LAND MANAGEMENT HANDBOOK

78

A Guide to Provincial Information on Ecosystems and Ecological Communities in Coastal British Columbia

2025

BRITISH COLUMBIA

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Jackie Churchill, Heather Klassen, Sari Saunders, Michael Stefanyk, and Jason Straka

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This document provides users and producers of ecosystem-based information, data, and mapping in coastal British Columbia with provincial information on ecosystem classification, identification, delineation, conservation status, and management. It also provides clarification on terms used when discussing ecosystem information from provincial publicly available mapping, databases, and planning documents, including how ecological communities relate to ecosystems. Finally, this document notes where to find information through provincial internet resources and partner agencies, and whom to contact for additional information. This material has been developed by provincial ecologists from the British Columbia Ministry of Forests and Ministry of Water, Land and Resource Stewardship.

In data and mapping developed and managed by the British Columbia government, terrestrial[1] ecosystems are classified according to the Biogeoclimatic Ecosystem Classification (BEC) system, a hierarchical classification that combines four classifications: climate, site, vegetation, and seral (i.e., successional stage) (Pojar et al. 1987; Meidinger and Pojar 1991). For the purposes of BEC, a terrestrial ecosystem is a unit or portion of the landscape, inclusive of the life on and in it. In BEC, the site association is the basic unit of site classification and includes all ecosystems capable of developing vegetation that belongs to the same plant association at the mature successional stage of vegetation development. Site series are subdivisions of site associations, which are further divided based on the climatic conditions of the biogeoclimatic subzone or variant where the site series occurs.

The British Columbia Conservation Data Centre (B.C. CDC), a member of the international NatureServe network, uses the term "ecological community" to refer to ecosystems in British Columbia. In practice, an ecological community is typically defined by a characteristic suite of plant species and environmental conditions. Examples include plant associations from the vegetation classification of the BEC system and other natural plant communities from outside of BEC. Ecological communities are referred to by a scientific name or an English name that usually consists of the assemblage of characteristic plants.

To spatially represent terrestrial ecosystems in British Columbia, ecosystem mapping is used in accordance with established provincial Resources Information Standards Committee (RISC) standards and the Terrestrial Ecosystem Information System (TEIS). The TEIS includes the development, management, and provision of Terrestrial Ecosystem Information (TEI) standards, tools for accessing information, systems for storing data, support for end-users, training materials, and websites for submitting and accessing data. Examples of ecosystem mapping products include Broad Ecosystem Mapping, Terrestrial Ecosystem Mapping, and Predictive Ecosystem Mapping.

In British Columbia, the most common way ecological communities are identified and mapped is by identifying the BEC site series or site association, and then translating (i.e., crosswalking) this classification to a potential plant association or ecological community. The B.C. CDC maps known locations of ecological communities at risk as element occurrences (EOs) following the NatureServe methodology (NatureServe 2002).

The B.C. CDC also uses methods and standards established by NatureServe (Faber-Langendoen et al. 2012; Master et al. 2012a; Master et al. 2012b) to complete assessments of conservation status for ecological communities. The B.C. CDC assigns subnational (S) ranks to ecological communities and then groups them into Red, Blue, or Yellow Lists as a way of simplifying status ranks for communication purposes. In British Columbia, ecological communities at risk are those that have been assigned a status rank corresponding to the Red (i.e., extirpated, endangered, or threatened) or Blue (i.e., special concern, formerly referred to as "vulnerable") Lists. Ecological communities assigned a Yellow status rank are apparently secure and not at risk of extirpation.

Conservation and management of ecosystems and ecological communities is supported through legislation, policy, and management strategies. In British Columbia, several pieces of legislation, legal orders, policy, and management strategies pertain directly or indirectly to ecosystems and ecological communities. Examples include provincial legislation (e.g., *Forest and Range Practices Act* and *Water Sustainability Act*), Great Bear Rainforest Land Use Objectives Order, coastal Strategic Land Use Plans, management strategies for select ecosystem types (e.g., Garry oak ecosystems), and provincial and local government environmental assessment processes, status reports, and forest management certification. Data and resources for identifying, locating, and stewarding terrestrial ecosystems are available through multiple provincial agencies and partner groups.

1 For the purposes of this document, the term "terrestrial" includes terrestrial and terrestrial interface realms.

A Ministry of Forests (FOR) and Ministry of Water, Land and Resource Stewardship (WLRS) working group produced this guide based on the framework and original content compiled by Laurie Kremsater (consultant in forest wildlife ecology and management) in 2013, followed by updates by Adrian de Groot (Vegetation Ecologist, Drosera Consulting) in 2015.

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ACRONYMS AND INITIALISMS

Acronym/Initialism	Definition
AOO	Area of Occupancy
BAPID	Business Area Project Identifier
B.C. CDC	B.C. Conservation Data Centre
BCSEE	BC Species and Ecosystem Explorer
BCTS	BC Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
BEI	Broad Ecosystem Inventory
BEM	Broad Ecosystem Mapping
BEMVRI	Broad Ecosystem Mapping and Vegetation Resource Inventory
BEU	Broad Ecosystem Unit
BGC	Biogeoclimatic
BMP	Best management practice
CDFAE	Coastal Douglas-fir and associated ecosystems
CDFCP	Coastal Douglas-fir Conservation Partnership
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DEM	Digital elevation model
EAO	Environmental Assessment Office
EIA	Ecological Integrity Assessment
EIRS BDP	Environmental Information Resources System for Biodiversity
EIRS EP	Environmental Information Resources System for Environmental Protection
EP	Ministry of Environment and Parks
EO	Element occurrence
FOR	Ministry of Forests
FRPA	*Forest and Range Practices Act*
GBRLUOO	Great Bear Rainforest Land Use Objectives Order
GBRO	Great Bear Rainforest Order
GOERT	Garry Oak Ecosystems Recovery Team
LiDAR	Light Detection and Ranging
LMH	Land Management Handbook
LRMP	Land and Resource Management Plan
nBEC	Biogeoclimatic Ecosystem Classification for non-forested ecosystems
NEM	Terrestrial Ecosystem Mapping without bioterrain
PEM	Predictive Ecosystem Mapping
QA/QC	Quality assurance/quality control
RAPR	Riparian Areas Protection Regulation
RISC (previously RIC)	Resources Information Standards Committee
SCCP	South Coast Conservation Program
SEI	Sensitive Ecosystem Inventory
SOIL	Soil Inventory Mapping
SPEA	Streamside protection and enhancement area
TEI	Terrestrial Ecosystem Information
TEIS	Terrestrial Ecosystem Information System
TEM	Terrestrial Ecosystem Mapping
TEMNSS	Terrestrial Ecosystem Mapping with no structural stage
TRIM	Terrain Resource Information Management
VILUP	Vancouver Island Land Use Plan
VRI	Vegetation Resources Inventory
WET	Wetland Mapping
WLRS	Ministry of Water, Land and Resource Stewardship
WSA	*Water Sustainability Act*

