested ecosystems, including wetlands, flood sites, rock outcrops, talus, and avalanche paths, also provide critical habitat for species diversity across the landscape (see Chapter 6).

Disturbance

The ESSFdk1 landscape consists of young to mid-seral forests interspersed with patches of older trees and forests. Historical fire regimes were mixed-severity, and included stand-replacing **wildfires** that occurred at infrequent to frequent intervals, and less severe and more frequent fire events that left large trees and snags on site.

Fire history in the ESSFdk1 is complex and highly variable over time and at any given place on the landscape. This irregularity is often a result of topography, ignition sources, and/or weather factors. In the subalpine forests of the Rocky Mountains, fire patterns are largely weather-dependent; most large fires burn during periods of prolonged drought (Agee 1997). In wetter years, ignition probability and fire spread are lower, which results in fewer, smaller fires. Stand type can also influence fire regimes in the ESSF. Flammability of Pl-dominated stands is often higher than that of other stand types, particularly where Pl occurs on the driest sites. Fire severity generally increases following endemic or episodic infestations of mountain pine beetle in these stands. Fd stands in the ESSFdk1 may experience more mixed-severity fire, largely because Fd is more fire-resistant and Fd-dominated stands generally occur on rockier sites that slow the spread of fire. Contiguity with lower-elevation ecosystems can also influence fire in the ESSFdk1; fires that ignite in lower-elevation, dry forests will often burn uphill into adjacent ESSF stands.

Individual trees and patches that survive fires provide important structural diversity and habitat. Local studies found that residual patches within large, otherwise stand-replacing fires varied from 1 to 100 ha and were common, particularly along streams.[3] Fd and Lw were the most common

[3] Mean size of remnant patches within burn perimeters was 10.4 ha (± 6.2 ha) for islands and 13.5 ha (± 7.7 ha) for skips.

remnant trees, both as scattered veterans and in partially burned clumped patches. Se was abundant only in larger remnant patches (Stuart-Smith and Hendry 1998).[4]

Mountain pine beetle epidemics, including a prolonged outbreak in the Flathead and Wigwam valleys that peaked in 1979–1980, have had a large influence on the current landscape by creating diverse stand- and landscape-level structure and species composition (Dykstra and Braumandl 2006; Amoroso et al. 2013). Recent outbreaks have continued to cause high mortality in Pl stands. **Spruce beetle** can also cause high mortality in mature stands, especially following fire or blowdown, or where slash retention is high after harvest; this is an emerging concern at landscape scales. Endemic levels of **western balsam bark beetle** create small gaps in the canopy and are key drivers of regeneration and development of multi-aged stands. Where Fd is abundant, largely on warm-aspect sites in the Rocky Mountains, Douglas-fir beetle can occur but is not a major source of mortality in the ESSFdk1. **White pine blister rust** and mountain pine beetle have had devastating effects on Pa, while larch needle blight has localized effects on La, particularly in the Purcell Mountains.

Forest harvesting has been extensive throughout much of the ESSFdk1. Mining, particularly in the Elk Valley and Kimberly areas, has had large, localized effects on forest cover in the ESSFdk1.

Soils, Geology, and Landforms

Geology in the southern Purcell and Rocky Mountains is highly diverse. Sedimentary rocks such as siltstone, sandstone, shale, and limestone underlie approximately half of the area mapped as ESSFdk1. Dolomite, argillite, and conglomerates are also common throughout the unit. In the Rocky Mountains, finer-grained bedrock types such as mudstone, siltstone, and shale are abundant. Coarse sedimentary rocks are very common east of Fernie, while coarse-grained granodioritic intrusions occur, particularly in the Upper Skookumchuck and Buhl Creek drainages.

The mix of fine- to coarse-grained parent materials leads to a range of soil textures, including silty clay loam, silt loam, and sandy loam. In areas of calcareous parent materials, carbonate-enriched (Cca) subsoil layers are usually present at depth. Colluvial and morainal deposits are the dominant landforms, although large glaciofluvial deposits occur in the upper valleys of the Fording and Flathead Rivers and in the Michel, Alexander, and Skookumchuck Creek valleys. These deposits have soil textures ranging from loam to loamy sand, generally with high gravel content and greater

[4] Data are primarily from areas now mapped as ESSFdk1, ESSFdk2, MSdw, and MSdk.

coarse fragment content at depth. Rocky terrain with talus, cliffs, and rock outcrops frequently occurs in association with very shallow (< 50 cm thick) colluvial and morainal veneers.

Wildlife Habitat

The ESSFdk1 supports high-value summer range for **Rocky Mountain bighorn sheep**, **elk**, **mule deer, mountain goats**, and **moose**. In the Purcell Mountains, many areas also provide year-round habitat for **mountain caribou**, which rely on older forests with lichen-loaded trees for critical forage, especially in winter.

Herbaceous vegetation, particularly in avalanche run-out zones, riparian areas, and wetland habitats, provides spring forage for **grizzly bears** and **black bears**, while huckleberries are consumed whenever available. High habitat suitability is also available for other wide-ranging carnivores, such as **wolverine, Canada lynx**, and **grey wolf**. Furbearers, such as **American marten** and **snowshoe hare**, are locally abundant.

High-elevation grasslands are relatively unique to the ESSFdk1, and are most common in the Elk and Flathead valleys. These grasslands are associated with a very **high diversity of at-risk plant species.** They also provide critical forage for ungulates, as well as habitat for other at-risk and regionally significant species, including **American badger**, **white-tailed ptarmigan**, **American pipet**, and **Clark's nutcracker**. **Bighorn sheep** and elk rely on these grasslands as important food sources. Grassland sites in proximity to exposed, rocky escape terrain are particularly important for **mountain goats**.

Rock outcrops, **talus**, and **cliffs** provide habitat for many species, including at-risk **least chipmunk**, **red-tailed chipmunk**, **southern red-backed vole**, **little brown myotis**, **peregrine falcon**, and **black swift**.

Cutthroat trout, **bull trout**, and **Rocky Mountain tailed frog** breed in cold, fast-moving streams with coarse substrates, and are generally associated with hydrologically stable watersheds and intact streamside habitats. At-risk **western toads** are also associated with riparian and wetland sites.

A variety of species that are associated with old and mature forests breed in the ESSFdk1, including at-risk **northern goshawk**, **Swainson's hawk**, and **olive-sided flycatcher**, as well as **black-backed woodpecker**, **American three-toed woodpecker**, **red-breasted nuthatch**, **mountain chickadee**, **brown creeper**, and **Pacific wren**. Retention of **old-forest** and **associated structure** is necessary to sustain these species; this includes large, live and dead wildlife trees with heart rot, cavities, and strong horizontal limbs, hollow logs, and other large pieces of coarse woody debris.

Common bird species include ruby-crowned kinglet, Swainson's thrush, hermit thrush, Wilson's warbler, and yellow-rumped warbler.

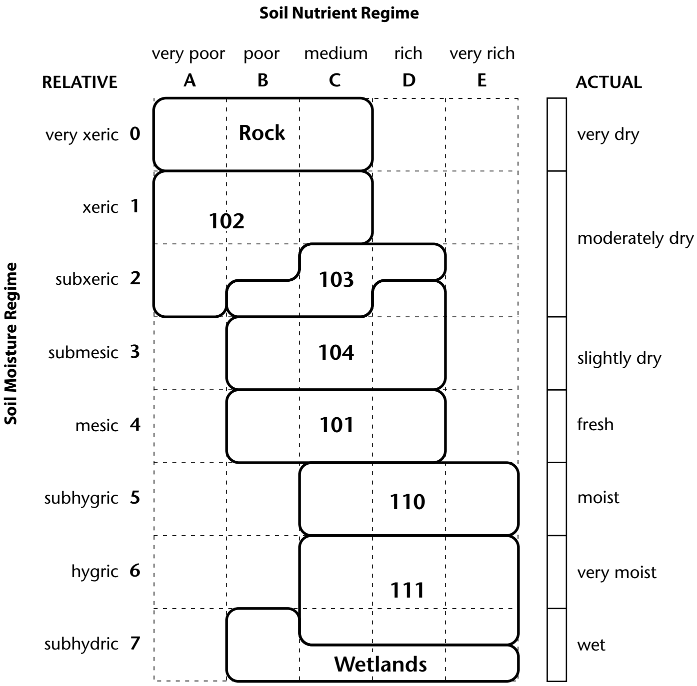
Marsh valerian
Valeriana dioica

Sitka valerian
Valeriana sitchensis

Distinguishing the ESSFdk1 from Adjacent Biogeoclimatic Units

In the **MSdw**, most sites have:	- pinegrass - less grouseberry
zonal sites have:	- more Pl and Lw, less Bl - sparse false azalea - no white-flowered rhododendron or black huckleberry - thimbleberry and birch-leaved spirea are common
dry sites have:	- widespread Fd and Lw - more abundant pinegrass and bluebunch wheatgrass
In the **ESSFdk2**, most sites have:	- red-stemmed feathermoss, step moss, and knight's plume - sparse/restricted grassland and brushland ecosystems
zonal sites have:	- moderate cover of bunchberry - red-stemmed feathermoss, step moss, and knight's plume
In the **ESSFdkw**, most sites have:	- lower productivity - less false azalea and white-flowered rhododendron - high-elevation species, including Pa, La, anemones, or mountain-heathers
zonal sites have:	- no Pl
dry sites have:	- frequent occurrence of Pa and/or La and no Fd
wet sites have:	- valerian, anemones, and meadowrues - no black twinberry, false azalea, or black gooseberry
In the **ESSFwm4**, most sites have:	- Hw and Cw, especially at lower elevations - more foamflower, black huckleberry, and white-flowered rhododendron
zonal sites have:	- no Pl - sparse cover of grouseberry/low bilberry - more foamflower
dry sites have:	- little or no pinegrass
wet sites have:	- oak fern, lady fern, and/or spiny wood fern
In the **ESSFwm1**, most sites have:	- more black huckleberry and white-flowered rhododendron - sparse/restricted grassland and brushland ecosystems
zonal sites have:	- more foamflower - minor cover of oak fern - little or no grouseberry/low bilberry - no Pl
dry sites have:	- less soopolallie, juniper, Pl, and pinegrass
wet sites have:	- oak fern, lady fern, and/or spiny wood fern

Edatopic Grid



Site series

101 BlSe – Azalea
102 PlFd – Juniper – Douglas maple
103 BlPl – Grouseberry
104 BlPl – Azalea – Grouseberry
110 BlSe – Azalea – Foamflower
111 Se – Horsetail – Bluejoint

Site Series Flowchart

Forest group	Site characteristics	Site series
VERY DRY to DRY FORESTS • warm aspects • shallow soils	• SMR 1 (2) • Fd (Pl, Bl) stands • exposed rock prominent • soopolallie, juniper, and saskatoon common • pinegrass, stonecrops, saxifrages, pussytoes	**102**
	• SMR 2 • Pl, often with minor Se and Bl • steep, warm aspects; coarse and/or shallow soils • birch-leaved spirea, common juniper, soopolallie • grouseberry/low bilberry (usually 10–20% cover) • pinegrass	**103**
SLIGHTLY DRY to MESIC FORESTS • mid slopes (usually) with deep soils	• SMR 3 (2) • Pl, Se, Bl stands • mostly warm aspects • abundant grouseberry/low bilberry (> 25% cover) • may contain minor cover of arnica (< 5%)	**104**
	• SMR 4 • Se, Bl (Pl) stands • arnica has moderate cover (~ 3–10%) • low to moderate cover of grouseberry/low bilberry (< 10%)	**101**
MOIST to VERY WET FORESTS • gentle, lower, or toe slopes • seepage or mottles present • usually associated with riparian areas	• SMR 5 • Se, Bl stands • receiving sites, seepage 50–100 cm • foamflower, meadowrue, mitreworts, and black gooseberry • often with false-hellebore, arrow-leaved groundsel, and/or cow-parsnip	**110**
	• SMR 6 (7) • Se, Bl stands • receiving sites, seepage at or near surface • cold-air pooling is common • abundant bluejoint reedgrass and horsetails	**111**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	Common name
Trees	*Pinus contorta*	□□□	■■■■	■■■■	□□□	*		lodgepole pine
	Pseudotsuga menziesii	■■■	*					Douglas-fir
	Abies lasiocarpa	*	*	■■■■	■■■■	■■■■	□□□	subalpine fir
	Picea engelmannii			■■■	■■■■	■■■■	■■■■	Engelmann spruce
Regen	*Abies lasiocarpa*	□□	□□	■■■	■■■	■■■	■■■	subalpine fir
	Picea engelmannii	□	*	□□□	□□	□□	■■■	Engelmann spruce
Shrubs	*Juniperus communis*	■■■	■■					common juniper
	Shepherdia canadensis	■■	□□					soopolallie
	Acer glabrum	■■						Douglas maple
	Amelanchier alnifolia	□□	*					saskatoon
	Paxistima myrsinites	□□	*					falsebox
	Spiraea lucida	□	■■					birch-leaved spirea
	Vaccinium membranaceum	*	□□	□□	□□	□□	□□	black huckleberry
	Menziesia ferruginea			■■■■■	■■■■	■■■■	■■	false azalea
	Rhododendron albiflorum			□□□	□□□	*		white-flowered rhododendron
	Ribes lacustre				*	■■■	■■■	black gooseberry
	Lonicera involucrata					*	■■	black twinberry

Layer	Scientific name	102	103	104	101	110	111	Common name
Herbs	*Calamagrostis rubescens*	□□□□	■■■					pinegrass
	Fragaria spp.	□□	□□					strawberry
	Heuchera cylindrica	□□						round-leaved alumroot
	"saxifrages"[a]	□□						saxifrages
	Antennaria spp.	□						pussytoes
	Sedum spp.	□						stonecrops
	Vaccinium scoparium/myrtillus	*	■■■■	■■■■■	■■■	■■	■	grouseberry/low bilberry
	Arnica spp.		*	□	■■■	■■■	■■■	arnicas
	Tiarella trifoliata var. *unifoliata*				*	■■■	■■	one-leaved foamflower
	Thalictrum occidentale				*	□□□	*	western meadowrue
	Heracleum maximum					□□	■■	cow-parsnip
	"mitreworts"[a]					■■	■	mitreworts
	Veratrum viride					□□	■	false-hellebore
	Senecio triangularis					□	■■	arrow-leaved groundsel
	Galium triflorum					*	□	sweet-scented bedstraw
	Equisetum spp.						■■■■	horsetails
	Calamagrostis canadensis						■■■■	bluejoint reedgrass
	Parnassia fimbriata						□□□	fringed grass-of-Parnassus
	Trollius albiflorus						□	globeflower
Moss layer	*Cladonia* spp.	□□	*	■■				clad lichens
	Brachythecium spp.		□□	□□□	■■■	■■■	■■■	ragged-mosses
	Dicranum spp.			■■■	*	*		heron's-bill mosses
	"leafy liverworts"[a]			□□	□□	□□	*	leafy liverworts
	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

Environment Table[a]

Site series	102	103	104	101	110	111
No. of plots	9	14	18	23	15	4
SMR	1 (2)	2	3 (2)	4	5 (4)	6 (7)
SNR	B–C (A)	C (B, D)	B (C–D)	C–D (B)	C–D (E)	D–E (C)
Slope position	UP (MD)	MD–UP (CR)	MD (LW, UP)	MD	LW, TO (MD)	LV, TO, DP
Typical slope/ aspect	Steep–moderately steep/warm	Steep/warm	Moderate/ warm	Moderate/ neutral (cool)	Gentle (moderate)	Gentle (moderate)
Common compensating conditions		Neutral aspects with high sun exposure	Upper/cool–neutral, shedding; shallow or coarse on neutral, cool, or lower/warm	Lower/coarse; gentle/warm	Mid-slope receiving sites; moderately coarse toe slopes	
Surficial materials	Cx/R, Mx/R (Cvb)	Cv, Cb (Mv)	Mb (Cb)	Mb (Cb)	F (M, C)	F (L, Ov)
Soil texture	SL, SiL, LS	SL, LS, SiL	SL (L, SiL)	SiL, SCL, SL, FSL	SL, SiL (LS, SCL, L)	SiL, CL, SCL
Coarse fragment content	Fragmental (moderate–high)	Moderate–high (fragmental)	High (moderate)	Low–moderate	Low–moderate	Low (moderate)
Important features	(Bed)rock is prominent and abundant; soils are often fragmental	Insolation			Seasonal seepage at depth	Water table at or near surface; can have thin organic veneers; associated with cold air and riparian areas

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

BlSe – Azalea 101

General Description

SMR 4. The 101 site series typically occurs on **mid**-slope positions of **neutral to cool aspects** with deep, medium-textured soils. Due to compensating factors, this site series also occurs on lower slope positions on warm aspects. Soils are generally Orthic Humo-Ferric Podzols, Dystric Brunisols, or Eurtric Brunisols with moderate coarse fragment content, often increasing at depth.

Se and **Bl** are dominant in the overstorey and understorey, although Pl is commonly present, particularly in earlier seral stands. **False azalea** is typically present, and cover is often high (20–50%). Presence and cover of other shrubs such as white-flowered rhododendron and black huckleberry vary, but covers are usually low to moderate (< 10%). Bl regeneration is usually present and often moderately abundant. **Grouseberry** and/or **low bilberry** typically have < 10% cover. **Arnicas**, both heart-leaved (*Arnica cordifolia*) and mountain (*A. latifolia*), are usually present and can be dominant or codominant with grouseberry and/or low bilberry in the herb layer. Other species such as foamflower, one-sided wintergreen (*Orthilia secunda*), violets (*Viola* spp.), and western meadowrue are usually present with low cover. Mosses are variable, but ragged-mosses and leafy liverworts are most common.

Differentiating from Other Site Series

Slightly drier sites (104) occur on submesic sites and have abundant grouseberry and/or low bilberry (> 10%), less arnica, and minor cover of clad lichens, and Pl is more prominent in stands of all seral stages. Slightly moister sites (110) have more mitreworts, cow-parsnip, and false-hellebore, as well as abundant foamflower and/or black gooseberry.

Variability

False azalea cover varies widely from none to dominant. Grouseberry and/or low bilberry cover often increases with increasing elevation. Pl is often more abundant in early to mid seral stands.

Management Issues

High cover of shrubs can compete with regenerating conifers. On steep slopes, snowpress can be a concern in winter. Cold-air pooling and frost may also limit the success of regenerating trees.

102 PlFd – Juniper – Douglas maple

General Description

SMR 1 (2). The 102 occurs on forested sites with exposed **bedrock** or, occasionally, coarse **talus**. Soils are very shallow and rocky, and growing conditions are very dry on these warm-aspect sites. Soils are generally derived in situ or from colluvial deposits, and textures are closely linked to bedrock characteristics. The occurrence of this site series is very dependent on soil depth, and it often occurs adjacent to 103 forests and non-forested rock outcrops or talus.

Fd and Pl typically occur in the overstorey, sometimes with Bl or minor amounts of Se, Pa, and/or Pf. **Soopolallie**, **common juniper**, **saskatoon**, **Douglas maple**, and falsebox are common shrubs that occur with a variety of dry herb species such as **round-leaved alumroot**, pinegrass, **saxifrages**, and, occasionally, bluebunch wheatgrass (*Pseudoroegneria spicata*) or shrubby penstemon (*Penstemon fruticosus*). Clad lichens, pelt lichens (*Peltigera* spp.), and rock-mosses (*Racomitrium* spp.) are common.

Differentiating from Other Site Series

The 102 is the driest forested site series and is easily differentiated by the combination of a forested canopy (> 10% tree cover at maturity) and the abundance of exposed rock (bedrock or talus). Drier sites are non-forested rock outcrops and talus sites (see Section 6.6). Slightly moister sites (103) have little or no exposed rock and lack species associated with rock outcrops, such as saxifrages, round-leaved alumroot, and stonecrops. 103 sites usually have abundant grouseberry and/or low bilberry.

Variability

Understorey species composition varies depending on soil depth and parent materials. Species typically associated with moister sites occur often on 102 sites with calcareous bedrock or on microsites with slightly deeper soils. Fd can be abundant, even at upper elevations approaching the woodland; this occurs most frequently on sites with calcareous parent materials.

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 species (e.g., Pa or Pf).

BlPl – Grouseberry 103

General Description

SMR 2. 103 sites occur on **upper** to **mid slopes** on moderately steep to **steep**, **warm aspects**, typically with coarse and/or shallow, rocky soils, and occasionally on warm and/or dry crests. Soil textures are generally sandy loam with high to fragmental coarse fragment content. Soils are typically derived from colluvial deposits on steep slopes or morainal deposits on crests, and the most common soil types are Eutric and Dystric Brunisols.

Pl usually dominates the open to moderately open canopy, often with minor cover of Bl. Fd, Lw, Se, and/or Pa may be present with low cover. **Grouseberry and/or low bilberry** are typically dominant, often with minor cover (< 2%) of wild strawberry, arnicas, and diverse understorey forbs. **Pinegrass** is usually present and sometimes abundant (10–20% cover). **Common juniper**, **birch-leaved spirea**, and/or soopolallie are usually present, while false azalea is sparse or absent. The moss layer is generally sparse, with ragged-mosses, minor clad and pelt lichens, and low cover of haircap mosses (*Polytrichum* spp.).

Differentiating from Other Site Series

Slightly drier sites (102) have prominent exposed bedrock, and rock outcrop–associated species such as saxifrages, round-leaved alumroot, and stonecrops. Slightly moister sites (104) lack pinegrass, common juniper, and birch-leaved spirea, have higher cover of Bl and Se, and often have moderate to high cover of false azalea and/or white-flowered rhododendron.

Variability

Bear-grass may be present, particularly in the southern extent of the ESSFdk1. Forb diversity can be high, with dry-site species such as lupines (*Lupinus* spp.), showy aster (*Eurybia conspicua*), pearly everlasting (*Anaphalis margaritacea*), yarrow, and pussytoes often present with very low covers. Thimbleberry is often present, particularly in earlier seral stands. Pinegrass cover can be highly variable, ranging from nil to abundant.

Management Issues

Drought may limit conifer regeneration, particularly during drier than average growing seasons. On steep slopes, avalanching and snowpress can damage regenerating trees in winter, while soil erosion can be a concern during the growing season. Pa or Pf stands and individual trees are not recommended for harvest.

104 BlPl – Azalea – Grouseberry

General Description

SMR 3 (2). The 104 site series typically occurs on moderately sloping, warm-aspect sites with medium- to coarse-textured, deep soils and on cool- to neutral-aspect sites on upper, shedding slope positions. On cool and neutral aspects, soils are usually shallow and/or coarse to very coarse textured. Most soils are Dystric Brunisols or Orthic Humo-Ferric Podzols and are not calcareous. Glacial till and colluvium are the most common surficial materials, although 104 sites can also occur on coarse-textured glaciofluvial deposits. Soil textures range from silt loam to loamy sand with moderate to high coarse fragment content.

Bl, Se, and Pl typify the canopy. Minor amounts of Pa may be present. Understorey plant communities are characterized by **abundant false azalea** and **grouseberry and/or low bilberry**. White-flowered rhododendron and black huckleberry are usually present with abundant Bl and Se regeneration in the shrub layer. Minor cover of arnicas and one-sided wintergreen is typical in the herb layer. The moss layer is variable, often with **heron's-bill mosses**, ragged-mosses, and minor cover of **clad lichens**. Red-stemmed feathermoss and pipecleaner moss (*Rhytidiopsis robusta*) are frequently present and occasionally abundant.

Differentiating from Other Site Series

Slightly drier sites (103) have less Bl and Se, have more juniper, soopolallie, birch-leaved spirea, and pinegrass, and have little to no false azalea and white-flowered rhododendron. Slightly moister sites (101) have less Pl and grouseberry/low bilberry and more arnica.

Variability

Cover of false azalea and white-flowered rhododendron varies from absent to dominant. High shrub cover is most common on cool-aspect sites, and is less common on neutral- and warm-aspect sites. Shrub-dominated sites also tend to have higher cover of leafy liverworts and mosses. Bear-grass can be common and abundant on these sites, especially in the Flathead and Wigwam valleys.

Management Issues

On steep slopes, avalanching and snowpress can damage regenerating trees in winter, while soil erosion can be a concern during the growing season. High cover of shrubs can compete with conifer regeneration.

BlSe – Azalea – Foamflower 110

General Description

SMR 5. 110 sites occur on **lower and toe slopes** in **moist sites** with **seasonal seepage** at depth. Sites are usually on gentle to moderate slopes (< 30%) and are often associated with **riparian areas**. Soils are typically moderately well to imperfectly drained Gleysols or Gleyed Brunisols derived from fluvial or, sometimes, morainal materials. Soil textures are variable, ranging from silt loam to loamy sand.

Se and Bl dominate the canopy, while black gooseberry, black twinberry, and regenerating Bl are typical in the shrub layer. Understorey herbs can be diverse and variable, often with moderate cover of **foamflower** and arnicas, and minor amounts of **cow-parsnip**, **false-hellebore**, **mitreworts**, and/or **arrow-leaved groundsel**. Ragged-mosses, red-stemmed feathermoss, leafy mosses, and leafy liverworts comprise much of the moss layer.

Differentiating from Other Site Series

Slightly drier sites (101) have little to no mitreworts, western meadowrue, false-hellebore, and black gooseberry, and only minor foamflower cover. Slightly moister sites (111) have abundant horsetails and/or bluejoint reedgrass, and seepage at or near the soil surface.

Variability

110 sites in the ESSFdk1 can be highly variable. The understorey herb layer is typically comprised of foamflower and/or arnicas with a mix of cow-parsnip, false-hellebore, mitreworts, arrow-leaved groundsel, and/or western meadowrue. However, one or more of these species is often absent. Oak fern is occasionally present, especially at lower elevations.

Management Issues

Cold air, frost, and brush competition may limit the success of regenerating trees. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should take place when soils are dry or frozen. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

111 Se – Horsetail – Bluejoint

General Description

SMR 6 (7). The 111 is an uncommon site series that occurs on **receiving** sites where the **water table is** at or near the surface. It occurs on gentle toe slopes and level sites, usually adjacent to streams, ponds, non-forested wetlands, or lakes. Soils are Gleysols, Humic Regosols, or occasionally Organic, and most sites experience occasional flooding (usually > 5-year intervals).

Se is dominant in the open overstorey, while **horsetails** are distinctive in the understorey. **Bluejoint reedgrass** is often present and abundant, while arrow-leaved groundsel, foamflower, arnicas, mitreworts, and a diversity of herbs occur with low to moderate cover. Moss cover is variable, often with a high diversity of species, usually including ragged-mosses.

Differentiating from Other Site Series

Slightly drier sites (110) lack horsetails and/or bluejoint reedgrass (< 2% cover), while wetter sites are non-forested wetlands (see Section 6.2).

Variability

Disturbed or earlier seral sites often have higher cover of bluejoint reedgrass and lower cover of horsetails. Understorey species composition can be highly diverse, with several species occurring, each with low cover. Sites are typically hummocky, with species associated with wetter conditions in depressions, and trees and species associated with drier conditions on elevated microsites.

111 sites are typically riparian-associated high bench floodplains with non-wetland soils. Occasionally, sites with very poor drainage and a thick, peaty, organic veneer occur; these can be classified as treed swamps (Ws08). Vegetation is very similar on both types of sites, and two site series phases are described to reflect the variability in site conditions:

111a for **riparian flood sites**
111b for the **swamp phase** (Ws08) (see Section 6.2)

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential hazards, and the water table may rise once trees are removed. Cold air, frost, and brush competition may limit tree regeneration following harvest. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

Other Ecosystems

The following ecosystems are also known to occur in the ESSFdk1. They are described in detail in Chapter 6.

Wetlands

The most common wetland ecosystems in the ESSFdk1 are fens (Wf), although marshes (Wm) and swamps (Ws) also occur. Alpine wetlands (Wa) are also present but only on very cold sites. Wetland ecosystems are described in Section 6.2.

Flood ecosystems

Low bench flood ecosystems are uncommon along the edges of streams and rivers in the ESSFdk1; they are described in Section 6.3.

Grasslands and brushlands

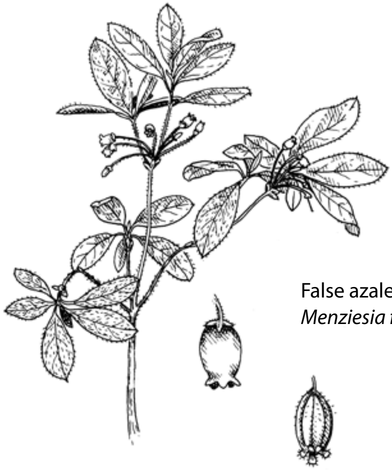
Grasslands and brushlands occur infrequently throughout the ESSFdk1, and are most common in the Elk and Flathead valleys. Section 6.4 describes the grassland and brushland site associations that are most common in the ESSFdk1.

Avalanche features

Avalanche tracks are common throughout the mountainous terrain of the ESSFdk1, and include highly diverse plant communities and numerous site associations. Most of the herb meadow (Vh) and shrub thicket (Vs) avalanche units that have been described occur in the ESSFdk1, and a number of currently undescribed treed avalanche (Vt) units are also known to occur. Avalanche ecosystems are described in Section 6.5.

Rock outcrops and talus

Abundant exposed rock and diverse bedrock geology occurs throughout the Rocky and Purcell Mountains; therefore, several rock outcrop (Ro) and talus (Rt) ecosystems commonly occur in the ESSFdk1. Rock Group ecosystems are described in Section 6.6.



False azalea
Menziesia ferruginea

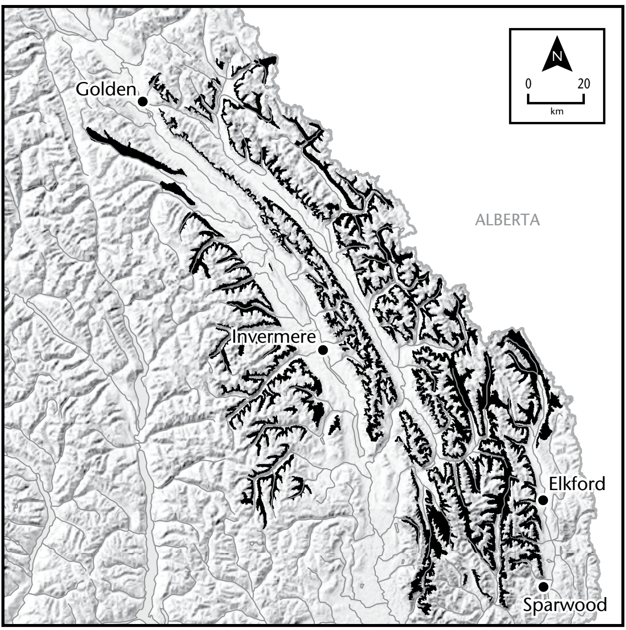
White-flowered rhododendron
Rhododendron albiflorum

ESSFdk2
Columbia Dry Cool
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFdk2 occurs at upper elevations in the central and northern Purcell Mountains from Doctor and Findlay Creeks north to the Spillimacheen River, and in the Rocky Mountains from the Upper Elk, Bull, and Wild Horse drainages north to the Kicking Horse River and Hospital Creek. Large areas occur in Yoho and Kootenay National Parks and in Top of the World, Elk Lakes, Height of the Rockies, and Mount Assiniboine Provincial Parks, and in the Purcell Wilderness Conservancy. The ESSFdk2 occurs below the ESSFdkw and mostly above the MSdk or, occasionally, the ICHmk5. The ESSFmm3 occurs at similar elevations at the northern extent. The ESSFwm2 occurs to the west, and the ESSFdk1 and ESSFwm1 (in the Bull River drainage) occur to the south.

Distribution of the ESSFdk2



Elevation Range

The ESSFdk2 occurs between approximately 1575 and 2000 m on cool aspects, 1650 and 2050 m on neutral aspects, and 1700 and 2100 on warm aspects. At the northern extent, upper elevation limits are approximately 50–100 m lower, and at the southern extent, upper elevation limits are approximately 50–100 m higher.

Climate[1]

The ESSFdk2 occurs in the Dry climate subregion. Winter, spring, and fall are cold and dry to moist, and summers are cool and moist. Snowfall is moderately deep to deep, and the snowpack generally persists from October or November through May. Growing-season moisture deficits typically occur on subxeric and drier sites, and on submesic to mesic sites in dry years. The ESSFdk2 climate is colder than that of the ESSFdk1 and drier than that of the ESSFmm3, ESSFwm2, and ESSFwm1.

Forest and Vegetation Characteristics

The ESSFdk2 is a large biogeoclimatic unit, spanning two major mountain ranges and a considerable north–south latitudinal gradient. As a result, there can be high variability in both soils and vegetation within the unit. Se and Bl are the most common tree species, followed by Pl and Fd, with minor amounts of Pa, Pf, and La.[2] Fd grows to high elevations on the driest sites, often as the dominant tree species, particularly on rocky, warm-aspect sites with limestone bedrock. Pl is often the dominant species on drier than mesic sites, but is also frequently present in mixed stands on mesic sites, especially in younger forests. Pa and Pf, both at-risk tree species, are uncommon and restricted to dry sites. La is most common on cool-aspect sites with rocky soils or blocky talus, often with cold air.

False azalea is the most common and abundant shrub, often forming dense thickets in the understorey. White-flowered rhododendron and black huckleberry occur, but their distribution and abundance are varied and inconsistent across the landscape. Other shrubs that are frequently present, usually with low cover, include black gooseberry on mesic and moister sites, and soopolallie, birch-leaved spirea, and prickly rose on drier than mesic sites. **Grouseberry/low bilberry** and **arnica** are prominent species throughout the ESSFdk2, particularly on submesic and moister sites. Bunchberry often occurs on mesic sites, particularly at lower elevations in the ESSFdk2.

[1] See Section 4.5 for more information on climate variables.

[2] Pa is *Pinus albicaulis* (whitebark pine); Pf is *P. flexilis* (limber pine); La is *Larix lyallii* (subalpine larch).

Pinegrass, kinnikinnick, twinflower, and strawberry are characteristic species on drier sites. Mitreworts, five-leaved bramble, one-leaved foamflower, and twistedstalks are common on moist to wet sites, and horsetails dominate on the wettest forested sites. Oak fern and lady fern occur on moist to wet sites in pockets of moister climatic conditions within the broader area mapped as ESSFdk2. Unlike the ESSFdk1, **feathermosses** are abundant in the ESSFdk2, with red-stemmed feathermoss, step moss, and knight's plume forming dense carpets in most forests.

Non-forest ecosystems are common in the ESSFdk2, especially those in the Avalanche Group (see Section 6.5) and Rock Group (see Section 6.6). Wetlands are typically restricted to small riparian complexes, and grasslands are uncommon.

The ESSFdk2 differs from wetter ESSF subzones/variants, which have more ferns and less grouseberry/low bilberry. At higher elevations, the ESSFdkw has shorter growing seasons, lower productivity, and a number of high-elevation species such as anemones, mountain-heathers, and woodrushes.

Disturbance

Historical fire regimes were mixed-severity, and included stand-replacing **wildfires** that occurred at infrequent to frequent intervals, and less severe and more frequent fire events that left large trees and snags on site. At a landscape scale, this has resulted in a mosaic of primarily even-aged stands of different ages, with some areas containing remnant stand structure. Forest harvesting has been extensive throughout much of the ESSFdk2.

In subalpine forests of the Rocky Mountains, fire patterns are largely weather-dependent, with most very large fires burning during years with prolonged drought (Agee 1997). In wetter years, ignition probability and fire spread are lower, which results in fewer, smaller fires. Stand type can also influence fire regimes in the ESSF. Pl-dominated stands often have higher flammability than Se and Bl stands, particularly where Pl occurs on drier sites. Fire severity also increases following endemic or episodic infestations of mountain pine beetle in these stands. Fd stands in the ESSFdk2 often have more mixed-severity fire regimes, largely because Fd is more fire-resistant than other species and because Fd-dominated stands generally occur on rockier sites, which slow the spread of fire. Contiguity with lower-elevation ecosystems can also influence fire within the ESSFdk2; fires that ignite in dry forests at lower elevation will often burn uphill into adjacent ESSF stands.

Individual trees and patches that survive fires provide important structural diversity and habitat. Local studies found that residual tree patches within large areas of younger, even-aged stands varied from 1 to 100 ha and were common, particularly along streams.[3] Fd and Lw were the most common remnant trees, both as scattered veterans and in partially burned clumped patches. Se was abundant only in larger remnant patches (Stuart-Smith and Hendry 1998).[4]

Mountain pine beetle is a significant cause of mortality in the ESSFdk2. **Spruce beetle** can also cause high mortality in mature stands, especially following fire or blowdown, or where slash retention is high after harvesting; this is an emerging concern at landscape scales. Endemic levels of **western balsam bark beetle** create small gaps in the canopy and are key drivers of tree regeneration and development of multi-aged stands. Where Fd is abundant, largely on warm-aspect sites in the Rocky Mountains, Douglas-fir beetle can occur but is not a major source of mortality in the ESSFdk2. **White pine blister rust** and mountain pine beetle have had devastating effects on Pa, while larch needle blight has localized effects on La, particularly in the Purcell Mountains.

Soils, Geology, and Landforms

The ESSFdk2 occurs across diverse geological areas of the Purcell and Rocky Mountains. Fine-grained bedrock types dominate, including siltstone, mudstone, shale, argillite, and slate, along with limestone, dolomite, and a variety of calcareous sedimentary types. Limestone, marble, and other calcareous bedrock types are particularly common in the Upper Bull, Upper White, and Upper Kicking Horse River drainages in the Rocky Mountains, and in the Foster and Horsethief Creek drainages in the Purcell Mountains. Quartzite, sandstones, and other coarse-grained sedimentary rocks are common in the Purcell Mountains north of Dutch Creek and in the Rocky Mountains north of the Cross River. Argillite, sandstones, and conglomerate turbidites are common in the upper Findlay Creek and upper Wildhorse River drainages.

Colluvial veneers and blankets with silt loam textures and moderate to very high coarse fragment content (20 to > 70%) are the dominant landforms in steep terrain of the ESSFdk2. Deep talus deposits are relatively common in the Purcell Mountains. Very shallow colluvial veneers (< 50 cm) are common throughout both the Rocky and Purcell Mountain ranges, and are often associated with large areas of exposed bedrock. Morainal deposits are very common in moderately steep terrain. Associated soils have silt loam to sandy loam textures, depending on parent material. In much of the

[3] Mean size of remnant patches within burn perimeters was 10.4 ha (± 6.2 ha) for islands and 13.5 ha (± 7.7 ha) for skips.

[4] Data are primarily from areas now mapped as ESSFdk1, ESSFdk2, MSdw, and MSdk.

Rocky Mountains and some areas of the Purcell Mountains, soils are derived from calcareous parent materials and often have carbonate-enriched (Cca) subsoil layers. These finer-textured soils can also have weak clay accumulation in Bt layers that impede water flow and restrict root penetration. Non-calcareous soils are most common in the Purcell Mountains. Glaciofluvial and fluvial landforms are uncommon and are restricted to the upper valley bottoms of the Elk and Kootenay River drainages.

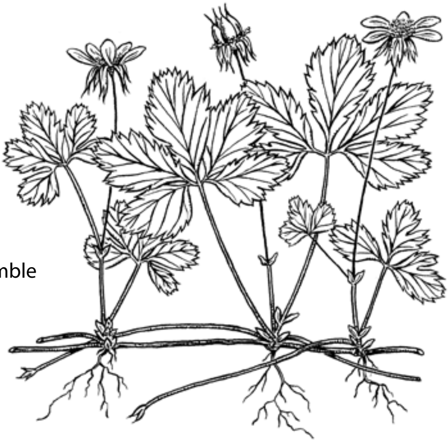
Wildlife Habitat

The ESSFdk2 supports valuable summer range for **Rocky Mountain bighorn sheep**, **elk**, **mule deer**, **mountain goat**, and **moose**. **Grizzly bears** and **black bears** forage broadly throughout the unit, targeting avalanche run-out zones and riparian/wetland habitats in spring and huckleberries through the late summer and early fall (where available). The ESSFdk2 also provides high-suitability habitat for other wide-ranging carnivores, such as at-risk **wolverine** and **American badger**, as well as Canada lynx and grey wolf. Furbearers, such as **American marten** and **snowshoe hare**, are locally abundant.

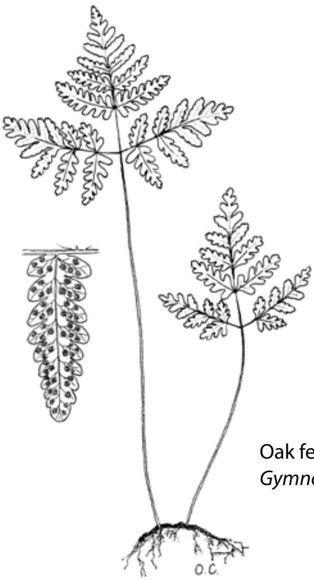
Old and mature forests and associated stand structures provide important habitat for **cavity-nesting**, **roosting**, **denning**, **and insect-feeding species** that are dependent on multi-layered canopies, large live and dead trees (including wildlife trees), and/or coarse woody debris. Species that require those attributes include at-risk **northern goshawk**, **olive-sided flycatcher**, and **Swainson's hawk**, as well as **black-backed woodpecker**, **American three-toed woodpecker**, **northern flicker**, **red-breasted nuthatch**, **mountain chickadee**, **boreal chickadee**, **brown creeper**, **Clark's nutcracker**, **Pacific wren**, **little brown myotis**, and **red squirrel**.

Stream and wetland habitats are used by at-risk **Gillette's checkerspot**, **western toad**, and **barn swallow**, as well as several other bird and mammal species. Fast-moving streams with coarse substrates may support **cutthroat trout** or **bull trout**. **Rocky habitats** in the ESSFdk2 provide important substrate for breeding, roosting, cover, and escape terrain used by a range of species including at-risk **least chipmunk**, **little brown myotis**, **black swift**, and **mountain goat**.

Several at-risk plant species occur in the ESSFdk2. Pa and its main seed disperser, Clark's nutcracker, occur across the unit, while Pf is less common but can occur on dry sites. Common bird species include varied thrush, hermit thrush, Swainson's thrush, pine siskin, and Townsend's warbler.



Five-leaved bramble
Rubus pedatus



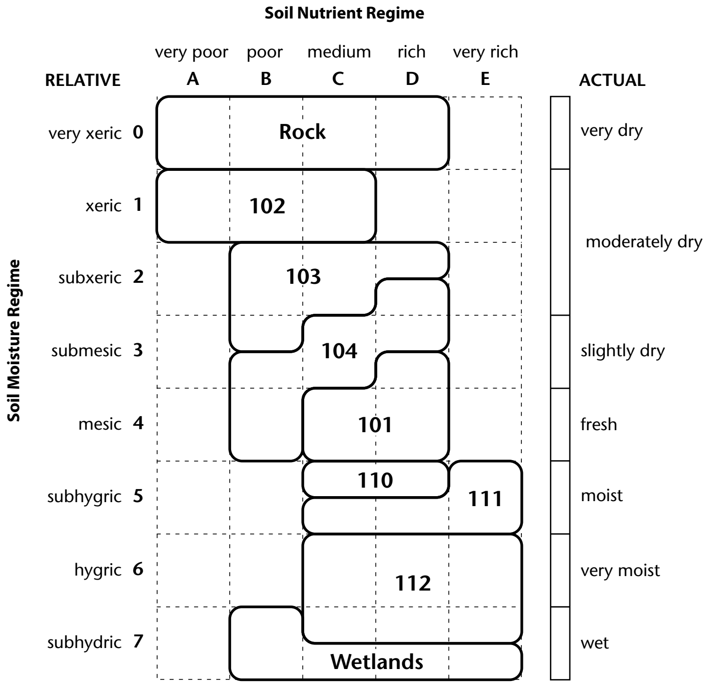
Oak fern
Gymnocarpium dryopteris

Distinguishing the ESSFdk2 from Adjacent Biogeoclimatic Units

In the **ESSFdk1**, most sites have:	- little or no step moss and knight's plume - grassland and brushland ecosystems more commonly on the landscape
zonal sites have:	- little or no bunchberry, red-stemmed feathermoss, step moss, or knight's plume
dry sites have:	- falsebox and sometimes bluebunch wheatgrass
wet sites have:	- more arrow-leaved groundsel, cow-parsnip, and/or false-hellebore
In the **ESSFdkw**, most sites have:	- generally lower productivity - mountain-heathers, wood-rushes, and/or anemones; little or no Pl
zonal sites have:	- no bunchberry - less false azalea
dry sites have:	- frequent occurrence of Pa and/or La; no Fd
wet sites have:	- more valerian and anemones
In the **ESSFmm3**,[a] most sites have:	- less Pl - more white-flowered rhododendron, oval-leaved blueberry, and five-leaved bramble
zonal sites have:	- five-leaved bramble and foamflower - no grouseberry/low bilberry
wet sites have:	- oak fern, lady fern, and/or spiny wood fern; more valerian
In the **MSdk**, most sites have:	- no white-flowered rhododendron - more abundant Fd and less Bl - little or no grouseberry/low bilberry (especially submesic–mesic sites)
zonal sites have:	- Fd - less false azalea, grouseberry/low bilberry, and heart-leaved arnica
dry sites have:	- Rocky Mountain juniper - more pinegrass and bluebunch wheatgrass
wet sites have:	- little or no foamflower or arrow-leaved groundsel
In the **ICHmk5**,[a] most sites have:	- Cw - less Bl
zonal sites have:	- Fd - less false azalea
dry sites have:	- Rocky Mountain juniper; more pinegrass and birch-leaved spirea
wet sites have:	- wild sarsaparilla, ferns, and/or devil's club

[a] The ESSFmm3 and ICHmk5 will be described in a future field guide.

Edatopic Grid



Site series

101	BlSe – Azalea – Feathermoss
102	PlFd – Juniper – Douglas maple
103	PlBl – Juniper – Showy aster
104	BlPl – Azalea – Grouseberry
110	BlSe – Azalea – Oak fern
111	BlSe – Azalea – Foamflower
112	SeBl – Horsetail – Feathermoss

Site Series Flowchart

VERY DRY to DRY FORESTS
- warm aspects
- shallow soils

- SMR 1
- Fd, Pl stands
- exposed bedrock or talus is prominent
- shrubby with soopolallie, common juniper, Douglas maple, and/or birch-leaved spirea
- minor amounts of dry-site species: nodding onion, yarrow, and pinegrass

→ **102**

- SMR 2 (3)
- Pl, Fd, Se (Bl) stands
- steep, warm aspects; coarse and/or shallow soils
- common juniper and soopolallie
- showy aster, pinegrass, and twinflower

→ **103**

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

- SMR 3 (4)
- Pl, Se, Bl stands
- > 10% grouseberry/low bilberry
- soopolallie and/or birch-leaved spirea present

→ **104**

- SMR 4 (3)
- Se, Bl (Pl) stands
- < 10% cover grouseberry/low bilberry
- bunchberry usually present

→ **101**

MOIST to WET FORESTS
- lower and toe slopes or level
- seepage, mottles, or water table present

- SMR 5
- Se, Bl stands
- lower slopes, often riparian
- occurs in wetter climatic areas of the ESSFdk2
- abundant one-leaved foamflower and oak fern
- little or no grouseberry/low bilberry

→ **110**

- SMR 5
- riparian; lower and toe slopes or level
- moderate amounts of black gooseberry and black twinberry
- foamflower, five-leaved bramble, bunchberry, arnica, and grouseberry/low bilberry

→ **111**

- SMR 6 (7)
- Se, Bl stands
- level or gentle sites; water table at or near the surface
- riparian; cold air common
- abundant horsetails

→ **112**

Vegetation Table

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Trees	*Pseudotsuga menziesii*	■■■■	□□□	*	*				Douglas-fir
	Pinus contorta	■■■	■■■■	■■■■	□□□				lodgepole pine
	Picea engelmannii		■■■	■■■■	■■■■	■■■■■	■■■■■	■■■■	Engelmann spruce
	Abies lasiocarpa		□□□	■■■	■■■■	■■■■	■■■■	■■■	subalpine fir
Regen	*Abies lasiocarpa*		■■■	■■■■	■■■	□□□	■■■■	■■■	subalpine fir
	Picea engelmannii			□□	□□	□□	■■■	■■■	Engelmann spruce
Shrubs	*Shepherdia canadensis*	■■■	■■■	□□					soopolallie
	Juniperus communis	■■■	■■■						common juniper
	Acer glabrum	□□□							Douglas maple
	Spiraea lucida	■	□	□					birch-leaved spirea
	Rosa acicularis	□	□						prickly rose
	Amelanchier alnifolia	□							saskatoon
	Menziesia ferruginea			■■■■	■■■■	■■■■	■■■	■■■	false azalea
	Vaccinium membranaceum			□□	□□	■■■	*	*	black huckleberry
	Ribes lacustre			*	■	■■■	■■	■■	black gooseberry
	Lonicera involucrata					□□	■■	■■	black twinberry
Herbs	*Arctostaphylos uva-ursi*	■■■	□□						kinnikinnick
	Linnaea borealis	■■	■■■	□□	□□				twinflower
	Eurybia conspicua	□□	■■■	*					showy aster
	Calamagrostis rubescens	□□	■■■						pinegrass
	Fragaria spp.	■	■■						strawberry
	Achillea spp.	■	*						yarrow
	Allium cernuum	■							nodding onion

Layer	Scientific name	102	103	104	101	110	111	112	Common name
Herbs	*Arnica* spp.		□□	■■	■■■	□□□	■■	*	arnicas
	Vaccinium scoparium/myrtillus		*	■■■■■	■■■	□□	■■■		grouseberry/low bilberry
	Orthilia secunda		*	□	■■	□	■		one-sided wintergreen
	Cornus canadensis			*	■■■	*	■■	*	bunchberry
	Tiarella trifoliata var. *unifoliata*					■■■■	□□□	□	one-leaved foamflower
	Gymnocarpium dryopteris					■■■■			oak fern
	Rubus pedatus					□□	□	□	five-leaved bramble
	Streptopus amplexifolius					■■	*	□	clasping twistedstalk
	Athyrium filix-femina					□			lady fern
	Dryopteris expansa					■			spiny wood fern
	Senecio triangularis					*	□	*	arrow-leaved groundsel
	Equisetum spp.					□	□	■■■■	horsetails
	"mitreworts"[a]						■	■■	mitreworts
Moss layer	*Peltigera* spp.	■■	□□	■■	■■		□		pelt lichens
	Cladonia spp.	□□	*	□					clad lichens
	Dicranum spp.		*	□□□	■■■	*	□□□		heron's-bill mosses
	Pleurozium schreberi		□□□	■■■■■	■■■■■	■■■■	■■■■■	■■■■	red-stemmed feathermoss
	Hylocomium splendens			□□□	□□□□		□□□□	*	step moss
	Ptilium crista-castrensis			*	□□□	*	*	*	knight's plume
	"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	101	110	111	112
No. of plots	8	20	37	22	6	14	7
SMR	1	2 (3)	3 (4)	4 (3)	5	5	6 (7)
SNR	C (A–B)	C–D (A–B)	C–D (B)	C–D	C (D)	D (C, E)	D–E
Slope position	MD (UP)	MD–UP (CR)	MD (LW, UP)	MD (LW)	LW (MD, GU)	LW, TO (LV)	TO, LV (DP)
Typical slope/ aspect	Steep–moderately steep/ warm	Steep/warm	Moderate/ warm	Moderate/neutral (cool)	Moderate (gentle)	Gentle (level–moderate)	Gentle–level
Common compensating conditions		Neutral aspects with high sun exposure	Upper, cool, shedding; shallow/ coarse, neutral or cool	Lower, coarse; gentle, warm		Mid-slope receiving sites; moderately coarse toe slopes	
Surficial materials	Cx/R, Mx/R (Cvb)	Cv, Cb (Mv)	Mb, Cb	Mb (Cb)	M, F, C	F (M, C)	F (Ov, M)
Soil texture	SL (SiL)	SiL (SL)	SiL (SL)	SiL (L, SCL)	SiL (FSL)	SiL (SL, LS, SiCL, SCL)	SiL (SL, FSL)
Coarse fragment content	High	High	High (moderate)	Moderate (low); often high on steep cool-aspect sites	Variable	Variable; often high, especially at depth	Variable
Important features	Bedrock is prominent and abundant; soils are often fragmental	Insolation			Seepage at depth; climatically wetter areas of the ESSFdk2	Seepage at depth; often associated with riparian areas	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.

BlSe – Azalea – Feathermoss 101

General Description

SMR 4 (3). The 101 site series typically occurs on **mid slopes** of **neutral** to **cool aspects** with deep, medium-textured soils. Due to compensating factors, this site series also occurs on gentle (< 30%) or lower slope positions on warm aspects. Soils are generally Orthic Humo-Ferric Podzols, Orthic Dystric Brunisols, or Eurtric Brunisols with silt loam textures and moderate coarse fragment content, often increasing at depth or on steep cool-aspect sites.

Bl and **Se** are abundant, although Pl is commonly present, particularly in earlier seral stands. False azalea cover is typically high, along with low to moderate (< 10%) cover of Bl regeneration, grouseberry/low bilberry, **bunchberry**, and heart-leaved arnica. Moss cover is high and is usually predominantly red-stemmed feathermoss, often with high cover of step moss, knight's plume, and/or heron's-bill mosses.

Differentiating from Other Site Series

Slightly drier sites (104) have more Pl and soopolallie, > 10% grouseberry/low bilberry, and little or no bunchberry. Species associated with drier conditions, such as showy aster, juniper, strawberry, birch-leaved spirea, and/or pinegrass also occur on 104 sites, often with low cover. Slightly moister sites (111) typically have foamflower, five-leaved bramble, clasping twistedstalk, arrow-leaved groundsel, and/or oak fern (110).

Variability

False azalea cover is highly variable, ranging from sparse to > 50% cover. Understorey herb cover is often very low, especially in old forests. Pl can be abundant in earlier seral stands but generally forms a minor component of mature and old stands where Bl and Se are dominant. Fd may occur with very low cover.

Management Issues

High cover of shrubs can compete with regenerating conifers. On steep slopes, snowpress can be a concern in winter. Cold-air pooling and frost may also limit the success of regenerating trees.

102 PlFd – Juniper – Douglas maple

General Description

SMR 1. The 102 occurs on forested sites with abundant exposed **bedrock** or, occasionally, coarse **talus**, and **root-restricting** layers at or near the surface. Soils are shallow and/or rocky, and growing conditions are very dry on these warm-aspect sites. Soils are generally derived in situ or from colluvial deposits, and textures are closely linked to bedrock characteristics. The occurrence of this site series is very dependent on soil depth, and it often occurs adjacent to 103 forests and non-forested rock outcrops or talus.

Fd and Pl typically occur in the overstorey, sometimes with minor amounts of Pa, Pf, Se, or Bl. Soopolallie, common juniper, Douglas maple, birch-leaved spirea, and saskatoon are common in the shrub layer. False azalea and white-flowered rhododendron are typically absent. Pinegrass, showy aster, kinnikinnick, and other dry-site species, including strawberry, yarrow, nodding onion, common harebell (*Campanula rotundifolia*), and yellow hedysarum (*Hedysarum sulphurescens*), typically occur in the understorey.

Differentiating from Other Site Series

The 102 is the driest forested site series and is easily differentiated by the forested canopy (> 10% tree cover at maturity) and the abundance of exposed rock (bedrock or talus). Drier sites are non-forested rock outcrops and talus sites (see Section 6.6). Slightly moister sites (103) lack exposed rock and usually have more Se, twinflower, arnica, and feathermosses.

Variability

Pa is often present, particularly at upper elevations, although mortality from white pine blister rust and mountain pine beetle has been high in most stands. Understorey species composition varies depending on soil depth and parent materials. Species typically associated with moister sites often occur on 102 sites with calcareous bedrock or on microsites with slightly deeper soils. Fd can be abundant, even at upper elevations approaching the woodland; this occurs most frequently on sites with calcareous parent materials.

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 species (e.g., Pa or Pf).

PlBl – Juniper – Showy aster 103

General Description

SMR 2 (3). 103 sites occur on **mid to upper slopes** on moderately steep to **steep**, **warm aspects**, typically with coarse and/or shallow, rocky soils, and occasionally on warm and/or dry crests. Soils are primarily rapidly to well-drained Eutric or (occasionally) Dystric Brunisols, usually with silt loam textures and high coarse fragment content.

Mixed stands of Pl, Fd, Se, Bl, and/or sometimes Pa are typical in the 103 site series, although Pl and sometimes Fd are usually the dominant species. Common juniper is usually present along with soopolallie and minor cover of prickly rose and/or birch-leaved spirea. Pinegrass, showy aster, twinflower, kinnikinnick, pussytoes (*Antennaria* spp.), and/or strawberry are characteristic species in the understorey.

Differentiating from Other Site Series

Slightly drier sites (102) have prominent exposed bedrock or talus, and often have a similar suite of plants but with more rock-associated species and less Se and Bl. Slightly moister sites (104) have little or no Fd, common juniper, soopolallie, or showy aster, and more false azalea, grouseberry/low bilberry, and mosses.

Variability

Pa may be present and can be abundant in some areas, although mortality from white pine blister rust and mountain pine beetle has been high in most stands. 103 stands often occur adjacent to drier 102 forested rock outcrop sites.

Management Issues

Drought may limit conifer regeneration, particularly during drier than average growing seasons. On steep slopes, avalanching and snowpress can damage regenerating trees in winter, while soil erosion can be a concern during the growing season. Pa or Pf stands and individual trees are not recommended for harvest.

104 BlPl – Azalea – Grouseberry

General Description

SMR 3 (4). The 104 site series typically occurs on moderately sloped, warm-aspect sites with medium- to coarse-textured**,** deep soils and on cool-to neutral-aspect sites in upper, shedding slope positions or with shallow and/or coarse- to very coarse-textured soils.

Mixed stands of Se, Bl, and Pl are typical in the overstorey, with moderate amounts of Bl and minor cover of Se in the understorey. False azalea is typically the dominant shrub, often with moderate amounts of black huckleberry. **Grouseberry and/or low bilberry** are usually abundant (> 20%) in the herb layer, although cover can be variable, particularly in younger, dense stands with lower light levels. Other common species include moderate (< 10%) cover of **heart-leaved arnica**, **twinflower**, and **soopolallie**, and minor (typically < 1%) cover of species associated with drier conditions, such as pinegrass, showy aster, strawberry, and/or common juniper. Moss cover is usually high, with **red-stemmed feathermoss** dominant, along with variable cover of heron's-bill mosses, step moss, and pelt lichens.

Differentiating from Other Site Series

Slightly drier sites (103) have more Fd, common juniper, pinegrass, showy aster, and kinnikinnick, and less Bl, Se, false azalea, grouseberry/low bilberry, and feathermosses. Slightly moister sites (101) have more Pl and grouseberry/low bilberry and less bunchberry. The 104 also has minor cover (< 1%) of one or more of the species that are usually abundant on the 103 site series.

Variability

Grouseberry/low bilberry cover is typically > 20% but can be < 10%, particularly where the understorey herb layer is sparse. Cool- and warm-aspect sites have similar plant composition, although false azalea is usually more abundant on cool or neutral aspects, and may be absent or sparse on warm aspects. Soils are variable but are frequently non-calcareous. Pa and white-flowered rhododendron may be present, especially at upper elevations. Minor amounts of Fd may be present at lower elevations and on sites with calcareous soils. Bunchberry may be present in small amounts, especially on sites close to the MSdk or ICHmk5.

Management Issues

On steep slopes, avalanching and snowpress can damage regenerating trees in winter, while soil erosion can be a concern during the growing season. High cover of shrubs can compete with conifer regeneration.

BlSe – Azalea – Oak fern 110

General Description

SMR 5. The 110 site series occurs on **moist lower slopes and gullies** in the **climatically wetter areas** of the ESSFdk2. Seasonal seepage is usually present in the upper 50–100 cm of the soil. Soils are generally fine-textured silt loams with low to moderate coarse fragment content, although soils with sandy loam textures and high coarse fragment content occur where seepage is constant throughout the growing season. This site series is uncommon in the ESSFdk2 and is closely related to plant communities in the slightly wetter climates of the ESSFmm and ESSFwm subzones.[5]

Forest cover is dominated by Se and Bl. The shrub layer incudes moderate amounts of **black gooseberry**, black huckleberry, and false azalea. The understorey herb layer is characterized by abundant **oak fern** and **foamflower**. **Spiny wood fern**, **lady fern**, **clasping twistedstalk**, and leafy mosses are also typically present, often with low cover.

Differentiating from Other Site Series

The 110 site series occurs on similar sites as the 111 but is easily differentiated by the presence and abundance of oak fern, spiny wood fern, and sometimes lady fern. Slightly drier sites (101) lack ferns and foamflower. Slightly moister sites (112) have abundant horsetails. The 110 site series has similar vegetation to the ESSFmm3/110 but occurs in areas that are well within the ESSFdk2.

Variability

Lady fern and/or spiny wood fern usually have low cover (< 5% combined) but can be abundant on this site series. Oak fern cover is variable but is typically > 3%. Cw and Hw may be present, usually in the understorey. Grouseberry/low bilberry are occasionally present, usually with minor cover.

Management Issues

Cold air, frost, and brush competition may limit the success of regenerating trees. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should take place when soils are dry or frozen. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

[5] The ESSFdk2 covers a very broad geographic area within the very complex topography of the Purcell and Rocky Mountains. Small-scale, localized rainshadow effects, with corresponding wetter areas, are common. Although well within the mapped boundaries of the ESSFdk2, these areas often have fern species that are absent from other site series in the ESSFdk2. 110 sites are distributed throughout the ESSFdk2.

111 BlSe – Azalea – Foamflower

General Description

SMR 5. 111 sites occur on gentle to level **lower and toe slopes** in moist, **receiving sites** where **seasonal seepage** occurs at depth. Mottles are often present within the top 40–75 cm but may be faint. Soils vary but are usually Gleyed Brunisols or Gleyed Gray Luvisols, and occasionally Gleysols. Silt loam is the most common soil texture, although soils with sandy loam or loamy sand textures and high coarse fragment content also occur where seepage is prominent for longer periods of the growing season.

Se is usually dominant with moderate to abundant Bl in the canopy and shrub layers. **Black gooseberry**, **black twinberry**, black huckleberry, and false azalea are usually present, often with moderate cover. Understorey herbs can be diverse and variable, and usually include **foamflower**, **five-leaved bramble**, clasping twistedstalk, bunchberry, heart-leaved arnica, and grouseberry/low bilberry. Minor (1–2%) cover of arrow-leaved groundsel, mitreworts, and/or horsetails is also common. Feathermosses and leafy liverworts are common in the well-developed moss layer.

Differentiating from Other Site Series

The 111 site series occurs on similar sites as the 110 but is more common across the cool, dry climate of the ESSFdk2. The 110 site series is restricted to wetter climatic areas of the ESSFdk2 and has oak fern, spiny wood fern, and/or lady fern. Slightly drier sites (101) lack black gooseberry, foamflower, clasping twistedstalk, and five-leaved bramble and have more Pl, twinflower, and feathermosses. Slightly moister sites (112) have abundant horsetails.

Variability

Arrow-leaved groundsel is more common at higher elevations, while foamflower, bunchberry, and clasping twistedstalk are more common at lower elevations. Grouseberry/low bilberry is usually present and can have moderate to high cover (15–30%). Minor cover (< 1%) of horsetails is common.

Management Issues

Cold air, frost, and brush competition may limit the success of regenerating trees. When soils are moist, compaction and rutting are potential harvesting hazards, and harvesting should take place when soils are dry or frozen. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

SeBl – Horsetail – Feathermoss 112

General Description

SMR 6 (7). 112 forests are uncommon in the ESSFdk2. They occur on level sites and gentle toe slopes, and in depressions where the water table is within the top 30 cm of the soil profile. A thin, peaty, **organic veneer** is common. Sites are typically associated with **riparian areas** and usually experience **infrequent flooding**. Soils are typically Gleysols or, on sites with a history of frequent flooding, Cumulic Regosols.

Open Se stands occur with minor to moderate cover of Bl in the overstorey and understorey. **Horsetails** (mostly common [*Equisetum arvense*] and meadow [*E. pratense*]) are distinctive in the understorey, typically with minor cover of black gooseberry, arrow-leaved groundsel, globeflower, clasping twistedstalk, and/or mitreworts. Red-stemmed feathermoss and leafy mosses (*Rhizomnium* spp.) usually occur with moderate to high cover.

Differentiating from Other Site Series

Slightly drier sites (110 and 111) lack abundant horsetails. Slightly wetter sites are non-forested (< 10% tree cover) wetlands (see Section 6.2).

Variability

Horsetail cover varies from ~ 5% to > 35%. Vegetation can be highly diverse, with many species associated with wet sites present. They usually have low cover (< 3 %) and include leatherleaf saxifrage (*Leptarrhena pyrolifolia*), fringed grass-of-Parnassus (*Parnassia fimbriata*), bluejoint reedgrass (*Calamagrostis canadensis*), rein orchids (*Platanthera* spp.), and willows (*Salix* spp.). Some sites can also be classified as forested swamps and two site series phases are described to reflect the variability in site conditions:

112a for **riparian flood sites**
112b for **forested swamps** (Ws08) where a thick organic layer is present (see Section 6.2)

Management Issues

This site series is not recommended for timber harvesting due to sensitive soils and proximity to streams and other water features. Compaction and rutting are potential hazards, and the water table may rise once trees are removed. Cold air, frost, and brush competition may limit tree regeneration following harvest. Sites often provide important forage, hiding cover, and travel corridors for wildlife.

Other Ecosystems

The following ecosystems occur in the ESSFdk2. They are described in Chapter 6.

Wetlands

The most common wetland ecosystems in the ESSFdk2 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.

Flood ecosystems

Low bench flood ecosystems, dominated by either alder or willows, are uncommon in the ESSFdk2. See Section 6.3 for details on the Flood Group.

Grasslands and brushlands

Grasslands and brushlands are very uncommon in the ESSFdk2; they occur at the southern extent near the ESSFdk1 and in very small openings in otherwise forested landscapes. See Section 6.4 for more information on the Grassland Group.

Avalanche features

Avalanche tracks are common throughout the mountainous terrain of the ESSFdk2, and include highly diverse plant communities and numerous site associations. Most of the herb meadow (Vh) and shrub thicket (Vs) avalanche units that have been described occur in the ESSFdk2, and a number of currently undescribed treed avalanche (Vt) units are also known to occur. Avalanche ecosystems are described in Section 6.5.

Rock outcrops and talus

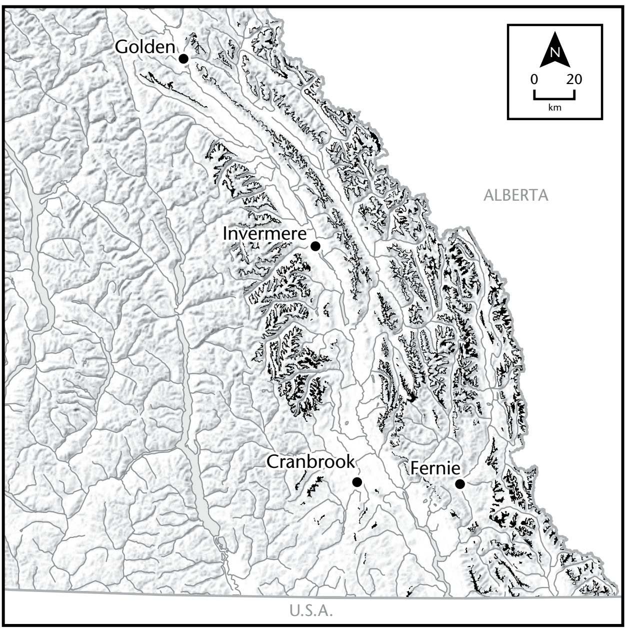
Abundant exposed rock and diverse bedrock geology occurs throughout the Rocky and Purcell Mountains; therefore, several rock outcrop (Ro) and talus (Rt) ecosystems commonly occur in the ESSFdk2. Ecosystems within the Rock Group are described in Section 6.6.

ESSFdkw
Dry Cool Woodland
Engelmann Spruce – Subalpine Fir

Geographic Distribution

The ESSFdkw covers large areas at upper elevations in the Purcell and Rocky Mountains. In the Rocky Mountains, it extends from the Kicking Horse River and Hospital Creek south to the U.S. border, and in the Purcell Mountains, it is common from the Spillimacheen valley south to Buhl Creek. It also occurs in the lower mountains of the southern Purcells, but is much less common. The ESSFdk1 and ESSFdk2 occur below the ESSFdkw, and the ESSFdkp occurs above it. The ESSFwmw occurs at similar elevations to the west and in the wet belt area around Fernie. The ESSFmmw occurs to the north of the ESSFdkw and adjacent to it in the upper Kootenay River valley and in drainages from the Spillimacheen River to Stockdale Creek.

Distribution of the ESSFdkw



Elevation Range

Upper- and lower-elevation limits change across the extensive area covered by the ESSFdkw. In general, lower limits are between 2000 and 2050 m on cool aspects, 2020 and 2100 m on neutral aspects, and 2050 and 2150 m on warm aspects. Upper limits are typically from 2200 to 2250 m on cool aspects, 2250 to 2300 m on neutral aspects, and 2250 to 2350 m on warm aspects.

Climate[1]

The ESSFdkw occurs at upper elevations of the Dry climate subregion. Temperatures are cold throughout the year, and mean annual temperatures barely exceed 0°C. Growing seasons are short with mean daily temperatures rising above freezing for only brief periods during summer. Winters are especially cold, and the mean temperature of the coldest month hovers below -10°C. Precipitation is moderate with relatively moist conditions throughout the year and deep snowpacks. Growing-season moisture deficits are uncommon on all but the driest sites.

Forest and Vegetation Characteristics

Woodland subzones form a transition between productive subalpine forests and higher-elevation parkland and alpine ecosystems. The woodland is differentiated from the parkland at the elevation at which continuous forests are replaced by patches of stunted trees and krummholz interspersed with open, herb- or shrub-dominated ecosystems. The ESSFdkw–dkp boundary can be very difficult to recognize, particularly in the Rocky Mountains where much of the high-elevation landscape is dominated by sparsely or non-vegetated rocky areas that frequently extend into the woodland. The process used to map the boundary between the ESSFdkw and ESSFdkp is climatically driven and based on landscape-level patterns of vegetation on aspects and elevations that are suitable for forests to develop (i.e., tree occurrence on sites with suitable soils). Where vegetation is sparse or non-forest ecosystems are abundant, the ESSFdkw and ESSFdkp appear similar, although the ESSFdkp plant communities will typically have more species that are related to alpine environments, and the ESSFdkw will have a higher proportion of plant species associated with subalpine and montane ecosystems.

Bl is the dominant tree species in the ESSFdkw. Se is also common and can be codominant on mesic and moister sites. Pa occurs on drier, often warm-aspect sites, and La commonly occurs on dry sites, particularly on cool aspects and at upper elevations, and is most common in the Purcell

[1] See Section 4.5 for more information on climate variables.

Mountains. Pl is uncommon on dry to moist sites. Grouseberry and/or low bilberry are the most common and consistently present understorey species in forests throughout the ESSFdkw. Both heart-leaved arnica (*Arnica cordifolia*) and mountain arnica (*A. latifolia*) are also common. White-flowered rhododendron, false azalea, and black huckleberry have variable distributions but are most common on circum-mesic sites. Common juniper may be present on drier sites. Subalpine forbs such as arrow-leaved groundsel, valerian, globeflower, and subalpine daisy occur on wetter sites.

Wood-rushes occur throughout the ESSFdkw but are most common in the Purcell Mountains and areas of the ESSFdkw above the ESSFdk1. Bear-grass (*Xerophyllum tenax*) often occurs at the southern extent of the ESSFdkw, especially in the Wigwam and Flathead valleys. Mountain-heathers (pink, yellow, and white) occur but are uncommon in the drier climate of the ESSFdkw and are often more abundant closer to the moister climates of the ESSFwmw and ESSFmmw.

Tree productivity is relatively low across the ESSFdkw. Large-diameter Se occur, especially on mesic and wetter sites, but tend to have shorter heights (< 20 m at maturity), more taper, and lower growth rates than trees at lower elevations in the ESSFdk1 and ESSFdk2. Cold air, frost, shorter growing seasons, and a deep snowpack limit tree regeneration and growth.

Non-forested ecosystems are abundant in the ESSFdkw. They include a combination of plant communities that typically occur at higher elevations in the parkland and alpine as well as those that are common in subalpine and montane environments. Grasslands are generally uncommon and occur most commonly in areas where the ESSFdkw is located above the ESSFdk1. They are most common in the Elk and Flathead valleys. Avalanche tracks are widespread in the steep terrain of the ESSFdkw and include diverse plant communities across dry to moist avalanche sites. Rock outcrops (Ro), talus (Rt), and cliffs (Rc) are especially common in the rocky environment of the subzone, while wetlands are limited in distribution. At higher elevations and on colder sites, ecosystems of the Alpine and Subalpine Shrub Groups occur in the ESSFdkw. These include herbaceous meadows (Am), late-snowmelt (As) patches in sheltered areas of cool-aspect slopes, krummholz (Sk) in areas that accumulate cold air, and alpine grasslands (Ag) on dry sites. For other non-forested groups, the woodland often includes both the alpine and the montane or subalpine variations of several site classes. Chapter 6 provides detailed descriptions of non-forested ecosystems.

Disturbance

Fire is the primary stand-replacing disturbance in the ESSFdkw. Historical fire regimes are best described as mixed-severity, including stand-replacing **wildfires** that occurred at infrequent to frequent intervals, as well as less severe and more frequent fire events that left large trees and snags on site. At a landscape scale, this has resulted in a mosaic of primarily even-aged stands of different ages, with areas containing remnant stand structure.

Spruce beetle can cause high mortality in mature stands, especially following fire or blowdown, or where slash retention is high after harvest, and is an emerging concern at landscape scales. Endemic levels of **western balsam bark beetle** create small gaps in the canopy and are key drivers of regeneration and development of multi-aged stands. **Mountain pine beetle** can cause mortality in the ESSFdkw, although Pl is sparse and temperatures are generally too cold to support extensive mountain pine beetle populations. **White pine blister rust** has had devastating effects on Pa, while larch needle blight has localized effects on La, particularly in the Purcell Mountains.

Soils, Geology, and Landforms

Bedrock geology is complex in this unit due to its large geographic extent, which includes areas in both the Purcell and Rocky Mountains. **Dolomite** is one of the dominant bedrock types that occurs with a mixture of other sedimentary rocks throughout the Rocky Mountains and in the Purcell Mountains south of Toby Creek. **Limestone** is also very common in the Rocky Mountains and is scattered throughout the Purcell Mountains, especially in the Spillimacheen River drainage. It is often found with slate, siltstone, and argillite, as well as other calcareous bedrock types. Coarser-textured bedrock types such as sandstones, quartzite, and conglomerates occur in the Rocky Mountains east of Fernie, southeast of Skookumchuck, and north of the Cross River, and with granodiorites throughout the Purcell Mountains. Fine-textured sedimentary rocks, including mudstone, siltstone, and shale, are common north of the Wild Horse River in the Rocky Mountains.

The most common landforms are colluvial veneers and blankets. Very shallow veneers (< 50 cm) with exposed bedrock also occur frequently. Parent materials are derived primarily from fine- to medium-grained bedrock, and surface textures are primarily silt loam throughout most of the subzone. Morainal deposits are also common in areas with gentler terrain, especially in the Rocky Mountains south of the Vermilion River. Most morainal soils have silt loam to sandy loam textures and podzolic (Bf) horizons, often overlying clay-enriched (Bt) layers. Calcareous parent materials are very common, and associated soils often contain carbonate-enriched (Cca) subsoil layers. Localized areas of non-calcareous soils with sandy loam textures (sometimes loam to loamy sand) occur where medium- to coarse-grained bedrock types are abundant.

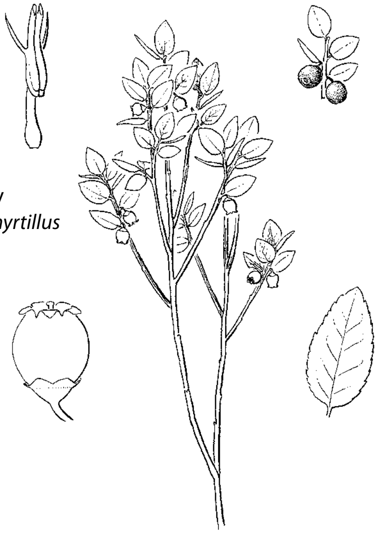
Wildlife Habitat

A number of high-elevation species use the forested areas that are interspersed with **exposed rock**, **grassland**, **wetland**, and **avalanche track habitats** in the ESSFdkw. This unit is critically important for **grizzly bear** populations, which rely on areas with abundant herbaceous vegetation (e.g., avalanche tracks, meadows, and wetlands) for spring food and patches of black huckleberries throughout late summer and early fall. A diversity of other wide-ranging **carnivore and furbearer species** use the ESSFdkw, including **Canada lynx** and at-risk **wolverine**.

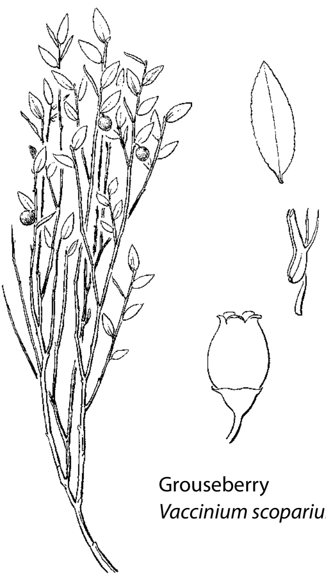
At its southwestern extent, the ESSFdkw provides habitat for the **declining southern Purcell mountain caribou** herd, and throughout much of its extent, it supports very high-value summer range for **Rocky Mountain bighorn sheep**, **elk**, **mule deer**, and **mountain goat**. **High-elevation windswept grasslands** in the ESSFdkw support unique plant assemblages, usually with high cover of fescues and often with a high diversity of at-risk vascular and non-vascular plant species. In addition to their value for grazing wild ungulates, these relatively unique grasslands are important for other wildlife species, such as at-risk **American badger** and **Gillette's checkerspot**, as well as migratory birds, including **prairie falcon**, **peregrine falcon**, **Swainson's hawk**, and **rough-legged hawk**.

Small wetlands, lakes, and seepage sites in woodland subzones are important for many species, including at-risk **western toad** and **olive-sided flycatcher**. Rocky habitats have potential to support **least chipmunk** and **red-tailed chipmunk**, and provide important escape terrain for **mountain goats.**

Birds of special interest in the ESSFdkw include the timberline subspecies of the **Brewer's sparrow**, **white-tailed ptarmigan**, **American pipit**, and **Clark's nutcracker**. More common bird species include fox sparrow, dark-eyed junco, gray jay, hermit thrush, pine siskin, and mountain chickadee. Declining **Pa** and **Pf** provide feeding, breeding, and perching substrate for many of these species. Many habitats and species associated with the upper-elevation ecosystems of the ESSFdkw are sensitive to disturbance and development.



Low bilberry
Vaccinium myrtillus

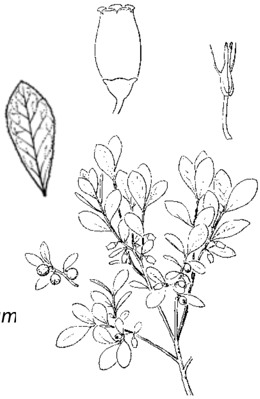


Grouseberry
Vaccinium scoparium

Distinguishing the ESSFdkw from Adjacent BGC Units

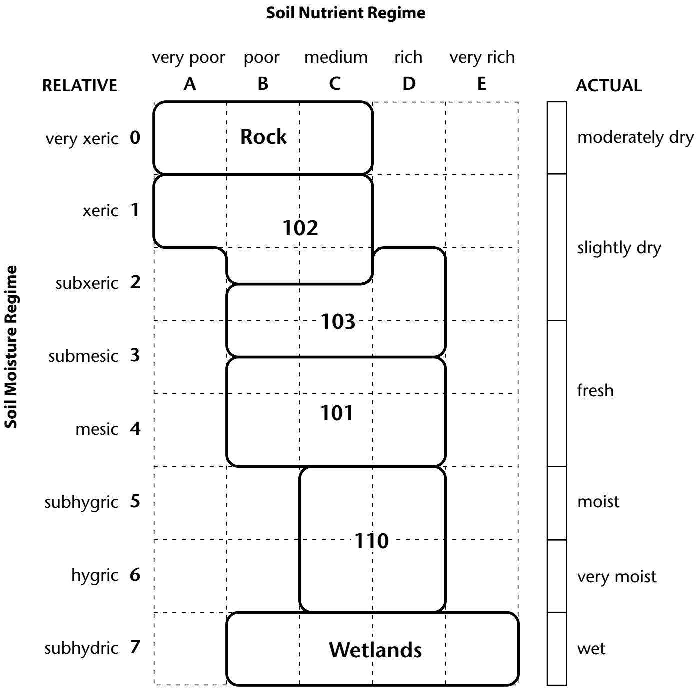
In the **ESSFdk1** and **ESSFdk2**, most sites have:	- higher productivity; mature trees are taller with less taper - Pl - more continuous forests
zonal sites have:	- more false azalea - bunchberry and/or twinflower - Pl
dry sites have:	- Fd - no La (except Rt21)
wet sites have:	- no anemones and less valerian
In the **ESSFdkp**, most sites have:	- shorter, stunted trees (krummholz), including clumpy islands of trees with upright form and stunted growth (can be > 10 m tall) and windswept, horizontal, low-growing, stunted trees - more non-forested, high-elevation plant communities
In the **ESSFwmw**,[a] most sites have:	- more white-flowered rhododendron - less grouseberry/low bilberry - more wood-rushes, and (sometimes) minor cover of oak fern
In the **ESSFmmw**,[b] most sites have:	- less grouseberry/low bilberry - more white-flowered rhododendron - minor cover of five-leaved bramble and oval-leaved blueberry

[a] Described in LMH 70 (MacKillop and Ehman 2016)
[b] The ESSFmmw will be described in a future field guide.



Dwarf blueberry
Vaccinium caespitosum

Edatopic Grid



Site series

101 BlSe – Grouseberry – Leafy liverwort
102 BlLa – Grouseberry
103 BlSePa – Grouseberry
110 BlSe – Grouseberry – Valerian

Site Series Flowchart

Forest group	Site characteristics	Site series
VERY DRY to DRY FORESTS • shallow and/or rocky soils	• SMR 2 (1) • Bl, La (Se) stands • rocky sites with coarse soils • pussytoes, grouseberry/low bilberry • mountain-heathers often present	**102**
	• SMR 3 (2) • Bl, Se (Pa) stands • steep, warm aspects • juniper often present • grouseberry/low bilberry • fireweed, strawberry, and arnica	**103**
SLIGHTLY DRY to MESIC FORESTS • mid slopes with deep soils	• SMR 3–4 • Se, Bl stands • mosses, leafy liverworts, arnica, and grouseberry/low bilberry • may have high cover of white-flowered rhododendron, black huckleberry, and/or false azalea (101.2 site series variation)	**101**
MOIST to WET FORESTS • lower or toe slopes • soils with mottles	• SMR 5 • Se, Bl stands • abundant valerian, arrow-leaved groundsel, meadowrues, globeflower, and/or subalpine daisy	**110**

Vegetation Table

Layer	Scientific name	102	103	101	110	Common name
Trees	*Abies lasiocarpa*	■■■	■■■	■■■■	■■■■	subalpine fir
	Larix lyallii	■■■				subalpine larch
	Picea engelmannii	*	■■■	■■■■	■■■■	Engelmann spruce
	Pinus albicaulis	*	□□□			whitebark pine
Regen	*Abies lasiocarpa*	■■■■	■■■	■■■	■■■■	subalpine fir
	Larix lyallii	□□□				subalpine larch
	Picea engelmannii		□□	□□	*	Engelmann spruce
Shrubs	*Juniperus communis*		□□			common juniper
	Rhododendron albiflorum		*	□□□□	*	white-flowered rhododendron
	Vaccinium membranaceum		*	□□□	*	black huckleberry
	Menziesia ferruginea			□□□		false azalea
Herbs	*Vaccinium scoparium/ myrtillus*	■■■■	■■■■	■■■■	■■■	grouseberry/low bilberry
	"mountain-heathers"[a]	□□		*		mountain-heathers
	Arnica spp.	□□	■■■	■■■	■■■	arnicas
	Antennaria spp.	□□	□□			pussytoes
	Luzula spp.	□□	*	*	*	wood-rushes
	Achillea spp.	□	□			yarrow
	Fragaria spp.	*	□□	*	*	strawberry
	Chamerion angustifolium	*	■■			fireweed
	Valeriana spp.	*		*	■■■	valerian
	Senecio triangularis				■■	arrow-leaved groundsel
	Erigeron peregrinus				□□	subalpine daisy
	Thalictrum spp.				□□	meadowrues
	Trollius albiflorus				□□	globeflower
Moss layer	*Peltigera* spp.	*	□□	□□	*	pelt lichens
	Cladonia spp.	*	□□	□□		clad lichens
	Brachythecium spp.	*	*	□□□	□□□□	ragged-mosses
	Dicranum spp.		*	□□□	*	heron's-bill 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

Environment Table[a]

Site series	102	103	101	110
No. of plots	11	24	44	9
SMR	2 (1)	3 (2)	4 (3)	5
SNR	B–C	B–D	C (B–D)	C–D (E)
Slope position	UP–CR (MD)	UP–MD (CR)	MD (UP, LW)	LW, MD (TO, LV)
Typical slope/ aspect	Steep–moderately steep	Steep/warm	Moderately steep	Gentle–moderate
Common compensating conditions		Neutral aspects with high sun exposure	Upper slope/deep soils; lower slope/ coarse soils	Seepage in mid-slope positions
Surficial materials	Cx/R, Mx/R, Dx	Cv, Mv (Cb, Mb)	Cb, Mb (Cv, Mv)	Mb, F (Cb)
Soil texture	SiL (SL, FSL)	SiL (SL, FSL, L)	SiL (FSL, SL, SiCL)	SiL, SiCL, L
Coarse fragment content	High–fragmental	Moderate–high (fragmental)	Moderate (often variable at depth)	Variable
Important features	Exposed bedrock and boulders are common; shallow, rocky soils	Insolation; moderately coarse or shallow soils		

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

BlSe – Grouseberry – Leafy liverwort 101

General Description

SMR 4 (3). The 101 site series is most common on **mid slopes** of **neutral-aspect sites** with **medium to moderately coarse-textured soils**. It also occurs on upper slopes with deep soils and on lower slopes with coarse-textured soils. Soils are typically Orthic Humo-Ferric Podzols, Eutric Brunisols, or Dystric Brunisols with moderate coarse fragment content that frequently increases at depth.

Bl and Se occur in the tree layers. White-flowered rhododendron, false azalea, and/or black huckleberry are commonly present, often with higher cover on cool to neutral aspects where snowpacks are deeper and snow persists longer. **Grouseberry/low bilberry** and **arnicas** are typically abundant. Mountain-heathers occur sporadically, and wood-rushes may be present, especially in the Purcell Mountains and in the Rocky Mountains where the ESSFdkw occurs above the ESSFdk1. **Leafy liverworts**, **ragged-mosses**, and **heron's bill-mosses** are typically part of the moderately well-developed moss layer and may have high cover on some sites.

Differentiating from Other Site Series

Slightly drier sites (103) have Pa, less Se and Bl, and strawberry, fireweed, and (often) common juniper. Slightly moister sites (110) have lush herb cover with valerian, arrow-leaved groundsel, globeflower, and/or subalpine daisy.

Variability

Minor amounts of La may be present, particularly in the Purcell Mountains. Cover of white-flowered rhododendron, false azalea, and black huckleberry is highly variable. Most sites have moderate cover of one or more of these shrubs, although very high cover and very low cover are also common. Where shrubs are sparse (< 30% cover), Bl and Se are often abundant in the shrub layer, and herb cover and diversity are often higher. Sparse shrubs are most common on warmer-aspect sites. Those who require additional information can use the following site series variations:

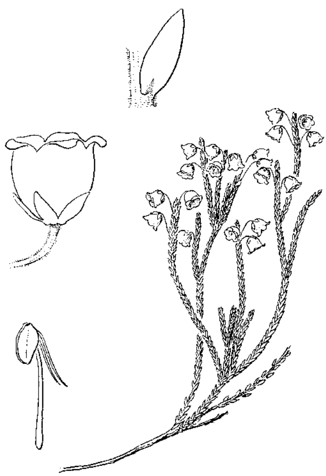
101.1 BlSe – Grouseberry – Leafy liverwort
low to moderate cover (< 30%) of white-flowered rhododendron, false azalea, and black huckleberry

101.2 BlSe –Rhododendron – Grouseberry
abundant cover (> 30%) of white-flowered rhododendron, false azalea, and black huckleberry

Management Issues

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

Pink mountain-heather
Phyllodoce empetriformis



White mountain-heather
Cassiope mertensiana

102 BlLa – Grouseberry

General Description

SMR 2 (1). The 102 site series occurs on **rocky sites** with **shallow, coarse soils**. It is most common on upper slopes and crests, usually on **neutral or** (slightly) **warm aspects**, and occasionally on cool slopes. Soil textures vary but usually have high or fragmental coarse fragment content. **Large boulders** and/or **exposed bedrock** are common.

Bl and/or **La** dominate the tree layers, often with minor Se cover. Bl regeneration and grouseberry/low bilberry are usually abundant in the understorey. Mountain-heathers and minor amounts of pussytoes, saxifrages (*Saxifraga* spp. and *Micranthes* spp.), and/or stonecrops (*Sedum* spp.) may be present.

Differentiating from Other Site Series

The 102 is the driest forested site series in the ESSFdkw. Drier sites are non-forested rock outcrops (Ro) and talus (Rt). Slightly moister sites (103) usually have little or no La, more Pa, and occasionally Pl, often with minor cover of juniper. A separate talus unit (Rt21) describes La-dominated sites with abundant mountain-heathers (> 10% cover); these sites occur on blocky talus with limited soils where cold air pools (see Section 6.6). The 102 site series is also similar to krummholz stands (Sk) in the ESSFdkp where La and mountain-heathers are also dominant (see Section 6.7).

Variability

La is almost always present, usually in the overstorey but occasionally only in the understorey. It is often more dominant on neutral- and cool-aspect sites. Pa and wood-rushes may occur, especially in the Purcell Mountains. Mountain-heathers are frequently present but usually with < 10% cover. Species diversity can be high, depending on parent materials and bedrock geology.

Management Issues

Timber harvesting is not recommended on this site series due to short growing seasons, low productivity, and 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).

BlSePa – Grouseberry 103

General Description

SMR 3 (2). The 103 site series is common on **steep**, **warm-aspect slopes** with **shallow and/or rocky, coarse-textured soils**. It also occurs on **shallow, coarse-textured, moisture-shedding crests and upper slopes** on neutral aspects. Soils are typically Eutric or Dystric Brunisols with silt loam, loam, or sandy loam textures and moderate to high coarse fragment content.

Bl, Se, and **Pa** typify the tree layers. La may occur but is not dominant. Shrub cover is usually low, sometimes with minor amounts of juniper, white-flowered rhododendron, and/or black huckleberry. **Grouseberry/ low bilberry** are usually present with moderate to high cover, and often occur with **fireweed**, arnicas, and minor amounts of wild strawberry, yarrow, and/or pussytoes. Moss cover is variable but usually low.

Differentiating from Other Site Series

Slightly drier sites (102) have more La and mountain-heathers, and less Pa, Se, juniper, and herbs. Slightly moister sites (101) have more Se, and (usually) more white-flowered rhododendron, false azalea, and/or black huckleberry.

Variability

Se is more abundant on neutral aspects, while Pa, juniper, and grouseberry/ low bilberry have higher covers on warm aspects. Soopolallie may occur, especially on sites with calcareous soils. Minor amounts of La may occur, especially in the Purcell Mountains. Bear-grass is often present in the Flathead and Wigwam valleys and in areas adjacent to the ESSFwmw.

Management Issues

Timber harvesting is not recommended on these sites due to short growing seasons, high snow cover, and low tree productivity. Where harvesting does occur, vegetation competition and frost may be a concern. Avalanching and snowpress are likely on steep slopes and can damage regenerating trees. Soil erosion may be a problem on steep slopes following harvesting.