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British Columbia contains a diverse range of **ecosystems**[1] that support many thousands of plant and animal species. The health, security, and quality of life for all depend on the structure (arrangement of features), composition (set of species), and function (interactions or processes) of ecosystems. Healthy ecosystems provide important **ecosystem services** to people, such as food, clean drinking water, clean air, flood control, cultural services and recreation, economic resources (e.g., timber, fisheries, ecotourism), and **habitat** for British Columbia's plants and animals. The management of ecosystems is important for land use planning and biodiversity conservation, leading to sustainable resource management. Increasing the understanding of ecosystem identification and classification, and the role of ecosystems as elements of biodiversity with conservation status ranks and recovery objectives, is important to appropriately manage and conserve ecosystems in coastal British Columbia.

This document provides users and producers of ecosystem-based information, data, and mapping in coastal British Columbia with information on ecosystem classification, identification, status, conservation, and management. The classifications and definitions provided are applicable province-wide, while the examples and guidance materials are specific to coastal British Columbia. In this document, coastal British Columbia includes the West Coast, South Coast, and coastal portions of the Skeena Natural Resource Regions, which encompass all coastal areas of British Columbia. Because numerous ecosystem-based resources, including technical reports, data, spatial mapping, and legislation, are available through government websites and databases, only key concepts and basic information are summarized within this guide. The aim is to provide guidance and support to land managers, planners, and natural resource professionals in coastal British Columbia in fulfilling their responsibilities for stewardship and conservation.

1.1 Purpose

This document has the following objectives:

- outline how ecosystems are classified and relate to ecological communities (Section 2.0)
- describe how ecosystems are mapped (Section 3.0)
- describe how ecological communities are mapped, assessed, and ranked for conservation status (Section 4.0)
- provide information on current management and conservation of ecosystems and ecological communities in coastal British Columbia (Section 5.0)
- provide information and resources to support management of ecosystems and ecological communities (Section 6.0)
- provide contacts for additional advice and support in identifying and understanding ecosystems and ecological communities in the context of provincial data sources, classifications, and management (Section 7.0).

1.2 Collaboration with Indigenous Peoples

In the spirit of reconciliation and in alignment with the *Declaration on the Rights of Indigenous Peoples Act*, the Province is working toward shared natural resource decision-making with First Nations to incorporate Indigenous Knowledge in these processes. The concepts presented in this guide are based on scientific principles that may not fully encapsulate or reflect Indigenous Knowledge.

Collaborating and sharing decision-making with First Nations is the best way to develop joint priorities that reflect Indigenous Knowledge, values, and practices within ecosystems. To advance reconciliation with Indigenous Peoples in the province, we must create an ethical space[2] to collaborate with our First Nations partners and engage as early as possible when assessing and making land management decisions that involve ecosystems. Ethical space is a place to embrace multiple knowledge systems, where they are validated and respected (also called "two-eyed seeing"), and where it is possible to arrive at joint decisions arising out of mutually agreed upon protocols (First Nations-BC Wildlife and Habitat Conservation Forum 2018).

To identify which First Nations may be interested in providing input on a project within an area of interest, access the Contacts for First Nations Consultation Areas public map service at: https://maps.gov.bc.ca/ess/hm/cadb/.

1 To aid the reader, select terms are bolded on first use and are defined in the Glossary at the end of the document.

2 "Ethical space is formed when two societies, with disparate worldviews, are poised to engage each other" (Ermine 2007).

Care must be taken to engage all potentially affected and interested First Nations communities because they each have their own unique Indigenous Knowledge, values, social needs, and economic structures.

Additional resources on engaging First Nations and on the Province's legal obligations to consult and accommodate are provided at:
https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/consulting-with-first-nations

1.3 What are Ecosystems?

Ecosystems are complex and dynamic systems of biological (biotic) and non-biological (abiotic) features interacting as a functional unit at a given scale, location, and time. Biological components (e.g., plants, animals, and other organisms), physical components (e.g., soil, water, and physiography), and processes or interactions (e.g., climate or natural disturbances) are all important components of ecosystems. In practice, one way of characterizing ecosystems is by a **plant community** (a unit of vegetation with relatively uniform species composition and physical structure) and the site and soil conditions on which it occurs (Meidinger and Pojar 1991). An ecosystem has geographical boundaries; its size is determined by the extent of the plant community and the associated abiotic conditions. Ecosystems are typically relatively homogeneous in composition, structure, and function; however, individual ecosystems can show some variation in their biotic and abiotic features. While boundaries between ecosystems on the landscape can be abrupt, ecosystems more often tend to transition gradually from one into another.

2 HOW AND WHY DO WE CLASSIFY ECOSYSTEMS?

Ecologists in British Columbia classify ecosystems in specific ways to facilitate inventory, management, and conservation. Ecosystem classification provides a framework for describing, understanding, and studying diverse landscapes, predicting outcomes of management or disturbance, and understanding trends and potential future conditions. Classification also provides a standardized language for scientific and administrative communication.

2.1 Biogeoclimatic Ecosystem Classification

In British Columbia, the standard way of classifying **terrestrial ecosystems** is according to the **Biogeoclimatic Ecosystem Classification (BEC)** system (Pojar et al. 1987; Meidinger and Pojar 1991; MacKenzie and Meidinger 2017). BEC is used to identify and delineate different ecosystems and support sound ecological management decisions. BEC is currently managed at provincial and regional levels by the BEC program within the British Columbia Ministry of Forests. Each of the eight Natural Resource Regions in the province manage and continue to refine their own classification and mapping of BEC units, which are then co-ordinated and standardized at the provincial level.