110 BlSe – Grouseberry – Valerian

General Description

SMR 5. 110 sites occupy **lower- and mid-slope positions** where **seepage** is present in the upper 30–70 cm of the soil. Sites can be associated with riparian areas but often occur in mid-slope seepage areas. Soils are usually Gleyed Brunisols or Gleyed Podzols.

Bl and Se dominate the overstorey, with **valerian** (*Valerian sitchensis* and/or *V. dioica*), **arrow-leaved groundsel**, meadowrues, subalpine daisy, globeflower, arnicas, and/or mitreworts in the understorey. False-hellebore (*Veratrum viride*), *Anemone* spp., and a variety of wildflowers are also commonly present. White-flowered rhododendron and black huckleberry often occur. Low to moderate cover (< 10%) of grouseberry/low bilberry is common. Moss cover is variable, with ragged-mosses and leafy liverworts the most common species.

Differentiating from Other Site Series

Slightly drier sites (101) lack the lush herbs associated with the 110 and have little or no valerian, arrow-leaved groundsel, globeflower, and subalpine daisy. Slightly moister sites are non-forested wetlands and meadows, which are described in Chapter 6.

Variability

Minor cover of horsetails (*Equisetum* spp.) is common. The herb and moss layers can be very diverse and highly variable, with a number of species occurring infrequently and with low cover.

Management Issues

Timber harvesting is not recommended on these sites due to short growing seasons, high snow cover, sensitive soils and hydrology, low tree productivity in regenerating stands, and proximity to streams and other water features. Compaction and rutting are potential harvesting hazards, and the water table may rise once trees are removed. Where harvesting occurs, vegetation competition and frost may limit the success of regenerating trees.

Other Ecosystems

The following ecosystems are known to occur in the ESSFdkw. They 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), brushlands (Gb), and alpine grasslands (Ag) are uncommon in the ESSFdkw. In most areas, they occur as small patches on warm-aspect sites. In the Flathead and Elk valleys, they are more widespread and provide important habitats and ecosystem diversity. The Grassland Group, including Alpine grasslands (Ag), is described in detail in Section 6.4.

Avalanche features

The combination of steep terrain and a deep snowpack results in widespread avalanche paths. Section 6.5 describes the herbaceous (Vh), shrub (Vs), and treed (Vt) avalanche ecosystems of the ESSFdkw.

Rock outcrops and talus

Rock outcrops (Ro), talus (Rt), and cliffs (Rc) are very common in the steep, mountainous terrain of the ESSFdkw. Section 6.6 provides detailed descriptions for the Rock Group ecosystems of the ESSFdkw.

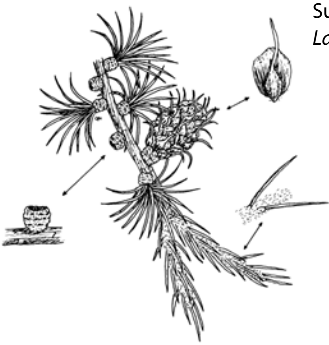
Subalpine shrub ecosystems

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

Shrub carr ecosystems (Sc-c) occur on moist sites with cold mineral soils that are prone to cold air and growing-season frost. These "transitional ecosystems" do not flood, although groundwater is the primary source of moisture. Willows and scrub birch (*Betula nana*) are the dominant shrub species. Shrublands (Sc-b) occur on drier sites with cold air, frost, and cold soils, and include black huckleberry and white-flowered rhododendron shrub fields. Section 6.7 provides an overview of the Subalpine Shrub Class.

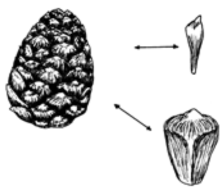
Alpine ecosystems

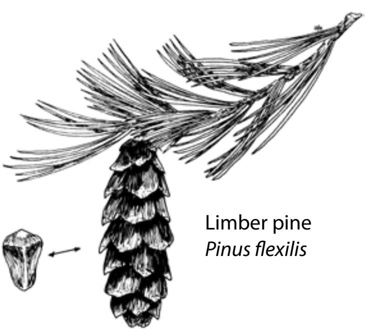
Non-forested ecosystems that are more commonly associated with the alpine and parkland often occur in the woodland where cold air pools. These include alpine meadow (Am) and alpine tundra (At), as well as alpine heath (Ah), late snowbed (As), and fellfield (Af). Detailed classification is still in progress for these units. Section 6.7 provides an overview of high-elevation ecosystems, including classes within the Alpine Group.



Subalpine larch
Larix lyallii

Whitebark pine
Pinus albicaulis





Limber pine
Pinus flexilis

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 wetland, avalanche, rock outcrop, grassland, and floodplain types. Non-forest, as referred to here, also includes non-commercial cottonwood floodplain forests and wetland-associated forests that are part of the Flood Group or the Wetland Realm 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.

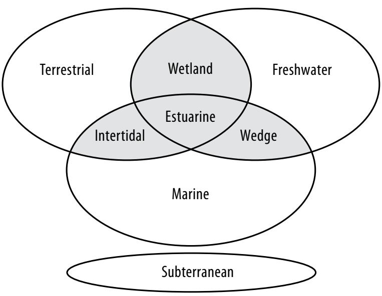


FIGURE 6.1.1 *Site (ecosystem) realms. Core realms are unshaded; interface realms are shaded grey. (Modified from Fraser et al. 1995.)*

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).

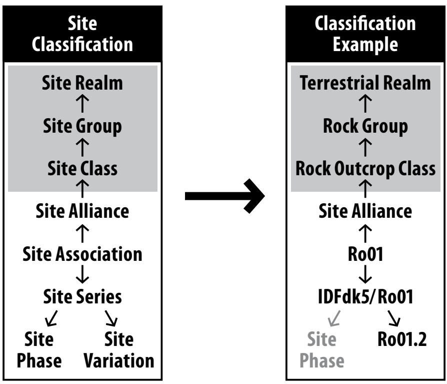


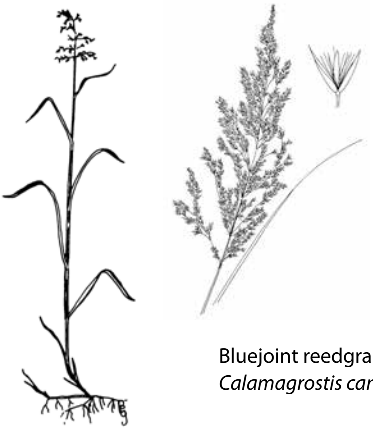
FIGURE 6.1.2 *Site classification framework (with broad-level site units used in non-forested classification highlighted in grey). This example shows the levels of classification for the* Selaginella – Bluebunch wheatgrass – Screw-moss *variation of the Ro01 rock outcrop.*

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 classifica-

tion system because they are part of the Wetland Realm or Flood Group.
- Non-forested ecosystems typically occur where environmental factors preclude 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.



Bluejoint reedgrass
Calamagrostis canadensis

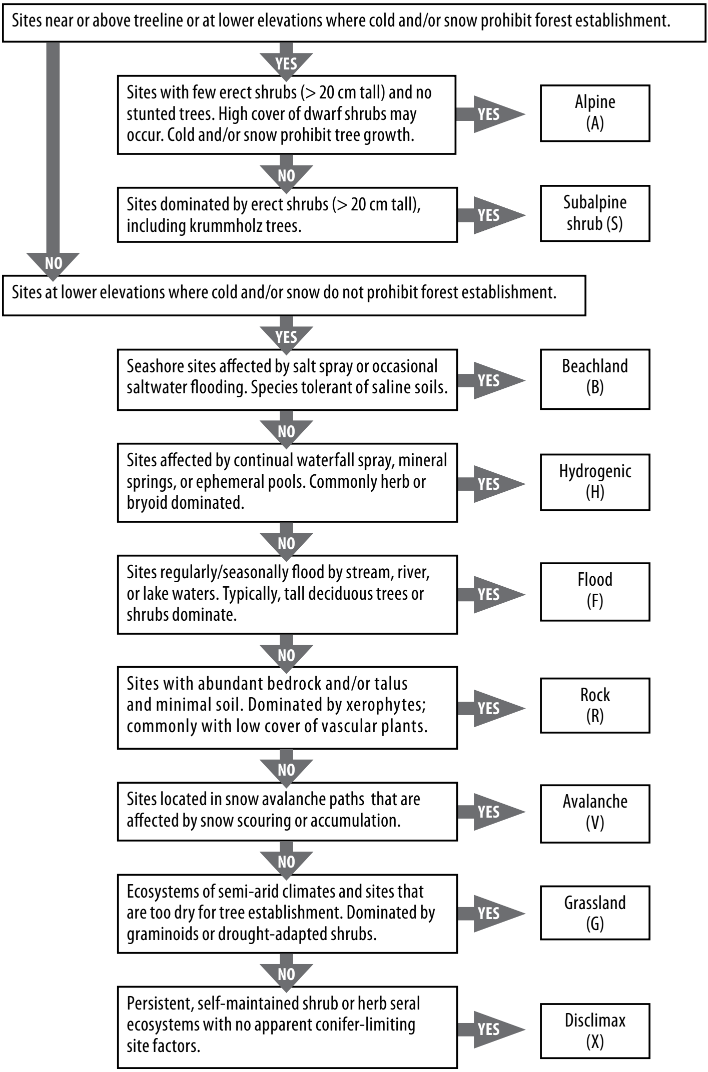


FIGURE 6.1.3 *Key to non-forested Terrestrial groups.*

TABLE 6.1.1 *Wetland and Terrestrial site groups, classes, and codes for non-forested and related 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., ESSFwm1/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.

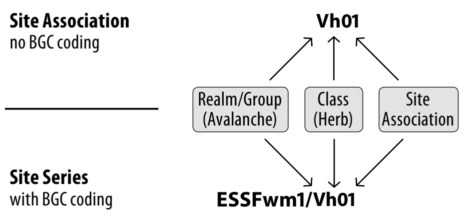


FIGURE 6.1.4 *Non-forested ecosystem nomenclature and coding (showing the* Vh01 Cow-parsnip – Fireweed – Nettle *avalanche herb meadow site association as an example).*

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. 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.

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 weedy-species–infested grassland or a livestock-affected 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.

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 306), but this coding could be applied to other aggressive invasive species and other site groups (e.g., Grasslands).[3]

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 Grassland, Brushland, Shrub-steppe, and Alkaline/Saline Meadow Ecosystems
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.

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

[3] Aggressive invasive species codes are tracked on the BECWeb site. Any additional species will be listed there.

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 or bogs and cottonwood middle bench floodplain ecosystems.

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 (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

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.

For all species that are shown in the vegetation table for a given site realm/group (including both the scientific and common name), 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. Tree species are described in the text and flowcharts using the standard codes for British Columbia (see Appendix 3.7).

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 IDFdm2 is close to the ICHdm).

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)
- LMH 70: *A Field Guide to Ecosystem Classification and Identification for Southeast British Columbia: the South-central Columbia Mountains* (MacKillop and Ehman 2016)
- The Ecology Program website: BECWeb
- Additional field guides for southern British Columbia

6.2 Wetland Ecosystems

This section provides a brief overview of classification and identification of the most common wetland ecosystems in the East Kootenay. 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 for long enough periods that excess moisture and resulting low oxygen levels determine both vegetation and soil development. Wetlands include a broad range of ecosystems, from those permanently inundated with 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, alkaline, 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 important 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.

Wetlands provide critical habitat, biodiversity, and hydrologic function at all elevations and are particularly important in the valley bottom of the Rocky Mountain Trench. Stretching from Columbia Lake to Donald, the Columbia Wetlands is one of the longest intact wetland complexes in North America and is recognized as a Ramsar Wetland of International Importance.[1] Additional wetlands provide important habitat at mid and low elevations along the Kootenay, Elk, Bull, and St. Mary Rivers, and other rivers and creeks such as Horsethief. Although much smaller in area, high-elevation wetlands provide important habitat and diversity throughout the Purcell and Rocky Mountains. Wetland diversity is particularly high in the East Kootenay; nearly all fen site associations classified in southern British Columbia occur in addition to most marsh site associations, a number of swamp site associations, and some of the only bog site associations found in the southern part of the province. It is likely that undescribed wetland ecosystems also occur in the field guide area.

Wetlands are ecologically, economically, and socially important throughout the East Kootenay. They are also at risk from or have been lost to numerous development threats, including urban and rural development, agriculture, grazing, hydroelectric dams, and recreation activities. Invasive plant species are also a significant threat to wetland environments. Several wetland plant communities are considered to be at risk by the Conservation Data Centre.

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. 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.

The wetland classes used in this field guide 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 that are described below.

[1] The Ramsar Convention on Wetlands of International Importance was signed in 1971 in Ramsar, Iran, and is an international treaty for the conservation and sustainable use of wetlands.

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 table near surface throughout the growing 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 year	Mineral, but may be capped with a well-decomposed organic veneer; nutrient rich; Gleysols	Emergent sedges, reeds, rushes, 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 alpine sedge	High elevation; cold soils and climate

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 299. 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 (see Section 6.1).

Wetlands dominated by aggressive invasive species

Where extremely aggressive species have overtaken wetlands (or floodplains[2]), special coding can be used to classify ecosystems (see page 299). Five aggressive invasive wetland plant 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 (*Reynoutria* spp.).[3] Some of these communities (reed canarygrass 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 (e.g., wetland or flood classes).

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 occur on cleared swamps (Ws) or low bench floodplains (Fl), or marshes (Wm). Determining the pre-disturbance wetland (or flood) 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.

[2] Aggressive invasive species can also dominate in cleared floodplain ecosystems.
[3] Coding is described on page 299.

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 of increasing concern 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*),[4] which is a native species 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 3 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. European common reed is not included in the Wm14 marsh site association, which only includes American common reed.

Knotweeds [!.5]

Knotweeds, including Japanese knotweed (*Reynoutria japonica*), Bohemian knotweed (*R.* x *bohemica*), giant knotweed (*R. sachalenensis*), and Himalayan knotweed (*Polygonum polystachyum*), thrive in riparian areas, stream banks, irrigation canals, ditches, and other sites with high soil moisture. They are ornamental escapees that form dense thickets. They have small white-green flowers that grow in showy, branched clusters, and hollow, upright,

[4] The non-native, invasive subspecies differs from the native subspecies in that it grows taller; out-competes other species, which results 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. Genetic analysis is often required to confirm identification.

"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). Knotweeds prefer well-drained soils, and sites are typically Fl!.5 or Fm!.5, but can be Ws!.5 or Wm!.5.

Wetland ecosystems in the East Kootenay

This section describes the wetland ecosystems that are expected to occur in the field guide area. Many of these site associations are described in the *Wetlands of British Columbia* field guide (MacKenzie and Moran 2004). However, the descriptions here focus on the species and conditions most likely to be encountered in southern British Columbia and, where data allow, in the field guide area. Users may wish to consult the *Wetlands of British Columbia* field guide for additional information or for sites that do not appear to "fit" the units described here. With abundant and diverse wetlands in the field guide area, it is likely that some ecosystems will not be adequately described.

Bog Class (Wb)

Bogs are part of the Peatland Group and are uncommon in the field guide area. Bogs are shrubby or treed, generally 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. Most bogs in British Columbia meet some characteristics of the bog definition and some characteristics of poor fens. In central and northern British Columbia, most forested bogs contain black spruce, a species that does not grow in the southern portion of the province. In the East Kootenay, where soils are generally nutrient-rich (particularly in the Rocky Mountains), bogs can occur where thick peat accumulation has reduced nutrient availability, even though mineral soils (beneath the peat accumulations) are rich. This is because bogs are, by definition, isolated from groundwater influence.

The bogs described here are usually forested (> 10% tree cover). These sites are given both a non-forest site association code and a forested site series code.[5] A flowchart for identifying bog site associations is not provided since differentiation is based on dominance of Labrador tea (Wb15) or trapper's tea (Wb16).

[5] Conifer-dominated forests are described using site series, while non-forest and deciduous-dominated stands are part of the non-forest and related section of the classification. This results in descriptions and codes occurring in two parts of the BEC system, even though the wetland site association and corresponding forested site series codes describe the same ecosystems.

Distribution of bog (Wb) site associations by biogeoclimatic unit[a]

Zone	MS		ESSF	
Unit/BGC	MSdk	MSdw	ESSFdk1	ESSFdk2
Wb15	X	⁎	⁎	⁎
Wb16		X	⁎	

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "⁎" indicates ecosystems that occur less frequently.

Vegetation Table – Bogs

Layer	Scientific name	Wb15	Wb16	Common name
	Number of plots	12	8	
Trees	*Picea engelmannii* x *glauca*	■■■	■■■■	interior spruce
	Pinus contorta	□□□	■■■	lodgepole pine
Regen	*Picea engelmannii* x *glauca*	■■■	■■■	interior spruce
	Abies lasiocarpa	□□	□□□	subalpine fir
	Pinus contorta	⁎	□□	lodgepole pine
Shrubs	*Betula nana*	□□□	⁎	scrub birch
	Rhododendron groenlandicum	■■■■		Labrador tea
	Rhododendron columbianum		■■■■	trapper's tea
Herbs	*Calamagrostis canadensis*	□□□	■■	bluejoint reedgrass
	Carex spp.	□□□	□□	sedges
	Carex aquatilis/utriculata	□□	□□□	water/beaked sedge
	Cornus canadensis	■■	□□	bunchberry
	Equisetum spp.	□□□	□□□	horsetails
	Kalmia microphylla	⁎	■■	western bog-laurel
	Rubus pedatus		□□□	five-leaved bramble
	Vaccinium scoparium/myrtillus	⁎	■■	grouseberry/low bilberry
Moss layer	*Aulacomnium palustre*	■	■■■	glow moss
	Pleurozium schreberi	■■■		red-stemmed feathermoss
	Sphagnum spp.	■■■■■	■■■■■	peat-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

Wb15 Spruce – Labrador tea – Peat-moss

The Wb15 is uncommon in the MSdk and occasionally occurs in adjacent areas of the MSdw, ESSFdk1, and ESSFdk2. It is typically found in wet depressions in areas where cold air accumulates. Labrador tea and peat-mosses are abundant. Sxw grows on elevated microsites with lesser amounts of Pl and Bl. The tree canopy is very open, and overstorey trees may be sparse, with as little as 5% cover. Understorey herbs are variable, with bluejoint reedgrass, sedges, and horsetails commonly present. Scrub birch is often present, but Labrador tea is dominant in the shrub layer. The Wb15 is a newly described site association that was not included in *Wetlands of British Columbia* (MacKenzie and Moran 2004).[6]

In the MSdk, the Wb15 site association also corresponds to the bog phase of the 112 forested site series (MSdk/112b).[7] These are the same ecological unit but are coded by using two parts of the BEC system: the sites can be coded using only the forested site series and phase codes (i.e., MSdk/112b), only the wetland site association code (Wb15), or the forested site series and phase codes with the wetland site association codes (MSdk/112b(Wb15)). The Wb15 occasionally occurs in the MSdw[8], where it can also be coded as the MSdw/112.2 site series variation. In the ESSFdk1 and ESSFdk2, this unit does not correspond to a forested site series; if encountered, it can be coded only as Wb15.

Wb16 Spruce – Trapper's tea – Peat-moss

The Wb16 is uncommon in the MSdw and occurs occasionally at low elevations in the ESSFdk1. Trapper's tea and peat-mosses are abundant. Trees are relatively sparse and limited to elevated microsites. The open forested canopy consists of Sxw, Pl, and sometimes Bl, and can be sparse, with as little as 5% cover. Understorey herbs are variable, with bluejoint reedgrass, sedges, five-leaved bramble, grouseberry and/or low bilberry, and horsetails commonly present. The Wb16 is a newly described site association that was not included in *Wetlands of British Columbia* (MacKenzie and Moran 2004).[6]

In the MSdw, the Wb16 site association also corresponds to the 112.1 forested site series. These are the same ecological unit but are coded using two parts of the BEC system: the sites can be coded by using only the site

[6] The Wb07 is the site association from *Wetlands of British Columbia* that most closely resembles the Wb15 and Wb16; the Wb07 has higher cover of big sedges (*Carex aquatilis* and *C. utriculata*), more Pl, and Labrador-tea (not trapper's tea).

[7] A riparian site series phase of the *Spruce – Labrador tea – Peat-moss* site series is also identified in the MSdk as 112a. It has a similar plant community but occurs on mineral soils instead of the wetland soils of the more typically encountered 112b bog phase. See Chapter 5.

[8] The Wb15 is uncommon in the MSdw; it usually occurs at the northern extent, in areas approaching the MSdk. The Wb16 is more common on similar sites.

series code (i.e., MSdw/112.1), the wetland site association code (Wb16), or both the site series and the wetland site association codes (MSdw/112.1 (Wb16)). In the ESSFdk1, the Wb16 does not correspond to a forested site series and, if encountered, can be coded only as Wb16.

Fen Class (Wf)

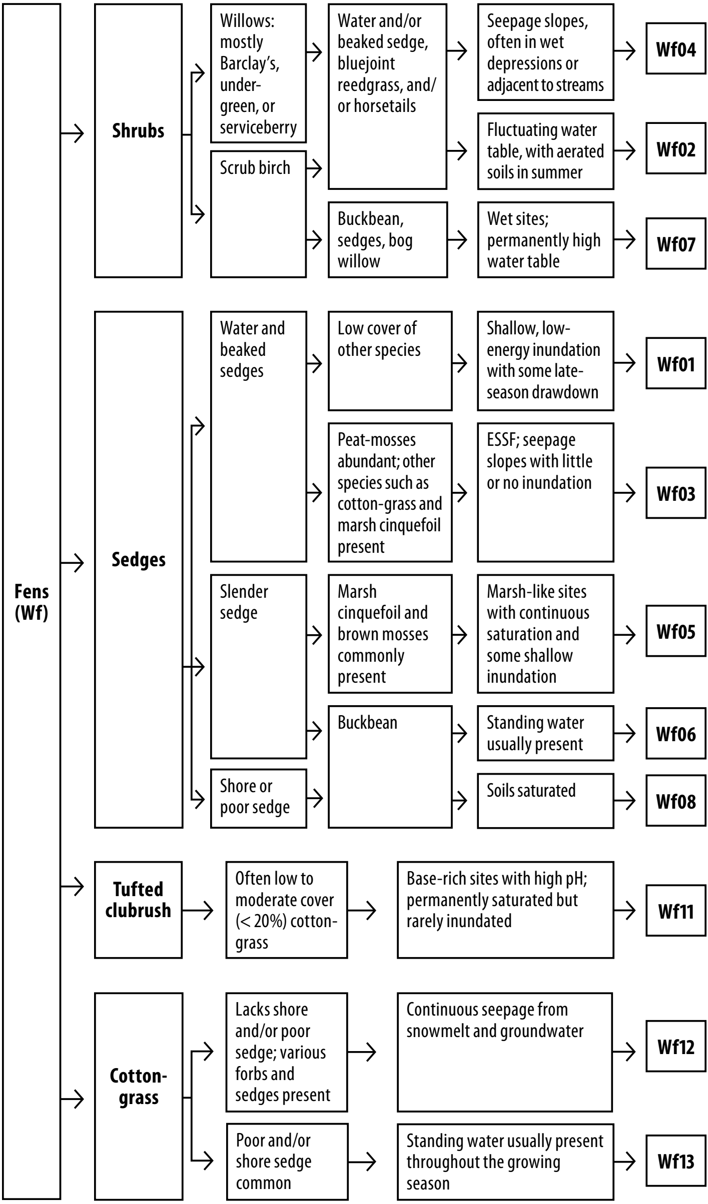
Fens are nutrient-medium peatlands where groundwater inflow maintains relatively high dissolved mineral and oxygen content within the rooting zone. They develop where permanently saturated soil conditions are maintained, and are most common along pond, lake, and stream margins, in basins, and along seepage slopes. The water table is usually at or just below the peat surface for most of the growing season, although low-energy, shallow flooding often occurs in some site associations. Fens are characterized by non-ericaceous shrubs, sedges, grasses, semi-aquatic forbs, brown mosses, and some peat-mosses. Fens occur infrequently throughout the East Kootenay.

Distribution of fen (Wf) site associations by biogeoclimatic unit[a]

Zone	IDF				MS		ICH	ESSF				
Unit/BGC	**IDFxx2**	**IDFxk**	**IDFdm2**	**IDFdk5**	**MSdk**	**MSdw**	**ICHmk4**	**ESSFwm1**	**ESSFdk1**	**ESSFdk2**	**ESSFdkw**	**ESSFwmw**
Wf01	*	*	*	X	X	X	X	*	*	*		
Wf02		*	*	X	X	X	*	*	X	X		
Wf03								*	*	*	*	*
Wf04								*	X	X	*	*
Wf05			*	X	X	X	*					
Wf06					*	*						
Wf07					*	*						
Wf08					*	*						
Wf11					*	*	*	*	*	*		
Wf12								*	*	*	*	*
Wf13								*	*	*	*	*

[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	Wf02	Wf03	Wf04	Wf05	Wf06	Wf07	Wf08	Wf11	Wf12	Wf13	Common name
	Number of plots	108	62	15	29	56	12	8	7	46	76	17	
Shrubs	*Betula nana*		■■■■■					■■■■					scrub birch
	Salix barclayi[a]				■■■■■			■■■					Barclay's willow
	Salix pedicellaris						*	■■■					bog willow
Herbs	*Carex aquatilis*	■■■■■	■■■■■	□□□□	□□□□□	□□□	*	*					water sedge
	Carex utriculata	■■■■■	□□□	*	*	*							beaked sedge
	Carex spp.[b]	*	□□□	□□□	*		□□	■■■	□□□	*	□□□	*	sedge
	Calamagrostis canadensis	*	*	□□	□□□				*			□□	bluejoint reedgrass
	Comarum palustre		*	□□	*	□□	■■■	□	■				marsh cinquefoil
	Eriophorum angustifolium			□□	*				*	■■■	■■■■■	■■■■	narrow-leaved cotton-grass
	Carex lasiocarpa					■■■■■	■■■■■	□□□□					slender sedge
	Menyanthes trifoliata						■■■■	■■■■	■■■■				buckbean
	Carex magellanica/limosa							■■■■	■■■			■■■■	poor/shore sedge
	Kalmia microphylla									□	□	□	western bog-laurel
	Trichophorum cespitosum									■■■■■			tufted clubrush
Moss layer	"brown mosses"[c]	*	■■■■■	*	□□□	□□□□	□□□□	■■■■■	■■■■■	□□□□	□□□	*	brown mosses
	Aulacomnium palustre		□□□	□□□	□□□			*	*		*	*	glow moss
	Sphagnum spp.			■■■■■	□□□□		*	*	*	■■■■	□□□□	■■■■■	peat-moss

[a] Typically also includes under-green willow (*Salix commutata*) and serviceberry willow (*S. pseudomonticola*).
[b] Includes many *Carex* species not otherwise listed here.
[c] Lists of grouped species are provided in Appendix 1.1. Brown mosses include hook-mosses, star-mosses, fen mosses, and scorpion 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

Wf01 Water sedge – Beaked sedge

The Wf01 is the most common fen type in southeast 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 low- to mid-elevation biogeoclimatic zones 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 a thick (> 40 cm) peaty, organic layer.

Wf02 Scrub birch – Water sedge

The Wf02 is relatively common in the IDF, MS, and dry ESSF in the East Kootenay, and occasionally occurs in the ICHmk4 and ESSFwm1. Sites are hummocky, with scrub birch, stunted Sxw trees, and minor cover of various shrub species growing on mounds. Water sedge is abundant, often with beaked sedge and minor cover of marsh cinquefoil and/or bluejoint reedgrass. Brown mosses, especially golden fuzzy fen moss (*Tomentypnum nitens*), dominate the dense moss layer, often with lesser amounts of peat-mosses and/or glow moss. The Wf02 often occurs adjacent to the Wf01, generally on slightly drier sites. The Wf07 also has abundant scrub birch and occurs infrequently in the East Kootenay. It occurs on wetter sites than the Wf02, and has moderate to abundant cover of buckbean.

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 or beaked sedge and peat-mosses. Smaller amounts of narrow-leaved cotton-grass, various sedges, marsh cinquefoil, and a variety of other forbs and grasses, including leatherleaf saxifrage, arrow-leaved groundsel, western bog-laurel, and/or bluejoint reedgrass, are often 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 may occur adjacent to the Wf12.

Wf04 Barclay's willow – Water sedge – Glow moss

Wf04 sites are found in frost-prone basins, on high-elevation seepage slopes, and on gentle areas adjacent to streams. Sites are characterized by an abundance of willows, primarily Barclay's willow, under-green willow, or serviceberry 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 variable, and glow moss, brown mosses, and peat-mosses are most common. The Wf04 is typically a higher-elevation ESSF unit (including woodland) that occurs in isolation or adjacent to sedge (Wf03) or cotton-grass (Wf12) fens.

Wf05 Slender sedge – Common hook-moss
The Wf05 occurs at the margins of small lakes or ponds and in palustrine basins (i.e., wet depressions) at low to mid elevations (IDF, MS, and ICH in the East Kootenay). The water table remains at the surface throughout the growing season. High cover of slender sedge is characteristic, often with small amounts of water sedge, beaked sedge, and marsh cinquefoil. An assortment of brown mosses, including common hook-moss (*Drepanocladus aduncus*), golden star-moss (*Campylium stellatum*), and scorpion-mosses (*Scorpidium* spp.) are usually present.

Wf06 Slender sedge – Buckbean
The Wf06 occurs on very wet sites adjacent to shallow lakes or ponds and other stagnant open-water sites. Sites are permanently saturated and usually inundated throughout the growing season; standing water is commonly present. Soils are generally deep peat derived from decomposing sedges. Cover of slender sedge is consistently high, although other sedges are often present and can be abundant. Buckbean has moderate to high cover and usually grows in wetter depressions. Other commonly present herbs include wetland-adapted species such as swamp horsetail and marsh cinquefoil. Moss cover varies from low to moderate, with hook-mosses, golden star-moss, and peat-mosses most common. The Wf08 also has moderate to high cover of sedges and buckbean but occurs on slightly drier sites with less open water and lacks slender sedge. The Wf07 is also similar but has scrub birch and willows. The Wf06 is the wettest fen site association in the East Kootenay that has buckbean.

Wf07 Scrub birch – Buckbean – Shore sedge
The Wf07 occurs on hummocky sites with a permanently high water table. Sites are characterized by open cover of scrub birch, often with willows, and abundant buckbean. Sedges are also prominent, with shore/poor sedge, slender sedge, and lesser-panicled sedge (*Carex diandra*) usually present and often abundant. Common hook-moss, other brown mosses, and peat-mosses occur in the variable moss layer. Wf07 sites are frequently associated with Wf08 and Wf06 fens, but those have little or no scrub birch or willows (typically < 5% shrub cover).

Wf08 Shore sedge – Buckbean – Hook moss
The Wf08 occurs on permanently saturated sites with very shallow (< 2 cm) or non-existent flooding. Sedges, especially shore and/or poor sedge and lesser-panicled sedge, have high cover; buckbean has moderate to high cover. Other species in the herb layer can be highly variable and are associated with wet conditions. These include common horsetail and cotton-grass, which may be present with low cover. Moss cover is typically high, with abundant hook-mosses, golden star-moss, and other brown mosses. The Wf06 site association also has abundant sedges and buckbean but occurs on wetter sites with permanent inundation, more open water, and a more marsh-like appearance. The Wf06 also differs in that it is typically dominated by slender sedge.

Wf11 Tufted clubrush – Star-moss
The Wf11 occurs on level and gently sloped sites with base-rich parent materials and very high pH conditions. 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. The Wf11 occurs infrequently from mid to high elevations in the ESSF and at upper elevations in the ICH and MS in the East Kootenay.

Wf12 Narrow-leaved cotton-grass – Marsh-marigold
The Wf12 occurs on level to gentle seepage slopes in the ESSF where moisture inputs are continuous from snowmelt and groundwater. Narrow-leaved cotton-grass is always present and typically dominant, although a variety of other species generally occur with low to moderate cover, including leatherleaf saxifrage, western bog-laurel, and a wide variety of sedges; black alpine sedge is common at higher elevations. The moss layer is variable but is frequently dominated by peat-mosses, brown mosses, and sometimes glow moss. Although it is in the site association name, mountain marsh-marigold is often sparse or absent in southern British Columbia. The Wf12 occurs across the ESSF elevation gradient, including woodland units, but is most common in wet, snowy subalpine climates (e.g., ESSFwc, wm, vc). The Wf12 often occurs in larger wetland complexes that include the Wf03.

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 with poor and/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 occurs on wetter sites than the Wf12, and the two often occur together in complexes that may also include Wf03 and Wf11 sites. The Wf13 occurs mainly in the ESSF, including woodland and, occasionally, parkland units.

Marsh Class (Wm)

Marshes are permanently to seasonally inundated mineral wetlands that are dominated by emergent grass-like vegetation. Marshes occur along lakeshores, on floodplains, and in old oxbows, potholes, basins, and depressions. They are most often shallowly flooded but fluctuating water tables are common, both throughout a single growing season and across different 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 Gleysols. 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 and are comprised of only one or two dominant species.

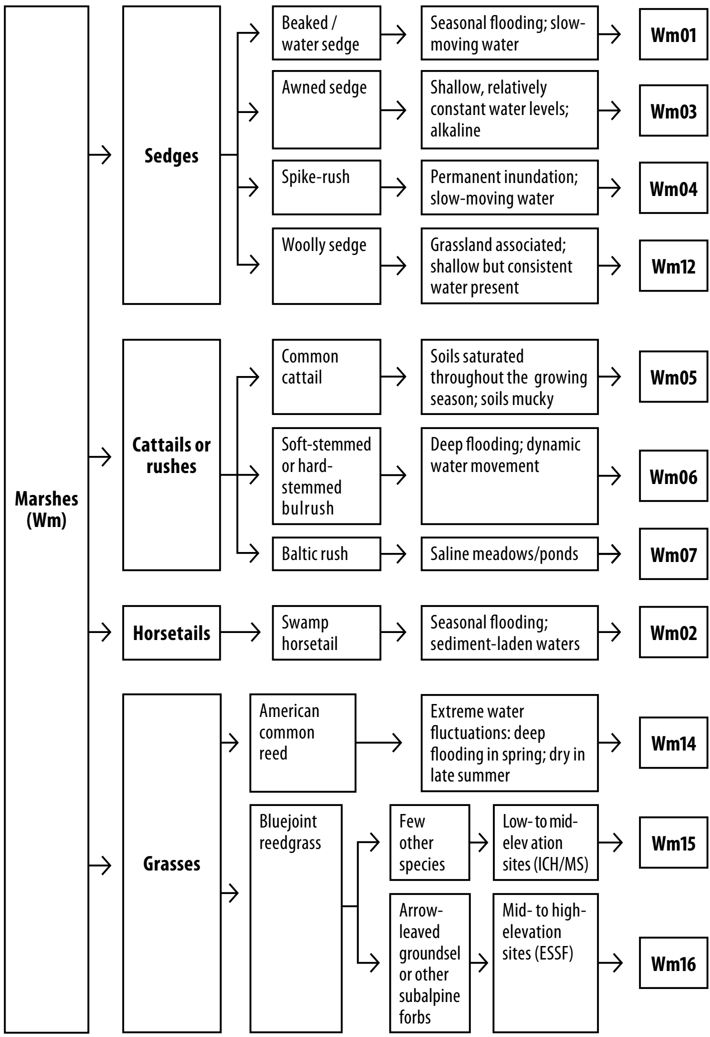
Marshes are most common in warmer, drier climates and at lower elevations. They are the most dynamic wetland class, and species composition can shift rapidly following a few wet or dry years, particularly in dry to very dry climates (e.g., IDF, PP, BG). Marshes are the most heavily used wetland type for most wetland-associated wildlife species. They provide palatable vegetation for smaller and larger animals, and cover adjacent to open water for waterfowl, amphibians, and semi-aquatic mammals. Cattle and other livestock often graze in marshes.

Distribution of marsh (Wm) site associations by biogeoclimatic unit[a]

Zone	IDF				MS		ICH	ESSF				
Unit/BGC	IDFxx2	IDFxk	IDFdm2	IDFdk5	MSdk	MSdw	ICHmk4	ESSFwm1	ESSFdk1	ESSFdk2	ESSFdkw	ESSFwmw
Wm01	X	X	X	X	X	X	*	*	*	*		
Wm02	X	X	X	X	*	*	*					
Wm03	*		*									
Wm04	*	*	*	*	*	*	*					
Wm05	X	X	X	X	X	X	X					
Wm06	X	X	X	X	*	*	*					
Wm07	*	*	*	*								
Wm12	*	*	*	*								
Wm14	*	*	*	*								
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



Vegetation Table – Marshes

Layer	Scientific name	Wm01	Wm02	Wm03	Wm04	Wm05	Wm06	Wm07	Wm12	Wm14	Wm15	Wm16	Common name
	Number of plots	134	40	17	17	66	70	26	7	3	11	10	
Herbs	*Carex utriculata*	■■■■■	□□□□	*		*			*	■■■	□		beaked sedge
	Carex aquatilis	□□□□									□		water sedge
	Equisetum fluviatile		■■■■■										swamp horsetail
	Carex atherodes			■■■■■									awned sedge
	Eleocharis palustris				■■■■■								common spike-rush
	Typha latifolia					■■■■■							common cattail
	Schoenoplectus tabernaemontani						□□□□□						soft-stemmed bulrush
	Schoenoplectus acutus						□□□□□						hard-stemmed bulrush
	Juncus balticus							■■■■■	*				Baltic rush
	Carex pellita								■■■■■				woolly sedge
	Phragmites australis spp. *americanus*[a]									■■■■■			American common reed
	Calamagrostis canadensis	*									■■■■■	■■■■■	bluejoint reedgrass
	Senecio triangularis											■■■	arrow-leaved groundsel
	Valeriana sitchensis											□□□	Sitka valerian

[a] A related non-native and invasive subspecies, *Phragmites australis* ssp. *australis*, also occurs in marshes of the East Kootenay (see p. 307).

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, typically 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, although beaked sedge is often more prominent in the Wm01. The Wm01 occurs on mineral soils (often with a < 40 cm thick organic layer) with deeper flooding and more dynamic hydrology than the Wf01. The Wm01 occurs from low to subalpine elevations but is most common in the IDF and MS in the East Kootenay. The Wm15 occurs on similar sites but is dominated by bluejoint reedgrass. Wm01 sites with disturbance, particularly disturbances that cause drier conditions, can have 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 and river channels. High cover of swamp horsetail characterizes the Wm02, but beaked sedge may also be present with substantial cover. The Wm02 is relatively common at low to mid elevations and is often adjacent to tall willow swamps or slow-moving open water.

Wm03 Awned sedge
The Wm03 is uncommon and restricted to dry, hot climates. Sites are always dominated by awned sedge, but infrequently other species, including beaked sedge, occur in abundance. These marshes are generally small and occur most commonly in small potholes surrounded by forest, where water levels are shallow and relatively constant. Standing water is slightly alkaline, and rooting substrates are fine-textured mineral or shallow, sedge-derived peat. Common soil types are Humisols and Humic Gleysols.

Wm04 Common spike-rush
The Wm04 is uncommon, occurring in depressions, on fringes of ponds, and along streams and lakeshores with slow-moving water. Shallow water is typically present throughout the growing season. Sites are dominated by high cover of common spike-rush, often with a minor component of submerged or floating aquatic species. Other species are usually absent. Mineral soils are most often sandy or gravelly Gleysols. The Wm04 occurs at low to mid elevations in the East Kootenay.

Wm05 Cattail

The Wm05 is relatively common in climates with warm summers. It occurs in depressions and along lakeshores and pond edges, and is easily recognized by an abundance of common cattail. Other species typically have low cover. Soils are often mucky due to veneers of well-decomposed organic materials. Cattail can also increase in areas where the water table is controlled and less dynamic (e.g., ditches). The Wm05 occurs at low to mid elevations in the field guide area and often occurs with the Wm06.

Wm06 Great bulrush[9]

The Wm06 occurs along lake margins and in depressions in areas with warm and dry summers. Floodwaters can be up to 1.5 m deep in spring, but sites dry up significantly into the growing season. The vegetation community is characterized by hard-stemmed bulrush and/or soft-stemmed bulrush. Overall, plant species diversity is low. The Wm06 is uncommon at low to mid elevations in the field guide area, where it often occurs with the Wm05.

Wm07 Baltic rush

The Wm07 is uncommon on saline sites where there is early-season inundation followed by a gradual water table drop to below the surface. Baltic rush is always dominant, although other species may occur. In the East Kootenay, the Wm07 occurs only in the IDF. These sites are often associated with ecosystems in the Alkaline/Saline Meadow Class (Ga) of the Grassland Group (see Section 6.4). Both have saline soils, and Ga sites often occur upslope from Wm07 sites.

Wm12 Woolly sedge

Wm12 sites are uncommon, occurring in small, freshwater depressions that are surrounded by grasslands. Water levels are shallow and relatively constant throughout the growing season, and the water is slightly alkaline. Woolly sedge always dominates. The Wm12 has similar characteristics to the Wm03, but those marshes are dominated by awned sedge. This ecosystem is briefly described in *Wetlands of British Columbia* (MacKenzie and Moran 2004) but was not assigned a site association number.

Wm14 American common reed

Wm14 marshes are uncommon in the IDF in the Rocky Mountain Trench. Sites are dominated by American common reed, a rhizomatous grass that grows up to 3 m tall on mineral soils in shallow water of lakes, ponds, and slow-moving streams. Wm14 sites often occur adjacent to Wm02, Wm05,

[9] Great bulrush includes two separate species: hard-stemmed bulrush (*Schoenoplectus acutus*) and soft-stemmed bulrush (*S. tabernaemontani*); the Wm06 includes both species.

and Wm06 sites at low to mid elevations. This ecosystem is briefly described in *Wetlands of British Columbia* (MacKenzie and Moran 2004) but was not assigned a site association number.

A related subspecies, European common reed (*Phragmites australis* ssp. *australis*), also occurs in marshes of the East Kootenay. European common reed is non-native and invasive and can alter the habitat values of marshes and shallow flood sites, particularly where natural flood regimes are altered by dams and dikes and where nutrient inputs from agricultural runoff are high. European common reed is included in the aggressive invasive species group as !.4 (see Section 6.2.4). The Wm14 includes only the native subspecies, American common reed, although differentiation can be difficult.

Wm15 Bluejoint – Beaked sedge

Wm15 sites occur across low- to mid-elevation biogeoclimatic units 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 be found with minor cover. Soils are seasonally flooded and frequently have a well-decomposed, thin organic layer. At higher elevations (ESSF, upper 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 (disturbed) 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 occurs generally 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 also be present. Soils frequently have a well-decomposed 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 Wm15 occurs on similar sites where bluejoint reedgrass dominates, and the Wm01 occurs where water sedge and/or beaked sedge dominate. These lower-elevation types lack subalpine forb species. The Wm16 is newly described and 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 allow for growth of trees or tall shrubs on otherwise saturated soils. 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 often capped with a humic organic layer that may exude a foul sulphur odour. Swamps are most common in areas with subdivided terrain.In steep terrain, swamps are often limited to narrow strips near water bodies.

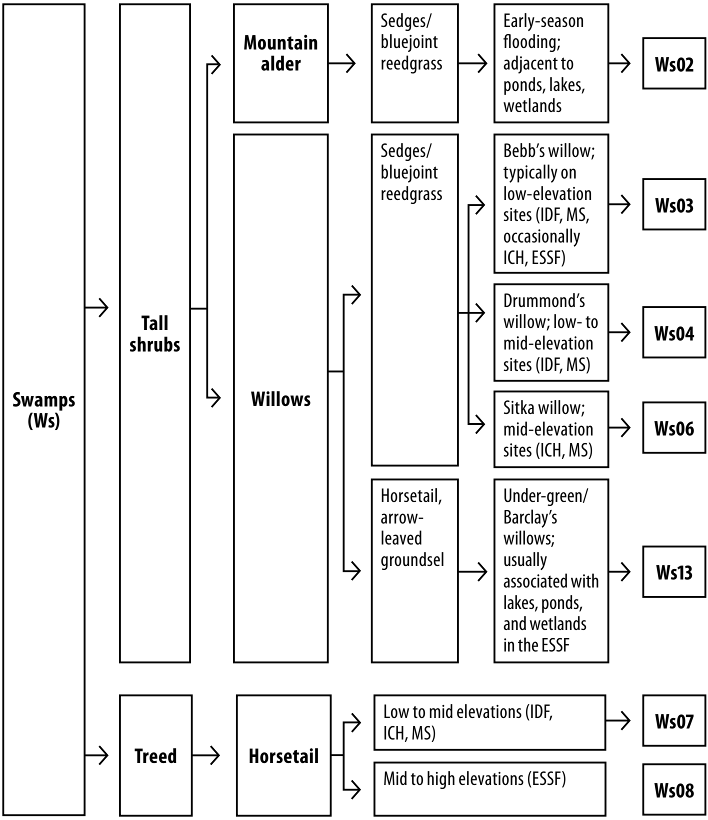
Swamps can be divided into two distinct subgroups: one characterized by tall shrubs, the other by trees. Swamps are often hummocky, with shrubs and/or trees growing on mounds, and forbs, grasses, sedges, and mosses dominating in wetter hollows.

Distribution of swamp (Ws) site associations by biogeoclimatic unit[a]

Zone	IDF				MS		ICH	ESSF				
Unit/BGC	IDFxx2	IDFxk	IDFdm2	IDFdk5	MSdk	MSdw	ICHmk4	ESSFwm1	ESSFdk1	ESSFdk2	ESSFdkw	ESSFwmw
Tall shrub swamps												
Ws02					*	*	*					
Ws03			*	X	X	X	*		*	*		
Ws04			*	*	*	*						
Ws06					X	X	X					
Ws13								*	*	*	*	*
Treed swamps												
Ws07			*	*	*	*	*					
Ws08								*	*	*		

[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
		Ws02	Ws03	Ws04	Ws06	Ws13	Ws07	Ws08	
	Number of plots	22	13	23	18	21	8	26	
Trees	*Picea* spp.	*					■■■■■	■■■■	spruce
	Abies lasiocarpa							■■■	subalpine fir
	Thuja plicata								western redcedar
	Tsuga heterophylla								western hemlock
Regen	*Abies lasiocarpa*					□□		■■■	subalpine fir
	Picea spp.					*	■■■	■■■	spruce
	Thuja plicata								western redcedar
	Tsuga heterophylla								western hemlock
Shrubs	*Alnus incana*	■■■■			*		□□□		mountain alder
	Spiraea douglasii	□□□□			□□□				pink spirea
	Lonicera involucrata	□□□	*		*		□□	□□	black twinberry
	Salix bebbiana		■■■■						Bebb's willow
	Salix drummondiana			■■■■■					Drummond's willow
	Salix sitchensis	*			■■■■■				Sitka willow
	Salix commutata/barclayi					■■■■■			under-green/Barclay's willow
	Cornus stolonifera						□□□		red-osier dogwood
	Rhododendron albiflorum							□□□	white-flowered rhododendron
	Vaccinium membranaceum							□□	black huckleberry

Layer	Scientific name	Tall shrub swamps					Treed swamps		Common name
		Ws02	Ws03	Ws04	Ws06	Ws13	Ws07	Ws08	
	Number of plots	22	13	23	25	20	8	26	
Herbs	*Carex utriculata/aquatilis*	■■■■■	□□□□	■■■■■	■■■■■			*	beaked/water sedges
	Calamagrostis canadensis	□□□	□□	□□□	□□	*	*	■■■	bluejoint reedgrass
	Comarum palustre	□□			□□				marsh cinquefoil
	Senecio triangularis	*				■■		■■■	arrow-leaved groundsel
	Equisetum spp.	*	*	*	□□□	■■■	■■■■■	■■■■	horsetails
	Valeriana sitchensis					□□		□□□	Sitka valerian
	Carex disperma						■■■		soft-leaved sedge
	Cornus canadensis						□□□	□□□	bunchberry
	Leptarrhena pyrolifolia					*		□□	leatherleaf saxifrage
	Trollius albiflorus							□□	globeflower
	Rubus pedatus							■■■	five-leaved bramble
	Ligusticum canbyii							□□□	Canby's lovage
	Caltha leptosepala							□□	white mountain marsh-marigold
Moss layer	"leafy mosses"[a]	*	*	*		*	□□□	□□□□	leafy mosses
	Sphagnum spp.	*					*	■■■■■	peat-mosses
	Aulacomnium palustre					*	*	□□□	glow 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

Tall Shrub Swamps

Ws02 Mountain alder – Pink spirea – Sitka sedge[10]

The Ws02 is uncommon in the MS and ICH in the East Kootenay. It 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. Pink spirea can be abundant but is more common in climates that are wetter than those in the East Kootenay. Black twinberry is often present with substantial cover. The herb layer is usually dominated by large sedges (water and beaked), although small-flowered bulrush (*Scirpus microcarpus*) or bluejoint reedgrass may dominate in some areas. Marsh cinquefoil is often present.

Ws03 Bebb's willow – Bluejoint

The Ws03 is uncommon in the IDF and MS, and occasionally occurs in the ICH and at lower elevations in the ESSF. It is most common along lake or pond margins, seasonal creeks, and fluvial terraces, and in depressions. Bebb's willow dominates the shrub layer, often with black twinberry. Mountain alder and red-osier dogwood may be present. Scattered Sxw trees can occur. Bluejoint reedgrass and/or beaked sedge have high cover in the herb layer; horsetails and a diversity of forbs frequently occur.

Ws04 Drummond's willow – Beaked sedge

Ws04 swamps are uncommon at low to mid elevations in the East Kootenay. They occur where water is stagnant, usually in depressions or adjacent to low-gradient streams. Drummond's willow dominates the shrub layer, although other willows may be present. The herb layer is typically dominated by beaked sedge and/or water sedge. Bluejoint reedgrass may occur. The Ws04 often occurs adjacent to *Fl05 Drummond's willow – Bluejoint* low bench flood sites (see Section 6.3). Drummond's willow, and its associated swamp and flood site associations, is most common in cooler climates and/or broad-scale plateau areas (e.g., central British Columbia).

Ws06 Sitka willow – Sitka sedge[10]

The Ws06 is typically associated with fluvial systems in areas with prolonged periods of saturation and brief early-season flooding. It is typically dominated by Sitka willow, but lesser amounts of black twinberry, pink spirea, or mountain alder may occur along with various other willow species. The

[10] Sitka Sedge (*Carex sitchensis*) is uncommon in the field guide area; water sedge and beaked sedge are more common on these sites.

herb layer is most often comprised of beaked sedge and/or water sedge, frequently with horsetails (mostly common horsetail). Bluejoint reedgrass is often present. The Ws06 occurs on sites similar to the Ws04 and has similar herb-layer species but is more common in wetter, mountainous areas. It is often found adjacent to Wm01 or Wm02 marshes or *Fl04 Sitka willow – Red-osier dogwood – Horsetail* low bench floodplain ecosystems (see Section 6.3).

Ws13 Barclay's willow – Common horsetail – Arrow-leaved groundsel
The Ws13 occurs on a variety of sites, including along the margins of large wetland complexes, in shallow depressions, and adjacent to streams. It is characterized by a high cover of willows, primarily under-green (*Salix commutata*) and/or Barclay's (*S. barclayi*), 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, including occasional occurrence in the woodland. This unit is newly described and is not included in *Wetlands of British Columbia* (MacKenzie and Moran 2004).

Treed Swamps

Treed swamps have > 10% cover of conifer trees and soils that indicate a wetland environment. They are uncommon in the East Kootenay in the IDF, MS, ICH, and occasionally at lower elevations in the ESSF. At a provincial scale, treed swamps are given a non-forest site association code (e.g., Ws07 and Ws08 for treed swamps that occur in the East Kootenay); however, these treed wetland sites are also part of the forested site series classification described in this guide and have a corresponding site series number.[11] In many cases, the wettest forested site series include sites that occur in both "swamp" and "upland" environments, with similar plant community composition on both site conditions. Where this occurs in the classification, site series phases are used to differentiate between sites with the same plant community occurring in different environmental conditions.

In this field guide, site series phases are assigned where treed swamps occur in the IDF, MS, and ESSF. Treed swamps, with organic soils, are described as a "swamp phase," while sites with upland soils in the same site

[11] Conifer-dominated forests are described using site series, while non-forest and deciduous-dominated stands are part of the non-forest and related classification system. This results in descriptions and codes being duplicated in two parts of the BEC system, even though the conifer-dominated wetland site associations and corresponding forested site series swamp phases describe the same ecosystems.

series are coded as a "riparian phase." Users can refer to swamp phase sites with the forested site series and the phase code (e.g., MSdw/111b), the swamp code (MSdw/Ws07.2), and/or the site series, phase, and swamp code (e.g., MSdw/111b(Ws07.2)). Table 6.2.2 shows the relationship between forested site series and swamp site associations in the field guide area.

TABLE 6.2.2 *Treed swamp site associations and corresponding site series phases*[a]

	Ws07	**Ws08**
IDFxx2	112b	
IDFxk	113b	
IDFdm2	112b	
IDFdk5	111b	
ICHmk4	112b	
MSdk	111b	
MSdw	111b	
ESSFwm1		112b
ESSFdk1		111b
ESSFdk2		112b

[a] See Chapter 5 for site series descriptions.

Ws07 Spruce – Horsetail – Leafy moss

The Ws07 is uncommon on gentle or level sites, lower or toe slopes, and margins of non-forested fens. Sxw is dominant in the overstorey, with Sxw and some Bl in the understorey. Mountain alder, red-osier dogwood, and black twinberry are often present with low to moderate cover. Horsetails are always present and abundant with a diversity of other wetland and upland species, including bluejoint reedgrass, bunchberry, mitreworts (*Mitella* spp. and *Pectiantia* spp.), and twinflower (*Linnea borealis*). Two variations of the Ws07 are described to recognize different plant community composition:

Ws07.1 Spruce – Horsetail – Leafy moss
has little or no soft-leaved sedge and red-osier dogwood; most common in central and northern British Columbia but also occurs in the MS

Ws07.2 Spruce – Horsetail – Soft-leaved sedge – Leafy moss
soft-leaved sedge and red-osier dogwood are present and often abundant; most common in the field guide area, particularly in the IDF and warmer areas of the MS and ICHmk4

The Ws07 also corresponds to the swamp phase of the *Sxw – Horsetail* site series in several biogeoclimatic units (e.g., MSdw/111b) (see Table 6.2.2). These are the same ecological unit but are coded using two different parts of the BEC system. The swamp phase can be differentiated from the typic phase (usually riparian-associated, high bench flood sites) by the presence of "wetland soils" (e.g., Gleysols) that have a thick organic veneer, very poor drainage, and subhydric moisture regimes (rSMR 7). Swamp-phase sites also tend to have lower tree productivity.

Ws08 Subalpine fir – Sitka valerian – Horsetail
The Ws08 occurs infrequently in the field guide area on very wet sites in the ESSF, typically in depressions adjacent to gentle streams, lakeshores, and marshes or fens. Se and Bl are widely spaced in the relatively open canopy, with abundant horsetails, various sedges, bluejoint reedgrass, and numerous wet-site forbs in the understorey. Peat-mosses are also dominant, often with leafy mosses and/or glow moss.[12] The Ws08 is also described as a swamp phase of the *Se – Horsetail* site series in the ESSF (e.g., ESSFdk1/111b) (see Table 6.2.2). These are the same ecological unit but are coded using two different parts of the BEC system. The swamp phase can be differentiated from the typic phase (usually riparian-associated, high bench flood sites with Regosolic or gleyed soils) by the presence of "wetland soils" (e.g., Gleysols) that have a thick organic veneer, very poor drainage, and subhydric moisture regimes (rSMR 7). Swamp-phase sites also tend to have lower tree productivity.

[12] An additional site association variation occurs in wetter climates of the ESSF where Canby's lovage is abundant: *Ws08.2 Engelmann spruce – Subalpine fir – Horsetail – Canby's lovage* (see LMH 70 [MacKillop and Ehman 2016]). This variation may occur in the field guide area, particularly in the ESSFwm1.

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 commonly found at the edges of ponds and lakes, and are often bordered by marshes or swamps where emergent vegetation has > 10% cover. Shallow water plant communities are typically species-poor, and are usually dominated by yellow pond-lily (*Nuphar lutea*), although bladderworts (*Utricularia* spp.) or pondweeds (*Potamogeton* spp.) can be present and occasionally dominate the plant communities. Shallow water ecosystems may also be referred to as "aquatic wetlands." Water depths typically vary from 0.5 to 2 m deep but can be up to 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 had been recognized: yellow pond-lily types and pondweed types. No site associations have been described.

Alpine Wetland Class (Wa)

Alpine wetlands occur in the IMA, the ESSF parkland and woodland, and occasionally in cold-air basins in the upper portions of the ESSF. They occur on seeps and saturated flats that have site characteristics that are similar to lower-elevation swamps or marshes, including gleyed mineral soils, often with a thin organic capping and a persistent high water table during the growing season. However, 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 high elevations. Unlike fens and marshes, graminoid species are usually not dominant (except for black alpine sedge [*Carex nigricans*]). At the time of publication, no alpine wetland site associations had been described for the East Kootenay. Three Wa site associations that occur more frequently in wetter climates are described in LMH 70 (MacKillop and Ehman 2016), and these may occur in the wettest portions of the field guide area. Work is under way to continue high-elevation classification, and users should consult the BECweb site for future updates.

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 East Kootenay. 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

Ecosystems that are regularly inundated are part of the Flood Group. This includes ecosystems that are affected by periods of short to prolonged, periodic flooding. Most sites experience high inter-annual variability in flood duration and intensity. 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 or less frequent flooding. Cumulic Regosolic soils of stratified silts, sands, and gravels are most common.

Flood ecosystems are part of the broader riparian areas of stream, river, lake, and some wetland complexes. Flood sites are geomorphically and hydrologically dynamic, with frequent flooding, erosion, and deposition influencing site conditions. Changes in stream channel dynamics can lead to succession of site conditions and associated vegetation communities from low bench to middle bench to high bench ecosystems over time, often with the location of each flood class 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 help moderate stream temperatures. Throughout much of southeast British Columbia, floodplain sites have been seriously affected by hydroelectric development and human settlement.

Dams and dikes in the East Kootenay have had several negative effects on flood ecosystems, both through direct flooding (e.g., in the Koocanusa Reservoir) and from downstream effects. Downstream effects include changes in timing and intensity of stream flow, moderation of annual flooding, and reduced contribution of upstream sediment deposition. These changes can alter the distribution and composition of flood ecosystems. Land clearing for agriculture, livestock grazing, 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

The BEC system recognizes five flood classes: shrub-dominated low bench floodplains (Fl), broadleaf tree-dominated middle bench floodplains (Fm), conifer-dominated high bench floodplains (Fh), subirrigated flood fringe sites (Ff), and active channel flood sites (Fa). 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).[1] 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 component (usually cottonwood, aspen, and/or birch), particularly at low to mid elevations, but conifers dominate at maturity.

Flood fringe (Ff) ecosystems occur on sites that are subirrigated but rarely flooded. These include slope draws and gullies in areas with dry, hot climates (typically BG, PP, and dry IDF) and sites adjacent to lakes and ponds that are above the high water mark. Flood fringe ecosystems differ from the other flood classes in that they are rarely flooded. Instead, they 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 aspen trees < 10 m tall). Active channel flood (Fa) ecosystems occur on sites that are flooded annually, often for prolonged periods. Vegetation includes annual herbs or

[1] Full species names are used for trees in non-forest classification within the BEC system, while species codes (see Appendix 3.7) are used for trees in the forested classification.

perennials with extensive root systems that enable re-sprouting when above-ground structures are removed. These Fa sites include vegetated gravel bars within or adjacent to river and stream channels. Rocky, moss-covered sites at the margins of streams, rivers, and lakes are also Fa ecosystems. Site associations are not described for active flood channel ecosystems.

Duration of flooding is the primary environmental gradient that differentiates flood ecosystems at the site level. Low bench (Fl) ecosystems experience longer (20–40 days) and more powerful flooding than middle bench (Fm) sites (< 25 days). High bench flood forests (Fh) have even shorter-duration floods (< 10 days) and do not flood every year. Flood fringe (Ff) ecosystems may not experience any surface flooding, but subirrigation during spring runoff or growing-season rainstorms influences vegetation. Active channel (Fa) sites have highly variable flood regimes and often experience extended annual flooding and instream scouring. Figure 6.3.1 provides a schematic depiction of flood ecosystems.

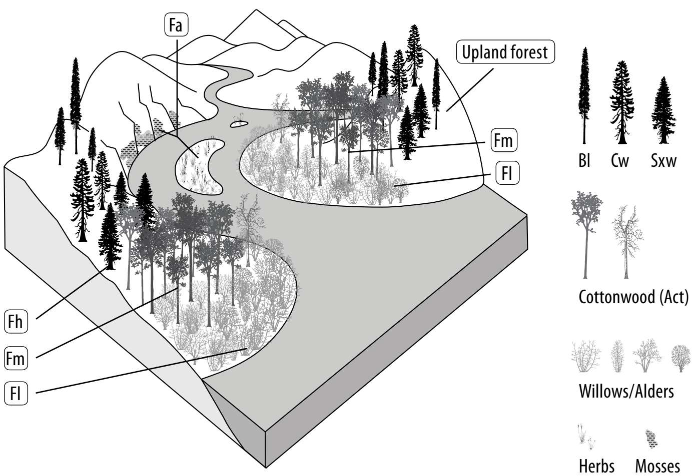


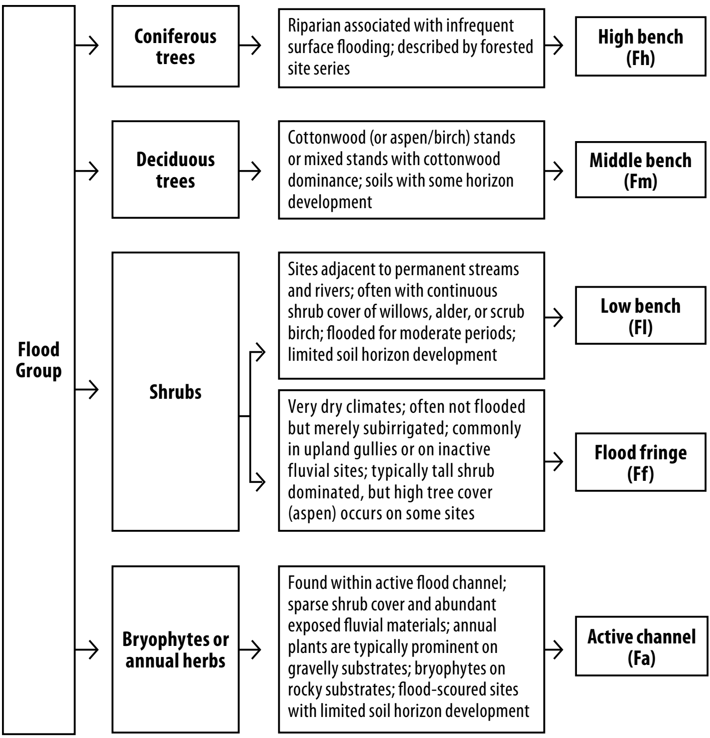
FIGURE 6.3.1 *Flood ecosystems in a typical mountainous environment in southeast British Columbia.*

Disturbance in flood ecosystems

Anthropogenic and other non-flood 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 East Kootenay include dams and other water diversions [W.d], domestic livestock grazing [B.d], and other activities.

The wetlands section (page 306) describes sites occupied by extremely aggressive invasive plant species and provides coding and explanations that are 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*), and knotweeds (*Reynoutria* spp.) have overtaken native plant communities on floodplains.

Flowchart – Flood Ecosystem Classes



Flood ecosystems in the East Kootenay

Flood ecosystems are highly diverse due to variability in local climates, intensity and frequency of flooding, and other stochastic 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 East Kootenay 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 flood ecosystems occur along lakes, streams, and rivers on sites that are briefly flooded (< 25 days) during freshet. Forests are dominated by flood-tolerant broadleaf species, usually black cottonwood, and sometimes trembling aspen. Conifers often occur as part of deciduous-dominated mixed stands. Due to the dynamic nature of flooding on these sites, vegetation is highly variable. Soils usually have some horizon development, typically with buried layers that result from repeated flooding (e.g., Cumulic Regosol soils). Available nutrients are usually very high due to continuous inputs of oxygenated, mineral-rich water through subirrigation.

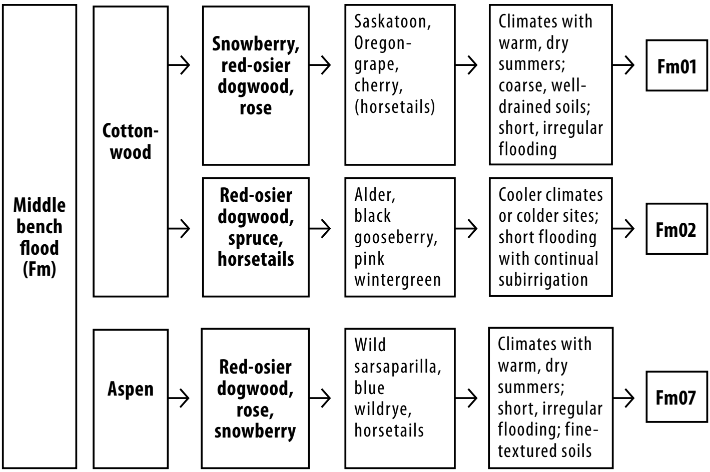
Six middle bench site associations are recognized in southern British Columbia, including three that are common in the East Kootenay: the Fm01, Fm02, and Fm07 (see below). The *Fm04 Cottonwood – Redcedar – Dogwood – Lady fern*, *Fm05 Cottonwood – Douglas-fir – Douglas maple – Snowberry*, and *Fm06 Cottonwood – Poison ivy* are newly identified site associations and are less likely to be encountered in the subzones/variants covered by this field guide. The Fm04 was described in LMH 70 (MacKillop and Ehman 2016), and the Fm05 and Fm06 will be described in field guides for the Boundary and Okanagan.

Distribution of cottonwood forest middle bench flood (Fm) site associations by biogeoclimatic unit[a]

Zone	IDF				MS		ICH
Unit/BGC	IDFxx2	IDFdm2	IDFxk	IDFdk5	MSdw	MSdk	ICHmk4
Fm01	X	X	X	X	X	X	X
Fm02	*	*	*	*	X	X	X
Fm07	X	*	*	*			

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Middle bench flood ecosystems



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, characteristic of the IDF and dry ICH, and on 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 but 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, including Cw, Fd, Lw, and Pl, are often present with minor cover. Shrub diversity is typically high, with snowberry and red-osier dogwood consistently present and often abundant. Nootka rose (*Rosa nutkana*), baldhip rose (*R. gymnocarpa*), Oregon-grape (*Berberis* spp.), mountain alder, saskatoon, black hawthorn, choke cherry (*Prunus virginiana*), and beaked hazelnut (*Corylus cornuta*) are often present. Understorey herbs are also diverse and have variable cover, with minor amounts of horsetails (mostly common [*Equisetum arvense*]), scouring-rush (*E. hyemale*), wild sarsaparilla (*Aralia nudicaulis*), sedges (*Carex* spp.), and blue wildrye. Weedy plant species such as dandelion (*Taraxacum* spp.), vetch (*Vicia* spp.), and buttercups (*Ranunculus* spp.) are often present on 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	Fm07	Common name
	Number of plots	49	26	4	
Trees	*Populus trichocarpa*	■■■■■	■■■■■		black cottonwood
	Picea engelmannii x *glauca*		▪▪▪		interior spruce
	Populus tremuloides			■■■■■	trembling aspen
	Populus trichocarpa	▪▪			black cottonwood
Regen	*Picea engelmannii* x *glauca*		▪▪		interior spruce
	Populus tremuloides			■■■	trembling aspen
Shrubs	*Cornus stolonifera*	■■■■	■■■■■	■■■■■	red-osier dogwood
	Symphoricarpos spp.	■■■■	*	■■■	snowberry
	Amelanchier alnifolia	▪▪		▪▪	saskatoon
	Rosa spp.	▪▪▪		■■■	roses
	Alnus incana	*	▪▪▪		mountain alder
	Viburnum edule		▪▪		highbush-cranberry
	Ribes lacustre		▪▪		black gooseberry
	Betula occidentalis			■■■	water birch
	Crataegus douglasii			■	black hawthorn
Herbs	*Equisetum* spp.	▪▪	▪▪▪	■■	horsetails
	Maianthemum stellatum	▪		■■	star-flowered false Solomon's-seal
	Elymus glaucus	*	*	▪	blue wildrye
	Osmorhiza spp.	*	▪▪		sweet-cicely
	Pyrola asarifolia		▪▪		pink wintergreen

[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
In southeast British Columbia, the Fm02 occurs in cool, low- to mid-elevation climates, primarily in the MS and IDF, 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 dominant in the overstorey, often with minor Sxw, and sometimes with Cw and/or Bl. Red-osier dogwood is dominant in the shrub layer and frequently occurs with mountain alder, black gooseberry, and/or highbush-cranberry. Willows and snowberry are also sometimes common. Horsetails, sweet-cicely, and pink wintergreen are usually present, often with minor cover of bluejoint reedgrass, false Solomon's-seal (*Maianthemum racemosum*), oak fern, and/or blue wildrye.

Fm07 Aspen – Dogwood – Water birch
The Fm07 is the only trembling aspen–dominated middle bench flood site association described in British Columbia. It occurs at low elevations in the IDF in the Rocky Mountain Trench, where it is most common along the floodplain of the Kootenay River. Unlike cottonwood-dominated floodplains, soils are typically fine-textured with little or no coarse fragments. Flood regimes are intermediate between middle and high bench flood ecosystems: flood events are less frequent and of shorter duration and lower intensity than cottonwood-dominated middle bench flood sites, and slightly more frequent and intense than conifer-dominated high bench flood sites. Trembling aspen dominates the overstorey, usually with water birch, red-osier dogwood, snowberry, and roses (Nootka, Wood's [*Rosa woodsii*], and/or baldhip rose) in the shrub layer. Typical herbs include horsetails (usually common horsetail), blue wildrye, star-flowered false Soloman's-seal, sedges, and sweet-scented bedstraw (*Galium triflorum*). Productivity of aspen trees is typically low, and trees are frequently stunted in growth compared to aspen in riparian areas on upland sites.

Many Fm07 sites have been separated from sediment-filled flood waters (by roads and railways). Flood waters still reach these sites, but less frequently and with fewer suspended sediments. On these sites, blue wildrye increases in cover along with increased forb diversity and productivity. These "disturbed" sites can be coded as Fm07$.

The Fm07 should not be confused with seral riparian stands on upland sites where aspen is often a significant component of mixed broadleaf–conifer stands. Those sites are classified as seral units of the forested site series described in Chapter 5. The Fm07 site is newly described and was not included in *Wetlands of British Columbia* (MacKenzie and Moran 2004).

Low Bench Flood Class (Fl)

Low bench ecosystems occur on sites that are flooded for moderate periods (20–40 days) during the growing season. The longer duration of flooding limits 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 systems but also occur on wave-washed beaches and shores of larger lakes. They are floristically similar to many shrubby swamps, but low bench flood ecosystems are drier throughout the mid growing season, have aerated soils, and have more intense flooding with erosion and deposition. In contrast, shrub swamps have wetland soils with accumulations of peaty organic surface layers, non-oxygenated soils, and an abundance of hydrophytic herb species. Low bench flood ecosystems also occur adjacent to stream channels or along lake shores, whereas swamps are generally associated with inactive floodplain back channels, peatland margins, and depressions.

Low bench flood units cover a broad range of vegetation types but are typically restricted to low- to mid-elevations within mountainous terrain (BG, PP, IDF, ICH, MS, and low- to mid-elevation ESSF). At the time of publication, six Fl site associations had been described for low bench floodplains across the interior of the province (MacKenzie and Moran 2004). All of these units occur in the East Kootenay.[2]

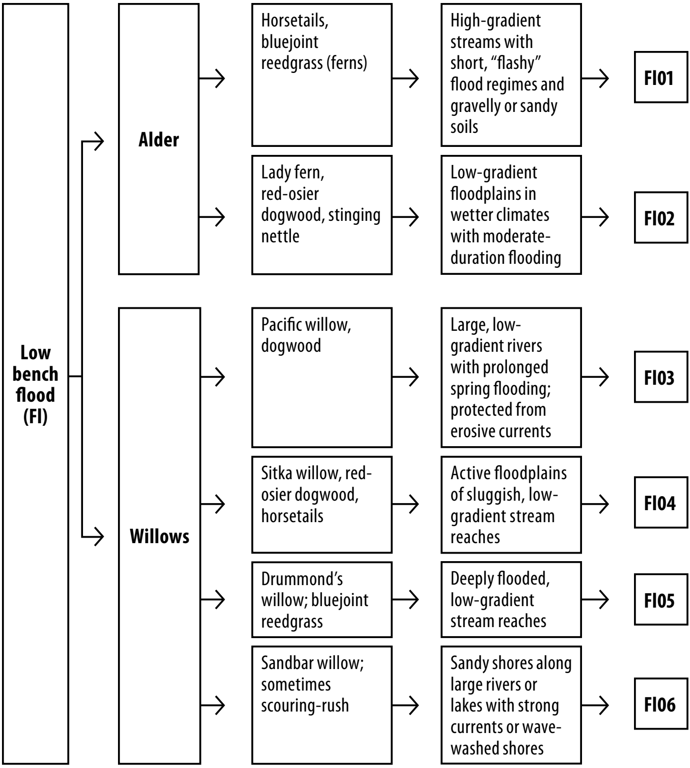
Distribution of low bench flood (Fl) site associations by biogeoclimatic unit[a]

Zone	IDF				MS		ICH	ESSF		
Unit/BGC	IDFxx2	IDFdm2	IDFxk	IDFdk5	MSdw	MSdk	ICHmk4	ESSFdk1	ESSFdk2	ESSFwm1
Fl01	*	X	*	X	X	X	X	*	*	*
Fl02					*	*	*			
Fl03	*	*	*	*						
Fl04					*	*	*			
Fl05		*		*	*	*	*	*	*	
Fl06	*	*	*	*						

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

[2] The Fl07 from *Wetlands of British Columbia* (MacKenzie and Moran 2004) is now classified as Ff01a (see Flood Fringe Class below).

Flowchart – Low bench flood ecosystems



Vegetation Table – Low bench flood ecosystems[a]

Layer	Scientific name	FI01	FI02	FI03	FI04	FI05	FI06	Common name
	Number of plots	4	4	5	15	10	2	
Shrubs	*Alnus incana*	■■■■■	■■■■■	■■■	*			mountain alder
	Lonicera involucrata	■■■	■■■■■		■■■	*		black twinberry
	Cornus stolonifera	■■	■■■	■■■■	■■■■			red-osier dogwood
	Salix drummondiana	*			□□□	■■■■■		Drummond's willow
	Salix sitchensis		□□□		■■■■■			Sitka willow
	Salix lasiandra			■■■■■	*			Pacific willow
	Salix exigua/interior						■■■■■	narrow-leaf/sandbar willow
Herbs	*Equisetum* spp.	■■■■	■■■	■■■	□□□	□□□		horsetails
	Calamagrostis canadensis	□□	□	□	□□□	■■■■■		bluejoint reedgrass
	Viola spp.	*	□□		*	■■		violets
	Urtica dioica	□	□			*		stinging nettle
	Athyrium filix-femina	■	■■■■					lady fern
	Heracleum maximum	■■	■■					cow-parsnip
	Thalictrum occidentale	□□	□					western meadowrue
	Geum macrophyllum	□	■			□□		large-leaved avens
	Equisetum fluviatile			□□				swamp horsetail

[a] Vegetation is based mostly on plots from southern British Columbia; data are limited and there are few plots from within the field guide area.

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 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 occasionally occur following summer storms. Mountain alder and horsetails are the dominant species, and often occur with bluejoint reedgrass, oak fern, lady fern, and western meadowrue.

Fl02 Mountain alder – Red-osier dogwood – Lady fern
Fl02 sites occur on low-gradient floodplains and in creek gullies where flooding is of moderate duration. The Fl02 is most common in wet climates. Mountain alder, red-osier dogwood, and black twinberry usually occur with lady fern and common horsetail. Sitka willow is sometimes a common shrub, and in colder climates, cow-parsnip is common. Fl02 sites often occur adjacent to Fm02 cottonwood forest sites.

Fl03 Pacific willow – Red-osier dogwood – Horsetail
The Fl03 site association occurs along large, low-gradient rivers that experience prolonged spring flooding but is restricted to areas that are protected from erosive currents, such as back channels and oxbows. Pacific willow is the dominant species and can grow over 10 m tall, forming closed canopies. Red-osier dogwood, mountain alder, or other willows often occur in the understorey along with variable cover of horsetails.

Fl04 Sitka willow – Red-osier dogwood – Horsetail
The Fl04 occurs on levees and sand or gravel bars in the active floodplains of sluggish, low-gradient streams. Soils are typically fine-sandy textured, well-drained, and saturated at depth for most of the growing season. Sitka willow is the dominant shrub, and often occurs with moderate cover of red-osier dogwood and black twinberry. Mountain alder, Drummond's willow, and Pacific willow can also be common, and sometimes have high cover. Horsetails (common and meadow [*Equisetum pratense*]) and/or bluejoint reedgrass are typically present on most sites, along with a variety of other herbs, except where herb cover is sparse due to recent flooding and sediment deposition. The Fl04 is most common in moist to wet climates and is generally absent from the IDF. Fl04 sites often occur adjacent to Fm02 sites.

Fl05 Drummond's willow – Bluejoint reedgrass
The Fl05 occurs along small, low-gradient streams from the upper IDF to the lower ESSF in the East Kootenay. These sites flood deeply during freshet but may be significantly elevated above the mid-season water table. Drummond's willow is most abundant, but other shrubs such as black twinberry commonly occur. Bluejoint reedgrass is abundant in the understorey, often with lower cover of horsetails. Soils are generally Cumulic Regosols with silty to fine-sandy loam textures. The Fl05 often occurs adjacent to Wm02 and Ws04 sites.

Fl06 Sandbar willow[3]
Sandbar willow sites occur on sandy lateral gravel and sand bars and on islands along very large river systems where spring flooding is prolonged and strong currents are common. It also occurs in hotter, drier climates on wave-washed shores of larger lakes. Plant diversity is low on these sites: sandbar willow dominates, often with sparse black cottonwood and mountain alder mixed in at the upper elevation fringes. Scouring-rush may occur, and often mixes with annual weedy herbs that establish on the exposed mineral soils of these sites. Fl06 sites occur infrequently along the larger Kootenay and Columbia River systems.

Flood Fringe Class (Ff)

Flood fringe ecosystems occur in two types of environment: (1) along the margins of lakes, ponds, or wetlands, and (2) in slope draws and gullies in grassland environments of the BG, PP, and IDF. They are unusual in the flood group since they occur on sites that are subirrigated but rarely flooded by surface waters. These sites are essentially "flooded" from below ground by a rising water table for short to moderate durations during spring freshet or summer storms. Ff ecosystems are characterized by tall broadleaf shrubs (e.g., willows, roses, water birch, snowberry) or low-growing trees (generally stunted aspen trees < 10 m tall). Moist soil conditions lead to vegetation that is distinct from surrounding ecosystems. Brushlands (Gb) are similarly "brushy" but are restricted to dry sites and lack species that are associated with moist conditions. At the time of publication, three Ff units had been described (see Coupé and Iverson 2012); only one occurs in the East Kootenay.

[3] Sandbar willow (*Salix interior*) and narrow-leaf willow (*S. exigua*) were previously treated as one species; this site association includes both.

Ff01 Water birch – Red-osier dogwood – Rose

Vegetation on Ff01 sites is dominated by water birch with roses and red-osier dogwood in the understorey. Snowberry and willows are sometimes present in minor amounts. Two site conditions are common for the Ff01, with site association phases used to describe each:

Ff01a fringe phase occurs along the margins of lakes, ponds, wetlands, or low-gradient creeks. Soils are Humic or Rego Gleysols. They are derived from fine-textured fluvial or lacustrine materials and remain wet throughout the growing season. Willows are often present in this phase.[4]

Ff01b grassland draw phase occurs in the driest climates of southern British Columbia in gullies, draws, and depressions in grassland environments of the BG, PP, and IDF. Soils are Gleyed Eutric or Melanic Brunisols and remain moist throughout the growing season. Weedy species such as burdock and Kentucky bluegrass are often present on disturbed sites.

Active Channel Flood Class (Fa)

Active channel ecosystems occur on sites that are annually flooded and often scoured for prolonged periods. Sites are exposed and 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 species with extensive root systems that are able to re-sprout after the aboveground structures have been removed by flooding and scouring. Unlike low bench flood ecosystems, plant communities on Fa sites are herb-dominated and have little or no cover of shrubs such as willows and alders. Fa ecosystems 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.

[4] This unit was previously classified as Fl07 in *Wetlands of British Columbia* (MacKenzie and Moran 2004).

6.4 Grassland Group: Grassland, Brushland, Shrub-steppe, and Alkaline/Saline Meadow Ecosystems

Four classes are recognized in the Grassland Group: Grassland (Gg), Brushland (Gb), Shrub-steppe (Gs), and Alkaline/saline meadow (Ga). Grasslands and brushlands occur from low-elevation IDF climates, through the MS, to the ESSF woodland and parkland in the field guide area. Shrub-steppe and alkaline/saline meadows are restricted to the hotter subzones/variants of the IDF. Although alpine grasslands (Ag) are part of the Alpine Group (see Section 6.7), they are described in this section because they are also grasslands.

Note that grassland (Gg) ecosystems are emphasized over other non-forested ecosystems in this field guide, with full-page descriptions for each site association and additional site identification tools, because of their importance for biodiversity, habitat, and forage values.

Ecological significance of grasslands, brushlands, shrub-steppe, and alkaline/saline meadows

The Grassland Group describes ecosystems where conditions are **too dry for forest establishment** as a result of **semi-arid climate or** because **sites** within otherwise forested areas are too dry and warm. Soil moisture availability and drainage characteristics, timing of moisture delivery, and depth of available moisture are key determinants of ecosystems within the Grassland Group.

Grassland, brushland, shrub-steppe, and alkaline/saline meadow ecosystems are generally considered **at-risk ecological communities** in British Columbia, and in the East Kootenay, because they are naturally uncommon and their condition is threatened by a number of factors, including urban and rural development, overgrazing by livestock and wildlife, introduction of invasive alien plant species, off-road vehicle use, and loss of natural fire patterns. In landscapes that are largely dominated by forests, ecosystems in the Grassland Group provide important habitat diversity. They provide valuable forage for livestock and significant habitat for grazing ungulates. They also frequently provide habitat for **at-risk species and species of concern**. At-risk plant species in the field guide area include Suksdorf's broomrape (*Orobanche ludoviciana* var. *ludoviciana*), little bluestem (*Schizachyrium scoparium*), spurred lupine (*Lupinus arbustus* ssp. *neolaxiflorus*), Spalding's campion (*Silene spaldingii*), common twinpod (*Physaria didymocarpa* ssp.

didymocarpa), and Hooker's townsendia (*Townsendia hookeri*).[1] Many of these species are unique to this part of British Columbia. Animals at-risk that are reliant on grasslands include American badger, sharp-tailed grouse, prairie falcon, long-billed curlew, Swainson's hawk, short-eared owl, and upland sandpiper.

Within the field guide area, **grasslands** are most common at low elevations in the southern half of the Rocky Mountain Trench and at mid to upper elevations in the Elk and Flathead valleys. In the IDF, large grassland complexes occur on dry, level sites and on warm-aspect slopes. In low-elevation grasslands with good or excellent ecological condition,[2] the soil surface between vascular plants is covered with a biological soil crust of lichens, bryophytes, algae, cyanobacteria, and microfungi. The crust protects the soil from wind and water erosion, contributes carbon and nitrogen to the soil, and improves the infiltration of water (Rosentreter et al. 2007). It is highly sensitive to disturbance and very slow to re-establish.

In the MS and ESSF in the Elk Valley, grasslands occur on steep, warm aspects where soils are derived from a wide variety of nutrient-rich sedimentary rocks. In other areas covered by this field guide, grasslands are scattered on the driest sites and often occur as small (0.5–3 ha) openings on dry, warm, upper-slope, shedding sites with coarse and/or shallow soils within broader forested, rock outcrop, and brushland complexes.

Alpine grasslands are uncommon in this field guide area, and occur on very cold sites from the ESSF to the IMA. 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** (Ag) are dominated by timber oatgrass, while grasslands in the Grassland Group (Gg) that are in good condition are usually characterized by bluebunch wheatgrass, Idaho fescue, and rough fescue.[3]

[1] See the Conservation Data Centre, B.C. Ministry of Environment, for continuously updated lists of plant and animal species at risk.

[2] Hereinafter, "condition" refers to ecological condition. Ecological condition includes the similarity of the plant community to what it would be without anthropogenic disturbances (e.g., to soils), grazing by livestock, the presence and abundance of alien invasive plants, and the degree of alteration of ecological processes. Although a recently burned grassland with no invasive plant species could be considered to be in good "ecological condition," throughout this guide, "good condition" applies to stands with "late seral" or "climax" vegetation communities.

[3] Both alpine grasslands (Ag) and grasslands (Gg) can occur together in the same landscape; grasslands can also occur at upper elevations in the East Kootenay. Timber oatgrass may also occur as a seral species in the Grassland Group.

In the area covered by this field guide, **brushlands** typically occur on warm-aspect sites where soils are shallow and rocky. They often occur in a mosaic with other ecosystems, including dry, open forests, rock outcrops, and grasslands. They differ from ecosystems in the Grassland Class in that woody shrubs are prominent, and from ecosystems in the Shrub-steppe Class in that the shrub species that are present are associated with dry forests instead of semi-arid grassland environments. Saskatoon, snowberry, and juniper are typical shrub species in brushlands of the East Kootenay. Brushlands provide important habitat for ungulates (deer and elk browsing), bears, and birds, and create landscape-level heterogeneity in forested environments.

In the East Kootenay, "climax" **shrub-steppe** ecosystems are limited to the IDF south of Canal Flats and are characterized by the presence and abundance of antelope-brush. They are uncommon and scattered on sites with pure-sand soils or warm-aspect, rocky colluvial slopes. Some grassland ecosystems also have increased cover of antelope-brush as a result of grazing disturbance. These sites belong to seral site associations in the Grassland Class.[4] Shrub-steppe sites provide important habitat for ungulates (Rocky Mountain bighorn sheep, mule deer, and Rocky Mountain elk) and other mammals (e.g., American badger, northern pocket gopher, yellow pine chipmunk), birds (western meadowlark, vesper sparrow, peregrine falcon, prairie falcon, western bluebird, and mountain bluebird), and reptiles (northern rubber boa, common garter snake, and western garter snake).

Alkaline/saline meadows occur on moist sites in dry climates that are inundated in the spring and then dry in summer and fall. As drying occurs, salts accumulate through evaporation. Vegetation is dominated by salt- and alkali-tolerant graminoids and forbs. Alkaline/saline meadows provide habitat for selected waterfowl, wading birds, shorebirds, and other migratory bird species, as well as ungulates, reptiles, and amphibians. They are also critical habitats for at-risk plant species such as saltwater cress (*Eutrema salsugineum*) and alkali plantain (*Plantago eriopoda*). Alkaline/saline meadow ecosystems are scattered and uncommon in the IDFxx2, IDFdm2, and IDFxk.

[4] Shrub-dominated seral grassland plant communities are described in seral vegetation tables and in the Vegetation Patterns with Grazing and Disturbance sections provided for each site series. Shrub-steppe ecosystems also differ by occurring only on rocky or very sandy soils.

The role of fire

Fire can be important in maintaining open structure in grassland, brushland, and shrub-steppe ecosystems. Historically, low-intensity fires would have killed many small trees that were encroaching on grassland areas and maintained open, savannah-like structure in landscapes with Py and Fd stands. Fire history studies have found historic mean fire return intervals in the East Kootenay that ranged from 6 to 19 years in the IDF and 15 to 75 years in the MS (Dorey 1979; Gray et al. 2004; Cochrane 2007; Daniels et al. 2011). Fire exclusion has resulted in large areas of open grassland being lost to tree encroachment (Gayton 1997; Ross 1998). The Rocky Mountain Trench Ecosystem Restoration Program has been actively working since the mid-1990s to restore grasslands and open forest conditions (Bond et al. 2013).

Most native grassland plants are well adapted to fire and will resprout from buds just at or below the ground surface following a burn (Daubenmire 1968). Fire releases nutrients and improves the palatability and productivity of shrubs and grasses in ecosystems of the Grassland Group. Fire can also temporarily remove litter, reduce biological soil crusts, and increase the area of exposed soil. These conditions may allow invasive alien plant species to establish or spread. Extensive **fire exclusion** has allowed tree and shrub encroachment to occur across the grassland landscape, and has resulted in broad-scale shifts from grasslands to forested communities. Tree encroachment also benefits shade-tolerant understorey species, including pinegrass and some shrubs that will out-compete important grassland-adapted species that are less shade-tolerant.

Threats

In the IDF, major threats to ecosystems in the Grassland Group, both current and past, include human settlement in valley bottoms, the introduction and spread of invasive alien plant species, overgrazing by livestock and wildlife, off-road recreational vehicle use, fire exclusion, and construction of linear corridors for roads, power transmission lines, and natural gas pipelines. In the MS and ESSF, major threats include mines, construction of linear corridors for roads, power lines, and pipelines, livestock overgrazing (primarily cattle), and off-road recreational vehicle use.

Grazing in the Rocky Mountain Trench, by both wildlife and livestock, has been the most extensive disturbance across grassland ecosystems. The Ktunaxa peoples have had horses since the early to mid 1700s, and large numbers of livestock were brought in during the gold mining boom and during the construction of the Canadian Pacific Railroad from the mid to late 1800s. Increasing elk and deer populations have also contributed to grazing pressure.

Overgrazing, particularly in the St. Mary's prairie and Tobacco Plains, has long been identified as a significant concern. Even in the late 1940s, overgrazing had altered natural vegetation communities to the extent that it was difficult to "infer the nature of the original vegetation" (Eastham 1949). Heavy grazing by livestock and wildlife was widespread in the Rocky Mountain Trench up to the 1950s. From the 1960s to the 2000s, livestock populations declined but elk and deer populations increased. Extensive forest encroachment and ingrowth has also reduced forage for both livestock and wildlife, and has concentrated animals on the smaller remaining areas. Establishment of wildlife exclusion fencing on private lands has further restricted wildlife to smaller areas. Considerable work has been under way since the early 2000s to improve range condition.

Soil disturbance and overgrazing create opportunities for the establishment of **invasive alien plant species**, which can have a major detrimental effect on grassland, brushland, shrub-steppe, and alkaline/saline meadow communities. Invasive alien plant species are a major threat to native species. Examples of the most common alien invasive plant species are non-native hawkweeds (*Hieracium* spp.), knapweeds (*Centaurea* spp.), sulphur cinquefoil (*Potentilla recta*), cheatgrass (*Bromus tectorum*) and other non-native annual bromes (*Bromus* spp.), and common St. John's-wort (*Hypericum perforatum*). Level sites and moister grasslands are vulnerable to invasion of Kentucky bluegrass (*Poa pratensis*) and Canada bluegrass (*Poa compressa*). Numerous other invasive alien plant species also occur in ecosystems of the Grassland Group.[5]

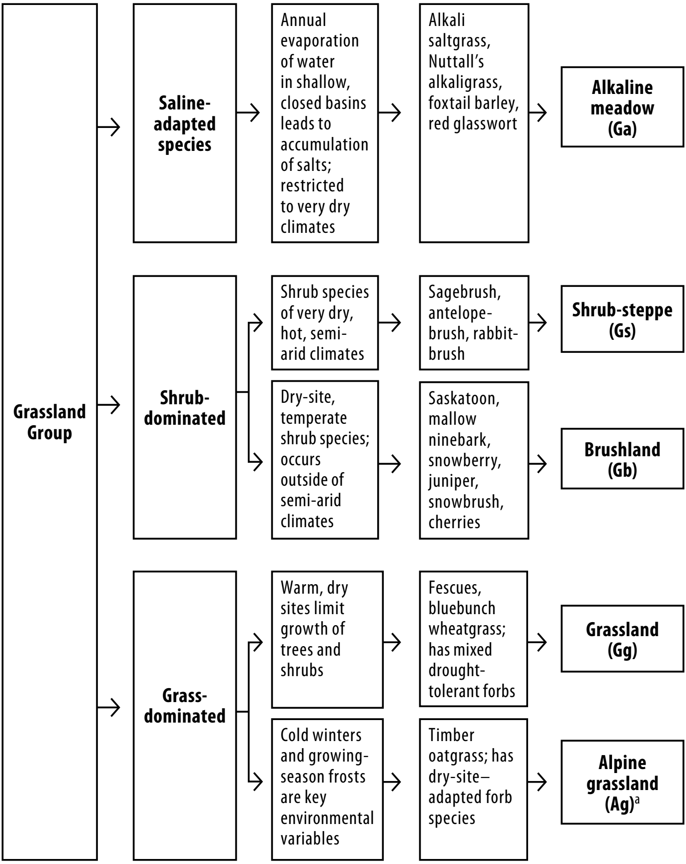
Disturbance, including grazing, urban/rural development, and off-road recreation, is widespread in the East Kootenay, particularly at low elevations. As a result, grasslands in good condition are uncommon across the landscape, especially in the IDF.