The BEC system is a hierarchical system that combines four classifications: climate, site, vegetation, and seral (i.e., successional stage) (Figure 1). Users interact primarily with the climate (zonal) (through biogeoclimatic mapping) and site (through field guides and ecosystem mapping) classifications. The vegetation classification is used in delineating, naming, and correlating (standardizing) units based on vegetation in a correlation hierarchy. The seral classification is used in other regions of the province (e.g., MacKillop et. al. 2021) but has not been developed for coastal British Columbia.

2.1.1 Climate classification

Broad geographic areas (regional ecosystems) influenced by similar regional climates are classified into **biogeoclimatic (BGC) units** in the climate (zonal) classification of the BEC system. Latitude, longitude, and elevation all influence distributional patterns of BGC units.

In the hierarchy of climatic units, the **biogeoclimatic subzone** is the basic unit; subzones are grouped into zones and divided into variants. Each biogeoclimatic subzone has a distinct and characteristic combination of plant species **(plant association)** in mature and old forests on zonal sites. **Zonal sites** are intermediate in soil moisture and nutrient conditions, and generally occur on a mid-slope position, with moderately deep soils of medium texture. These sites are not overly influenced by local site conditions such as slope, aspect, and cold air drainage. The late-successional vegetation on zonal sites is considered to best reflect the regional climatic conditions of the subzone.

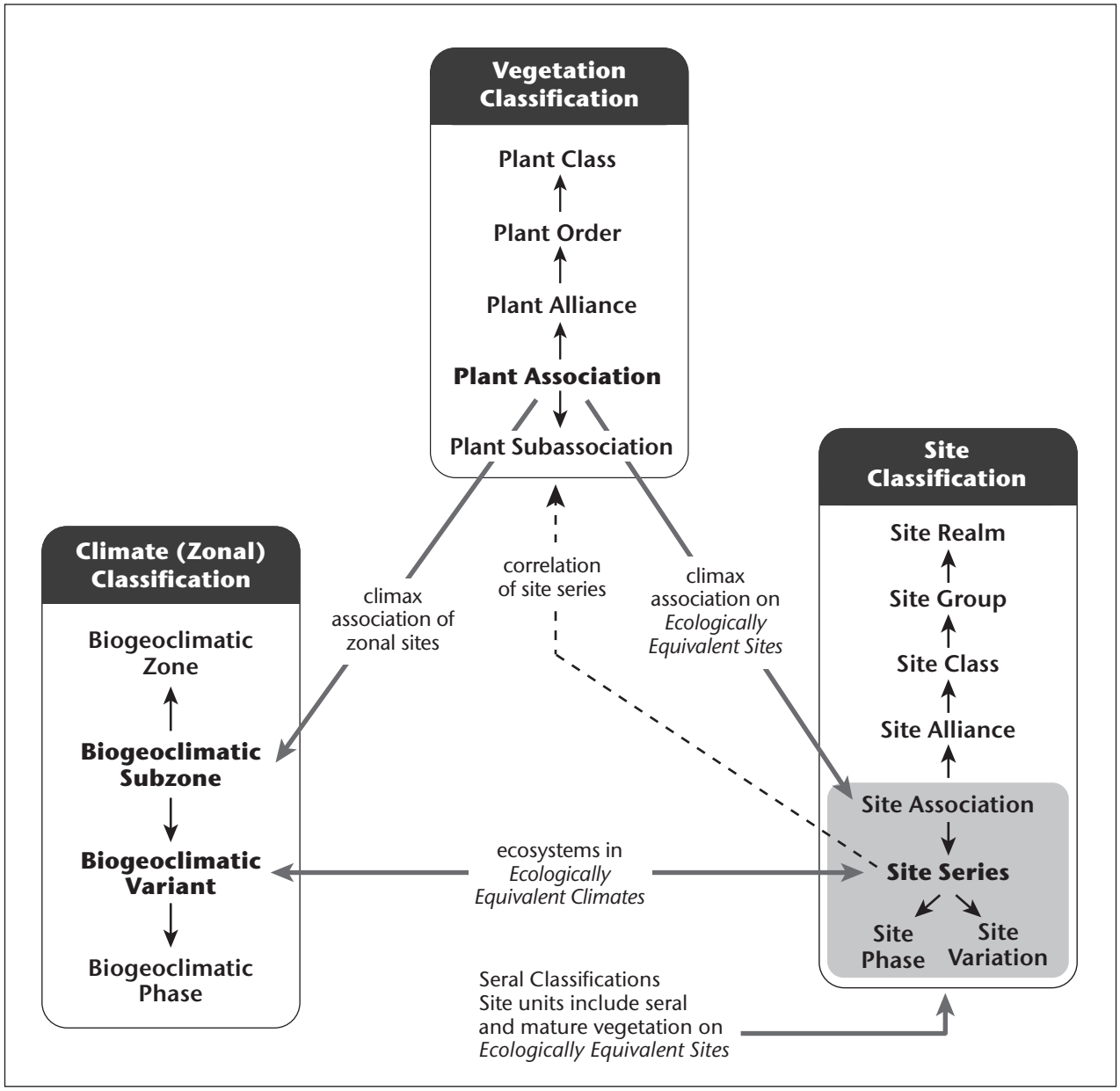


FIGURE 1 *Categories and relationships of the three component classifications integrated in the biogeoclimatic ecosystem classification (BEC) system. The shaded grey portion of the site classification highlights the units most described in the field guides (modified from MacKenzie and Meidinger 2017).*

Subzone names reflect climatic differentiation of zones into finer units based on the precipitation regime and, on the coast, continentality[3]; that is, degree of ocean influence. Continentality increases with distance from the ocean: hypermaritime subzones occur next to the open coast, maritime subzones are located further inland, and submaritime subzones occur on the leeward side of the Coast Mountains. A two-letter code is added to the zone name: the first letter denotes precipitation; the second denotes continentality (Table 1); for example, the Mountain Hemlock Wet Hypermaritime (MHwh) on Haida Gwaii. A third letter modifier can also be used to identify a parkland subzone that occurs above a forested

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

TABLE 1 *Connotative codes used for biogeoclimatic subzone names on British Columbia's coast*

Precipitation	Code	Continentality	Code
very dry	x	hypermaritime	h
dry	d	maritime	m
moist	m	submaritime	s
wet	w		
very wet	v		

subzone[4] but which has lower levels and less continuous distribution of forest cover. For example, the Mountain Hemlock Wet Hypermaritime parkland (MHwhp) occurs above the MHwh.