Naming and coding of the Grassland Group

The Grassland Group includes four classes: Grassland (Gg), Brushland (Gb), Shrub-steppe (Gs), and Alkaline/saline meadow (Ga). 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.

[5] The East Kootenay Invasive Species Council website provides detailed and updated information on invasive species.

Flowchart – Grassland Group



[a] Part of the Alpine Group.

Disturbance codes and seral classification for the Grassland Group

The BEC system focusses on naming and numbering site associations by using plant communities where the vegetation is relatively similar to what it would be with minimal anthropogenic influences, including livestock grazing (i.e., in good ecological condition). However, anthropogenic disturbances have had substantial effects on large areas within the landscape, which has altered vegetation communities observed today in grassland ecosystems. To assist users in site identification and management, this field guide describes plant communities in both late seral/good ecological condition and early to mid seral/poor or fair ecological condition.

The seral classification coding from the BEC system is used throughout this section to describe disturbed grasslands. All seral units are coded with the site association code (e.g., Gg15) followed by the $ symbol to denote seral conditions, a number to describe structural stage (e.g., 2 or 3), and another number to identify the specific seral plant community (e.g., Gg15$2.4). The specific seral plant communities are numbered in order of increasing disturbance levels, with lower numbers (e.g., .1) referring to the least disturbed sites. Not all seral plant communities described in the southern interior of the province occur within the field guide area; only those that are known to commonly occur in the East Kootenay are included.[6]

Users can also describe the type of disturbance using the coding and approach outlined in the introduction to non-forested ecosystems (Section 6.1). Common disturbances in grassland, brushland, shrub-steppe, alkaline/saline meadow, and alpine grassland ecosystems in the East Kootenay include livestock grazing [B.d], wildlife grazing/browsing [B.w], invasive plant species [B.v], soil disturbance associated with mining [S.m], and recreation-related effects [R] (see Section 6.1).

Although many seral plant communities are described, this field guide does not provide a complete description of all possible disturbed and seral grassland communities. In particular, highly altered sites that are dominated by invasive alien plants species, agronomics, cheatgrass, and other non-native species are not described. On these sites, it can be very difficult to determine the likely ecosystem development trajectory and potential plant community for a site, and in many cases, disturbances may be large enough that ecosystems do not recover native plant communities and may be dominated by invasive alien plants for a very long time.

[6] Seral association coding applies across the southern interior; some seral plant communities are restricted to the Boundary, Okanagan, Cariboo, or Thompson areas and do not occur in the East Kootenay. For these units, the lowest number presented in this field guide reflects the least disturbed seral unit that has been described for the field guide area, and is, in some cases, $2.3, $3.1, or $3.3. Shrub-dominated seral communities ($3.x) are presented with herb-dominated seral communities ($2.x) in the order of seral disturbance.

Codes and names for site associations in the Grassland Group in the East Kootenay

Grassland Class		
Low to mid elevation	Gg01	Bluebunch wheatgrass – Prairie sagewort – Junegrass
	Gg02	Bluebunch wheatgrass – Balsamroot
	Gg10	Rough fescue – Bluebunch wheatgrass
	Gg12	Rough fescue – Yarrow – Junegrass
	Gg15	Rough fescue – Idaho fescue
Mid to high elevation	Gg14	Idaho fescue – Sulphur buckwheat – Sandwort
	Gg16	Rough fescue – Sulphur buckwheat – Sandwort
	Gg17	Idaho fescue – Bluebunch wheatgrass – Sulphur buckwheat
	Gg33	Pinegrass – Yellow penstemon
Brushland Class		
	Gb01	Juniper – Kinnikinnick – Bluebunch wheatgrass
	Gb02	Saskatoon – Snowberry – Bluebunch wheatgrass
	Gb04	Choke cherry – Snowberry – Bluebunch wheatgrass
	Gb20	Saskatoon – Soopolallie – Juniper
Shrub-steppe Class		
	Gs12	Antelope-brush – Snowberry – Bluebunch wheatgrass
	Gs13	Antelope-brush – Prairie sandgrass
Alkaline/saline meadow Class		
	Ga01	Alkali saltgrass
	Ga02	Nuttall's alkaligrass – Foxtail barley
	Ga03	Field sedge
	Ga06	Seablite
Alpine grassland Class		
	Ag01	Timber oatgrass – Grouseberry – Sandwort

Grassland, brushland, shrub-steppe, alkaline/saline meadow, and alpine grassland ecosystems described for the East Kootenay

Nine grassland site associations, four brushland site associations, two shrub-steppe site associations, four alkaline/saline meadow site associations, and one alpine grassland site association are described for the East Kootenay. The full list of site associations described, by site class, is provided below. Seral associations, where described, are included throughout this section. Note that other Grassland Group plant communities that have not yet been described may also occur in the field guide area.

Grassland Class (Gg) and Alpine grassland Class (Ag)

Grasslands are ecologically, socially, and economically important ecosystems in the East Kootenay. Therefore, more detailed descriptions are provided in this section for grassland site associations than for other non-forest units. Grasslands occur from low elevations in the IDF to high-elevation sites in the ESSF, woodland, and parkland. Many grassland plant communities in the East Kootenay are similar to those in other areas of British Columbia and are grouped together into the same site association. Other site associations are similar but have species that are unique to, or more abundant in, the East Kootenay; these are generally described as site association variations. Four grassland site associations and two shrub-steppe site associations are unique to the East Kootenay and occur only within the field guide area: Gg15, Gg16, Gg17, and Gg33, and Gs12 and Gs13.

In the IDF, grasslands are most common on glaciofluvial deposits on the valley floor. These sites usually have a fine-textured eolian capping that ranges from shallow (5 cm) to deep (> 50 cm) over-topping rocky soils. The largest areas of grasslands occur on these types of sites in the IDFxx2 on the Tobacco Plains, St. Mary prairie, and Skookumchuck prairie. Grasslands are also moderately common on steep, warm-aspect sites throughout the IDFxx2 and IDFdm2. North of Canal Flats, in the IDFxk and adjacent areas of the IDFdk5, grasslands occur on steep-sloping scarps of glaciolacustrine terraces along Lake Windermere and Columbia Lake, and on level and gently sloping glaciolacustrine and glaciofluvial terraces capped with eolian material.

At higher elevations, grasslands are typically small pocket ecosystems that are restricted to steep, warm-aspect sites. More extensive and widespread higher-elevation grasslands occur within the Elk Valley, where they are often associated with coal deposits. Higher-elevation grasslands also occur in the Flathead valley. Alpine grasslands are uncommon and occur in the ESSF woodland and parkland, and in the IMA where cold-air pooling or growing-season frosts, rather than excessive aridity, prevent tree establishment. In southern British Columbia, these grasslands are dominated by timber oatgrass.

Site-based grassland classification in seral/disturbed site associations
Most grasslands, especially in the IDF, have been disturbed by modern anthropogenic factors, including land clearing, agriculture, recreation, and grazing. Grazing by livestock and wildlife has had particularly widespread effects. Because of the history of disturbance, users are unlikely to encounter later seral grasslands, and will instead find moderately to highly disturbed sites.

The classification of grasslands presented here follows the BEC approach. As described in Chapter 2, site associations are named after the mature plant association that develops on ecologically equivalent sites. Ecologically equivalent sites will have a variety of plant communities that reflect various disturbance histories and seral conditions. Where sites are ecologically equivalent, ecosystems are classified and described as either mature (late seral/climax) or seral (disturbed) within the same site association. For example, the Gg15$2.1 and Gg15$2.5 are seral associations within the Gg15 site association. Both units could occur on the same site (at different times), depending on disturbance history and seral development.

For these reasons, the classification and tools presented here start with site and soil factors: slope, aspect, soil characteristics, drainage, elevation, and insolation.[7] Slope and aspect are important for determining grassland vegetation because they influence how much sunlight, or insolation, a site receives. Insolation drives evaporation and snowmelt and governs the amount of available moisture. In dry, warm environments, gentle slope gradients can have large influences on insolation, and slopes greater than ~ 15% will have an effect on vegetation patterns.[8] In the East Kootenay, soil conditions are also extremely important, particularly on sites at the valley bottom in the Rocky Mountain Trench where rocky soils of glaciofluvial or morainal origin commonly have an eolian capping of variable thickness. The pattern of vegetation, including dominant grasses and presence/absence of conifers is related to both the thickness of the eolian layer and the rockiness of underlying soils. Calcareous soils can also create root-restricting layers, which can limit conifer growth and influence available surface soil moisture. See Chapter 4 for more information on site/soil relationships in the East Kootenay.

7 Site and soil factors are more detailed than SMR/SNR; specific conditions (e.g., different levels of insolation) within the same SMR/SNR can support different grassland site associations because of the physiological preferences of individual grass and forb species.

8 Common slope thresholds for insolation are 15% slope gradients in dry climates, 25% slope gradients in moist climates, and 35% slope gradients in wet climates.

Site and soil information provide the initial premise for determining the correct site association, while vegetation on a given grassland site can be used to confirm the site association (e.g., Gg15), and is particularly important for determining the seral site association (e.g., Gg15$2.2). The steps for classifying grasslands using this field guide are:

(1) identify the biogeoclimatic subzone/ variant	→	(2) determine site/soil conditions	→	(3) identify the site association using site, soil, and vegetation	→	(4) classify the seral or mature plant association using vegetation and disturbance indicators

This approach is particularly helpful in identifying the site association on disturbed sites where the vegetation differs from the later seral/good-condition plant community that would be expected. Knowing the site association is also important for deriving management applications, including range condition, site productivity, forage capability, and restoration potential.

Patterns of vegetation in seral/disturbed site associations

Grazing by wildlife and livestock typically targets the larger, more palatable bunchgrasses, such as rough fescue, Idaho fescue, and bluebunch wheatgrass. This can have important effects on the ecology of grassland ecosystems. Grazing can create drier microclimates by reducing litter and vegetation cover, which can result in higher soil temperatures, increased evaporation, and reduced surface soil moisture availability (Johnston 1962; Johnston et al. 1971; Willms et al. 1986; Willms 1988; Dormaar et al. 1989). Grazing can also cause soil compaction (Dormaar et al. 1989), which further reduces the amount and rate of water infiltration (Johnston 1962). Disturbance also affects the biological soil crust by reducing the cover of mosses and lichens and generally shifting the species composition from foliose and squamulose (or scale) lichens to crust or gelatinous lichens.[9]

Rough fescue, Idaho fescue, and bluebunch wheatgrass can be reduced or eliminated by moderate or heavy grazing (Johnson 1961; Willms et al. 1990; Dormaar and Willms 1998). Data from Alberta grasslands indicate that

[9] Foliose lichens are somewhat leaf-like and are loosely attached to the soil; they most commonly include Peltigera spp. Squamulose (scale) lichens (e.g., Cladonia and Psora spp.) have small, scale-like lobes. Crust lichens (e.g., Diploschistes spp.) are so tightly attached to the soil that they are damaged if removal is attempted. Gelatinous lichens (e.g., Collema spp.) have a single-cell structure and rubbery, jelly-like texture.

Idaho fescue replaces rough fescue on highly grazed circum-mesic sites, and that Idaho fescue is more common on drier sites or in drier climates, likely because it is more drought-tolerant than rough fescue (Willms et al. 1985; Dormaar and Willms 1990; Willoughby and Alexander 2005). Overgrazing and the associated reduction in soil moisture availability also facilitates a shift in species composition from large bunchgrasses to less productive, smaller, and more shallowly rooted native bunchgrasses such as needlegrasses, junegrass, and Sandberg's bluegrass (McLean and Tisdale 1972; Wikeem et al. 2012). Cover of invasive annual bromes such as cheatgrass, rhizomatous grasses such as Canada bluegrass and Kentucky bluegrass, and weedy or invasive forb species also increases. Season of grazing can also negatively affect grassland communities, particularly when sites are grazed too early in spring (McLean and Wikeem 1985). These changes reduce forage productivity and palatability, which has negative consequences for grazing animals.

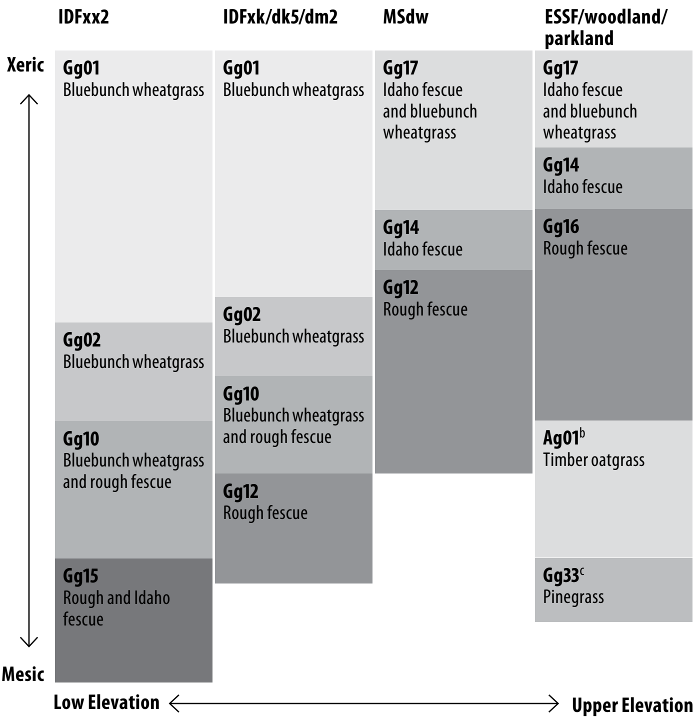
Distribution of grassland (Gg/Ag) site associations by biogeoclimatic unit[a]

	Zone	IDF				MS		ESSF						
Elevation range	**Unit/BGC**	**IDFxx2**	**IDFxk**	**IDFdm2**	**IDFdk5**	**MSdw**	**MSdk**	**ESSFdk1[b]**	**ESSFdkw**	**ESSFdkp**	**ESSFwm1**	**ESSFwmw**	**ESSFwmp**	**IMAun**
Low to mid	**Gg01**	X	X	*	*									
	Gg02	*	*	*	*									
	Gg10	*	*	*	*									
	Gg12		X	X	*	*								
	Gg15	X												
Mid to high	**Gg14**					*	*	X	X	X	*			
	Gg16							*	X	X		*	*	
	Gg17					X		X	*					
	Gg33							*	*					
	Ag01							*	*	*		*	*	*

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

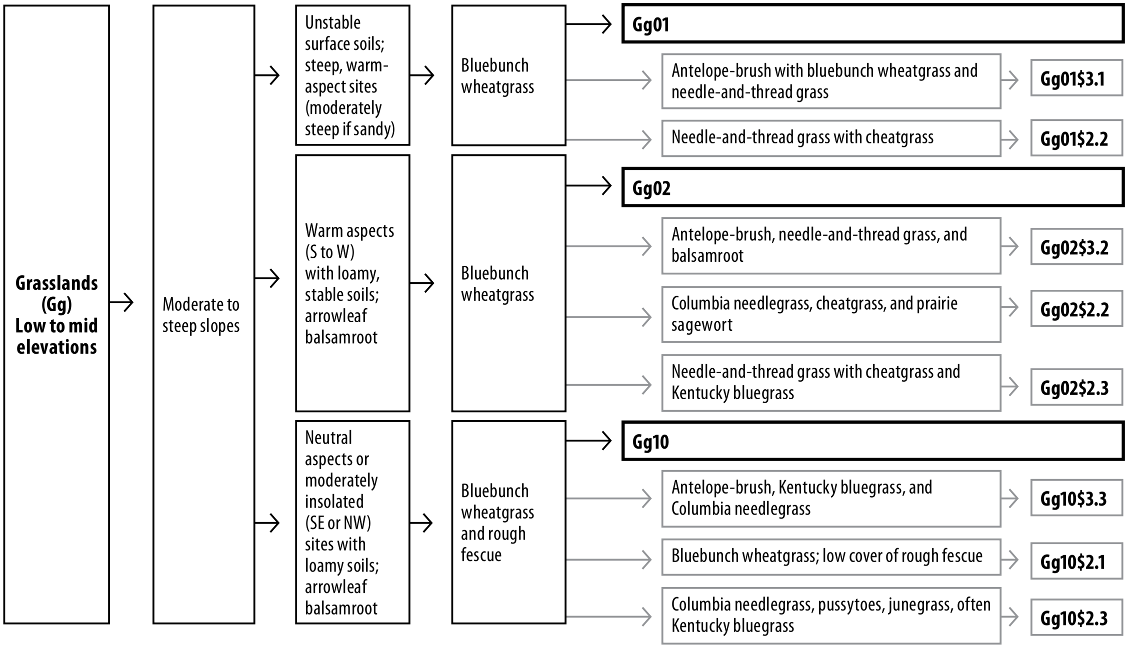
[b] Note that grasslands may occur occasionally in the ESSFdk2, particularly where it is adjacent to the ESSFdk1.

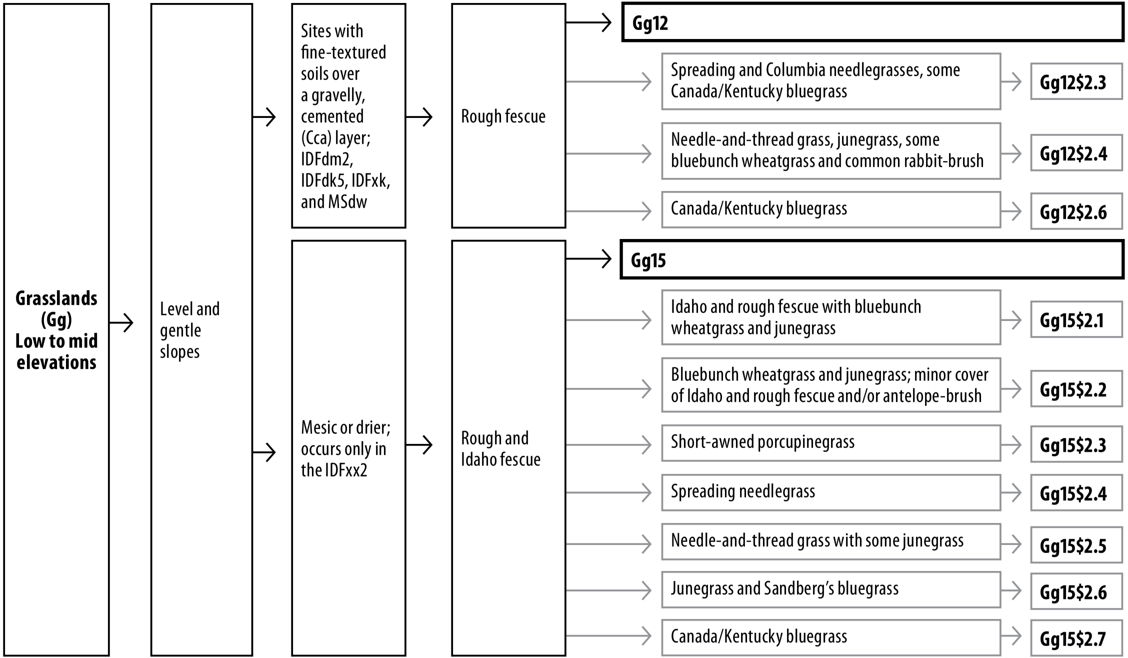
Distribution of grassland site associations and bunchgrasses[a] across biogeoclimatic units and moisture gradients in the East Kootenay



[a] Bunchgrasses that are found in good ecological condition/late seral plant communities.
[b] Can also occur on mesic sites with cold-air pooling.
[c] Occurs on drier sites in forested environments and on snow-accumulating sites in areas with drier grasslands.

Flowchart – Low to mid-elevation grasslands[a,b]





[a] Coding for late seral/good-condition sites is shown in bold font; disturbed/earlier seral/poor-condition sites (i.e., seral associations) are indicated by grey lines and boxes. Vegetation changes with changes in seral stage, but site, soil, and environment conditions do not differ between late seral and early seral plant associations.

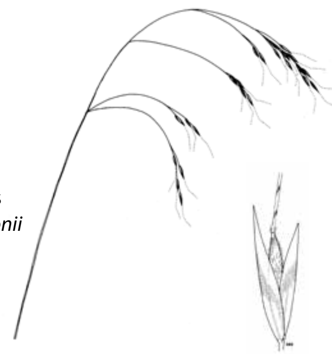
[b] In the hot, dry environments where these grasslands occur, the influence of insolation occurs on less-steep slopes than in moister climates. A gentle slope is typically < 15%; moderate slopes are generally 15–25%; moderately steep is approximately 25%–40%; and steep slopes are > 40%.

Vegetation Table – Low- to mid-elevation grasslands in good condition[a]

Layer	Scientific name	Gg01	Gg02	Gg10	Gg12	Gg15[b]	Common name
Grasses	*Pseudoroegneria spicata*	■■■■■	■■■■■	■■■■	*	□□	bluebunch wheatgrass
	Koeleria macrantha	■■■	■■■	*	■■■	■	junegrass
	Festuca campestris		□	■■■■■	■■■■■	■■■■■	rough fescue
	Festuca idahoensis				*	■■■■	Idaho fescue
	Achnatherum richardsonii				□□□		spreading needlegrass
Other herbs	*Artemisia frigida*	■■■	■■	*			prairie sagewort
	Heterotheca villosa	□	□	□		□	golden-aster
	Boechera retrofracta	□	□				Holboell's rockcress
	Erigeron spp.	□	■	■	*	□	fleabanes/daisies
	Achillea spp.	*	■	■	■■	■	yarrow
	Lithospermum ruderale		■			□	lemonweed
	Balsamorhiza sagittata		■■■	■■			arrowleaf balsamroot
	Antennaria spp.		□		□□		pussytoes
	Lupinus sericeus		*		*	□□□	silky lupine
	Arctostaphylos uva-ursi				□□□		kinnikinnick
	Penstemon confertus				■	■	yellow penstemon
	Calochortus spp.					■	mariposa lilies
	Arnica fulgens					■	orange arnica
Moss layer	"biological soil crust"[c]	■	■■■	■■■	■■■■	■■■■	biological soil crust
	Bryum spp.	*	□	■■	*	■■	thread-mosses
	Syntrichia ruralis	*	□	■	□□□		sidewalk screw-moss
	Cladonia spp.		□□□	□□	■■■■	■■■	clad lichens
	Peltigera spp.		□	□	■■	□	pelt lichens

[a] Data in summaries are from plots within the East Kootenay, except for the Gg02 and Gg10, where plots from southern British Columbia were included.
[b] Includes Gg15a and Gg15b site association phases; plant communities are similar but site conditions differ across site phases.
[c] Biological soil crust includes all moss and lichen species, including crust, scale, and gelatinous species, as well as those shown in this table (see Appendix 1.1).

Bluebunch wheatgrass
Pseudoroegneria spicata



Spreading needlegrass
Achnatherum richardsonii

Junegrass
Koeleria macrantha

Comparative vegetation table for common disturbed grasslands: Gg01, Gg02, and Gg10

Layer	Scientific name	Gg01	Gg01 $3.1	Gg01 $2.2	Gg02	Gg02 $3.2	Gg02 $2.2
Shrubs	*Purshia tridentata*		■■■■	□□	*	■■■	□
Grasses	*Pseudoroegneria spicata*	■■■■	■■■■	□□□	■■■■■	■■■■■	
	Festuca campestris				□		
	Koeleria macrantha	■■■	□□□	*	■■■	■■■	■■
	Hesperostipa comata		■■■	■■■■	*	■■■	
	Bromus spp.[a]		■■	■■■	*	■	■■■
	Achnatherum nelsonii					*	■■■
	Poa compressa/pratensis		■	*		□	

[a] Primarily *Bromus tectorum* (cheatgrass).

Comparative vegetation table for common disturbed grasslands: Gg12 and Gg15[a]

Layer	Scientific name	Gg12	Gg12 $2.3	Gg12 $2.4	Gg12 $2.6	Gg15[b]
Shrubs	*Purshia tridentata*					
	Ericameria nauseosa			□□□		
Grasses	*Festuca campestris*	■■■■■				■■■■■
	Festuca idahoensis		□□			■■■■
	Pseudoroegneria spicata			■■■		□□
	Koeleria macrantha	■■■	■■	■■■■		■
	Hesperostipa curtiseta					
	Achnatherum richardsonii	□□□	■■■■		*	
	Achnatherum nelsonii		■■■		□□	
	Poa compressa/ pratensis		■■■	□□	■■■■	■■
	Hesperostipa comata			■■■■		
	Poa secunda					

[a] Disturbance generally increases and ecological condition declines as the seral association number increases (e.g., Gg15$2.7 is generally more disturbed than Gg15$2.1).
[b] Seral units are most relevant for the Gg15a dry phase. Most disturbed sites for the Gg15b have been converted to cultivated fields.

Gg02 \$2.3	Gg10	Gg10 \$3.3	Gg10 \$2.1	Gg10 \$2.4	Common name
*	■■	■■■■			antelope-brush
	■■■■	■■■■	■■■■	□□	bluebunch wheatgrass
	■■■■■		□□	□	rough fescue
■■■		■■	□□□	■■■	junegrass
■■■■■					needle-and-thread grass
■■■	*	■■	□□	□□	invasive annual bromes
		■■■		■■■■	Columbia needlegrass
■■■		■■■■		□□□	Canada/Kentucky bluegrass

Gg15 \$2.1	Gg15 \$2.2	Gg15 \$2.3	Gg15 \$2.4	Gg15 \$2.5	Gg15 \$2.6	Gg15 \$2.7	Common name
*	□□□	*					antelope-brush
							common rabbit-brush
□□□	□□						rough fescue
□□□□□	□□□	□□□					Idaho fescue
■■■	■■■■				□		bluebunch wheatgrass
■■■	■■■■	■■	□□	■■■	■■■	□□	junegrass
		■■■■■					short-awned porcupinegrass
*			■■■■■				spreading needlegrass
			*			*	Columbia needlegrass
		■	■	□□	*	■■■■■	Canada/Kentucky bluegrass
				■■■■■			needle-and-thread grass
	□□□				□□□□		Sandberg's bluegrass

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

Common grassland site associations and seral associations[a,b,c,d] of low- to mid-elevation grasslands

Unit	Name	Effect of past grazing	Key species
Gg01	**Bluebunch wheatgrass – Prairie sagewort – Junegrass**		
Gg01$3.1	$ Antelope-brush – Bluebunch wheatgrass –Needle-and-thread grass – Cheatgrass	Moderate	Shrub site with bluebunch wheatgrass, needle-and-thread grass, and antelope-brush
Gg01$2.2	$ Needle-and-thread grass – Cheatgrass	High	Needle-and-thread grass more abundant than blue-bunch wheatgrass
Gg02	**Bluebunch wheatgrass – Balsamroot**		
Gg02$3.2	$ Antelope-brush – Bluebunch wheatgrass – Needle-and-thread grass	Moderate	Shrub site with bluebunch wheatgrass , needle-and-thread grass, and arrowleaf balsamroot
Gg02$2.2	$ Columbia needle-grass – Cheatgrass	High	Columbia needlegrass and invasive annual bromes
Gg02$2.3	$ Needle-and-thread grass – Cheatgrass	High	Needle-and-thread grass with little or no bluebunch wheatgrass
Gg10	**Rough fescue – Bluebunch wheatgrass**		
Gg10$3.3	$ Antelope-brush – Saskatoon – Bluebunch wheatgrass – Kentucky bluegrass	Moderate to high	Shrub site with bluebunch wheatgrass and abundant Canada/Kentucky bluegrass with some Columbia needle-grass
Gg10$2.1	$ Bluebunch wheat-grass – Junegrass – Sandberg's bluegrass	Moderate	Bluebunch wheatgrass with few or no fescues
Gg10$2.3	$ Columbia needle-grass – Junegrass	High	Dominated by Columbia needlegrass with junegrass; very few or no fescues

Gg12	**Rough fescue – Yarrow – Junegrass**		
Gg12$2.3	$ Spreading needle-grass – Columbia needlegrass	High	Spreading and Columbia needlegrasses and low cover of fescues
Gg12$2.4	$ Rabbit-brush – Needle-and-thread grass – Junegrass	High	Needle-and-thread grass with low cover of rough fes-cue; often moderate cover bluebunch wheatgrass
Gg12$2.6	$ Canada bluegrass – Dandelion	High	Abundant Canada/Kentucky bluegrass with low cover of rough fescue
Gg15[e]	**Rough fescue – Idaho fescue**		
Gg15$2.1	$ Idaho fescue – Blue-bunch wheatgrass – Yellow salsify	Light	High cover of Idaho fescue with some bluebunch wheatgrass and rough fescue
Gg15$2.2	$ Bluebunch wheat-grass – Junegrass – Sandberg's bluegrass	Moderate	Low to moderate cover of fescues with high cover of bluebunch wheatgrass and junegrass
Gg15$2.3	$ Short-awned porcu-pinegrass – Yarrow	Moderate	High cover of short-awned porcupinegrass and minor cover of fescues
Gg15$2.4	$ Spreading needle-grass – Kentucky bluegrass	High	Spreading needlegrass with minimal fescues
Gg15$2.5	$ Needle-and-thread grass – Junegrass	High	Needle-and-thread grass dominates with minimal fescues
Gg15$2.6	$ Junegrass – Sand-berg's bluegrass – Yellow salsify	High	Sandberg's bluegrass and junegrass dominate with minimal fescues
Gg15$2.7	$ Canada bluegrass – Kentucky bluegrass	High	Abundant Canada/Kentucky bluegrass with minimal fescues

[a] Late seral plant associations are shown in bold.
[b] Coding for disturbed (earlier seral) plant associations is described in Section 6.1.
[c] Not all seral plant communities that are named in British Columbia occur within the guidebook area; some occur in the Thompson–Okanagan or Cariboo grasslands. Only those seral associations that occur in the field guide area are included here. A complete suite of seral units is provided for the Gg15 because it is restricted to the field guide area.
[d] Other seral plant associations occur that have not been named or described here. This includes highy impacted sites dominated by alien invasive species and may include novel plant assemblages.
[e] Seral units are most relevant for the Gg15a dry phase. Most disturbed sites for the Gg15b have been converted to cultivated fields.

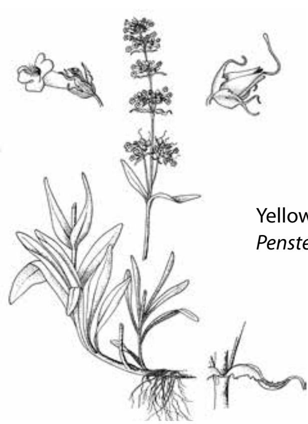
Environment Table – Low- to mid-elevation grasslands[a]

Site association	Gg01	Gg02	Gg10	Gg12	Gg15a	Gg15b
No. of plots	22	X[b]	X[b]	8	6	4
SMR	1–2	2–3	2–3	2–3	2 (3)	(3) 4
SNR	B–D	C–D	C–D	C–D	C–D	D
Slope position	LW–UP	LW–UP (CR)	LW–UP (CR)	LV, LW–UP	LV (LW–UP)	TO, LW, DP
Typical slope/ aspect	Steep/warm	Moderately steep/ warm (S–W)	Moderately steep/SE or NW slopes	Gentle/(cool, neutral)	Gentle/ (neutral)	Gentle or moderate/ (cool)
Common compensating conditions	Moderate slope and insolation where soils are sandy	May have very shallow soils on gentle crests	Gentle crests and gentle slopes with shallow soils	Often very rocky at depth		
Surficial materials	FG, M, LG (E)	Ev, FG, M (LG)	FG, M (C)	Exv/Mb, Ev/FG, FG	Exv/FG, Exv/Mb (FG)	Mb, Exv/Mb
Soil texture	SL (FSL, SiL)	SiL, L (SL, SiL/SL)	SiL, SL (FSL)	FSL, SiL, SL (SiL/SL)	SiL/SL, SiL/LS	SiL, L
Coarse fragment content	Variable	Variable	Variable	Low at surface, moderate to high at depth	Low at surface, high at depth	Low–moderate
Insolation	High	High	Moderate	Low	Low	Low
Important features	Active erosion of surface soil		Neutral/ slightly warm sites	Gentle sites in IDFxk, IDFdm2, IDFdk5, and (MSdw); strong Cca layer	IDFxx2 only; gravelly soils and strong Cca layer	IDFxx2 only

[a] Codes and categories are in Chapter 3. Keys for use in the field are in the appendices.
[b] Data in summaries are from plots within the East Kootenay, except for the Gg02 and Gg10, where plots from southern British Columbia were added.

Flowchart – Mid- to high-elevation grasslands

Grasslands (Gg) and Alpine grasslands (Ag) Mid to high elevations →	Idaho fescue →	Windswept slopes on moderately steep S and SW or steep SE aspects; loamy surface soils, often rockier at depth →	**Gg14**
→	Rough fescue →	Moderately steep–steep, warm aspects; nutrient-rich, rocky soils with loamy textures →	**Gg16**
→	Idaho fescue and bluebunch wheatgrass →	Windswept, warm-aspect sites on very dry, rocky soils; often with surface erosion; driest of the mid- to high-elevation grasslands →	**Gg17**
→	Pinegrass →	Usually neutral to warm, moderately steep–steep; typically occurs in small pockets in ESSFdk1 and dkw forests or patches within drier grasslands →	**Gg33**
→	Timber oatgrass →	Shallow soils, warm to neutral upper slopes in the IMA and cold-air sites in the ESSF →	**Ag01**



Yellow penstemon
Penstemon confertus

Vegetation Table – Mid- to high-elevation grasslands[a,b]

Layer	Scientific name	Gg14	Gg16	Gg17	Gg33	Ag01	Common name
Shrubs	*Juniperus communis*				■■		common juniper
Grasses	*Festuca idahoensis*	■■■■		■■■■	□□		Idaho fescue
	Festuca campestris		■■■■				rough fescue
	Pseudoroegneria spicata			■■■■			bluebunch wheatgrass
	Calamagrostis rubescens				■■■■■		pinegrass
	Danthonia intermedia				*	■■■■■	timber oatgrass
Other herbs	*Eriogonum umbellatum*	■■	■■■	■■	■■		sulphur buckwheat
	Eremogone capillaris	■■	■■■	□□	*	□□□	thread-leaved sandwort
	Fragaria spp.	■■	□□□		■■■	□□	strawberry
	Achillea spp.	■■	■■	■■	□□	■■	yarrow
	Antennaria spp.	■■	□□	■■		■■■	pussytoes
	Lupinus sericeus	□□□	□□	□□□			silky lupine
	Penstemon confertus	□□	□□	□	■■		yellow penstemon
	Erigeron spp.	□□	□	*			fleabanes/daisies
	Campanula rotundifolia	□		□			common harebell
	Sedum lanceolatum	□	□	□		□	lance-leaved stonecrop
	Potentilla glaucophylla	*	■■				diverse-leaved cinquefoil
	Heuchera cylindrica	*	□	□	□		round-leaved alumroot
	Carex phaeocephala		□□				dunhead sedge
	Selaginella spp.		□□	*		■■■	selaginellas
	Vaccinium scoparium/myrtillus					■■■	grouseberry/low bilberry
Moss layer	*Peltigera* spp.	□	□			□□	pelt lichens
	Cladonia spp.	□□	*			□□	clad lichens
	Syntrichia ruralis	□□		*			sidewalk screw-moss

[a] Based on field data from the East Kootenay.
[b] ESSF, woodland, parkland, IMA, and some MS.

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 – Mid- to high-elevation grasslands[a]

Site association	Gg14	Gg16	Gg17	Gg33	Ag01
No. of plots	28	45	17	5	10
SMR	(1) 2	2–3	1 (2)	3–4	1–2 (3–4)
SNR	C–D	D–E	C–D	C–D	B–D
Slope position	MD (UP, CR)	UP (MD, CR)	MD–UP (CR)	MD–UP, LV	MD–UP
Typical slope/ aspect	Moderately steep–steep/ warm	Moderately steep–steep/ warm	Moderately steep–steep/ warm	Moderately steep–steep/ neutral–warm	Moderately steep–steep/ warm–neutral
Common compensating conditions	Gentle upper slopes with shallow soils	Neutral aspect crests			Depressions with cold air
Surficial materials	Cvb (Ex/Cv)	Ex/Mv (Ev/Cv, Mv)	Cvb, Ex/Mv, Ex/Cv	Mb, Cv	Cv, Mv
Soil texture	SiL (SL, FSL)	SiL (SL)	SiL (FSL, SL)	L, SiL (SL, FSL)	SiL (FSL)
Coarse fragment content	Moderate–high at depth	High, especially 30 cm and below	High at surface and high–very high at depth	Variable	Moderate–high
Insolation	High	High	High	Moderate	Moderate (low)
Important features	Windswept slopes; rockier soils at depth	Rich sites; can be associated with coal deposits; rocky soils	Windswept slopes; very dry, rocky soils, often with surface erosion	Often small openings in forests or patches in drier grasslands; ESSF and woodland	Shallow soils; sites where a cold climate is responsible for grassland presence

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

Gg01 Bluebunch wheatgrass – Prairie sagewort – Junegrass

General Description

The Gg01 is the most common and widespread grassland at lower elevations in the Rocky Mountain Trench. It typically occurs where surface soils are unstable and prone to erosion, and It is most common on **steep** (> 45%), **warm-aspect** slopes with loamy soil textures and moderate to high coarse fragment content. It also occurs on moderate, warm-aspect slopes (20–35%) with sandy soils in the IDFxx2. The Gg01 occurs in both grassland-dominated areas and as pocket grasslands in forested areas.

Vegetation is dominated by widely spaced **bluebunch wheatgrass** with low cover of junegrass, prairie sagewort, and **scattered forbs with low cover**, including fuzzy-tongued penstemon (*Penstemon eriantherus)*, golden-aster, and Holboell's rockcress. The biological soil crust is poorly developed and is dominated by low cover of gelatinous, crust, and scale lichens and mosses, with little or no cover of clad lichens. Overall cover and diversity of all species is typically low on these sites because of the droughty conditions and unstable surface soils.

Differentiating from Other Site Associations

The Gg01 differs from other grasslands by occurring on steep, warm-aspect slopes with unstable surface soils. The Gg02 and Gg10 also have abundant bluebunch wheatgrass, but those site associations occur where surface soils are stable, and in later seral stages, they have abundant arrowleaf balsamroot, fescues (Gg10), and greater diversity and cover of forbs.

Variability

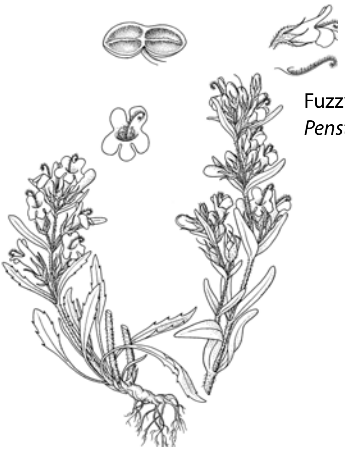
On sites south of Canal Flats, there is often low cover of antelope-brush. Common rabbit-brush and needle-and-thread grass frequently occur in the IDFxk and IDFdk5; Rocky Mountain juniper is commonly scattered in the IDFdm2 and IDFdk5. The cover of the biological soil crust is highest (up to 30%) on sites with glaciolacustrine soils in the IDFxk.

Vegetation Patterns with Grazing and Disturbance

The Gg01 is the only low-elevation grassland site association in the field guide area where ecosystems in good condition are common because these steep sites are less accessible to cattle, wildlife, and recreational vehicles. Where overgrazing occurs, bluebunch wheatgrass cover declines and the cover of needle-and-thread grass (**Gg01$2.2**) and antelope-brush (in the IDFxx2 and IDFdm2) (**Gg01$3.2**) increases. In the **Gg01$2.2**, Canada or Kentucky bluegrass is occasionally dominant; sand dropseed can increase with overgrazing where soils are sandy. Invasive annual bromes such as cheatgrass commonly become established on disturbed sites in the IDFxx2 and IDFdm2.[10]

Management Issues

Soils are sensitive to erosion, and the biological soil crust is easily damaged. Both can be highly disturbed by recreation activities and grazing animals. Insolation causes these sites to lose snow cover more quickly and grass growth to resume earlier in spring; productivity may be reduced on these sites if they are grazed too early in the growing season.



Fuzzy-tongued penstemon
Penstemon eriantherus

Holboell's rockcress
Boechera retrofracta

[10] Seral site associations have not been described for plant communities dominated by cheatgrass and other invasive species. These sites can be coded using the more general Gg01$ coding.

General Description

The Gg02 is a common and widespread grassland ecosystem at lower elevations in the Rocky Mountain Trench and across the southern interior of British Columbia. It occurs on **moderately steep** (20–45%), **warm-aspect** (S to W) slopes, and occasionally on gentler crests where soils are shallow. Soils are stable with loamy textures and moderate to high amounts of coarse fragments.

Late seral vegetation is dominated by vigorous **bluebunch wheatgrass** with variable cover of **arrowleaf balsamroot**, Sandberg's bluegrass, and junegrass. Many other forbs occur with low cover, including yarrow, pussytoes, prairie sagewort, fleabanes, desert-parsley (*Lomatium* spp.), yellow salsify, lemonweed, and golden-aster. Minor cover (< 1%) of fescues often occurs. Scattered shrubs are common and often include roses and saskatoon. The biological soil crust is moderately developed with scattered clad lichens, and minor cover of sidewalk screw-moss, pelt lichens, and gelatinous and crust lichens.

Differentiating from Other Site Associations

The Gg01 occurs on steeper slopes or sandier soils, has lower vegetation productivity, lacks arrowleaf balsamroot, and has unstable surface soils. The Gg10 occurs on cooler aspects (SE and NW) and has abundant rough fescue, especially on mature, undisturbed sites. The Gs12 occurs on similarly steep, warm-aspect slopes but has very rocky soils and abundant shrub cover.

Variability

Low cover of dryland shrubs frequently occurs and includes common rabbitbrush in the IDFxk and IDFdk5 and antelope-brush in the IDFdm2 and IDFxx2. Forb diversity is generally high, with many species with low covers.

Vegetation Patterns with Grazing and Disturbance

Sites in good ecological condition are uncommon because bluebunch wheatgrass is highly palatable to livestock and wildlife. Overgrazing also reduces the cover of arrowleaf balsamroot and increases the cover of smaller, more shallow-rooted and drought-tolerant native grasses, including Columbia needlegrass (Gg02$2.2) and needle-and-thread grass (Gg02$2.3). Canada and/or Kentucky bluegrass can occur in the Gg02$2.3. Invasive annual bromes such as cheatgrass are common on disturbed sites in the IDFxx2 and IDFdm2; cover of antelope-brush also increases with overgrazing in these variants (Gg02$3.2).

Management Issues

The moderately steep conditions where Gg02 sites are found do not deter livestock access. Spring growth starts early on these sites, and productivity may be reduced if the sites are grazed too soon. Biological soil crusts that are important for stabilizing soils on these sites are also sensitive to disturbance.

General Description

The Gg10 occurs on **moderately sloping**, slightly warm-aspect (**SE or NW**) **slopes** or shallow, **gentle crests**. It is uncommon across the IDFxx2, IDFdm2, IDFxk, and IDFdk5. Soils are stable, loamy, or coarse loamy, and have moderate to high amounts of coarse fragments.

Late seral vegetation is dominated by high cover of **bluebunch wheatgrass**, **rough fescue**, and **arrowleaf balsamroot**. Forb species occur with low cover, and typically include yarrow, golden-aster, yellow salsify, and fleabanes. Low cover of widely scattered dryland shrubs often occurs, including antelope-brush, saskatoon, and/or Rocky Mountain juniper. On good-condition sites, thick cover of bunchgrasses limits the cover of mosses and lichens.

Differentiating from Other Site Associations

The Gg10 is the only grassland in the East Kootenay IDF that occurs on neutral to slightly warm-aspect (SE or NW) slopes. The Gg02 also has bluebunch wheatgrass, but occurs on warmer-aspect slopes (S–W) and has little or no rough fescue on good-condition sites. The Gg12 occurs on cooler and/or gentler sites, and has little or no bluebunch wheatgrass on good-condition sites.

Variability

In the IDFxk and IDFdk5, Rocky Mountain juniper and common rabbit-brush are often scattered at low densities; antelope-brush and saskatoon are common in the IDFdm2 and IDFxx2.

Vegetation Patterns with Grazing and Disturbance

Sites in good condition are uncommon. Grazing leads to declines in rough fescue cover and initial increases in bluebunch wheatgrass vigour (Gg10$2.1). Longer-term overgrazing eliminates rough fescue and reduces the cover of bluebunch wheatgrass and arrowleaf balsamroot. These grasses are replaced by smaller, more drought-tolerant species such as Columbia needlegrass, pussytoes, and junegrass, and sometimes Kentucky bluegrass (Gg10$2.3); in the IDFxx2 and IDFdm2, antelope-brush can increase to more than 10% cover (Gg10$3.3). Grazed sites often appear to be similar to the Gg02, with little or no rough fescue, but are most easily differentiated by the Gg10 being restricted to neutral or slightly warm (SE, NW) aspects.