Subzones with similar climatic characteristics and zonal ecosystems (and thus, often, similar late-successional tree species) are grouped into **biogeoclimatic zones**. A zone is a large geographic area with a broadly homogeneous climate. Zones in coastal British Columbia include the Coastal Douglas-fir, Coastal Western Hemlock, Mountain Hemlock, and Coastal Mountain-Heather Alpine, and parts of adjacent interior zones such as the Interior Douglas-fir and Engelmann Spruce – Subalpine Fir. Zone names reflect the dominant, shade-tolerant tree species of late-successional vegetation on zonal sites. A two- to four-letter code is used to abbreviate the name; for example, CWH = Coastal Western Hemlock.

Subzones may be subdivided into **biogeoclimatic variants**, sometimes referred to as subzone variants, that differ from each other in climate at the subregional level. For example, variants could be assigned to areas that are slightly drier, wetter, snowier, warmer, or colder than other areas within a subzone. This is reflected in slight differences in the vegetation of the variants. Variant names reflect geographic distribution, and related climatic refinement, within a subzone (e.g., east versus west; submontane versus montane; windward versus leeward). Variants are coded with a number; (e.g., CWHvm1 = Coastal Western Hemlock Very Wet Maritime subzone, submontane variant, where the "1" indicates the submontane variant).

2.1.2 Site classification

Site units classify soil and physiographic properties at various scales. The **site association** is the fundamental unit of site classification and links the vegetation and climatic classifications at the subzone level (Figure 1).

4 Forested BEC subzones named using these conventions have > 10% cover of trees > 10 m in height.

The site association groups all sites across all climatic units, such as variants, with similar mature (late successional) plant communities; this similarity in plant associations reflects the similar environmental properties, including soil moisture and soil nutrient regimes, of the sites. Site associations are named after the mature plant association, but because they are site-based, they include locations that would support both the seral and mature plant associations, dependent on the stage of forest development, that occur on the same **ecologically equivalent** sites. The site association does not change when an old-growth forest is disturbed (e.g., burned, logged) and a new, early seral plant community starts to develop.

Site series are the units of site classification most used for management (Figure 1). Site series refers collectively to all sites within a specific climatic unit (biogeoclimatic subzone or variant) that can produce mature plant communities of the same plant association. Each biogeoclimatic unit has a characteristic suite of site series associated with soil moisture and soil nutrient conditions, and other environmental drivers such as flooding regime, solar insolation, late snow occurrence, or cold air ponding. Site series typically use the same name as the site association, preceded by the appropriate biogeoclimatic subzone or variant. For example, the Coastal Douglas-fir Moist Maritime (CDFmm)/Douglas-fir – Salal – Oregon-grape is the zonal site series in the CDFmm subzone (see Table 2 for more examples). It is important to note that in the BEC system, each plant association and, by extension, site association can potentially occur on one or more site series, but each site series has the potential to produce only one mature plant association. In Table 2, for example, the Western Redcedar – Western Hemlock – Salal – Deer fern plant association occurs on both the Coastal Western Hemlock Very Wet Hypermaritime Haida Gwaii variant (CWHvh3)/101 and Coastal Western Hemlock Wet Hypermaritime Submontane variant (CWHwh1)/110 site series.

Historically, forested site series were assigned a two-digit numeric code ranging from 01 to 29 to indicate their position in the edatopic grid. Within a given subzone or variant, 01 always represented the zonal site series; remaining site series were numbered sequentially from dry to wet, and secondarily, from very nutrient poor to very nutrient rich, for units with comparable moisture regimes. Recent updates to BEC include a new site series numbering system that uses a three-digit code (Table 2). The first number indicates the revision version of the classification; for example, "101" is the designation for the zonal ecosystem under the first revision

TABLE 2 *Coding and naming examples for coastal Biogeoclimatic Ecosystem Classification units*

	Biogeoclimatic unit (zone, subzone, variant)		Site series unit (site series, phase, variation)	
	Code	**Name**	**Code**	**Name**
Site series	CWHvh3	Coastal Western Hemlock Very Wet Hypermaritime Haida Gwaii variant	/101	CwHw[a] – Salal – Deer fern site series
Site series phase	CWHwh1	Coastal Western Hemlock Wet Hypermaritime Submontane variant	/110a /110b	CwHw – Salal – Deer fern site series, podzolic site series phase CwHw – Salal – Deer fern site series, gleysolic/organic site series phase
Site series variation	CWHvh3	Coastal Western Hemlock Very Wet Hypermaritime Haida Gwaii variant	/103.1 /103.2	Ss – Salal site series, typic site series variation Ss – Salal site series, reedgrass site series variation

a Cw = western redcedar; Hw = western hemlock; Ss = Sitka spruce (see B.C. Ministry of Forests and Range and B.C. Ministry of Environment. 2010 [ver. 2023]).

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 than zonal, with the 102 being the driest and most nutrient poor. Numbers 110 to 119 are reserved for forested units that are wetter or more nutrient rich than zonal sites. For more information on the new coding schemes, see MacKenzie (2011).

Non-forested ecosystems have been variously included and numbered in field guides and ecosystem mapping. The new coding for these ecosystems follows a convention introduced for wetlands by MacKenzie and Moran (2004) and further developed by MacKenzie (2012). In their full form, these codes have four-characters: the first two characters are alphabetic and reflect the higher site levels of **site realm/group** and **site class**; the last two digits, where used (i.e., where sufficient data are available), are numeric and reflect differentiation at finer levels of ecological organization.

The **site series phase** is applied when the same vegetation community is found on different site conditions (e.g., slope, parent material, soil, local climate) that have important management implications. For example, the same plant community may occur on both mineral and organic soil conditions. The **site series variation** is applied where mature vegetation differs on similar site conditions. Because the site conditions do not differentiate the vegetation, a site series is not applicable.