Management Issues

Sites in good condition have high forage value. The moderately sloping conditions where Gg10 sites are found make them easily accessible to livestock. Spring growth starts early on these sites, and productivity may be reduced if the sites are grazed too soon. Fescues are desirable species for grazing animals and are easily eliminated from these sites with overgrazing.

General Description

In the East Kootenay, the Gg12 typically occurs on **level and gently sloping sites** in the IDFxk, IDFdm2, IDFdk5, and occasionally in the MSdw, particularly in the Flathead valley. It can also occur on moderately sloping, cool- or neutral-aspect sites with thin soils. Soils typically have a thin loamy, eolian veneer overlying very gravelly soils, often with a cemented calcareous (Cca) layer. The Gg12 is most common along level areas and terraces adjacent to streams and rivers, particularly the Kootenay River, and on terraces above Columbia Lake.

Late seral vegetation is dominated by abundant **rough fescue** with spreading needlegrass, junegrass, and diverse scattered forbs such as pussytoes, yarrow, nodding onion, and yellow penstemon; **kinnikinnick** is sometimes present and can be abundant. Scattered rose and saskatoon are common. The biological soil crust is moderately well developed and dominated by clad lichens, sidewalk screw-moss, and pelt lichens.

Differentiating from Other Site Associations

The Gg12 is the only grassland site association that occurs on dry, level to gently sloping sites in the IDFxk, IDFdm2, and IDFdk5; the Gg15 occurs on similar sites in the IDFxx2. Overgrazed Gg12 sites can have Idaho fescue and similar disturbed vegetation patterns as the Gg15 unit, but do not occur in the IDFxx2. Gg10 sites occur on sloping sites, and both rough fescue and bluebunch wheatgrass occur on good-condition sites. Rough fescue–dominated grasslands (Gg16) in the MS and ESSF have thread-leaved sandwort and abundant sulphur buckwheat.

Variability

In the MSdw and upper elevations of the IDF, small amounts of selaginella, sulphur buckwheat, and old man's whiskers can occur.

Vegetation Patterns with Grazing and Disturbance

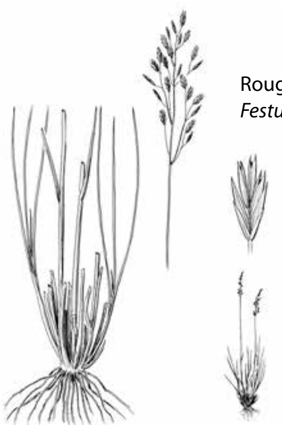
Sites in good condition are very uncommon and the few remaining sites are still subject to wildlife and livestock grazing. Overgrazed sites are commonly dominated by spreading needlegrass and/or Columbia needlegrass with

[11] The Gg12 has two site association variations. The Gg12.1 *Rough fescue – Yarrow – Old man's whiskers* occurs in the Boundary–Okanagan. This variation, Gg12.2 *Rough fescue – Yarrow – Junegrass*, occurs only in the East Kootenay. All references to the Gg12 in this field guide describe the Gg12.2.

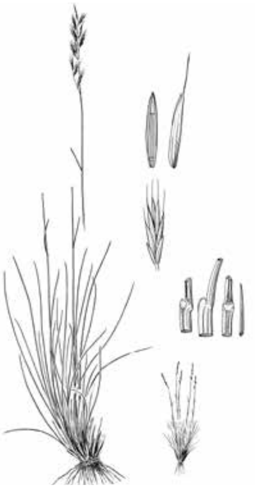
some Idaho fescue (Gg12$2.3), or are dominated by junegrass, needle-and-thread grass, and bluebunch wheatgrass (Gg12$2.4). Other overgrazed sites are dominated by Kentucky and/or Canada bluegrass (Gg12$2.6). Extremely disturbed sites, some of which may have been seeded, are dominated by a variety of non-native and agronomic species, including alfalfa, crested wheatgrass, black medic, and smooth brome. On distributed sites, the biological soil crust often shifts from clad and pelt lichens to scale, gelatinous, and crust lichens.

Management Issues

These sites receive low insolation, which makes them moister and more vulnerable to forest encroachment. Cooler-aspect slopes are likely more productive and recover from grazing more quickly than level sites.



Rough fescue
Festuca campestris



Idaho fescue
Festuca idahoensis

General Description

The Gg14 site association occurs on **middle and upper slopes** at high elevations that are often **windswept**. **Insolation** is prominent, and sites are restricted to moderately steep, warm-aspect (S to W) or steep to very steep, moderately warm (SE) sites. Gg14 sites occasionally occur on very shallow, gentle upper slopes. Soils are loamy and often rocky below 20–30 cm depth. The Gg14 is the most common grassland site association in the Flathead valley. In the Elk Valley, it commonly occurs as smaller, drier patches within the Gg16-dominated areas. It is uncommon elsewhere in the region.

Vegetation is dominated by **Idaho fescue** with scattered forbs, including sulphur buckwheat, thread-leaved sandwort, yarrow, wild strawberry, and pussytoes, and often includes silky lupine, yellow penstemon, fleabanes, and common harebell. Grasses and forbs dominate most of the site, resulting in low cover of mosses, lichens, and exposed mineral soil. Common moss and lichen species are sidewalk screw-moss, clad lichens, and pelt lichens.

Differentiating from Other Site Associations

The Gg12 and Gg16 occur across the same geographic areas but are differentiated by the dominance of rough fescue. The Gg14 is similar to the Gg17, and they often occur on adjacent sites. The Gg17 occurs on slightly drier (often rockier) sites than the Gg14, and has significant cover of bluebunch wheatgrass with Idaho fescue and overall lower vegetation cover. Where they occur adjacent to each other, the Gg14 occurs on slightly cooler aspects or gentler slopes. In the MSdw, the climate is warmer, and the Gg17 is more common on steep, warm aspects, while the Gg14 occurs on moderate, neutral (SE) aspects.

Variability

The Gg14 occurs in the ESSFdk1, ESSFdkw, and ESSFdkp, and occasionally in the MSdw and ESSFwm1. Silky lupine commonly occurs in the ESSFdkw but only infrequently in other subzones. In the warmer climate of the MSdw, the Gg14 occurs on moderately steep (30%) southeast aspects but not on steep, south to west aspects.

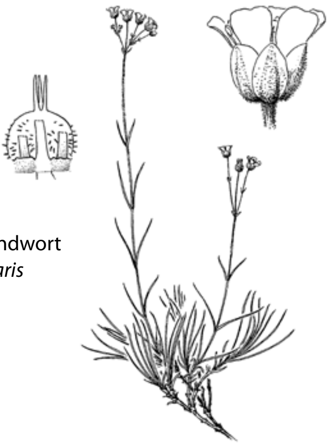
Vegetation Patterns with Grazing and Disturbance

Livestock grazing is uncommon in the areas where this site association occurs. No data are available for describing poor-condition sites, although with overgrazing, cover of Idaho fescue likely declines, and timber oatgrass, forbs, invasive plant species, and exposed soil increase.

Management Issues

These grasslands provide landscape heterogeneity for biodiversity as well as critical habitat for Rocky Mountain bighorn sheep, particularly in the Flathead valley where this is the most common Gg unit.

Common harebell
Campanula rotundifolia



Thread-leaved sandwort
Eremogone capillaris

General Description

The Gg15 is limited to the bottomlands of the southern Rocky Mountain Trench in the **IDFxx2**, where it is common and widespread on **level and gently sloping sites**. It occurs as both openings in forests with scattered trees (< 10% cover) and in extensive grassland areas. Two phases are described below.

Rough fescue dominates on sites in good condition, often with **Idaho fescue**, and usually with **minor cover of bluebunch wheatgrass** and **junegrass**. Common forbs, all with low cover, include pussytoes, orange arnica, yarrow, golden-aster, mariposa lilies, fleabanes, yellow penstemon, and desert-parsley. The biological soil crust is variable in cover, and may be uncommon on later seral sites where thick litter prevents its development.

Differentiating from Other Site Associations

The Gg12 is similar but typically lacks Idaho fescue. It occurs on similar sites in the IDFxk, IDFdm2, and IDFdk5 but does not occur in the IDFxx2. The Gg16 is also rough fescue–dominated but occurs on warm-aspect slopes in the ESSF. The Gs13 occurs in the IDFxx2 and has antelope-brush and prairie sandgrass, and it occurs on warm-aspect sites where soils are sandy and lack coarse fragments.

Variability

Two phases are recognized in this site association:

Gg15a dry phase occurs on subxeric sites, either with a finer-textured cap at the surface (10–30 cm deep) over sandy, gravelly soils, or, occasionally, on sites with deep, sandy soils. These sites are less productive than the mesic phase, and usually have more mosses and lichens.

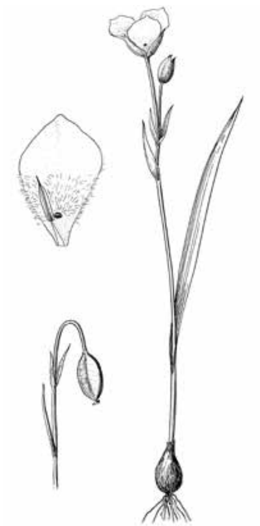
Gg15b mesic phase occurs on sites with loamy soils and low to moderate coarse fragment content; silky lupine is also more common and abundant on these sites. More shaded sites, such as small grassland openings in forested areas, may be dominatd by rough fescue without Idaho fescue.

Vegetation Patterns with Grazing and Disturbance

Most Gg15b sites have been converted to cultivated fields, and for the Gg15a, there are few sites in good range condition. With some grazing, Idaho fescue typically increases over rough fescue (Gg15$2.1). Overgrazing shifts species dominance to bluebunch wheatgrass and junegrass, with antelope-brush on some sites (Gg15$2.2), and then to medium-sized native bunchgrasses such as porcupine grass (Gg15$2.3) or spreading needlegrass, sometimes with Columbia needlegrass (Gg15$2.4). Poor-condition sites are dominated by small, drought-tolerant bunchgrasses such as junegrass with needle-and-threadgrass (Gg15$2.5), or junegrass with or without Sandberg's bluegrass (Gg15$2.6). Canada bluegrass and Kentucky bluegrass can also dominate highly disturbed sites (Gg15$2.7). Overgrazing disturbance also reduces moss and lichen cover, particularly clad lichens, and shifts lichen cover to mostly gelatinous, scale, and crust lichens.

Management Issues

Sites are easily accessible and are vulnerable to disturbance from off-road recreation vehicles, overgrazing, forest encroachment, and conversion to agriculture and human settlement. Many of the Gg15b (mesic phase) sites have been converted to cultivated fields. Sites recover slowly from overgrazing, especially the less productive Gg15a (dry phase). Managing for better range conditions will improve native grass productivity over the long term. Sites may require prescribed burning to prevent tree encroachment.



Three-spot mariposa lily
Calochortus apiculatus

Golden-aster
Heterotheca villosa

General Description

The Gg16 site association occurs on **moderately steep to steep**, **warm, upper and middle** slopes. It is most common in the upper ESSF, especially in the Elk Valley. Soils are loamy, moderately shallow, and have high coarse fragment content at depth. They are non-calcareous but nutrient-rich. Sites have low to moderate cover of exposed mineral soil. This grassland site association is often linked to areas with coal deposits.

Late seral vegetation is dominated by **rough fescue**, although cover varies from moderate to high (15–45%). Forbs are abundant and diverse, with sulphur buckwheat, thread-leaved sandwort, wild strawberry, pussytoes, yarrow, yellow penstemon, and diverse-leaved cinquefoil commonly present. The moss and lichen layer is poorly developed with low cover of sidewalk screw-moss, clad lichens, and pelt lichens.

Differentiating from Other Site Associations

The Gg12 and Gg15 are both dominated by rough fescue when in good condition but lack thread-leaved sandwort and sulphur buckwheat, and occur at lower elevations than the Gg16. The Gg17 occurs at similar elevations but is dominated by Idaho fescue and bluebunch wheatgrass, and occurs on drier, more windswept sites, and on less nutrient-rich soils. Vegetation in the Gg16 is also very similar to the Vh12 avalanche site association, but the Vh12 occurs in avalanche tracks and run-out zones that are surrounded by forest. The Gg16 can also occur in the initiation zones of avalanche paths.

Variability

Cover and productivity of rough fescue and forbs are lower on steeper slopes and sites with thinner soils. Silky lupine is sometimes abundant, especially in the ESSF and woodland, and is usually absent in the parkland. Wild strawberry, diverse-leaved cinquefoil, and dunhead sedge are all more common at higher elevations in the woodland and parkland.

Vegetation Patterns with Grazing and Disturbance

Areas with more intensive grazing experience a shift in dominance from rough fescue to Idaho fescue. As such, seral sites may resemble the Gg14 site association, but differ in that Gg14 sites occur on drier, more windswept locations. Disturbed Gg16 sites will also have exposed mineral soil, evidence of grazed bunchgrasses, and presence of weedy native and/or non-native plant species. Sites with few or no rocks in the upper soil (eolian materials) often have disturbance from small-mammal digging.

Management Issues

Gg16 sites provide very nutritious forage for grazing ungulates, including Rocky Mountain bighorn sheep and elk. Many Gg16 sites occur in the Elk Valley in areas with coal mining and associated infrastructure.

General Description

The Gg17 site association occurs on **moderate to steep, middle and upper slopes** on **warm aspects** (SE to NW) and are **often windswept**. It occurs in the MSdw, ESSFdk1, and ESSFdkw, especially in the Flathead valley, and commonly as smaller, drier patches in Gg16-dominated areas in the Elk Valley. Soils are loamy, often with a thin eolian capping, and are usually very rocky below a depth of 20–30 cm. Surface soils are often actively eroding, and exposed mineral soil has low to moderate cover.

Late seral vegetation is dominated by **bluebunch wheatgrass** and **Idaho fescue** with scattered forbs, including sulphur buckwheat, yarrow, pussytoes, and often silky lupine, fleabanes, and thread-leaved sandwort. There is low cover of mosses and lichens such as clad lichens, pelt lichens, and sidewalk screw-moss.

Differentiating from Other Site Associations

The Gg17 is similar to the Gg14, and they often occur on adjacent sites. The Gg17 differs in that it occurs on slightly drier, warmer, steeper sites than the Gg14 and has high cover of bluebunch wheatgrass with Idado fescue and lower overall vegetation cover and diversity. In the MSdw, the Gg17 is more common, and the Gg14 is restricted to steep, warm-aspect sites. The Gg12 and Gg16 occur across the same geographic areas but are dominated by rough fescue.

Variability

Total cover of Idaho fescue is lower on warmer-aspect (SW) sites where more bluebunch wheatgrass, saskatoon, arrow-leaved balsamroot, and lance-leaved stonecrop are typically present. South and southeast aspects have more yarrow, pussytoes, and sulphur buckwheat; thread-leaved sandwort is most common on southeast aspects. In the ESSF and woodland, yellow penstemon and silky lupine usually occur, while sticky cinquefoil occurs only in the MS.

Vegetation Patterns with Grazing and Disturbance

Overgrazing shifts vegetation composition from Idaho fescue to bluebunch wheatgrass. Overall vegetation cover and productivity also declines. Cover of exposed mineral soil increases with disturbance from grazing animals.

Management Issues

The Gg17 provides important habitat for ungulates, especially in the MSdw, where it is the only grassland commonly occurring on warm aspects.

Other High-elevation and Alpine Grasslands

Gg33 Pinegrass – Yellow penstemon

The Gg33 site association occurs in the ESSFdkw and ESSFdk1. In forested areas, it occurs as small (< 1 ha) patches on moderately steep, shallow, coarse-textured soils on warm to neutral aspects. It occasionally occurs on gentler sites with very coarse or shallow soils. In larger grassland complexes, the Gg33 occurs in moister swales and snow-accumulating sites. The Gg33 is most common in the Elk Valley, but also occurs at high elevations in the East Kootenay (e.g., McGillvary Range) and is uncommon elsewhere. The vegetation is dominated by **pinegrass**, often with some Idaho fescue. Pinegrass is common on all sites, but forb composition is highly variable from site to site, and often includes wild strawberry, yellow penstemon, and sulphur buckwheat. Scattered common juniper and roses are frequently present. Pinegrass provides less desirable forage than fescue-dominated grasslands, and pinegrass-dominated sites are unlikely to be heavily used by grazing animals.

Ag01 Timber oatgrass – Grouseberry – Sandwort

The Ag01 occurs on neutral to warm, moderate to steep, upper slopes in alpine, parkland, and woodland subzones, and in gentle depressions where cold air accumulates. Soils are typically medium- to coarse-textured, shallow morainal and colluvial materials. Vegetation has high cover in the herb layer and is dominated by timber oatgrass with selaginellas (*Selaginella* spp.). Grouseberry and/or low bilberry, thread-leaved sandwort, and pussytoes commonly occur with low to moderate cover. The moss layer is highly variable, with pelt lichens, haircap mosses, and clad lichens occurring most commonly. Cold, gentle, depression sites tend to have more wild strawberry and sibbaldia (*Sibbaldia procumbens*); dry slopes have more thread-leaved sandwort, sulphur buckwheat, and selaginellas. Ag01 sites can be important ungulate winter ranges, as forage is available on the windswept ridges. The Ag01 is uncommon in the IMAun, ESSFdkp, and dkw, and occurs very infrequently in the ESSFwmw and wmp.

Brushland Class (Gb)

Brushland ecosystems occur in dry to moist climates on warm, dry, insolated sites where shrubs persist because tree growth is restricted by dry conditions. These ecosystems typically occur on sites with rockier and shallower soils than those of grassland sites. Typical dryland shrubs on these sites in the East Kootenay include common juniper, Rocky Mountain juniper, snowberry, saskatoon, soopolallie, and roses. Brushlands occur in the IDF, MS, and ESSF, including the woodland and occasionally the parkland. In contrast, shrub-steppe (Gs) sites are limited to very hot, dry climates and are dominated by desert-adapted shrub species such as big sagebrush (*Artemisia tridentata*) and antelope-brush. Similarly, brushlands do not occur at high elevations where cold air limits tree growth or in wet climates. Shrub-dominated ecosystems that persist under those conditions are reflecting site factors other than dry sites and climates, and are not considered to be brushlands.[12] Four brushland site associations are described for the field guide area.

Brushland sites often occur adjacent to grasslands, rock outcrops, and dry forests. They differ from grasslands by the prominence of shrubs, even where those shrubs are small in stature (e.g., stunted bushes). Grasses and/or forbs are often abundant on brushland sites. 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. Brushlands provide browse for elk and deer, and important cover and nesting sites for birds and small mammals.

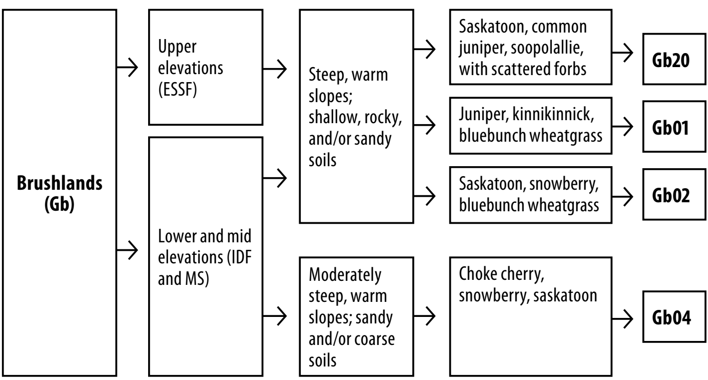
[12] At higher elevations on frost-prone, cold-air accumulating sites, subalpine shrubland ecosystems (Sc-b) dominated by high-elevation dry-site shrub species, and shrub carr ecosystems (Sc-c) dominated by willows (*Salix* spp.) or scrub birch (*Betula nana*) may also occur, and are described briefly in Section 6.7. Ecosystems dominated by moist shrub species such as alders (*Alnus* spp.), white-flowered rhododendron (*Rhododendron albiflorum*), and thimbleberry (*Rubus parviflorus*) are part of the disclimax shrub group (Xv-s) (See Section 6.1) (MacKenzie 2012).

Distribution of brushland (Gb) site associations by biogeoclimatic unit[a]

Zone	IDF				MS		ESSF			
Unit/BGC	IDFxx2	IDFxk	IDFdk5	IDFdm2	MSdw	MSdk	ESSFdk1	ESSFdk2	ESSFdkw	ESSFwm1
Gb01		*	*		*	*				
Gb02				*						
Gb04	*			*	*					
Gb20							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	Gb01	Gb02	Gb04	Gb20	Common name
	Number of plots	8[a]	8[a]	5[a]	13	
Shrubs	*Juniperus communis*	■■■			■■■	common juniper
	Amelanchier alnifolia	■■■	■■■	□□□	■■■	saskatoon
	Rosa acicularis	■■	*		□	prickly rose
	Juniperus scopulorum	□□	*			Rocky Mountain juniper
	Shepherdia canadensis	□□			■■■	soopolallie
	Symphoricarpos spp.	*	■■■■	■■■■■		snowberry
	Prunus virginiana			■■■		choke cherry
	Rosa nutkana			□□		Nootka rose
	Spiraea lucida				■■	birch-leaved spirea
Grasses	*Pseudoroegneria spicata*	■■■■	■■■■	■■		bluebunch wheatgrass
	Calamagrostis rubescens				□□□	pinegrass
Forbs	*Arctostaphylos uva-ursi*	■■■	□		□□□	kinnikinnick
	Balsamorhiza sagittata	□□□	*	□		arrowleaf balsamroot
	Achillea spp.	■	■	■	■■■	yarrow
	Fragaria spp.	■	□	■	■■	strawberry
	Penstemon spp.	□	*		■■■	penstemons
	Lomatium spp.		■■			desert parsley
	Allium cernuum	□			■	nodding onion
	Lupinus sericeus		*	■■		silky lupine
	Eriogonum umbellatum				□□	sulphur buckwheat

[a] Includes plots from other areas of southern British Columbia.

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

Gb01 Juniper – Kinnikinnick – Bluebunch wheatgrass

The Gb01 occurs infrequently on steep, warm slopes with shallow, rocky or sandy soils. This moderately shrubby brushland association is dominated by common juniper, roses, and often saskatoon. In the field guide area, Rocky Mountain juniper is also common. The forb layer is dominated by bluebunch wheatgrass and kinnikinnick, and often has scattered dryland species such as arrowleaf balsamroot, Holboell's rockcress, shrubby penstemon (*Penstemon fruticosus*), nodding onion, and yarrow. Invasive alien plants such as knapweeds, St. John's-wort, cheatgrass, and non-native hawkweeds colonize disturbed sites. The Gb01 is uncommon in the IDFdk5, IDFxk, MSdw, and MSdk, and may occur in other subzones and variants in the East Kootenay.

Gb02 Saskatoon – Snowberry – Bluebunch wheatgrass
The Gb02 occurs infrequently on steep, warm slopes with coarse-textured and rocky soils. This moderately shrubby brushland association is dominated by saskatoon and snowberry. In the East Kootenay, the shrub layer often includes minor cover of antelope-brush. The herb layer has relatively low cover and is characterized by bluebunch wheatgrass with scattered dryland species, including junegrass, kinnikinnick, desert parsley, and yarrow. Following grazing disturbance, invasive annual bromes such as cheatgrass, and other invasive alien plant species establish and spread on these sites. The Gb02 occurs in the IDFdm2 and may occur elsewhere in the IDF. The Gs12 has similar species but is dominated by antelope-brush.

Gb04 Choke cherry – Snowberry – Bluebunch wheatgrass
The Gb04 occurs infrequently on moderate to steep, warm aspects with coarse loamy or sandy soils. Soils are generally rich with thick Ah layers, and most sites have some moisture at depth (SMR 3). The vegetation is very shrubby and is dominated by snowberry and choke cherry with low cover of saskatoon and roses. The sparse herb layer is characterized by scattered bluebunch wheatgrass and silky lupine. In the East Kootenay, the Gb04 occurs in the IDFxx2, IDFdm2, and MSdw. Ff02 sites can also have high cover of choke cherry and snowberry but occur in draws, depressions, gullies, and other moisture-collecting sites within grassland environments in dry climates (BG, PP, and dry IDF). The Ff02 also has Kentucky bluegrass instead of bluebunch wheatgrass (see Section 6.3).

Gb20 Saskatoon – Soopolallie – Juniper
The Gb20 occurs at upper elevations on steep, warm slopes with rocky soils. This shrubby brushland site association is dominated by moderate cover of saskatoon, common juniper, and soopollalie with minor covers of birch-leaved spirea and/or prickly rose. Forbs and grasses are sparse and scattered, and usually consist of strawberry, yarrow, penstemons, and nodding onion. Occasionally, kinnikinnick, pinegrass, and sulphur buckwheat are present. The Gb20 is the only brushland site association described for the ESSFdk1, dk2, dkw, and wm1.

Shrub-steppe Class (Gs)

Shrub-steppe ecosystems occur only in relatively hot, semi-arid climates and are restricted to the IDFxx2 and IDFdm2 in the driest portions of the southern Rocky Mountain Trench. They occur as small patches on sandy eolian or glaciofluvial deposits in areas with open ponderosa pine forests, and as small patches on colluvial slopes with rocky soils. They typically occur on sites with sandier or rockier soils than those of grassland sites. Site conditions may be similar to those where brushland site associations occur, but shrub-steppe is distinguished by the presence and abundance of antelope-brush.

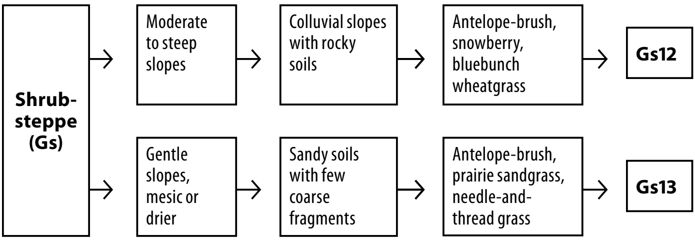
Antelope-brush is limited to the area south of Canal Flats, which limits shrub-steppe communities to the same area. Antelope-brush occurs in true shrub-steppe ecosystems and in response to grazing disturbance in many grassland site associations; historically, its cover would have been reduced by fire on many of the grassland sites (Zlatnik 1999; Krannitz and Mottishaw 2003). Shrubby grassland sites that are recovering from heavy grazing pressure and fire suppression can be distinguished from true shrub-steppe by having soils that are less rocky on steep slopes or by occurring on steeper slopes where soils are sandy. They also lack prairie sandgrass. Two shrub-steppe site associations are described for the field guide area.

Distribution of shrub-steppe (Gs) site associations by biogeoclimatic unit[a]

Unit/BGC	IDFxx2	IDFdm2
Gs12	*	*
Gs13	*	

[a] Based on data and observations; "*" indicates ecosystems that occur less frequently. No "X" values are used because shrub-steppe sites are uncommon throughout the field guide area.

Flowchart – Shrub-steppe



Vegetation Table – Shrub-steppe

Layer	Scientific name	Gs12	Gs13	Common name
	Number of plots	4	5	
Shrubs	*Purshia tridentata*	■■■■■	■■■■	antelope-brush
	Symphoricarpos spp.	■■■■		snowberry
	Amelanchier alnifolia	■■■		saskatoon
	Berberis spp.	■■		Oregon-grape
	Prunus virginiana	■■		choke cherry
Grasses	*Pseudoroegneria spicata*	■■■■	*	bluebunch wheatgrass
	Koeleria macrantha	■■	■■■	junegrass
	Calamovilfa longifolia		■■■■	prairie sandgrass
	Hesperostipa comata		■■■	needle-and-thread grass
Forbs	*Balsamorhiza sagittata*	■■		arrowleaf balsamroot
	Achillea spp.	■	■	yarrow
	Antennaria spp.	■	■	pussytoes
	Apocynum androsaemifolium	■		spreading dogbane
	Arctostaphylos uva-ursi		■■■	kinnikinnick
	Phlox caespitosa		■	tufted phlox
	Heterotheca villosa		■	golden-aster
Moss layer	*Syntrichia ruralis*		■■■■	sidewalk screw-moss
	Bryum spp.		■■■	thread-mosses
	Cladonia spp.		■■■	clad 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

General Description

The Gs12 site association occurs on **steep, warm-aspect, colluvial slopes with rocky soils**. It also occurs occasionally on glaciofluvial slopes with high amounts of coarse fragments. It is limited in distribution to the Rocky Mountain Trench south of Canal Flats (IDFxx2 and IDFdm2).

The vegetation is dominated by **antelope-brush** with lesser amounts of **snowberry**, **saskatoon**, and Oregon-grape. Grasses are common in the understorey, with moderate cover of **bluebunch wheatgrass** and minor cover of junegrass. **Arrowleaf balsamroot**, yarrow, pussytoes, and spreading dogbane are usually present and scattered. Mosses and lichens are sparse or absent.

Differentiating from Other Site Associations

The steep, rocky soils and high shrub cover differentiate the Gs12 from other ecosystems in the Grassland Group. The Gs12 can occur adjacent to the Gg01, but the Gs12 has rockier soils and shrubbier vegetation. The Gs12 is distinguished from the Gb01 and Gb02 by the abundance of antelope-brush. The Gs12 may also appear to be similar to some shrub stages of forested site series, but trees, stumps, and regeneration are apparent on those sites. In some grasslands, antelope-brush increases with grazing; however, those sites do not have rocky or very sandy soils.

Variability

Rockier sites tend to have higher shrub cover. Sites with extensive soil pockets between rocks have higher grass and forb cover. Minor cover of Fd is common in the shrub layer. Invasive and naturalized alien plant species often occur, including yellow salsify (*Tragopogon dubius*) and field filago (*Logfia arvensis*).

Vegetation Patterns with Grazing and Disturbance

Higher levels of grazing reduce bluebunch wheatgrass cover, which is replaced by increased cover of needle-and-thread grass and/or cheatgrass. Antelope-brush occurs in this site association naturally but also increases in cover with overgrazing and fire exclusion.

Management Issues

Steep slopes and rocky soils make this site association unlikely to be intensively grazed by livestock. Sites are vulnerable to invasive alien plant species following soil disturbance.

General Description

The Gs13 site association occurs on **gentle, warm-aspect slopes with sandy soils**. It is limited in distribution to the IDFxx2 in the southern Rocky Mountain Trench. Soils are developed from sandy eolian cappings, often over glaciofluvial materials, with little or no coarse fragments. Sites typically occur as small (< 1 ha) patches in otherwise forested areas.

The vegetation is dominated by **antelope-brush** and **prairie sandgrass** with low to moderate cover of **needle-and-thread grass**, junegrass, **kinnikinnick**, and tufted phlox. Plant species diversity is generally low on these sites, although other scattered forbs often occur with low cover. The biological soil crust is moderately abundant and dominated by sidewalk screw-moss, thread-mosses, and clad lichens.

Differentiating from Other Site Associations

The Gs13 differs from other shrub-steppe ecosystems by having sandy soils with little or no coarse fragments, and by occurring on gentle slopes. It also has prairie sandgrass and little or no snowberry, Oregon-grape, or saskatoon. In grasslands, antelope-brush can increase with fire exclusion. These seral grassland sites (e.g., Gg01$3.1, Gg02$3.2, and Gg10$3.3) occur on loamy soils with moderate to high coarse fragments, and lack prairie sandgrass.

Variability

Late seral sites may have small amounts of bluebunch wheatgrass or rough fescue. Minor cover (< 10%) of Py is common in the shrub and tree layers.

Vegetation Patterns with Grazing and Disturbance

Sites disturbed by grazing tend to have lower cover of prairie sandgrass, more needle-and-thread grass. Trampling by grazing animals will also disturb the fragile soils and reduce the cover of mosses and lichens.

Management Issues

This ecosystem is unique to the southern Rocky Mountain Trench in British Columbia. Soils are fragile and easily disturbed, and sites are vulnerable to invasive alien plant species following disturbance. The absence of fire has likely led to increased cover of antelope-brush on these sites.

Alkaline/Saline Meadow Class (Ga)

Alkaline/saline meadows occur in shallow, closed basins in the driest inland climates where evaporation of standing waters leads to the progressive **accumulation of salts**. These meadows generally experience a brief period of inundation, after which the water table drops below the rooting zone throughout the growing season, which results in a well-aerated rooting medium. Plant species are flood-adapted and salt- and alkali-tolerant. Mosses and lichens are typically sparse or absent.

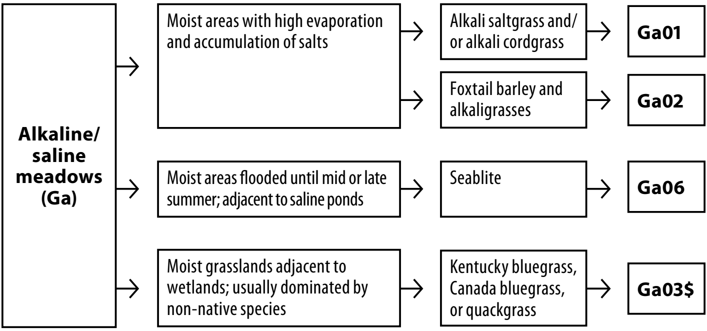
In the Rocky Mountain Trench, akaline/saline meadows are restricted to low elevations in the IDF. They occur infrequently in low-lying areas, in grassland seepage areas, and adjacent to small alkaline wetlands. They are most extensive along the Kootenay River between Wasa and Fort Steele and in the Lavington pasture west of Canal Flats, and are scattered elsewhere in the IDF. **At-risk plant species** that are associated with this class include alkali plantain (*Plantago eriopoda*) and saltwater cress (*Eutrema salsugineum*).

Distribution of alkaline/saline meadow site associations by biogeoclimatic unit[a]

Unit/BGC	IDFxx2	IDFxk	IDFdk5	IDFdm2
Ga01	*	*		*
Ga02	*	*		*
Ga03$	*	*	*	*
Ga06	*			

[a] Based on data and observations; "*" indicates ecosystems that occur less frequently. No "X" values are used because alkaline/saline meadows are extremely uncommon throughout the field guide area.

Flowchart – Alkaline/saline meadows



Vegetation Table – Alkaline/saline meadows

Layer	Scientific name	Ga01	Ga02	Ga03$	Ga06	Common name
	Number of plots	7	X[a]	5	X[a]	
Herbs	*Distichlis spicata*	■■■■	*		*	alkali saltgrass
	Spartina gracilis	■■■■				alkali cordgrass
	Puccinellia spp.	■■	■■		■	alkaligrasses
	Hordeum jubatum	■	■■■■■		*	foxtail barley
	Antennaria spp.	■		■■		pussytoes
	Symphyotrichum ericoides	■	■			tufted white prairie aster
	Poa pratensis	*	■■■	■■■■■		Kentucky bluegrass
	Juncus balticus			■■■		Baltic rush
	Medicago lupulina			■■■		black medic
	Suaeda calceoliformis				■■■■■	seablite

[a] Based on limited data from the East Kootenay; supplemented with data from other areas in British Columbia.

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

Ga01 Alkali saltgrass
The Ga01 occurs infrequently in moist, saline, low-lying areas, often adjacent to small alkaline wetlands in the southern interior of British Columbia. It occurs on seasonally flooded sites where evaporation leads to salt accumulations and vegetation is limited to salt-tolerant plants. In the East Kootenay, the Ga01 is uncommon in seepage and low-lying areas in the IDFxx2, IDFdm2, and IDFxk. Soils are typically loamy and have no coarse fragments. The vegetation in this site association can be quite variable depending on soil moisture, which fluctuates both seasonally and from year to year, and with livestock disturbance. Sites are typically dominated by either alkali saltgrass (Ga01.1) or alkali cordgrass (Ga01.2) with scattered foxtail barley, tufted white prairie aster, and a few other salt-tolerant species. The Ga01 is slightly less alkali and drier than the related Ga02, which is characterized by moderate to high cover of foxtail barley and higher cover of alkaligrasses.

Ga02 Nuttall's alkaligrass – Foxtail barley
The Ga02 is very uncommon in the East Kootenay. It occurs in moist, saline depressions or low-lying areas. Soils are fine-textured and seasonally flooded, and have accumulated salts due to evaporation. The vegetation in this site association can be quite variable depending on soil moisture, which will fluctuate both seasonally and from year to year, and on disturbance. Dominant plants are foxtail barley and alkaligrass. Tufted white prairie aster is often present. Cattle that access adjacent water holes often disturb these sites through grazing and soil trampling. Foxtail barley may become dominant with disturbance or long-term drying conditions. The Ga02 generally occurs on more alkali and moister sites than the Ga01; these two site associations often intergrade.

Ga03$ Field sedge (seral)
The Ga03$ is a common disturbed moist meadow ecosystem that typically occurs on toe slopes adjacent to wetlands. Sites in good condition have not been observed within the field guide area.[13] The Ga03 occurs on sites that are briefly inundated and are moderately saline. Soils are loamy or fine-textured, have little or no coarse fragments, and are usually gleyed. Good-condition sites in the Ga03 in other areas of the province are dominated by field sedge (*Carex praegracilis*), with low cover of Baltic rush. Other common species include slender wheatgrass (*Elymus trachycaulus*) and tufted white

[13] Data for good-condition sites are primarily from Cariboo grasslands (Coupé and Iverson 2014). The seral condition is emphasized here because no undisturbed sites have been observed and there is some uncertainty as to the expected plant community on sites in good ecological condition.

prairie aster. In the field guide area, these sites are disturbed (Ga03$) and are heavily used by cattle for grazing and for accessing watering sources. These sites are generally dominated by Kentucky bluegrass, and typically include low to moderate cover of Baltic rush. Other non-native grasses, including quackgrass (*Elymus repens*) and Canada bluegrass, commonly occur together with various scattered native and non-native forbs such as common dandelion (*Taraxacum officinale*) and black medic. Vegetation composition varies between the wetter edge adjacent to the wetland and the drier edge adjacent to upland areas.

Ga06 Seablite

The Ga06 occurs infrequently in the southern interior of British Columbia; it occurs adjacent to saline ponds on exposed mineral soil that is often flooded until mid to late summer. In the East Kootenay, it is uncommon. Soils are fine-textured, have no coarse fragments, and are gleyed. The vegetation is dominated by seablite with a few other salt-tolerant species such as alkaligrasses and sometimes alkali saltgrass or foxtail barley.

Kentucky bluegrass
Poa pratensis

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 East Kootenay.

This is the first correlated BEC classification of avalanche plant communities for the Southern Interior. Avalanche ecosystems have diverse vegetation communities and highly varied disturbance regimes. The classification presented here is based on limited available data and 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 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 or track: the initiation zone, the chute, and the run-out zone. Avalanche initiation zones typically occur on steep, upper slopes in alpine or parkland 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 [MacKenzie 2012]) (see Section 6.1, Figure 6.1.3). The chute and run-out zones 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 and power of an avalanche, and the amount of snow deposition in a path, critically affect vegetation communities in avalanche ecosystems. Avalanche frequency varies from paths that experience multiple avalanches in any 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 caused by 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 Sitka alder, willows, thimbleberry, fireweed, cow-parsnip, ferns, and grasses, although diversity both within and among avalanche path ecosystems is extremely high. Boundaries between avalanche paths and adjacent ecosystems are often discrete, but 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 avalanche events. 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, mid-track positions have lower snow depths. On warmer aspects, this often leads to earlier snow-free conditions and longer growing seasons, favouring drier-site species. 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 forage value but may provide cover. 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 are particularly important habitat for grizzly bears and mountain caribou. 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 recreational activities and infrastructure such as roads 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 negative downstream effects.

Naming and coding of avalanche ecosystems

The Avalanche Group is divided into three classes: those dominated by herbs (Vh), shrubs (Vs), and shrub-sized trees (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; they are included in the Alpine Group. Similarly, the Avalanche Group does not include rock or talus areas affected by avalanches; rock-dominated sites 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 but are differentiated by site conditions.

Due to the highly variable site conditions in avalanche ecosystems, floristically broad site associations have been created. Site associations are based on data from a wide range of geographic areas and biogeoclimatic subzones/variants. As a result, considerable variation in plant species composition can be expected within each site association. To assist users in site identification and interpretation, **site association variations** have been described for site associations where a subset of sites has a distinct species component (e.g., *Vs01.2 Sitka 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) occur.

Avalanche ecosystems in the East Kootenay

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 forests. Trees in Vt ecosystems show evidence of **pruning and bark damage** from frequent avalanche events. Growing-season site conditions are typically dry, often with rocky or coarse-textured soils. Treed avalanche classification is under development. Future publications may address a Vt site association classification.

Avalanche Herb Meadow Class (Vh)

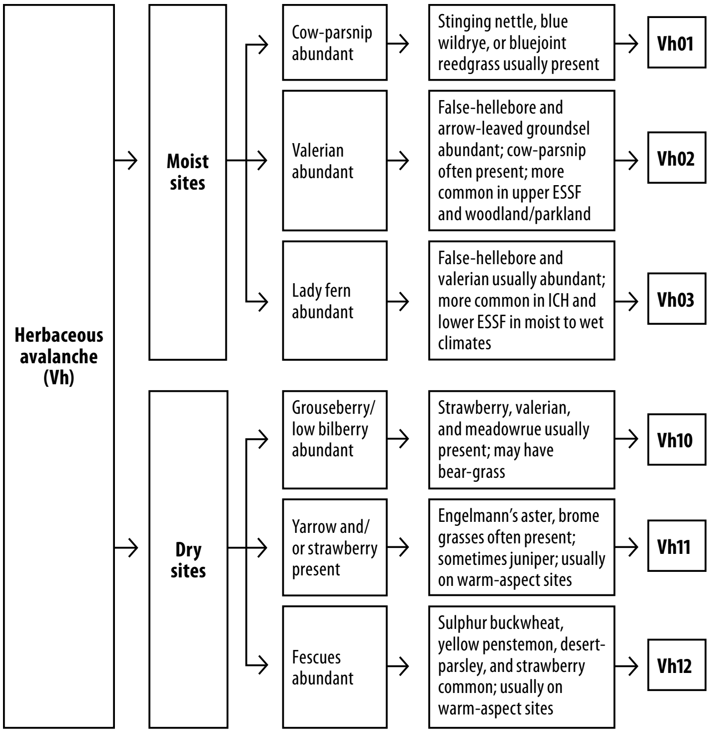
Herbaceous avalanche ecosystems are dominated by forbs, graminoids, and/or dwarf woody shrubs (e.g., grouseberry). They typically occur in both the central part of the track and the run-out zone of avalanche paths. Where Vh communities occur mid track, shrub and tree establishment is typically limited by movement of snow and soils substrates. In run-out zones, high snow accumulation and late snowmelt frequently results in moist, herbaceous plant communities. Five herbaceous avalanche site associations are described for the East Kootenay.

Distribution of herb-dominated avalanche (Vh) site associations by biogeoclimatic unit[a]

Zone	MS		ICH	ESSF				
Unit/BGC	MSdw	MSdk	ICHmk4	ESSFwm1	ESSFdk1	ESSFdk2	ESSFdkw	ESSFwmw
Vh01	*	*	*	X	X	X	X	*
Vh02				X	X	X	X	X
Vh03			*	*				
Vh10	X	X		*	X	X	X	*
Vh11	*	*	*	*	X	X	X	*
Vh12	*				*		*	

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.

Flowchart – Herb-dominated Avalanche (Vh)



Vh01 Cow-parsnip – Fireweed – Nettle

The Vh01 is common in run-out zones and lower-track sections in the ICH, MS, and lower ESSF. It occurs on nutrient-rich soils with mesic to moist moisture regimes. 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 described:

Vh01.1 Cow-parsnip – Fireweed – Nettle
bluejoint is typically sparse or absent; blue wildrye is usually present

Vh01.2 Cow-parsnip – Fireweed – Bluejoint
high cover of bluejoint; blue wildrye is sparse or absent

Vegetation Table – Herb-dominated Avalanche (Vh)

Layer	Scientific name	Vh01	Vh02	Vh03	Vh10	Vh11	Vh12	Common name
	Number of plots	44	45	6	10	7	7	
Herbs	*Heracleum maximum*	■■■■	□□□	□□		*		cow-parsnip
	Chamerion angustifolium	■■■■	■■■	*	■■■■	■■■	■■	fireweed
	Calamagrostis canadensis	□□□□	*	□□□				bluejoint reedgrass
	Thalictrum occidentale	■■■	*		■■■	*		western meadowrue
	Urtica dioica	■■■						stinging nettle
	Elymus glaucus	□□□	*		*	*		blue wildrye
	Fragaria spp.	□□	*		■■■	■■■■	■■■	strawberry
	Veratrum viride	*	■■■■	■■■■	*			false-hellebore
	Valeriana spp.[a]	*	■■■■	□□□□	■■■	*	*	valerian
	Senecio triangularis	*	■■■■	□□	*			arrow-leaved groundsel
	Carex spectabilis		□□□	*				showy sedge
	"mitreworts"[b]		□□	■■				mitreworts
	Athyrium filix-femina			■■■■■				lady fern
	Gymnocarpium dryopteris			□□□				oak fern
	Vaccinium scoparium/myrtillus				■■■■■			grouseberry/low bilberry
	Achillea spp.				■	■■■	■	yarrow
	Phleum alpinum				□	■■		alpine timothy
	Penstemon spp.					■■	■■	penstemons
	Festuca spp.						■■■	fescues
	Eriogonum umbellatum					*	■■■	sulphur buckwheat
	Lomatium spp.						■	desert-parsley

[a] Both Sitka valerian (*Valeriana sitchensis*) and wood valerian (*V. dioica*) are common in the Rocky Mountains; Sitka valerian is common in the Purcell Mountains.
[b] 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

Vh02 Valerian – Hellebore – Fireweed
The Vh02 is common in the ESSF on cooler sites and at higher elevations, including the woodland and parkland. It is most common in the run-out zone and lower track positions, but can also occur on mid-track seepage sites. It is associated with mesic to moist moisture regimes and medium to rich soils. 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 described:

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

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. Sites generally have moist and wetter soil moister regimes with abundant soil nutrients. The Vh03 is dominated by lady fern, usually with valerian, false-hellebore, oak fern, and a wide variety of species that are associated with moist conditions.

Vh10 Fireweed – Grouseberry
The Vh10 is common throughout the ESSF and MS in the East Kootenay, and occasionally occurs in the ICHmk4. It typically occurs in upper- and mid-track positions where soil moisture regimes are mesic or, usually, drier, and soil nutrient regimes are poor to medium. The Vh10 is dominated by fireweed and grouseberry and/or low bilberry. Strawberry is common, along with valerian and western meadowrue. Bear-grass may be present, particularly at the southern extent of the field guide area.

Vh11 Fireweed – Yarrow – Strawberry
The Vh11 occurs on dry sites, usually with warm aspects. It is most common in mid- to lower-track positions at upper elevations in the ESSF and woodland. Soil moisture regimes are typically submesic or drier; soil nutrient regimes are medium to rich. The Vh11 is characterized by fireweed, strawberry, and yarrow; common juniper, grasses, and penstemons are often present, while species characteristic of Vh units on moist sites (e.g., ferns, cow-parsnip, or valerian) are sparse or absent. In the Rocky Mountains, cut-leaved anemone (*Anemone multifida*) and nodding onion (*Allium cernuum*) are often present, while blue wildrye is more common in the Purcell Mountains.

Vh12 Idaho fescue – Sulphur buckwheat – Fireweed

The Vh12 occurs on dry, warm-aspect avalanche paths in the East Kootenay. Soils are generally dry but rich and usually have an Ah layer. Idaho fescue is abundant, but other fescues may occur with high cover (especially rough fescue). Sulphur buckwheat, fireweed, and wild strawberry generally have moderate to high cover. Other common species include yellow penstemon, desert-parsley, Scouler's hawkweed (*Hieracium scouleri*), and yarrow. The Vh12 vegetation looks much like a grassland but is included with other avalanche site associations because mass snow movement is the limiting factor for trees, not excessively dry climate or site conditions. Most sites occur in the mid-chute or run-out portions of avalanche paths; grasslands in start zones typically belong to the Grassland Class (Gg).

Avalanche Shrub Thicket Class (Vs)

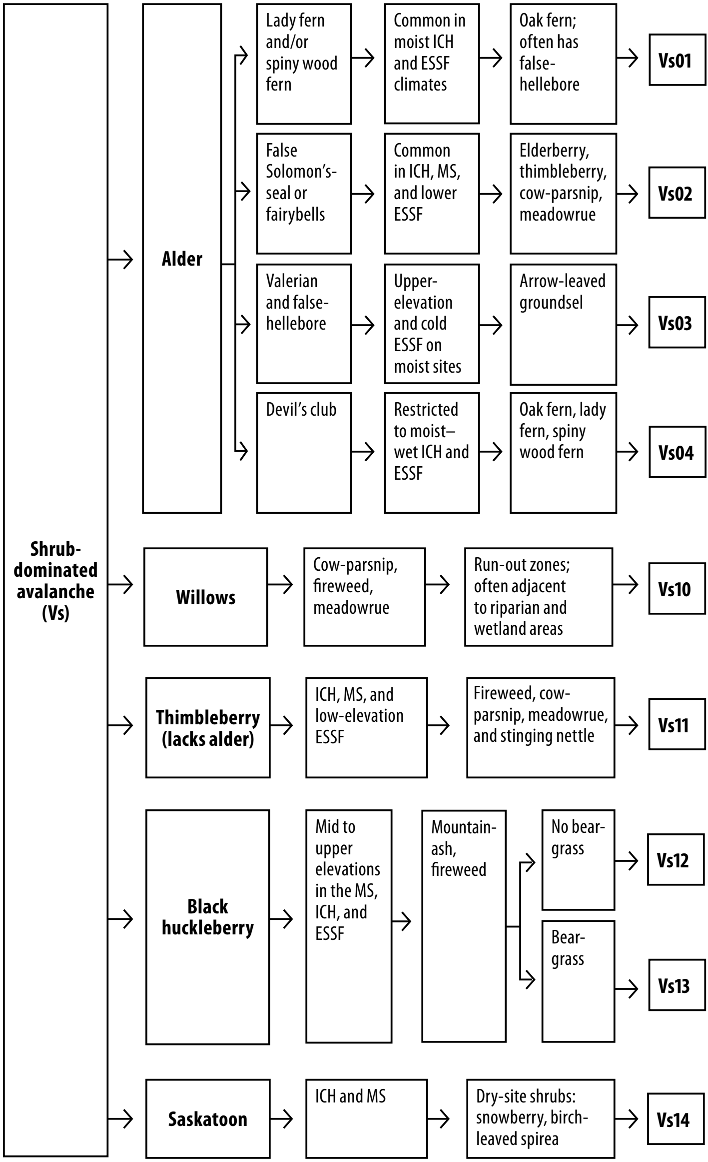
Avalanche shrub thicket (Vs) ecosystems are dominated by deciduous shrubs. These ecosystems are most frequently associated with the track and lateral run-out portions of avalanche paths where deep snow accumulation occurs infrequently. Nine Vs avalanche site associations are described for the East Kootenay.

Distribution of shrub-dominated avalanche (Vs) site associations by biogeoclimatic unit[a]

Zone	MS		ICH	ESSF				
Unit/BGC	MSdw	MSdk	ICHmk4	ESSFwm1	ESSFdk1	ESSFdk2	ESSFdkw	ESSFwmw
Vs01			X	X		*		
Vs02	X	X	X	X	X	X		
Vs03				X	X	X	*	*
Vs04			*	*				
Vs10	*	*	*	X	X	X		
Vs11	X	X	X	*	*	*		
Vs12	*	*	*	*	*	*	*	*
Vs13	*			*	*		*	*
Vs14	X	X	*					

[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* spp. *sinuata*	■■■■■	■■■■■	■■■■■	■■■■■						Sitka alder
	Sambucus racemosa var. *melanocarpa*	■■■	■■■	▪▪	*		▪▪				black elderberry
	Rubus parviflorus	*	▪▪▪				■■■■■			*	thimbleberry
	Oplopanax horridus				■■■■■						devil's club
	Salix spp.					■■■■					willows
	Sorbus spp.							■■■	■■■		mountain-ash
	Abies lasiocarpa							■■■	■■■		subalpine fir
	Vaccinium membranaceum							■■■■	■■■■		black huckleberry
	Rhododendron albiflorum							■■■■	*		white-flowered rhododendron
	Spiraea lucida								▪▪	■■■	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
	Prosartes spp.		□□□		*						fairybells
	Valeriana spp.			■■■		□□□		□□□	□		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. Sites are often moist or wet with rich soils and occur in steep to moderately steep, mid to lower areas of the track or, less commonly, in lateral run-out areas. Sitka alder growth is dense (typically 60–90% cover), with lady fern and/or spiny wood fern dominant beneath. The understorey herb layer is lush and diverse, with oak fern, twistedstalks, and false-hellebore being common. 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

Vs02 Sitka alder – Solomon's-seal
The Vs02 is common on circum-mesic sites in the MS, ICHmk4, and lower elevations in the ESSF. Sites typically occur in moderately steep, mid to lower portions of the track, and less commonly in lateral run-out areas. 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; thimbleberry occurs more frequently in drier ESSF and MS climates. The Vs02 occurs on sites that are warmer and drier than the Vs01.

Vs03 Sitka alder – Hellebore
The Vs03 occurs at upper elevations in the ESSF, including the woodland. It is most common on steep to moderately steep, mid to lower portions of the track. Soils are usually mesic or wetter and nutrient rich. Sitka alder dominates the tall shrub layer, with false-hellebore and valerian abundant in the understorey. Arrow-leaved groundsel, western meadowrue, cow-parsnip, and violets are also common and frequently abundant.

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. Soils frequently have very rocky substrates with continuous subsurface flows of nutrient-enriched water that supports the dense herb and shrub layers. 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.

Vs10 Willow – Cow-parsnip – Fireweed

Vs10 sites are dominated by willows—usually Sitka or Barclay's—and commonly contain black twinberry, fireweed, cow-parsnip, western meadowrue, valerian, 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

The Vs11 is found 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 lateral run-out zones. Abundant thimbleberry characterizes the plant community. Cow-parsnip, fireweed, western meadowrue, and stinging nettle occur in the understorey and in small openings between patches of thimbleberry.

Vs12 Huckleberry – Rhododendron – Fireweed

The Vs12 occurs on dry, usually warm-aspect slopes in the ESSF, MS, and ICH in climates where bear-grass is not present. In the East Kootenay, it is uncommon in the ESSFdk1 and dk2, the MSdk and dw, and the ICHmk4. Common species include black huckleberry, mountain-ash, fireweed, and Sitka valerian; white-flowered rhododendron may have high cover, particularly on ESSF sites. The Vs12 is similar to the Vs13 but bear-grass is absent.

Vs13 Huckleberry – Bear-grass – Fireweed

The Vs13 occurs on dry, rocky, avalanche paths in southern areas of the East Kootenay within the distribution of bear-grass: ESSFwm1, wmw, and the most southerly portions of the MSdw, ESSFdk1, and dkw (most commonly in the Flathead and Wigwam valleys and sometimes in the southern Purcell Mountains). Bear-grass and black huckleberry are common and abundant. 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 the Vs12 lacks bear-grass. Soils are usually submesic and drier with poor to medium soil nutrient regimes.

Vs14 Saskatoon – Snowberry – Strawberry

The Vs14 usually occurs on warm aspects at lower elevations in the ICH and MS. Soils have mesic or drier moisture regimes and medium to rich nutrient regimes. Saskatoon, snowberry, and/or birch-leaved spirea are abundant, and common juniper may be present. Fireweed, strawberry, and yarrow usually occur with low to moderate cover. Low cover of fescues, blue stickweed (*Hackelia micrantha*), and western meadowrue frequently occurs.

Wood strawberry
Fragaria vesca

Wild strawberry
Fragaria virginiana

6.6 Rock Outcrop and Talus Ecosystems

The Rock Group occurs where limited soil and abundant rock restricts vascular plant establishment and growth. Trees are sparse to absent and cover of vascular plants is generally low. Mosses, lichens, and liverworts typically dominate the vegetation.

The Rock Group is divided into five classes: rock outcrops (Ro), talus (Rt), 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 East Kootenay. Site associations for cliffs, lava flows, and dunes are not described. Alpine rock features are part of the alpine ecosystem classification as subclasses of the Alpine Fellfield class (see Section 6.7).[2]

This section provides the first correlated rock and talus ecosystem classification for the Southern Interior of British Columbia, and users may find additional rock and talus ecosystems that are not described in this guide. Ecosystem units are described at the site association level of the site classification hierarchy, but wherever possible, site association variations have been used to capture finer-scale variability in vegetation patterns. Additional detail and new site associations and variations may develop over time as more data are collected.

Ecological significance of rock outcrop and talus ecosystems

Plant species composition is highly variable in rock-dominated ecosystems. Vegetation is related to species in adjacent ecosystems, disturbance history, climate, rock characteristics (including geology and rock shape/configuration), and depth/distribution of soil pockets. Vascular plant cover is usually low, while mosses, lichens, and/or liverworts frequently have very high cover. Vascular plant growth is usually highest in soil pockets between rocks where there is higher capacity for moisture and nutrient retention.[3]

Rock and talus ecosystems are often interspersed with the driest forested site series (102) and, in dry climates, with grassland (Gg), shrub-steppe (Gs), and brushland (Gb) ecosystems. Rock outcrops and talus sites often provide distinct habitat for ecosystem specialists, including birds, rodents, reptiles,

[1] Dunes are not strictly rock ecosystems but are included in this group because they support 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 on 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.

and both vascular and non-vascular plants. At-risk plant and animal species are often associated with these ecosystems.

Limited soil development and depth makes rock ecosystems highly susceptible to erosion and disturbance. Where pockets of deeper soils occur, there is a high risk of non-native invasive plant establishment.

Rock and talus ecosystems in the East Kootenay

Nine rock outcrops and nine talus units are described for the East Kootenay.

Rock Outcrop Class (Ro)

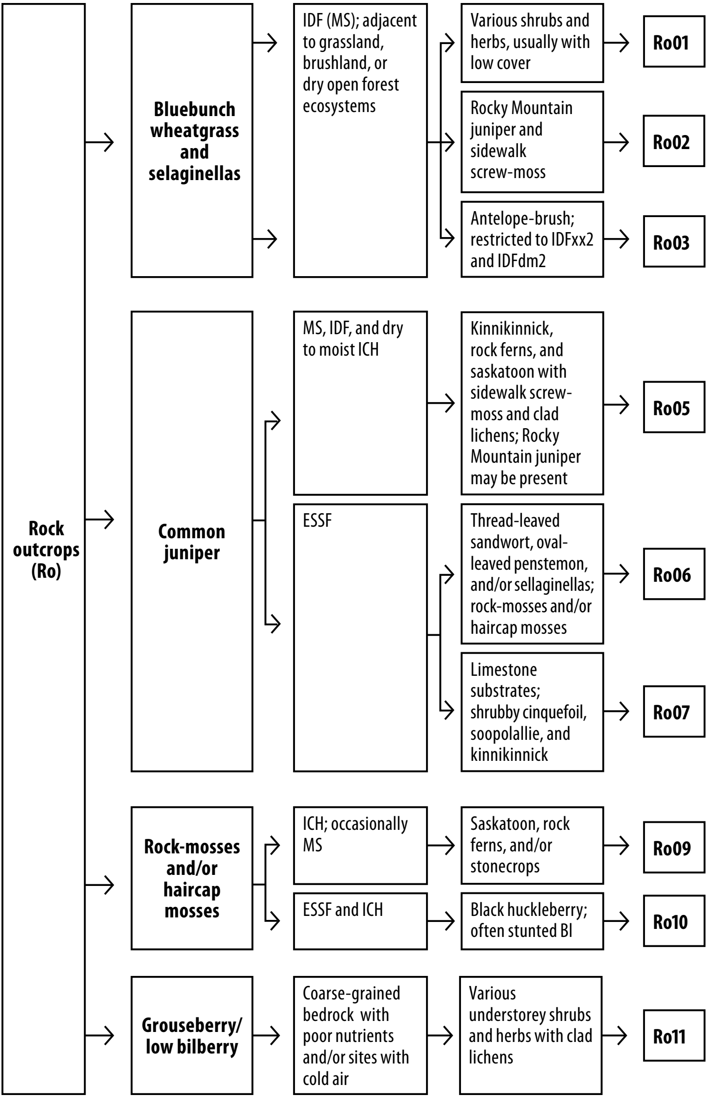
Rock outcrop ecosystems occur where the dominant substrate is exposed bedrock. On these sites, soil development is very limited. Herbs and shrubs are usually restricted to pockets of soil or cracks in the rock surface, and total cover of vascular plants is usually low (but can be highly variable). Mosses, lichens, and liverworts frequently dominate plant communities on rock outcrops.

Distribution of rock outcrop (Ro) site associations by biogeoclimatic unit[a]

Zone	IDF				MS / ICH			ESSF				
Unit/BGC	IDFxx2[b]	IDFdm2	IDFxk	IDFdk5	MSdw	MSdk	ICHmk4[c]	ESSFwm1	ESSFdk1	ESSFdk2	ESSFdkw	ESSFwmw
Ro01	*	*	*	*	*	*						
Ro02	*	X	X	X								
Ro03	*	*										
Ro05		*	*	*	X	X	*					
Ro06								X	*	*	*	X
Ro07								*	X	X	*	*
Ro09					*	*	*					
Ro10							*	*	*	*	*	*
Ro11					*	*		*	X	X	X	X

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.
[b] Rock outcrops are uncommon in the IDFxx2.
[c] Limited data for the ICHmk4.

Flowchart – Rock outcrops



Vegetation Table – Rock outcrops

Layer	Scientific name	Ro01	Ro02	Ro03	Ro05	Ro06	Ro07	Ro09	Ro10	Ro11	Common name
	Number of plots	4	11	4	10	8	7	X[a]	4	6	
Shrub-sized trees	*Pseudotsuga menziesii*	□	□□	□	■■		*	*			Douglas-fir
	Pinus albicaulis					□□			□□	□	whitebark pine
	Abies lasiocarpa					□	■■		■■	□	subalpine fir
Shrubs	*Amelanchier alnifolia*	■		■■	■■			□□			saskatoon
	Juniperus scopulorum		■■■		□□□						Rocky Mountain juniper
	Purshia tridentata			■■■							antelope-brush
	Juniperus communis				■■■	■■■	■■■■			□□	common juniper
	Shepherdia canadensis				□□		■■■				soopolallie
	Dasiphora fruticosa						■■				shrubby cinquefoil
	Paxistima myrsinites							□□			falsebox
	Vaccinium membranaceum								■■■	*	black huckleberry
Herbs	*Pseudoroegneria spicata*	■■■	■■■■	■■■	*						bluebunch wheatgrass
	Selaginella spp.	■■	■■■	□□	*	□□□	□	□□			selaginellas
	Achillea spp.	■	■	□	□	■	■	□			yarrow
	Heuchera cylindrica	■		□	■			□			round-leaved alumroot
	"rock ferns"[b]	□	□	■	■			■■			rock ferns
	Sedum spp.	□			□	□	□	□			stonecrops

Layer	Scientific name	Ro01	Ro02	Ro03	Ro05	Ro06	Ro07	Ro09	Ro10	Ro11	Common name
	Number of plots	4	11	4	10	8	7	X[a]	4	6	
Herbs	*Arctostaphylos uva-ursi*	*		*	■■■		■■■	*			kinnikinnick
	Koeleria macrantha		■■	■							junegrass
	Penstemon fruticosus		■■	■■	*					□□□	shrubby penstemon
	Heterotheca villosa		□	■							golden-aster
	Fragaria spp.			□	■		■■	□□			strawberry
	Penstemon ellipticus					□□□					oval-leaved penstemon
	Eremogone capillaris					□□			■	□□	thread-leaved sandwort
	Trisetum spicatum					□	■				spike trisetum
	"saxifrages"[b]					*	■■		□□		saxifrages
	Vaccinium scoparium/myrtillus									■■■	grouseberry/low bilberry
Moss layer	*Syntrichia ruralis*	□□□□	■■■■	■■	□	*	*		*	■	sidewalk screw-moss
	Cladonia spp.	□□□	*	□	□	■■		■■■	■■	□	clad lichens
	Polytrichum spp.	■■■		*	*	■■■		■■■	■■■■	□	haircap mosses
	Peltigera spp.	■■	□□		■	□	□			*	pelt lichens
	Racomitrium spp.					□□□		■■■■■	■■■■	*	rock-mosses
	Dicranum spp.								□□□		heron's-bill mosses

[a] All plots used to describe these site associations are from within the East Kootenay, except in the Ro09, where plots from across the Southern Interior were used.
[b] 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

Ro01 Selaginella – Bluebunch wheatgrass – Screw-moss
The Ro01 is common at low elevations across the Southern Interior in the BG, PP, and IDF, and occasionally in the MS. It is associated with open Py or Fd forests and grassland environments. The vegetation is characterized by variable cover of bluebunch wheatgrass with selaginellas, sidewalk screw-moss, haircap mosses, and clad or pelt lichens. Saskatoon, yarrow, round-leaved alumroot, rock ferns, and stonecrops, along with a number of other species with low cover, are often present. Two variations are recognized:

> **Ro01.1 Selaginella – Bluebunch wheatgrass – Screw-moss**
> includes sites with > 5% cover bluebunch wheatgrass
> **Ro01.2 Selaginella – Screw-moss**
> includes sites with < 5% cover bluebunch wheatgrass; generally shrubbier and/or more shaded than Ro01.1, often with higher moss cover as a result

Ro02 Rocky Mountain juniper – Selaginella – Bluebunch wheatgrass
The Ro02 is restricted to the IDF in the East Kootenay. It is characterized by low to moderate cover of Rocky Mountain juniper (typically 2–10%), bluebunch wheatgrass, and selaginellas. Sidewalk screw-moss, junegrass, common juniper, and shrubby penstemon may occur. Rock-mosses are generally absent, and haircap mosses are sparse or absent. Bluebunch wheatgrass and selaginellas are also present on the Ro01, which lacks Rocky Mountain juniper, and on the Ro03, which has antelope-brush instead of Rocky Mountain juniper. Ro02 sites occur adjacent to open Py or Fd forests and grassland environments.

Ro03 Antelope-brush – Selaginella – Bluebunch wheatgrass
The Ro03 occurs at low elevations across the driest climates of the Southern Interior in the BG, PP, and IDF. In the East Kootenay, it is restricted to the IDFxx2 and IDFdm2 (south of Canal Flats). Antelope-brush, selaginellas, and bluebunch wheatgrass are characteristic species. The Gs12 also has abundant antelope-brush and bluebunch wheatgrass but is a shrub-steppe ecosystem that occurs on deep, rocky soils rather than on sites with exposed bedrock. Ro03 sites occur adjacent to grasslands, open Py or Fd forests, and Gs12 sites (see Section 6.4).

Ro05 Juniper – Kinnikinnick – Penstemon
The Ro05 is common at low to mid elevations across the ICH, MS, and IDF in the field guide area. It is characterized by moderate to abundant cover

(3–20%) of common juniper with kinnikinnick and shrubby penstemon. Rocky Mountain juniper, saskatoon, soopolallie, and falsebox are often present. Round-leaved alumroot, stonecrops, rock ferns (usually cliff ferns [*Woodsia* spp.]), pussytoes (*Antennaria* spp.), and yarrow may occur with variable cover. Moss and lichen cover is relatively low on these shrubbier sites. The Ro05 usually occurs adjacent to forests dominated by Fd, often with Pl and occasionally with Py. The Ro06 also has common juniper but occurs in the ESSF and has thread-leaved sandwort, oval-leaved penstemon, and/or spike trisetum.

Ro06 Juniper – Stonecrop – Sandwort
The Ro06 occurs across the ESSF in southern British Columbia. It is characterized by common juniper (2–10% cover), thread-leaved sandwort, and selaginellas. Minor amounts of stonecrops, yarrow, and pussytoes are common with oval-leaved penstemon, round-leaved alumroot, rock-mosses, and haircap mosses. Kinnikinnick may be present but is typically more abundant in drier climates in the Okanagan (Ro06.2). Pelt and clad lichens often grow on exposed rock. The Ro05 occurs on similar sites at lower elevations (ICH, MS, IDF). Ro06 sites usually occur adjacent to forests with Se, Bl, Pl, and/or Pa.

Ro07 Juniper – Soopolallie – Shrubby cinquefoil
Ro07 rock outcrops are associated with nutrient-rich, limestone bedrock in the ESSF of the Rocky Mountains. Vascular plant cover is high for a rock outcrop, with common juniper, soopolallie, shrubby cinquefoil, and shrub-sized Bl usually present with spotted saxifrage (*Saxifraga bronchialis)*, yarrow, stonecrops, kinnikinnick, and strawberry. Other herbaceous species associated with these sites include spikelike goldenrod (*Solidago glutinosa*), cut-leaved daisy (*Erigeron compositus*), cut-leaved anemone (*Anemone multifida*), and spike trisetum. Moss, lichen, and liverwort cover is relatively low (< 5%). Fd, Pl, Se, Bl, and sometimes Pa or Pf are common in adjacent forests.

Ro09 Saskatoon – Rock-moss – Clad lichen
The Ro09 occurs occasionally in the MSdw and dk, although it is more common in the ICH. Rock-mosses and clad lichens typically form a dense mat, often with haircap mosses and a variety of other mosses with low covers. Shrubs can be highly variable with covers ranging from sparse (< 3%) to abundant (> 20%). Small amounts of saskatoon, falsebox, birch-leaved spirea, Oregon-grape (*Berberis* spp.), and/or common juniper are usually present. Rock ferns (mostly parsley fern [*Cryptogramma acrostichoides*] and

cliff ferns), round-leaved alumroot, stonecrops, and selaginellas are usually present with low cover (< 5% each). In the ICH, poverty oatgrass (*Danthonia spicata*) can be abundant (Ro09.2).

Ro10 Huckleberry – Rock-moss – Haircap moss

The Ro10 is uncommon in the ESSFwm1 and wmw, and occurs occasionally in the ICHmk4, ESSFdk1, dk2, and dkw in the East Kootenay. It is more common in wetter biogeoclimatic units to the west. Black huckleberry, rock-mosses, and haircap mosses (mostly awned [*Polytrichum piliferum*]) are the characteristic species. Bl is often present as scattered, stunted trees or saplings, sometimes with Se or Sxw. Herb cover is typically sparse, with minor cover of Alaska saxifrage (*Micranthes ferruginea*) and/or Ross' sedge (*Carex rossii*) and other dry-site sedge species. Clad lichens, heron's-bill mosses, and leafy liverworts (mostly *Barbiliphozia* spp.) commonly occur. Variability in vegetation can be high, with cover of black huckleberry, rock-mosses, and haircap mosses ranging from sparse (< 1%) to moderate (> 10%). The Ro10 typically occurs adjacent to ESSF forests with Se and Bl, or adjacent to ICH forests with Cw, Hw, and/or Fd.

Ro11 Grouseberry – Clad lichen

The Ro11 is common in the dry ESSF and MS in the East Kootenay, and it also occurs in the ESSFwm1, wmw, and other ESSFwm subzones to the west. It is characterized by grouseberry and/or low bilberry. Bl and Pl are often present as scattered, stunted trees or saplings. Other common species include black huckleberry, shrubby penstemon, dry-site sedges (usually Ross' sedge), heron's-bill mosses, haircap mosses, and clad lichens. Selaginellas and rock-mosses often occur, especially in moister climates. Bedrock types are often coarse grained and nutrient poor. Sites are frequently associated with cold-air accumulation. Ro11 sites occur adjacent to forests with Se, Sxw, Bl, and/or Pl.

Rock Talus Class (Rt)

Talus ecosystems are comprised of rock debris, and include both stable slopes dominated by boulders and unstable slopes consisting of smaller cobbles and gravels that are actively moving (often imperceptibly) due to gravity.[4] Talus is distinct from other terrestrial environments in that there is minimal soil

[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 of rock debris.

(particles < 2 mm) 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 on the rock substrate. 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 materials such as granitic rocks (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, phyllite, slate) rock types are more easily weathered and tend to break down rapidly into fine-textured materials or smaller fragments (see Appendix 3.5). Finer textures support the establishment of herbs, shrubs, and some trees, although the smaller, plate-like rock pieces are also more mobile, which limits plant establishment.

Distribution of talus (Rt) site associations by biogeoclimatic unit[a]

Zone	IDF				MS/ICH			ESSF				
Unit/BGC	IDFxx2	IDFdm2	IDFxk	IDFdk5	MSdk	MSdw	ICHmk4	ESSFwm1	ESSFdk1	ESSFdk2	ESSFdkw	ESSFwmw
Rt01	X	X	X	X	X	X	X	X	X	X	X	X
Rt02					*	*	*	*				
Rt03		*		*	*	*	*					
Rt04	*	X	X	X	X	X						
Rt06		*		*								
Rt07		*		X	X	X	*	*	X	X		
Rt08		*		*	X	X	X					
Rt20					*	*	*	X	X	X	X	*
Rt21								*	*	*	X	X

[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently..

Flowchart – Talus (Rt)

Talus (Rt)

Mosses or lichens with few herbs/shrubs	Common in all BGC units; lichen-dominated	Green map, rocktripe, and crust lichens	**Rt01**
	ICH, MS, ESSFwm1; moss-dominated with lichens	Abundant rock-mosses with clad lichens, rocktripe, and haircap mosses	**Rt02**
Red raspberry	MS, ICH, IDF	Very mossy with red-stemmed feathermoss, heron's-bill mosses, clad lichens, and pelt lichens	**Rt03**
Saskatoon with bluebunch wheatgrass	IDF, MS	Often has rock ferns and sidewalk screw-moss	**Rt04**
Saskatoon and mock-orange	IDF, MS	Choke cherry and snowberry with rock ferns	**Rt06**
Common juniper	MS, IDF, ESSF (ICH)	Falsebox, yarrow, and strawberry; may have abundant aspen	**Rt07**
Aspen, Douglas maple, saskatoon	MS, ICH, IDF	Kinnikinnick, snowberry, choke cherry	**Rt08**
Spotted saxifrage	ESSF, MS, ICH	Clad lichens and rock ferns	**Rt20**
Subalpine larch	Upper ESSF, woodland	Mountain-heathers, often with grouseberry/low bilberry	**Rt21**

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 stable, blocky talus covered with lichens and low 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 granitic and volcanic types, with no soil.

Rt02 Rock-moss – Clad lichen

The Rt02 is uncommon in the MS, ICH, and ESSFwm1 in the East Kootenay; it is more common in the moist climates to the west. In the field guide area, the Rt02 usually occurs 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 or no soil. These sites support high cover of clad lichens, rocktripe lichens, and rock-mosses, often with haircap mosses and reindeer lichens. The key characteristic is the dominance of bryophytes and lichens with limited herb and shrub cover (typically < 5% in each layer).

Rt03 Raspberry – Red-stemmed feathermoss – Clad lichen

The Rt03 occurs in the MS, ICH, and IDFdm2, and dk5 in the field guide area. 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. Fd, Py, Pl, and Lw are common in adjacent forests.

Rt04 Saskatoon – Bluebunch wheatgrass

The Rt04 is a widespread unit of dry, warm climates, occurring primarily in the IDF and on warmer sites in the MS. Substrates typically consist of small- to medium-sized cobbles and gravels (2–7.5 cm diameter), often with patches of exposed mineral soil. Vegetation cover is variable and depends on the amount of soil present. Saskatoon, bluebunch wheatgrass, and sidewalk screw-moss are characteristic of these sites. Stunted Fd may also be present. Other species include choke cherry, snowberry, roses, and rock ferns, as well as clad and pelt lichens. Crustose and rocktripe lichens are often present on larger, stable stones and boulders.

Vegetation Table – Talus[a]

Layer	Scientific name	Rt01	Rt02	Rt03	Rt04	Rt06	Rt07	Rt08	Rt20	Rt21	Common name
	Number of plots	26	35	12	13	11	24	15	9	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
	Vaccinium membranaceum									■■■	black huckleberry
Herbs	"rock ferns"[b]		□	□□	□	■■	■	□	□		rock ferns
	Saxifraga bronchialis			□□□			*		■■■		spotted saxifrage
	Pseudoroegneria spicata				■■■	□	*	*			bluebunch wheatgrass
	Heuchera cylindrica					□		□			round-leaved alumroot
	Penstemon spp.					*	□	□	*	*	penstemons
	Arctostaphylos uva-ursi						*	□□□			kinnikinnick
	Phyllodoce empetriformis									■■■■	pink mountain-heather
	Vaccinium scoparium/myrtillus									□□□	grouseberry/low bilberry
	Luzula spp.									■■	wood-rushes

Layer	Scientific name	Rt01	Rt02	Rt03	Rt04	Rt06	Rt07	Rt08	Rt20	Rt21	Common name
	Number of plots	26	35	12	13	11	24	15	9	6	
Moss layer	*Umbilicaria* spp.	■■■	■■■	*	□□	□□	□□	*			rocktripe lichens
	Rhizocarpon geographicum	□□□	*								green map
	Cladonia spp.	■■	■■■	■■■	□	*	■■	□	□□	■■	clad lichens
	Racomitrium spp.	□□	■■■■	*							rock-mosses
	Cladina spp.		□□□	□□							reindeer lichens
	Dicranum spp.	*	■■	■■■						■■■■	heron's-bill mosses
	Polytrichum spp.		□□	■■						□	haircap mosses
	Pleurozium schreberi		*	■■■■							red-stemmed feathermoss
	"leafy liverworts"[b]	*	*	□□□						□□□	leafy liverworts
	Peltigera spp.		*	■■	*	*	□	□	*	□	pelt lichens
	Syntrichia ruralis				■■	□□	*	□			sidewalk screw-moss

[a] Plots are from across the Southern Interior except for those in the Rt08 and Rt20, where they are only from the East Kootenay.
[b] 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

Rt06 Saskatoon – Mock-orange – Bluebunch wheatgrass
The Rt06 occurs on dry, warm sites in the dry ICH (xw, xwa, and dw) and on cooler sites in the PP and IDF in the Boundary, Okanagan, and East Kootenay. 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 mock-orange, saskatoon, choke cherry, and snowberry. Bluebunch wheatgrass and fescues are often present with low cover, along with rock ferns and round-leaved alumroot. Fd and Py are common in adjacent forests.

Rt07 Aspen – Juniper – Rocktripe
The Rt07 occurs in dry, cool, or cold environments. It is most common in the East Kootenay in the MS and IDF but also occurs in the ICH (mk and dm) and at lower elevations in the ESSFdk1, dk2, and wm1. Substrates typically consist of cobbles, roughly 10–30 cm in diameter. These sites are generally stable and may occur intermixed with other Rt units. Common juniper is present and often abundant. Other common species include false-box, penstemons, rock ferns, rocktripe lichens, and clad lichens. Trembling 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 trembling aspen:

Rt07.1 Aspen – Juniper – Rocktripe
trembling aspen is present, typically with > 5% cover

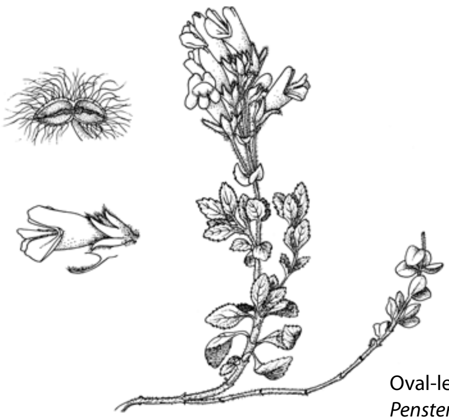
Rt07.2 Juniper – Rocktripe
trembling aspen is absent or sparse

Trembling aspen is also common in the Rt08, but that talus site association has high cover of saskatoon and/or Douglas maple and little or no common juniper. Fd, Pl, Sxw, Se, and Bl are common in forests adjacent to the Rt07.

Rt08 Aspen – Douglas maple – Saskatoon
The Rt08 is common in the East Kootenay in the MSdw, dk, and ICHmk4 and occurs less frequently in the IDFdm2 and dk5. It commonly occurs on stable, cobble-sized materials consisting of rocks between 10 and 30 cm in diameter. Stunted trembling aspen trees dominate the plant community, along with saskatoon and Douglas maple. Other common species include kinnikinnick, snowberry, choke cherry, roses, rock ferns, penstemons, and round-leaved alumroot. Adjacent forests are often dominated by Fd, Lw, Pl, and/or Sxw.

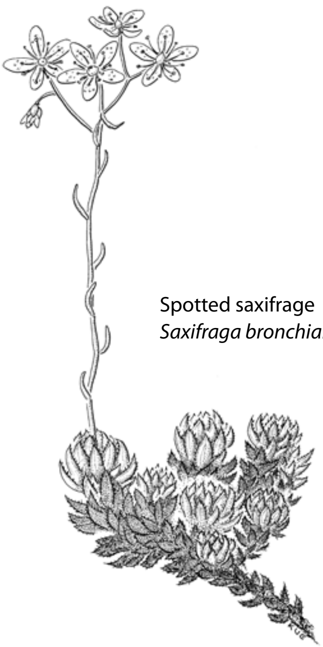
Rt20 Spotted saxifrage – Clad lichen
The Rt20 typically occurs in the ESSF and woodland, and occasionally at upper elevations in the MS and ICH. The substrate usually consists of base-rich rocks, including limestone. Most sites are dominated by cobbles or, sometimes, larger boulders, with little or no mineral soil. Vegetation is often very sparse, and spotted saxifrage is usually the most common and abundant species. Other species that are occasionally present include black gooseberry (*Ribes lacustre*), rock ferns, stonecrops, showy Jacob's-ladder (*Polemonium pulcherrimum*), alpine bluegrass (*Poa alpina*), yellow columbine (*Aquilegia flavescens*), and selaginellas. Mosses and lichens are sparse to absent, particularly on limestone, although clad and pelt lichens are sometimes present.

Rt21 Subalpine larch – Pink mountain-heather – Heron's-bill
The Rt21 occurs on blocky talus in the ESSFwmw and dkw and, occasionally, in the upper ESSF. It is restricted to very cold sites, typically on cool-aspect slopes above high-elevation lakes and basins. Subalpine larch is dominant as stunted trees in the shrub layer, and often occurs scattered in the tree layer (> 10 m tall). Grouseberry/low bilberry, mountain-heathers, and black huckleberry are usually present in the understorey, with mountain leafy liverwort (*Neoortocaulis floerkei*), heron's-bill mosses, and clad lichens in the moss layer. The Rt21 has many characteristics that are similar to the Krummholz (Sk) Class in the Subalpine Shrub Group (see section 6.7), but the Rt21 occurs on sites with blocky talus, and krummholz occurs on sites with deeper, often rocky soils.



Oval-leaved penstemon
Penstemon ellipticus

Alaska saxifrage
Micranthes ferruginea



Spotted saxifrage
Saxifraga bronchialis

6.7 High-elevation Ecosystems

Classification of high-elevation ecosystems is currently in progress. The following sections provide a brief description of the high-elevation biogeoclimatic subzones in the field guide area and an overview of the site classes in the Alpine and Subalpine Shrub Groups. Detailed site association classifications are not included but are expected to be presented in future publications.

The Alpine and Subalpine Shrub classifications apply to vegetated, non-forest ecosystems. In the BEC system, non-vegetated sites are defined as those with < 5% cover of vascular and/or non-vascular plants. This can be temporary, caused by a disturbance, or more permanent, caused by site-limiting factors. Where this is a temporary situation, sites may still fit within the vegetated site classification. Forested areas have, or have the potential to have, > 10% cover of trees that are > 10 m tall. In general, it is too cold in high-elevation ecosystems for forests to develop, and trees are restricted to krummholz forms. Krummholz, in the context used here, includes all patches of stunted trees, including those that are windswept, short, and deformed, and those with upright but stunted growth form. In the productive climates of southeast British Columbia, krummholz trees may exceed 10 m in height. Taller trees are more common closer to the woodland and where La is present; La is specially adapted to high elevations and is often taller than other tree species in the parkland.

Biogeoclimatic zones and subzones of high-elevation ecosystems in the East Kootenay

Three high-elevation biogeoclimatic units are mapped in the East Kootenay: undifferentiated Interior Mountain-heather Alpine (IMAun), Dry Cool Parkland Engelmann Spruce – Subalpine Fir (ESSFdkp), and Wet Mild Parkland Engelmann Spruce – Subalpine Fir (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 climates that support tree survival, but cold, short growing seasons and harsh winters create conditions where trees are stunted. Islands of trees occur in patchy clumps interspersed between herb- or shrub-dominated, high-elevation plant communities.

Woodland subzones occur below the parkland and reflect climates at the uppermost elevations where continuous forests occur. They occupy transitional areas between subalpine forests and the stunted tree clumps of parkland environments. Tree cover is extensive, but tree productivity is low in comparison to ESSF subzones below due to shorter growing seasons and increased snowpack. The Dry Cool Woodland Engelmann Spruce – Subalpine Fir (ESSFdkw) is described in Chapter 5. The Wet Mild Woodland Engelmann Spruce – Subalpine Fir (ESSFwmw) is described in LMH 70 (MacKillop and Ehman 2016). The high-elevation ecosystems described in this section are common in the IMA and parkland, frequently occur in the woodland, and sometimes occur in the upper ESSF, particularly on colder sites, including north-facing basins, near high-elevation lakes, and where cold air pools.

Interior Mountain-heather Alpine (IMA)

The IMA is the coldest, snowiest, harshest environment in the East Kootenay. In the field guide area, the IMA occurs above the ESSFdkp or ESSFwmp. Temperatures in the IMA are cold for most of the year, and high winds are common. Very deep snow, lasting for at least half the year, is common. In the IMA of the East Kootenay, snow accumulation typically begins in October and lasts through to June or early July.

Cold climatic conditions preclude establishment of trees in the IMA, although limited sites with occasional "shin tangle" or very low-growing krummholz-form Bl trees may occur. Dwarf shrub– or sedge-dominated plant communities are common throughout the IMA zone. A wide range of alpine ecosystems occurs in the IMA of the East Kootenay, including tundra (At), heath (Ah), meadow (Am), fellfield (Af), and late snowbed (As) site groups. Alpine grasslands (Ag) are very uncommon and occur most often on the driest, warm-aspect sites, largely in the Elk and Flathead valleys (see Section 6.4). Avalanche paths, particularly start zones and upper sections of tracks, are common (see Section 6.5). Non-vegetated rock and ice are also very common. Currently, no subzone/variant differentiation has been completed for the IMA,[1] although future mapping and delineation may occur.

Dry Cool Parkland Engelmann Spruce – Subalpine Fir (ESSFdkp)

The ESSFdkp occurs above the ESSFdkw. It covers an extensive area throughout the East Kootenay, including areas in the Purcell and Rocky Mountains. Although described as one biogeoclimatic unit here, users who require additional subdivisions can separate the ESSFdkp based on the ESSFdk variants that occur below: ESSFdkp1 and ESSFdkp2.

Open and clumpy stands of stunted Bl, with lesser amounts of Se, are the most common ecosystem across the ESSFdkp. Pa and La often grow on drier sites. In the parkland, trees are stunted in growth but may exceed 10 m in height, especially at lower elevations of the subzones. Alpine ecosystems,

[1] IMAun is the undifferentiated Interior Mountain-heather Alpine subzone; future work may lead to development of IMA subzones.

including tundra (At), meadows (Am), late snowbed (As), and fellfield (Af), are commonly interspersed with krummholz (Sk), while avalanche paths (Vs, Vh, Vt) are common in steep terrain (see Section 6.5). Alpine grasslands (Ag) are uncommon on dry sites with deep soils (see Section 6.4). Alpine heath (Ah) is occasionally present on sites with deep snow, while alpine wetlands (Wa) are restricted to seeps and saturated flats. Shrub carr (Sc-c) ecosystems are restricted to moist, frost-prone sites, and subalpine shrubland (Sc-b) occurs on cold, dry sites. Non-vegetated rock and ice are also common in the ESSFdkp.

Wet Mild Parkland Engelmann Spruce – Subalpine Fir (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. The ESSFwmp1 occurs in the southern Rocky Mountains of the field guide area. The ESSFwmp2 and ESSFwmp4 occur outside the field guide area in the Purcell Mountains west of, and adjacent to, the ESSFdkp. The ESSFwmp3 also occurs outside the East Kootenay area in the southern Selkirk Mountains.

In the ESSFwmp, open, clumpy tree patches are typically dominated by Bl, with lesser amounts of Se, La, or Pa. Trees are stunted in growth but may exceed 10 m in height, especially at lower elevations of the subzone. Pa and La occur throughout both the Purcell and Rocky Mountains. Alpine ecosystems, including tundra (At), meadows (Am), late snowbed (As), and fellfield (Af), are commonly interspersed with krummholz (Sk).[3] Avalanches (Vs, Vh, Vt) are common in steep terrain (see Section 6.5). Heath ecosystems (Ah) may occur on drier than mesic sites with deep snow, and alpine grasslands (Ag) are very uncommon on the driest, warm-aspect sites with deep soils (see Section 6.4). Alpine wetlands (Wa) are restricted to seeps and saturated flats (see Section 6.2). Non-vegetated rock and ice are also common in the ESSFwmp.

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[2] classes; the Subalpine Shrub Group includes two.

[2] Alpine wetlands are also described in Section 6.2.

Distribution of alpine and subalpine shrub site associations by biogeoclimatic unit[a]

Group	Class	Code	IMA	ESSFdkp	ESSFwmp	Woodland[b]
Alpine	Alpine meadow	Am	*	X	X	*
	Alpine grassland	Ag		*	*	*
	Alpine heath	Ah	*	*	*	*
	Alpine nivation (Late snowbed)	As	X	X	X	*
	Alpine tundra	At	X	X	X	*
	Alpine fellfield	Af	X	X	X	*
	Alpine zoogenic	Az	*	*	*	*
	Alpine wetland	Wa	*	*	*	*
Subalpine Shrub	Shrubland/Shrub carr	Sc		*	*	*
	Krummholz	Sk		X	X	*

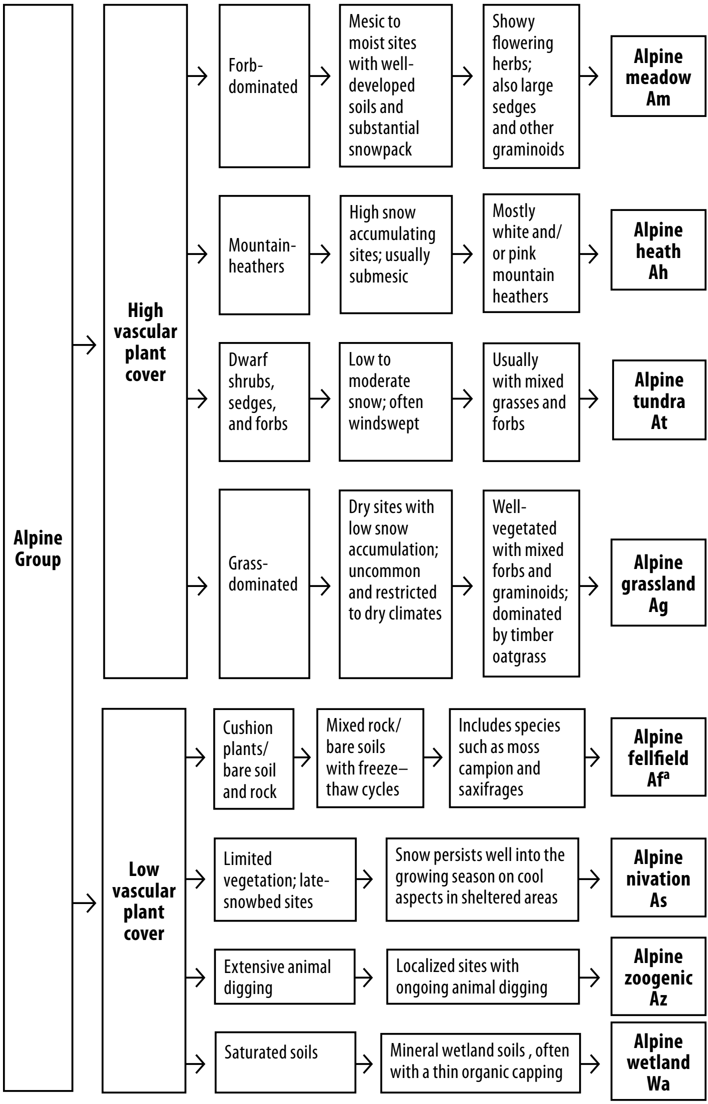
[a] Based on data and observations; "X" indicates ecosystems that occur more commonly; "*" indicates ecosystems that occur less frequently.
[b] Includes ESSFdkw and ESSFwmw.