Variations, phases, site series, and site associations can be grouped into broader classes such as site alliances, site classes, site groups, and site realms—the broadest site unit in the BEC system. Site realms, groups, and classes are more commonly used in management and description of **non-forested ecosystem units (nBEC)**. These are described more fully in *Wetlands of British Columbia* (MacKenzie and Moran 2004), *Biogeoclimatic Ecosystem Classification of Non-forested Ecosystems in British Columbia* (MacKenzie 2012), and select regional field guides (e.g., Banner et al. 2014). Such units in the Terrestrial Realm are designated with their Group and Class codes. For example, alpine meadows (Am) are a Class (meadows, m) within the Alpine Group (A) within the Terrestrial Realm. Units in other realms use Realm and Class for coding. For example, fens (Wf) are a Class (fen, f) within the Wetland Realm (W). Some alpine, beachland, grassland, and shrub types are classified and managed at the site association level; for example, American searocket (Bb01), Dune wildrye (Bb02), and Large-headed sedge – dune bluegrass (Bb03) associations within the beachland Class (b) of the Beachland Group (B) found on Haida Gwaii (Banner et al. 2014).

Example naming and coding conventions for coastal BEC units are provided in Table 2.

2.1.3 Vegetation classification

Relationships of site conditions and climate to vegetation are integral to the development of, and linkages between, the site and climate (zonal) classifications. Vegetation communities change with time and disturbance, so the "potential vegetation" of sites, along with selected environmental properties, is used to define and delineate site units in BEC. The BEC field guides focus on describing the plant communities of mature and old forests (or other ecosystems).

Plant associations are the basic unit of the vegetation classification hierarchy and are correlated (compared and standardized) across the province. They can be more finely differentiated into subassociations or combined into broader alliances, orders, and classes (Figure 1). Each unit in the vegetation classification hierarchy is differentiated by a diagnostic combination of species (see MacKenzie and Meidinger 2017 and Meidinger and Pojar 1991 for criteria). 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 are often ecologically equivalent to British Columbia Conservation Data Centre (B.C. CDC) ecological communities, which are the focus of conservation status ranking and mapping of **ecological communities at risk**.

Plant communities at earlier ages and stages of forest development after a disturbance—that is, **seral plant associations**—are described and coded within site series for some regions of the province (see examples in DeLong et al. 2011; MacKillop et al. 2021; Ryan et al. 2022). However, there is currently no classification for early successional communities in coastal British Columbia ecosystems.

2.2 Ecological Communities

The B.C. CDC, a member of the international NatureServe[5] network, uses the term **"ecological community"** to refer to ecosystems found in British Columbia. The term "ecological" refers to the relationships of living organisms to their surrounding environment, including features such as soil, landform, climate, and natural disturbances. The term "community" refers to the living, interacting organisms (e.g., plants, animals, fungi, bacteria) within a defined geographic area. In practice, an ecological community in British Columbia public databases (e.g., B.C. Species and Ecosystems Explorer) and mapping, and in the context of provincial land management, is typically defined by a characteristic suite of plant species and environmental conditions. Examples include plant associations from the vegetation classification of the Biogeoclimatic Ecosystem Classification system (see Section 2.1) and other natural plant communities recognized in ecosystem mapping projects, ecological reserve records, special inventory projects, and other available records.

The B.C. CDC is not responsible for classification. Instead, it adopts **ecosystem units** from classifications such as BEC and refers to them as ecological communities (Figure 2).

Ecological communities in British Columbia are generally equivalent to:

- site or plant associations defined by the BEC system for forested ecosystems, and the nBEC system for non-forested ecosystems; or
- plant associations from ecosystem classifications that are not represented in BEC or nBEC.

The most common way ecological communities are identified and mapped is by identifying a site series or site association and developing a relational database to translate (i.e., **crosswalk**) to a potential plant association or ecological community (Figure 2).

In some (uncommon) cases, ecological communities may be equivalent to seral associations (Figure 2, dashed line from seral associations; see also section 2.1.3). Seral associations occur because of natural or anthropogenic disturbances. Assessing the **ecological integrity** and conservation status of seral associations is complex because some disturbances can be critical to maintaining a plant association at a particular site, while other disturbances can disrupt processes that have previously maintained a plant association on a particular site, thereby altering the site and the community.[6] Depending on the type and severity of disturbance, some seral associations, given time, may develop into mature ecosystems with good or excellent ecological integrity, while others are more likely to have fair or poor ecological integrity. Seral plant associations may be of interest for conservation, such as ecosystems culturally maintained by Indigenous Peoples. Seral associations may also be of interest because some ecological communities are infrequently found in late stages of development, so "recruitment" occurrences representing earlier stages of development are relatively important for long-term conservation. Some programs in the NatureServe network have assessed the status of non-vegetated ecosystems such as glaciers, or ecosystems in the Freshwater, Marine, Subterranean, and Intertidal Realms (see MacKenzie 2012 for descriptions of these realms). This has not been done in British Columbia, where the focus has been on the conservation status of ecosystems with a strong vegetation component, but conservation status assessments for these other types of systems could be implemented using Terrestrial Ecosystem Information (TEI) map codes (see Figure 2).

2.2.1 Ecological communities and the Biogeoclimatic Ecosystem Classification

Understanding the relationships among BEC sites series, seral (successional) stages, and ecological communities is important when assessing conservation status. For forested ecosystems, ecological communities are defined

5 NatureServe is an international network of conservation data centres operating in the United States, Canada, Latin America, and the Caribbean. https://www.natureserve.org/.

6 For example, many ecosystems are adapted to, and maintained by, grazing and wildfire. However, intensive grazing, introduction of exotic, invasive species, and high-intensity wildfires (disturbances that exceed certain thresholds) may threaten the long-term persistence or resilience of ecosystems (Holling 1973; Peterson et al. 1998).