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, scree, and ice characterize the landscape of the Alpine Group. Soils are often shallow and derived from weathered bedrock or colluvium. Non-vegetated areas are common.

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; slope and aspect; soil depth, texture, and temperature; frost; and exposure to wind. Eight site classes are described for the Alpine Group.

Flowchart – Alpine classes



[a] There are four subclasses for the Alpine Fellfield Class: Fellfield (Af-f), Rock (Af-r), Felsenmeer (Af-n), and Scree (Af-s).

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.). Plant communities dominated by large sedges (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. Snow accumulation is moderate and 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 very wet climates with very high snow accumulations and are uncommon in the parkland and IMA in the East Kootenay.

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. Mountain avens (*Dryas* spp.) is common in the field guide area on sites with base-rich soils. Alpine tundra ecosystems occur on relatively exposed, cold, submesic to mesic sites with moderate snow cover. They often occur on windswept, gentle terrain such as high-elevation plateaus and rounded ridges and summits. In wetter climates, they are often restricted to warmer aspects. These ecosystems are very common in the dry to moist climates of the East Kootenay.

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 sea-

son and harsh 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) represents exposed bedrock; Scree (Af-s) is characterized by mobile, rocky substrates; Felsenmeer (Af-n) occurs where rock has been broken into angular boulders or blocks by frost action; 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 (e.g., *Saxifraga* spp. or *Micranthes* spp.). The Fellfield Class does not include non-vegetated sites.

Alpine grassland (Ag)
Alpine grasslands are grass-dominated ecosystems of dry, cold climates with low snowload 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 that limit tree growth, rather than hot, dry summers and associated growing-season aridity. Where alpine grasslands occur (infrequently) in the East Kootenay, they are dominated by timber oatgrass instead of the fescues and bluebunch wheatgrass that characterize most lower-elevation grassland (Gg) ecosystems. Other ecosystems with grasses occur in the IMA, ESSFwmp, and ESSFdkp, 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 ESSFdkw, dkp, wmw, and wmp.

Alpine zoogenic (Az)
Communities that are strongly affected by ongoing animal activities occur in highly localized areas and have vegetation that is distinct from adjacent ecosystems. Marmots and ground squirrels are often responsible for perpetuation of these ecosystems.

Alpine wetland (Wa)
Alpine wetlands occur in the IMA, the ESSF parkland and woodland, and occasionally in cold-air basins in the upper portions of the ESSF. They occur on seeps and saturated flats that have site characteristics similar to those of 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 high elevations. Unlike fens and marshes, graminoid species are usually not dominant (except for black alpine sedge [*Carex nigricans*]). At the time of publication, no alpine wetland site associations had been described for the East Kootenay, although three Wa site associations are described for wetter climates in LMH 70 (MacKillop and Ehman 2016).

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 accumulation 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 or tall shrubs. Shrubs or shrub-height conifer trees are characteristic. As with forested ecosystems, soil moisture regime is the primary environmental gradient that differentiates subalpine shrub ecosystems at the site level. Two Subalpine Shrub classes are identified: Krummholz (Sk) and Shrubland/Shrub carr (Sc).

Krummholz (Sk)
Krummholz ecosystems occur at the upper elevation extremes for conifer tolerance. Trees grow slowly due to harsh climatic conditions, including cold growing-season temperatures, winter frost, and wind exposure and damage. Trees occur in clumpy patches and can be upright with stunted growth (more common at lower elevations) or deformed, shrubby, and gnarled with dwarf stature (shrub-size) (more common at upper elevations). Bl is typically the most common tree species, although Se is common and Pa or La may occur. Individual krummholz trees can exceed 10 m in height in southern British Columbia, but stands are significantly less productive than woodland forests at lower elevations.

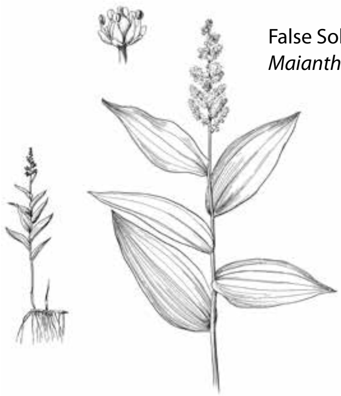
Krummholz sites are typically well to rapidly drained, with thin or coarse-textured soils. The thick, dense conifer patches are often interspersed with meadows (Am), tundra (At), and other alpine ecosystems. Some krummholz types are floristically similar to lower-elevation subalpine forests with species such as white-flowered rhododendron, black huckleberry, false-hellebore, grouseberry/low bilberry, wood-rushes, or Sitka valerian. Krummholz ecosystems are common in the ESSFwmp and ESSFdkp, and can occasionally occur on cold, wind-exposed 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 in climates 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) and shrubland (Sc-b).

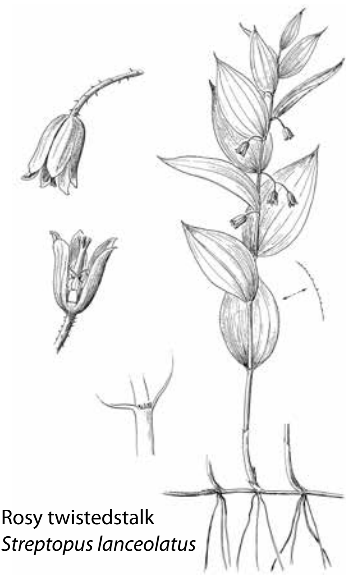
Shrub carr ecosystems (Sc-c) occur on moist and very moist sites. These are described in *Wetlands of British Columbia* (MacKenzie and Moran 2004) as occurring on sites with moist, cold mineral soils that are prone to cold-air pooling and frost. These "transitional ecosystems" do not flood, although groundwater is the primary source of moisture. Willows (*Salix* spp.) and scrub birch (*Betula nana*) are the dominant shrub species in the East Kootenay. MacKenzie and Moran (2004) recognize three shrub-carr site associations: *Sc01 Scrub birch – Kinnikinnick*, *Sc02 Grey-leaved willow – Glow moss*, and *Sc03 Barclay's willow – Arrow-leaved groundsel*. The Sc01 and Sc02 are most likely to occur in the East Kootenay.

Shrublands (Sc-b) occur on drier 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 East Kootenay. Shrublands differ from brushlands (Gb) in that cold air and growing-season frost are the dominant ecological drivers influencing vegetation, rather than hot, dry site conditions. Shrubland site associations have not yet been defined but are expected to be described in future publications.



False Solomon's-seal
Maianthemum racemosum

Hooker's fairybells
Prosartes hookeri



Rosy twistedstalk
Streptopus lanceolatus

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Sitka willow
Salix sitchensis

Drummond's willow
Salix drummondiana

Barclay's willow
Salix barclayi

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). Nomenclature for the scientific names of plants of North America is undergoing a widespread updating process, and changes are occurring at a rapid rate. These changes apply to both the scientific and common names of many plant species and genera. Some of these name changes are minor adjustments to subspecies and variations, while others reflect new information that separates one genus into multiple genera (e.g., what was formerly grouped in the *Aster* genus is now split into *Eurybia*, *Symphyotrichum, Canadanthus*, *Eucephalus*, and other genera). Efforts have been made to continue using the common name that is most frequently used in British Columbia, particularly where the scientific name has changed. Users may find common names helpful in researching updated plant scientific names.

This appendix includes four sections. Species grouped across genera but which have 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 (for both scientific and common names). A list of plant illustrations shown in this field guide is provided in Appendix 1.4.

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. However, due to the changes in nomenclature for many plants of North America, many plant species names are no longer current in published books. 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.	mitrewort
		Pectiantia breweri	Brewer's mitrewort
		Pectiantia pentandra	five-stamened mitrewort
	"saxifrages"	*Micranthes ferruginea*	Alaska saxifrage
		Micranthes spp.	saxifrage
		Saxifraga bronchialis	spotted saxifrage
		Saxifraga spp.	saxifrage
	"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.	leafy moss
		Rhizomnium magnifolium	large-leaf leafy moss
		Rhizomnium nudum	naked leaf moss
		Rhizomnium punctatum	dotted leafy moss
		Rhizomnium spp.	leafy moss
	"leafy liverworts"	*Barbilophozia barbata*	[no common name]
		Barbilophozia hatcheri	Hatcher's leafy wort
		Barbilophozia lycopodioides	common leafy liverwort
		Barbilophozia spp.	leafy liverwort
		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
	Berberis spp.	*Berberis aquifolium*	tall Oregon-grape
		Berberis nervosa	dull Oregon-grape
		Berberis repens	creeping Oregon-grape
	Rosa spp.	*Rosa acicularis*	prickly rose
		Rosa gymnocarpa	baldhip rose
		Rosa nutkana[c]	Nootka rose
		Rosa woodsii[c]	Wood's 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.[d]	*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
	Erigeron spp.	*Erigeron compositus*	cut-leaved daisy
		Erigeron corymbosus	long-leaved fleabane
		Erigeron filifolius	thread-leaved fleabane
		Erigeron pumilus	shaggy fleabane
		Erigeron speciosus	showy daisy
	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

Herbs	*Osmorhiza* spp.	*Osmorhiza berteroi*	mountain sweet-cicely
		Osmorhiza depauperata	blunt-fruited sweet-cicely
		Osmorhiza purpurea	purple sweet-cicely
	Penstemon spp.[e]	*Penstemon confertus*	yellow penstemon
		Penstemon procerus	small-flowered penstemon
	Penstemon spp.[f]	*Penstemon ellipticus*	oval-leaved penstemon
		Penstemon fruticosus	shrubby penstemon
	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
	Thalictrum spp.	*Thalictrum occidentale*	western meadowrue
		Thalictrum venulosum	veiny meadowrue
	Valeriana spp.	*Valeriana dioica*	wood valerian
		Valeriana sitchensis	Sitka valerian
	Viola spp.	*Viola adunca*	early blue violet
		Viola canadensis	Canada violet
		Viola glabella[g]	stream violet
		Viola orbiculata	round-leaved violet
		Viola palustris[g]	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.[h,i]	*Carex concinnoides*	northwestern sedge
		Carex hoodia	Hood's sedge
		Carex phaeocephala	dunhead sedge
		Carex rossii	Ross' sedge
	Carex spp.[h,j]	*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

Graminoids	*Carex* spp.[h,j]	*Carex illota*	sheep sedge
		Carex interior	inland 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
	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
	Bryum spp.	*Bryum argenteum*	silver-moss
		Bryum caespiticium	tufted thread-moss
		Bryum pseudotriquetrum	marsh thread-moss
	Cladina spp.	*Cladina arbuscula*	mesomorphic 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	bighorn pixie
		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

Mosses, lichens, liverworts	*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
	Racomitrium spp.	*Racomitrium canescens*	grey rock-moss
		Racomitrium elongatum	long rock-moss
		Racomitrium ericoides	shaggy rock-moss
		Racomitrium heterostichum	yellow-green rock-moss
	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] Included only in non-forest and IDF vegetation tables.
[d] Other knapweed species occur in the East Kootenay, but they were not sampled in the plots used to develop this classification.
[e] Herbaceous penstemons.
[f] Dwarf shrub penstemons.
[g] Moist sites only.
[h] Some *Carex* spp. occur on both moist and dry sites but are sorted here based on their most common affiliation. Where a specific *Carex* species is an indicator for a site unit, it is not lumped with other *Carex* spp. (e.g., in wetland classification).
[i] Dry-site sedge species.
[j] Moist- to wet-associated sedge species.

1.3 Recently changed plant names

The following table lists the species referred to in this field guide that have been assigned new names, 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*
	Berberis aquifolium	BERBAQU	tall Oregon-grape	*Mahonia aquifolium*[a]
	Berberis nervosa	BERBNER	dull Oregon-grape	*Mahonia nervosa*[a]
	Berberis repens	BERBREP	creeping Oregon-grape	*Mahonia repens*[a]
	Paxistima myrsinites	PAXIMYR	falsebox	*Pachistima myrsinites*
	Rhododendron columbianum	RHODCOL	trapper's tea	*Rhododendron neoglandulosum*[b]
	Rhododendron groenlandicum	RHODGRO	Labrador tea	*Ledum groenlandicum*
	Salix lasiandra	SALILAS	Pacific willow	*Salix lucida* ssp. *lasiandra*
	Salix pseudomonticola	SALIPSE	serviceberry willow	*Salix monticola*
	Spirea lucida	SPIRLUC	birch-leaved spirea[c]	*Spirea betulafolia*
Herbs	*Achillea borealis*	ACHIBOR	yarrow	*Achillea millefolium*[d]
	Anemone occidentalis	ANEMOCC	western pasqueflower	*Pulsatilla occidentalis*[e]
	Anticlea elegans	ANTIELE	mountain death-camas	*Zigadenus elegans*
	Boechera retrofracta	BOECRET	Holboell's rockcress[f]	*Arabis holboellii*
	Carex pellita	CAREPEL	woolly sedge	*Carex lanuginosa*
	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*

Lifeform	Current scientific name	Current code	Current common name	Retired/old scientific name
Herbs	*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*
	Prosartes hookeri	PROSHOO	Hooker's fairybells	*Disporum hookeri*
	Prosartes trachycarpa	PROSTRA	rough-fruited fairybells	*Disporum trachycarpum*
	Reynoutria japonica	REYNJAP	Japanese knotweed	*Fallopia japonica*[g]
	Reynoutria sachalinensis	REYNSAC	giant knotweed	*Fallopia sachalinensis*[g]
	Reynoutria × *bohemica*	REYNXBO	Bohemian knotweed	*Fallopia* x *bohemica*[g]
	Streptopus lanceolatus	STRELAN	rosy twistedstalk	*Streptopus roseus*
	Solidago glutinosa	SOLIGLU	spikelike goldenrod	*Solidago simplex*
	Symphyotrichum ciliolatum	SYMPCII	Lindley's aster	*Aster ciliolatus*
	Symphyotrichum foliaceum	SYMPFOL	leafy aster	*Aster foliaceus*
	Toxicoscordian venenosum	TOXIVEN	meadow death-camas	*Zigadenus venenosus*
	Trollius albiflorus	TROLALB	globeflower	*Trollius laxus*
Ferns	*Botrypus virginianus*	BOTRVIG	rattlesnake fern	*Botrychium virginianum*
	Cryptogramma acrostichoides	CRYPACR	parsley fern	*Cryptogramma crispa*
	Dryopteris expansa	DRYOEXP	spiny wood fern	*Dryopteris assimilis*

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*	PHRAAUS	American common reed	*Phragmites communis*
	Phragmites australis ssp. *australis*	PHRAAUS	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*
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*
	Syntrichia ruralis	SYNTRUR	sidewalk screw-moss	*Tortula ruralis*
	Sanionia uncinata	SANIUNC	sickle-moss	*Drepanocladus uncinatus*

[a] This change reverts back to the genus name used in the 1980s.
[b] Previously called *Ledum glandulosum*.
[c] Birch-leaved spirea is also referred to as "shiny-leaved meadow-sweet" or "white-flowered meadow-sweet" in some jurisdictions.
[d] *Achillea millefolium* is now used only for the non-native species of yarrow (likely a garden escapee); *A. borealis* is used for the native species.
[e] A reversion to *Pulsatilla* is being considered and may be implemented shortly after this field guide is published.
[f] Holboell's rockress is also referred to as "dangling suncress" or "reflexed rockcress" in some jurisdictions.
[g] Knotweeds were also called *Polygonum* spp.

1.4 Index of plant illustrations[a]

Larix occidentalis	western larch	486
Lonicera involucrata	black twinberry	142
Maianthemum racemosum	false Solomon's-seal	436
Menziesia ferruginea	false azalea	254
Micranthes ferruginea	Alaska saxifrage	426
Orthilia secunda	one-sided wintergreen	156
Penstemon confertus	yellow penstemon	369
Penstemon ellipticus	oval-leaved penstemon	425
Penstemon eriantherus	fuzzy-tongued penstemon	373
Phyllodoce empetriformis	pink mountain-heather	287
Pinus albicaulis	whitebark pine	292
Pinus flexilis	limber pine	292
Pinus ponderosa	ponderosa pine	486
Poa pratensis	Kentucky bluegrass	396
Prosartes hookeri	Hooker's fairybells	436
Pseudoregnaria spicata	bluebunch wheatgrass	363
Pseudotsuga menziesii	Douglas-fir	486
Purshia tridentata	antelope-brush	83
Rhododendron albiflorum	white-flowered rhododendron	254
Rhododendron columbianum	trapper's tea	182
Rhododendron groenlandicum	Labrador tea	182
Rubus pedatus	five-leaved bramble	260
Salix barclayi	Barclay's willow	446
Salix drummondiana	Drummond's willow	446
Salix sitchensis	Sitka willow	446
Saxifraga bronchialis	spotted saxifrage	426
Spiraea lucida	birch-leaved spirea	142
Streptopus lanceolatus	rosy twisted stalk	436
Thuja plicata	western redcedar	486
Toxicoscordion venenosum	meadow death-camas	6
Vaccinium caespitosum	dwarf blueberry	281
Vaccinium myrtillus	low bilberry	280
Vaccinium scoparium	grouseberry	280
Valeriana dioica	marsh valerian	240
Valeriana sitchensis	Sitka valerian	240

[a] Illustrations are from Douglas et al. (1998–2002), *Illustrated flora of British Columbia*.

APPENDIX 2 CROSSWALKS: BIOGEOCLIMATIC SUBZONES/ VARIANTS AND SITE SERIES

2.1 Biogeoclimatic subzone/variant crosswalk: old BEC to new BEC

OLD BEC	NEW BEC	Summary of changes
PPdh2	IDFxx2	Renamed with minor mapping adjustments in both Cranbrook and Invermere TSAs.
IDFxk[a]	IDFxk	Minor mapping adjustments; addition of first correlated site series for this unit.
IDFdm2	IDFdm2	Minor mapping adjustments in both Cranbrook and Invermere TSAs.
IDFdk5[b]	IDFdk5	Extended much further south, from Brisco to Columbia Lake; minor mapping adjustments in the north end.
MSdk1[c]	MSdw	Renamed with minor mapping adjustments. A small portion of IDFun near the Crownest Pass was merged with the MSdw.
MSdk2[c]	MSdk	Renamed with minor mapping adjustments.
ICHmk4[d]	ICHmk4	Now occurs only in the Cranbrook TSA. Northern portions of this unit are ICHmk5.[e]
ESSFwm[e]	ESSFwm1	Minor mapping adjustments.
ESSFwmw	ESSFwmw	Minor mapping adjustments above the ESSFwm1.
ESSFdk1[f]	ESSFdk1	Minor mapping adjustments.
ESSFdk2[f]	ESSFdk2	Minor mapping adjustments throughout; major changes to areas that abut the ESSFmm3.[g]
ESSFdkw	ESSFdkw	Minor mapping adjustments throughout; major changes to areas in TFL 14.

[a] The IDFxk was previously called IDFun.
[b] The IDFdk5 was previously mapped as IDFdm2N (until 2007) and managed as IDFdm2.
[c] Both the MSdk1 and MSdk2 were previously managed as MSdk.
[d] The ICHmk4 was previously managed as ICHmk1.
[e] The ESSFwm1 was previously managed as ESSFwm; other areas of ESSFwm are now mapped and managed as ESSFwm2 (MacKillop and Ehman 2016) and ESSFmm3 (to be described in a future BEC field guide).
[f] Both the ESSFdk1 and ESSFdk2 were previously managed as ESSFdk.
[g] The ICHmk5 and ESSFmm3 will be described in a future BEC field guide.

2.2 Site series crosswalk: new site series to old site series

TABLE 1 *IDF, MS, and ICH site series crosswalk*[a,b]

Current site unit	IDFxx2	IDFxk[c]	IDFdm2	IDFdk5[d]	MSdw	MSdk	ICHmk4
101	(PPdh2/01[e])	No match	IDFdm2/01	IDFdm2/01	MSdk/01	MSdk/01	ICHmk1/01
102	No match	No match	(IDFdm2/03)	(IDFdm2/03)	(MSdk/02) (MSdk/03)	(MSdk/02)	ICHmk1/02
103	(PPdh2/01)	No match	IDFdm2/03	IDFdm2/03	MSdk/03	MSdk/03	ICHmk1/03 ICHmk1/04
104	PPdh2/01	No match	(IDFdm2/01)	(IDFdm2/01)	MSdk/04	(MSdk/04)	–
105	–	No match	–	–	–	MSdk/04	–
110	(PPdh2/01) (PPdh2/03)	No match	IDFdm2/04	IDFdm2/05 (IDFdm2/04)	MSdk/05	MSdk/05	ICHmk1/06
111	(PPdh2/03)	No match	IDFdm2/05	IDFdm2/07	MSdk/06	MSdk/06	(ICHmk1/06)
112	–	No match	IDFdm2/07	–	MSdk/07	MSdk/07	ICHmk1/07
113	–	No match	–	–	–	–	–

[a] Old site series are defined in LMH 20 (Braumandl and Curran 1992).
[b] Old site series shown in brackets represent a poor fit to the new unit. This may be due to mapping changes or new site series concepts. "–" indicates no site series has been assigned that number.
[c] The IDFxk was formerly named IDFun and had no site series classification.
[d] The IDFdk5 was previously mapped as IDFdm2N and managed as IDFdm2. The IDFdk5 contains all secondary crosswalks because this is the first correlated site series classification.
[e] PPdh2/01 is a better fit to the IDFxx2/104 than the IDFxx2/101.

TABLE 2 *ESSF site series crosswalk*[a,b]

Current site unit	ESSFdk1	ESSFdk2	ESSFdkw[c]	ESSFwm1[d]	ESSFwmw[c]
101	ESSFdk/01	ESSFdk/01	(ESSFdk/01)	ESSFwm/01	(ESSFwm/01)
102	ESSFdk/02	ESSFdk/02	(ESSFdk/02)	ESSFwm/02	(ESSFwm/02)
103	(ESSFdk/02) (ESSFdk/04)	(ESSFdk/02) (ESSFdk/04)	(ESSFdk/03) (ESSFdk/04)	ESSFwm/02	(ESSFwm/02)
104	ESSFdk/03 (ESSFdk/04)	ESSFdk/03 (ESSFdk/04)	–	ESSFwm/02 (ESSFwm/03)	–
110	(ESSFdk/05)	–	(ESSFdk/06)	(ESSFwm/01) (ESSFwm/04)	(ESSFwm/04)
111	ESSFdk/06	(ESSFdk/05)	–	(ESSFwm/04)	–
112	–	ESSFdk/06	–	–	–

[a] Old site series are defined in LMH 20 (Braumandl and Curran 1992).
[b] Old site series shown in brackets represent a poor fit to the new unit. This may be due to mapping changes or new site series concepts. "–" indicates no site series has been assigned that number.
[c] The ESSFdkw and ESSFwmw contain all secondary crosswalks because this field guide presents the first correlated site series classifications for these units.
[d] The ESSFwm in LMH 20 (Braumandl and Curran 1992) described a very large area that included the area that is now mapped as ESSFwm1, as well as most of the Purcell Mountains. The old classification is a relatively poor fit for all site series in the ESSFwm1.

APPENDIX 3 KEYS AND CODES

APPENDIX 3.1 SOIL MOISTURE AND NUTRIENT REGIMES

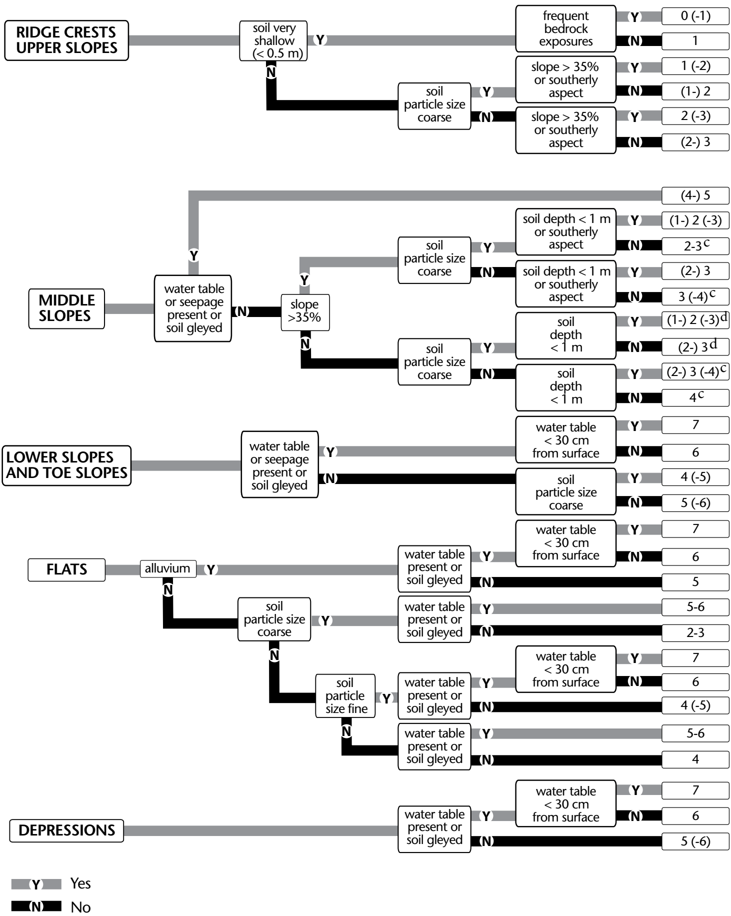
3.1.1 Definitions of terms used in the keys to identification of relative soil moisture and nutrient regimes[a]

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 toward 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.
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] or 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 positions in Chapter 3 of this handbook.
[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 Appendix 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).

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 > 20 cm (-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

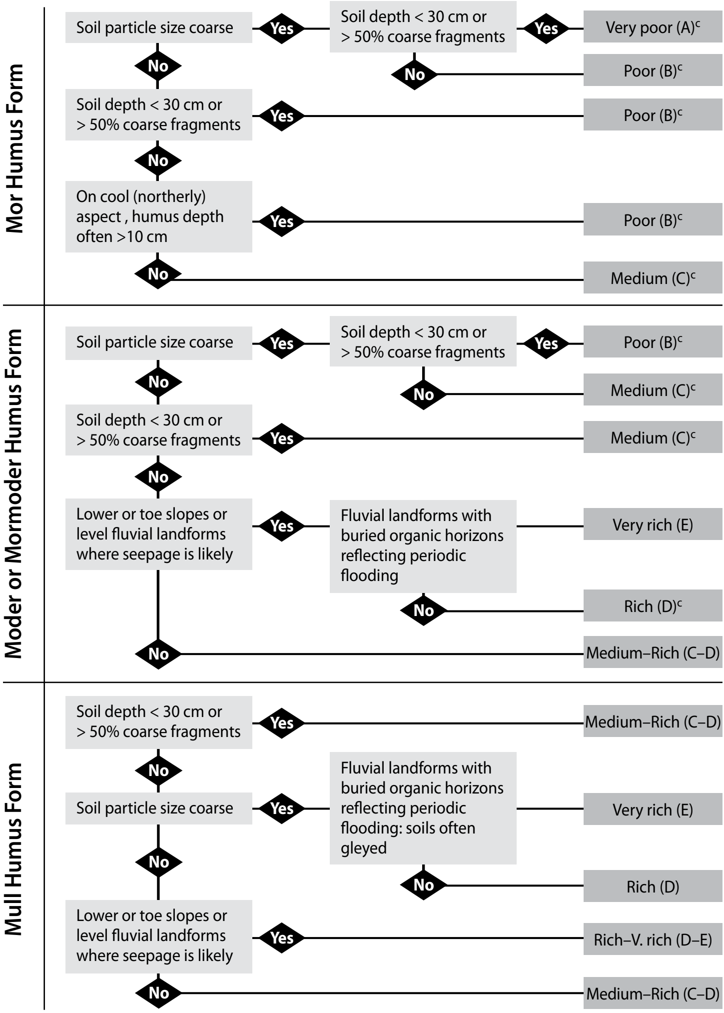
[a] Adapted from Lloyd et al. (1990). Appendix 3.5.2 provides information on rock types and their colour, size, and hardness.

3.1.3.2 Table for estimation of soil nutrient regime[a]

<table>
<tr><th></th><th></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 colspan="2">Available nutrients</td><td>very low</td><td>low</td><td>average</td><td>plentiful</td><td>abundant</td></tr>
<tr><td colspan="2" 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 colspan="2" 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 colspan="2" 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 colspan="2" 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 colspan="2">Soil texture</td><td>very coarse</td><td>coarse</td><td>medium</td><td>fine</td><td>very fine</td></tr>
<tr><td colspan="2">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 colspan="2" rowspan="2">Slope position related to seepage</td><td>upper</td><td></td><td>mid</td><td></td><td>lower</td></tr>
<tr><td>shedding</td><td></td><td>normal</td><td></td><td>receiving</td></tr>
<tr><td colspan="2" 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 rowspan="4">Coarse fragment type</td><td>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 colspan="2" 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 colspan="2">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 colspan="2">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,b]



[a] From Delong et al. (2010).
[b] See Appendix 3.1.1 for definitions of terms used in this key.
[c] On sites dominated by mature broadleaf trees, increase nutrient regime class by one category (e.g., medium to rich).

APPENDIX 3.2 SOIL TEXTURE

Soil textures can be accurately assessed only 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

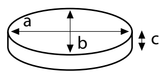
Soil texture refers to the relative proportions of **sand**, **silt**, and **clay** within a soil. These particles are referred to collectively as the **"fine fraction."** Coarse fragments also contribute to the overall characteristics of a soil.

> 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 473.
>
> **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. **Clay** forms hard lumps when dry, 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 and form stronger "casts" and longer, stronger "worms" (see "Tests used in hand texturing" on page 471). 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 473) 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 use 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 473. 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 (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

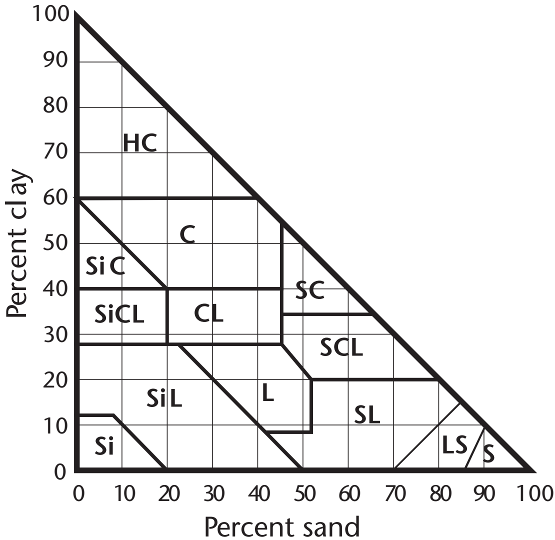
1. Determine **stickiness** and then **graininess** of the soil sample by working it between the thumb and forefinger, pressing and then separating the digits. Estimates of clay and sand content can be made using the categories on page 470.
2. After stickiness and graininess have been determined, use **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

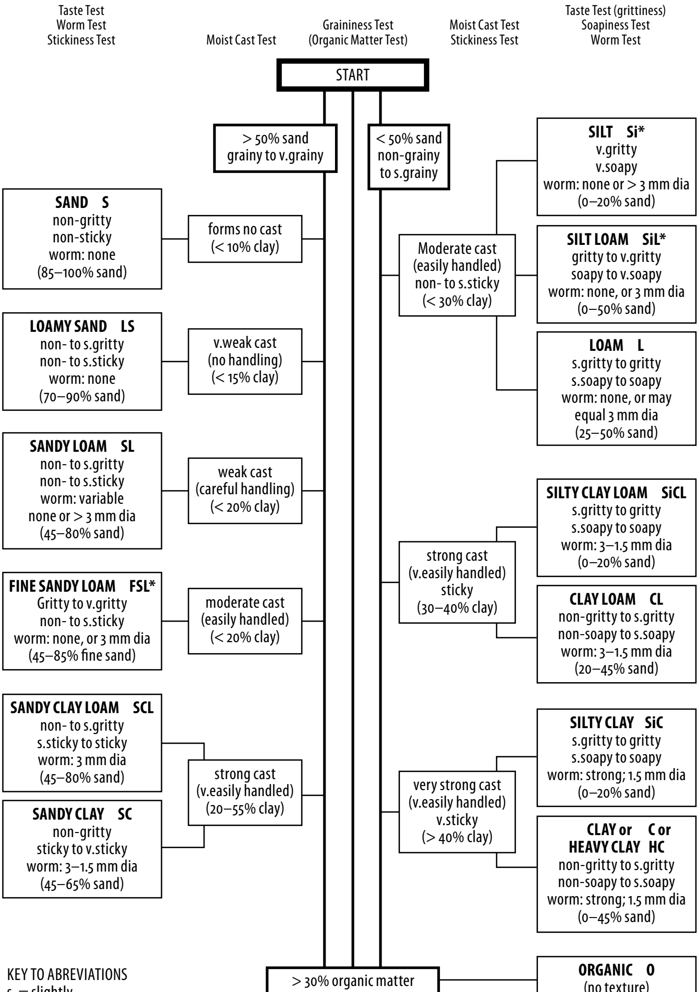
[a] Sand and clay limits are approximate.
[b] Loams contain balanced proportions of sand, silt, and clay and exhibit physical properties intermediate between them.

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

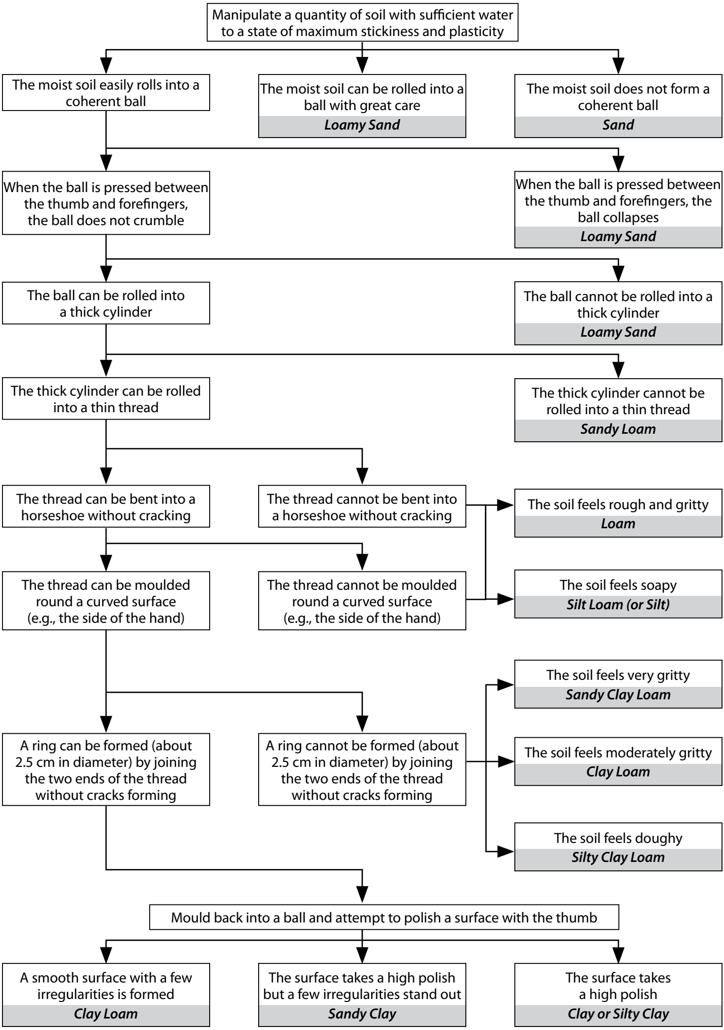
3.2.4 Soil texturing key 2: Traditional method



KEY TO ABREVIATIONS
s. = slightly
v. = very
dia. = diameter
* Silt feels slippery or soapy when wet; fine sand feels stiffer, like fine sandpaper. See particle size descriptions on p. 469.

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

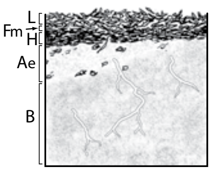
Full descriptions can be found in Green et al. (1993).

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).

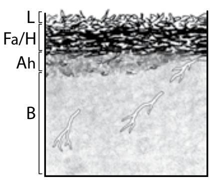
S layer – living layer of mosses, lichens, or hepatics.
L horizon – the organic (litter) horizon at the surface consisting of relatively fresh, undecomposed organic material.
F horizon – the organic (fermented) horizon consisting of partially decomposed organic material (below the L horizon).
H horizon – the organic (humic) horizon consisting of well-decomposed organic material (below the F horizon).

HUMUS FORM ORDERS

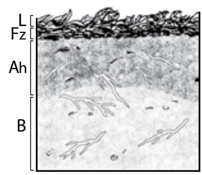
Mor
- L,F,H horizons prominent.
- matted "Fm" dominant; fungal mycelia often abundant.
- usually abrupt transition to mineral soil.



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 CANADIAN SYSTEM OF SOIL CLASSIFICATION[1]

3.4.1 Key to Soil Orders[a]

Soil Order	Diagnostic Horizon	Description	Criteria
Chernozemic	Ah, Ahe	A grassland soil whose diagnostic horizon is formed by high levels of organic matter additions from the roots of grasses.	Ah or Ahe ≥ 10 cm thick in grassland environments with mean annual temp ≥ 0° C
Solonetzic	Bn or Bnt	A grassland soil with high sodium (salt) levels in the B horizon; usually associated with a clay-rich B horizon and often with saline C horizon material.	Found in alkaline/saline meadows (Ga; see Section 6.4)
Podzolic	Bf, Bhf, or Bh	A forest soil normally associated with coniferous vegetation on igneous-rock derived parent materials. High acidity in the A horizon results in formation of a bleached Ae horizon and deposition of iron and aluminum in the B horizon.	Bf, Bhf, Bh ≥ 10 cm
Luvisolic	Bt	A forest soil found in areas with parent materials derived from sedimentary rocks. Dominant process is eluviation of clay from the Ae horizon and its deposition in the Bt horizon.	Bt horizon > 5 cm thick
Brunisolic	Bm, Bfj, or Btj	A forest soil whose properties are not strongly enough developed to meet the criteria for the Luvisolic or Podzolic Orders.	Bm, Btj, or Bfj ≥ 5 cm; Bf ≤ 10 cm
Gleysolic	Bg, Cg	Found throughout Canada wherever temporary or permanent water saturation causes formation of gleyed features in the profile.	Strong evidence of mottles or gleying ≤ 50 cm of the surface
Cryosolic	By, Cy, Cz	A soil of Arctic, tundra, and alpine regions; characterized by presence of permafrost.	Permafrost within 1 m of the surface; 2 m if high cryoturbation
Organic	O horizon	Organic soils are associated with the accumulation of organic materials (peat) in water-saturated conditions. They are most commonly associated with wetlands.	O horizon > 40 cm thick
Regosolic	No B horizon	Found throughout Canada wherever pedogenic (soil-forming) conditions prevent the formation of B horizons (unstable slopes, sand dunes, floodplains, etc.).	Soil ≥ 10 cm thick, but not meeting any of the above criteria

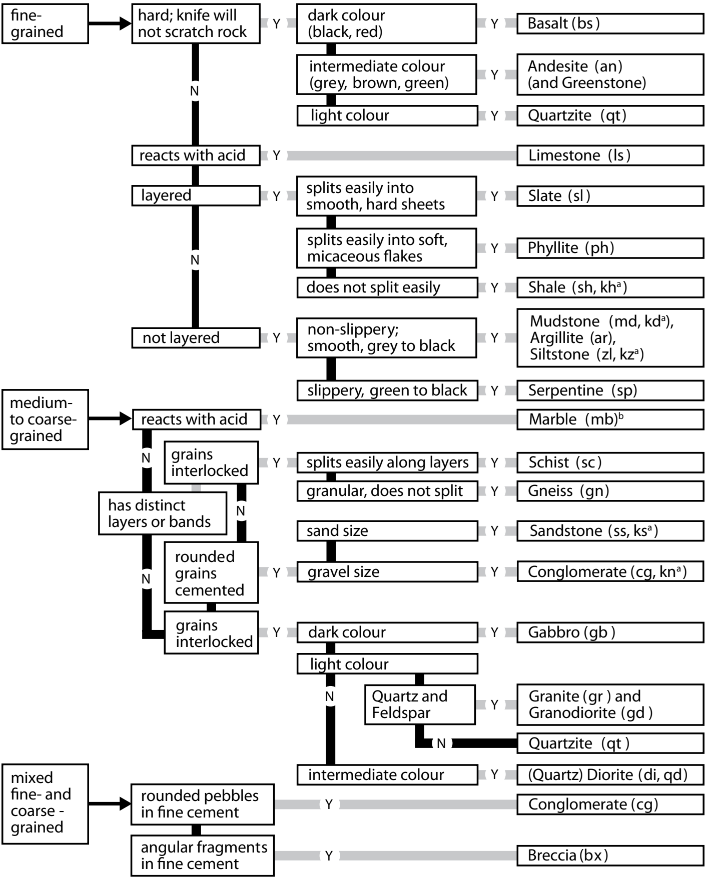
[a] Modified from SoilWeb200, University of British Columbia (Krzic et al. 2013).

3.4.2 Common Soil Order modifiers[a]

Soil Order modifier	Applicable Soil Orders	Key features
Eutric	Brunisol	pH ≥ 5.5
Dystric	Brunisol	pH < 5.5
Melanic	Brunisol	pH ≥ 5.5 and Ah ≥ 10 cm
Sombric	Brunisol	pH < 5.5 and Ah ≥ 10 cm
Eluviated	Many	Ae or Ahe > 2 cm
Gleyed	Many	Bg or Bgj (mottling)
Humic	Gleysol, Regosol	Ah ≥ 10 cm
Ferro-Humic	Podzol	Bhf ≥ 10 cm
Humo-Ferric	Podzol	Bf ≥ 10 cm
Cumulic	Regosol	Ahb and Cb
Orthic	Many	None of the above

[a] More detailed soil classification information can be found in Describing Terrestrial Ecosystems in the Field (LMH 25; Province of British Columbia 2010) and the *Canadian System of Soil Classification* (Soil Classification Working Group 1998).

3.5.1 Key to common rock types of British Columbia



Adapted from Braumandl and Curran (1992) and Lloyd et al. (1990).

[a] Both calcareous 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.

3.5.2 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
Sedi-mentary	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
	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.

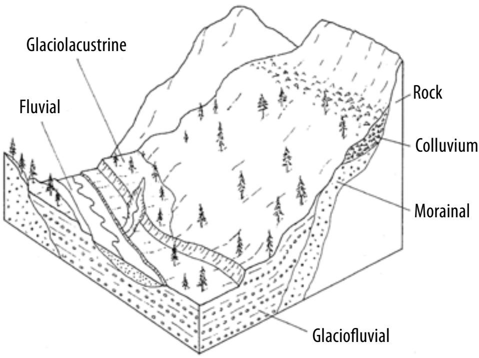
APPENDIX 3.6 COMMON SURFICIAL MATERIALS IN SOUTHEAST BRITISH COLUMBIA[a]

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. There are three types of till. **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. Colluvium can be talus or soil. It 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 little or no coarse fragments. Eolian materials 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 were derived from melting glaciers and 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-glacial) 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 10 cm of soil	Exposed bedrock commonly occurs on steep slopes and crests but also 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 3.7 TREE SPECIES CODES [a,b,c]

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**	
subalpine 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

[a] Data Custodian: Director, Forest Analysis and Inventory Branch.

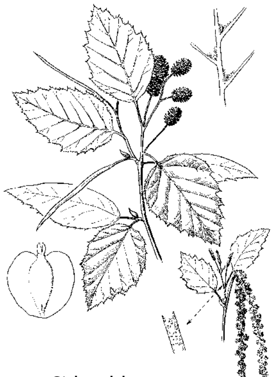
[b] Trees are defined as being woody, single stemmed, and capable of growing to greater than 10 m in height.

[c] A full list of native and non-native trees species codes is provided in LMH 25 (Province of British Columbia 2010).

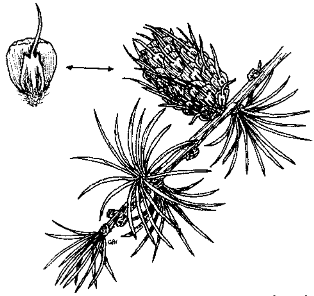
Native Hardwoods

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. lasiandra*		Wp
Scouler's willow	*S. scouleriana*		Ws
Sitka willow	*S. sitchensis*		Wt

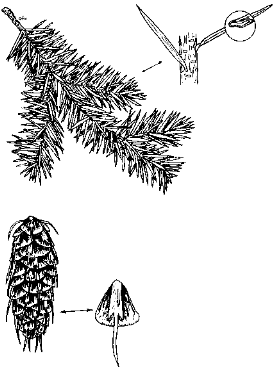
Paper birch
Betula papyrifera



Sitka alder
Alnus viridis ssp. *sinuata*

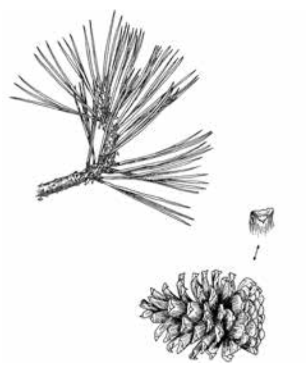


Western larch
Larix occidentalis



Douglas-fir
Pseudotsuga menziesii

Western redcedar
Thuja plicata



Ponderosa pine
Pinus ponderosa

APPENDIX 3.8 VISUAL ESTIMATES OF PERCENT COVER

3.8.1 Tips for visual estimates of percent cover

Equivalent dimension-to-percent cover relationships for a 400 m² plot

Percent cover equivalent in 400 m²	Dimensions	Equivalent Area
0.01%	20 x 20 cm	400 cm² (0.04 m²)
0.1%	63 x 63 cm	0.4 m²
0.25%	1 x 1 m	1 m²
1%	2 x 2 m	4 m²
5%	4 x 5 m	20 m²
10%	6.3 x 6.3 m	40 m²
25%	10 x 10 m	100 m²

- 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 m² 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 m² 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 m² (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 m² plot area (3.99 m radius plot) would be calculated as:

  (1% x 50 m²) = 0.5 m²

  sqrt(0.5 m²) = 0.7 m

  Therefore, 1% of a 50 m² plot is equivalent to 70 x 70 cm
- **Always compare estimates to the visual comparison charts (Appendix 3.8.2)as a cross-checking measure.**

3.8.2 Comparison charts for visual estimation of foliage cover