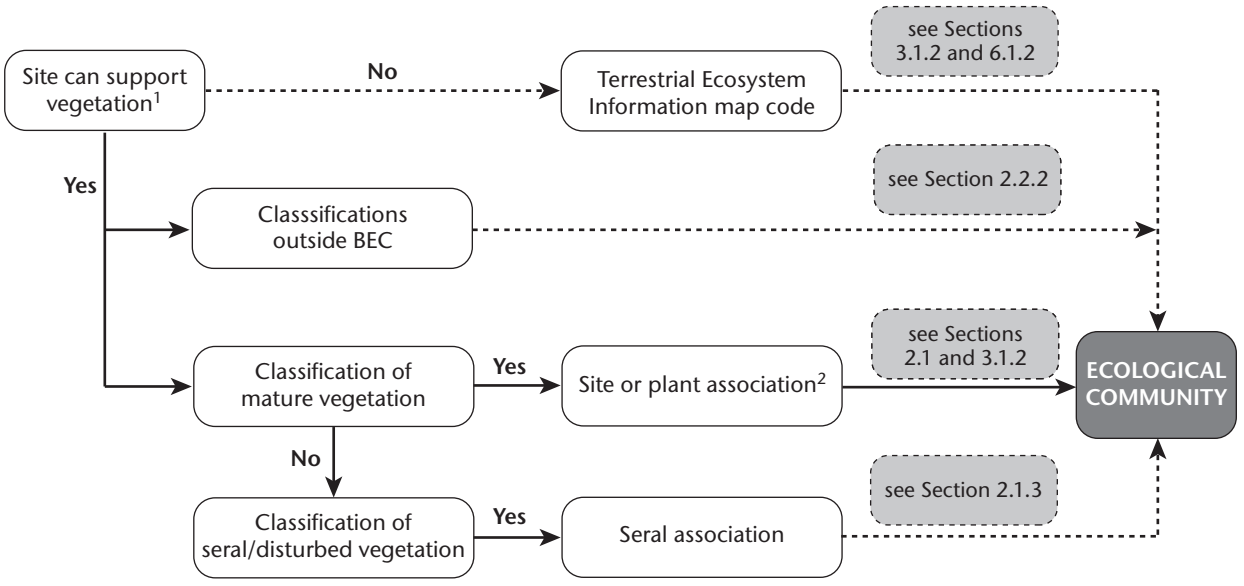


FIGURE 2 *Ecological communities of the terrestrial realm and terrestrial interface realms. The Biogeoclimatic Ecosystem Classification (BEC) and other classifications provide the ecological units (referred to as "ecological communities") that are assessed, ranked, and mapped by the British Columbia Conservation Data Centre. Solid arrows represent the most common relationships; dashed arrows represent uncommon relationships. Terrestrial interface realms include wetland, estuarine, and intertidal (see MacKenzie 2012).*

as equivalent to plant associations, which are generated from a correlation (standardization) of one or more site series and may include consideration of phases and variations (Figure 3).

In Figure 3, site series 101, 102, and 103 show a hypothetical example where more than one site series from different BEC subzone variants (different subregional climates) can produce the same plant association, and thus a single ecological community. An example from coastal British Columbia, based on the classification from Green and Klinka (1994), is site series CWHdm/06, CWHxm1/06, and CWHxm2/06, which all produce the same western hemlock – western redcedar/deer fern plant association, and thus a single ecological community.

Hypothetical site series 104 in Figure 3 is a straightforward example where the site series at late stages of development (e.g., mature or old forest) produces only one plant association and only one ecological community. An example from coastal British Columbia, based on the classification from Green and Klinka (1994), is site series CDFmm/04, which produces the grand fir/dull Oregon-grape plant association and ecological community.

Site series 104, 105, and 106 in Figure 3 also have recognized (early) seral variations, indicated by "$" for seral, and decimals for variations (.1 and .2). One site series can support different seral plant associations over time depending on disturbance and developmental trajectories. Additionally, any one seral plant community can occur across a broader set of site conditions (e.g., on site series 104$, 105$, and 106$). Thus, variations of a single seral site series can crosswalk to either separate (e.g., 104$.1 versus 104$.2) or equivalent (e.g., 104$.2, 105$.1, and 106$.2) plant associations and ecological communities. Currently, there are no classifications for early successional communities in coastal British Columbia ecosystems, but they do occur in other parts of British Columbia (see DeLong et al. 2011; MacKillop et al. 2021; Ryan et al. 2022). Seral variations in hypothetical site series 104 to 106 each have separate arrows linking them to plant associations because variations are considered individually in the vegetation hierarchy.

Hypothetical site series 110 in Figure 3 has two phases (110a and 110b) where both phases are the same plant association, equivalent to a single ecological community.

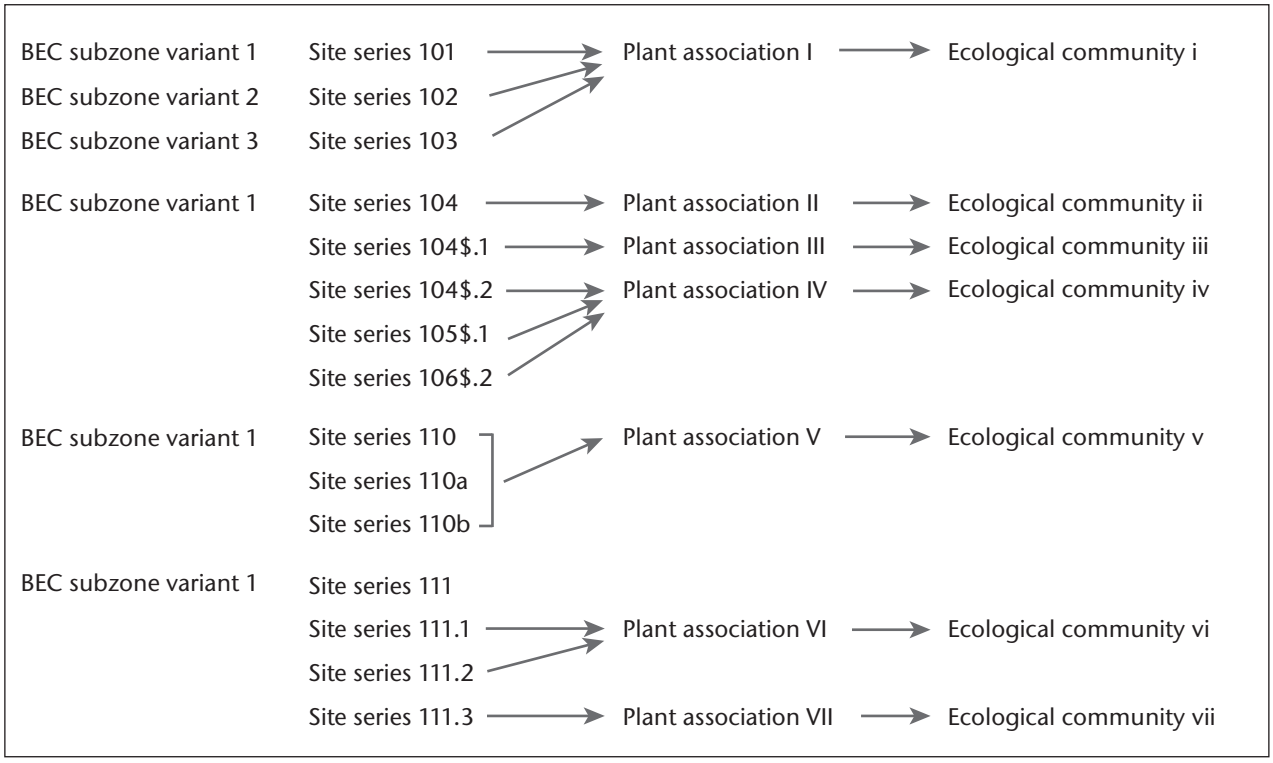


FIGURE 3 *Possible relationships of hypothetical site series, site series phases (indicated by a and b), site series variations (indicated by .1, .2, and .3), or seral units (indicated by "$") with plant associations and ecological communities. There is no arrow directly linking site series 111 with a plant association because site series variations are considered individually relative to plant associations. The relationship between a site series and plant association is determined through standardization of these ecological units by the provincial Biogeoclimatic Ecosystem Classification (BEC) program; this process is referred to as correlation.*

For example, the CWHwh/101 site series commonly occurs on both moderately well- to well-drained soils and on imperfectly drained soils (Banner et. al. 2014). Two phases are used to describe these situations: a mesic phase (101a) and a moister phase (101b). While the two phases exhibit different soil conditions, the plant association and ecological community remain the same (i.e., western hemlock/Sitka spruce – lanky moss). For site series 110, the arrow to plant association V encompasses all site series phases because phases are differentiated based on site conditions and so are not considered individually relative to plant communities in the vegetation hierarchy.

Hypothetical site series 111 in Figure 3 shows a site series with three variations (111.1, 111.2, and 111.3). There is no arrow directly linking site series 111 with a plant association because the variations are considered individually relative to plant associations. Variations 111.1 and 111.2 are both part of the same plant association and are considered one ecological community. For example, in both the CWHvh3 and CWHwh1, two variations are defined for the 103 Sitka spruce – salal shoreline forest site series: 103.1 typic variation, and 103.2 reedgrass variation (Banner et. al. 2014). While the two variations differ in understorey composition, the dominant species that define the plant association remain present on equivalent site and soil conditions. Variation 111.3 is part of a different plant association than variations 111.1 and 111.2, and therefore represents a different ecological community.

A site series has the potential to produce a characteristic plant association at a late seral stage (i.e., mature or old forest) and can be identified even when there is no vegetation present, based on site characteristics such as soil moisture and soil nutrient regimes. However, to identify an ecological community, the characteristic vegetation must be present to some extent.[7] The BC

7 In rare cases when dealing with ecological communities at risk, where there are no or few high-quality examples of the ecological community, an area may be considered to have relatively high conservation value even if it does not have "characteristic vegetation" of a plant association due to poor condition. Depending on the level of degradation and ongoing disturbances, such an area might still "recover" to a state where it is in better condition and has higher ecological integrity.

Species and Ecosystem Explorer lists the site series on which an ecological community is known to occur, but field verification is required to confirm if an ecological community is present (see Section 4.4 for further information). Furthermore, not all ecological communities have an associated site series that is recognized in BEC (see Section 2.2.2).

For forests, ecological communities at risk are most often those associated with late successional (mature or old forest) developmental and **structural stages**. While earlier successional plant associations on the same site conditions may not be red- or blue-listed, conservation of high-value sites (e.g., large patch size, high connectivity) with successional vegetation communities may be important for development (recruitment) of at-risk ecological communities over time. For example, residual elements of old forests, such as very old trees, may confer high recruitment value (Banner et al. 2019).

2.2.2 Ecological communities outside the Biogeoclimatic Ecosystem Classification

Some ecological communities have been adopted from classifications outside BEC to facilitate assessment of ecosystems that may be at risk of being lost before they can be formally documented in the expanding (but not yet comprehensive) coverage of field guides used for BEC classification. The Province aspires to achieve alignment between BEC site and plant associations and ecological communities assessed and tracked by the B.C. CDC. However, BEC has historically focussed on classifying and describing forested, mature, natural (i.e., non-anthropogenic), and common ecosystems. Concern over the conservation status of other specific ecosystems prompted the B.C. CDC to consider adopting some ecological communities from outside BEC, while working closely with the ecologists responsible for BEC to develop new concepts for plant associations. Some examples of ecological communities from outside BEC (many of which were later incorporated into BEC or are in the process of being incorporated) have included plant communities from alpine regions, beaches, spring-seeps, vernal pools, some grasslands and wetlands, and culturally maintained ecosystems (e.g., Indigenous cultural ecosystems). When deciding whether to adopt ecosystems from outside BEC as ecological communities, ecologists consider the strength and accessibility of the alternative classifications and descriptions; whether the potential ecological community could be repeatably and reliably recognized, identified, and mapped by other ecologists; and the likelihood that the ecological community is at risk of being lost. Practitioners working with information on ecological communities at risk should be aware of the origins of the classification of ecological communities and ensure that they consult appropriate references to correctly identify ecological communities from outside BEC and include them in their analyses.

2.2.3 Naming conventions for ecological communities

Ecological communities are referred to by a scientific (taxonomic Latin) name, or an English name, usually consisting of names of characteristic plants of the community. For forested ecological communities, names are based on BEC plant associations, which follow BEC naming conventions integrating diagnostic species from major strata or growth forms (e.g., tree, shrub, herb, moss and lichen). In some cases, the names of ecological communities will not include lower levels of taxonomic division such as species, subspecies, or variant. This may be done for simplicity in naming (e.g., *Pinus contorta* / *Sphagnum* spp. is used instead of *Pinus contorta* var. *contorta* / *Sphagnum* spp.) or when warranted by the natural variability of species composition (e.g., the ecological community name yellow-cedar / peat-mosses [*Callitropsis nootkatensis* / *Sphagnum* spp.] indicates that the community is characterized in part by a mix of *Sphagnum* species, rather than one particular diagnostic species of *Sphagnum*). Some non-forested ecological communities include an additional physiognomic descriptor, following international naming conventions (e.g., hard-stemmed bulrush Deep Marsh [*Schoenoplectus acutus* Deep Marsh] or spikenard sedge Herbaceous Vegetation [*Carex nardina* herbaceous vegetation]).[8]

Names of ecological communities are updated annually to reflect changes to names or taxonomy adopted by the B.C. CDC. These name changes typically follow changes to the names of plants that are included in the name of an ecological community. Documentation of updates are provided on the B.C. CDC website.

8 Among the taxa that are chosen to name the ecological community, those occurring in the same stratum or growth form (tree, shrub, herb, moss, lichen, floating, submerged) are separated by a hyphen (-) with a space on each side, and those occurring in different strata are separated by a slash (/). Diagnostic taxa occurring in the uppermost stratum are listed first, followed successively by those in lower strata. The order of taxon names within a stratum or growth form generally reflects a dominant of high constancy (whether or not strongly diagnostic), a dominant of moderate to strong diagnostic value, and a strong diagnostic species, whether or not dominant. Species may meet one or more of these criteria (Jennings et al. 2009; Faber-Langendoen et al. 2012).

3.1 Terrestrial Ecosystem Information

Terrestrial Ecosystem Information (TEI) is defined as the inventory, mapping, and modelling of terrestrial ecosystems, soils, terrain, habitat, and species. This information is managed through the Terrestrial Ecosystem Information System (TEIS) and is accessible through DataBC.[9] The TEIS includes the development, management, and provision of TEI standards, information access tools, data storage systems, end-user support and related training materials, data access, and data submission websites. TEI inventory and mapping data are collected and captured in accordance with established provincial Resources Information Standards Committee (RISC; previously the Resource Inventory Committee [RIC]) standards. TEI projects are assigned to a specific project type that defines the mapping method, and all mapping projects submitted to the TEI Unit are allocated a Business Area Project Identier (BAPID), the identification number used to identify and track digital project information.

In British Columbia, ecosystem maps are typically produced and verified by:

- direct mapping and digitization based on orthophotos or satellite imagery; or
- applying modelling algorithms using spatial data layers to predict the extent and location of ecosystems across the landscape.

Examples of methods used for modelling include machine learning and models refined based on expert knowledge, including crosswalking between one feature and another using lookup tables.

TEI mapping and modelling results in the stratification of a landscape into map units (polygons) according to a combination of features, primarily climate, physiography, surficial material, bedrock geology, soil, and vegetation. These polygons are assigned attributes based on project type/scope and site characteristics, using standardized fields and coding, that can be used to predict biological values and inform management strategies. Ecosystem unit is the term used in the RIC standards (RIC 1998) to define local, spatially discrete combinations of vegetation and developmental stage within the biogeoclimatic zones, subzones, or variants. These smaller units are typically derived from the BEC site series classification and are further differentiated by structural stage and site condition attributes.

Ecosystem map units are either simple, containing one ecosystem, or compound, containing up to three ecosystems for which one or more of three attributes (site series, **site modifier**, and structural stage) differ. The proportion of a polygon occupied by each ecosystem is indicated with "deciles" that must add to 10 (RIC 1998). Mapping and defining ecosystem units is the primary focus of any ecosystem mapping project.

To have a versatile final ecosystem product that can support numerous land management objectives, including determining ecosystem representation (the amount and distribution of different ecosystems in an area), developing wildlife population and habitat models, and identifying at-risk or sensitive ecosystems or habitats, the following attributes are generally included:

- ecosection unit
- biogeoclimatic unit
- ecosystem attributes, including site series, realm, group, class, site modifier(s), structural stage, stand composition, and disturbance
- bioterrain attributes, including terrain texture, qualifying descriptor, surficial/subsurficial material, and surface/subsurface expressions
- geomorphological processes
- soil drainage

Ecosystem mapping and modelling approaches involve field verification to inform the final ecosystem classifications and support more accurate end products. Varying **survey intensity levels** can be applied depending on project objectives, mapping scale, study area size, project timeframes, available funds, and access (logistical) considerations. Survey intensity is a measure of sampling density, characterized as either the percentage of polygons that have been field inspected or the actual density of field inspections on an area basis (hectares per field inspection). The provincial RIC standards outline six survey intensity levels for ecosystem mapping (RIC 1998).

9 DataBC encourages and enables the strategic management and sharing of data within government and with the public. It is responsible for the BC Data Catalogue, the Open Data initiative, and the B.C. Spatial Data Infrastructure and associated products and services.

Field data to support ecosystem mapping are collected in accordance with the *Field Manual for Describing Terrestrial Ecosystems* (B.C. Ministry of Forests and Range and B.C. Ministry of Environment 2010), which supports the use of standard field forms and sets coding and methodology standards for data collection in ecosystem plots. Field inspections are of three types: full plot, ground inspection, and visual check. Full plots, recorded on the multi-page Ecosystem Field Form (FS882), provide the most detailed ecological data, including site (FS882-1), soil (FS882-2), vegetation (FS882-3), mensuration (FS882-4), wildlife habitat assessment (FS882-5), tree attributes for wildlife (FS882-6), and coarse woody debris (FS882-7). Full plots are intended for use in the classification, description, and quantification of site series and (other) biogeoclimatic or ecosystem units. Ground inspections are abbreviated ground-based plots from which data are recorded, using the Site Visit Form (FS1333), to confirm the identification of ecosystem units or polygon designation and boundaries. Visual checks are the least detailed type of field inspection and are intended to be quick inspections for mapping purposes. Visual checks typically include confirming site series, structural stage, and terrain attributes, and briefly describing vegetation, assessing biogeoclimatic mapping, recording ecosystem or terrain component percentages (deciles), evaluating polygon boundaries, or noting special features. Visual checks can be conducted on the ground, from the air (helicopter), or from viewpoints using the Site Visit Form (FS1333).

Quality assurance/quality control (QA/QC), which assists mappers with creating the best possible product, is required for all government-funded mapping projects. Independent/external accuracy assessment, which quantifies specific measures of accuracy of the final mapping and includes sign-off by professionals, is also often a key project component. QA/QC and accuracy assessment help ensure that mappers are meeting all requirements as practicing professionals as regulated by an applicable governing body and/or associated legislation (e.g., the *Professional Governance Act*).

3.1.1 Ecosystem mapping and types of modelling projects

Numerous types of ecosystem mapping and modelling can be used to stratify the landscape into ecosystem units. To select an appropriate approach, project objectives, end goals, and expected current and future uses of the mapping should be considered. In addition, the types of available data, data coverage, data quality (e.g., vintage and resolution of imagery), and data reliability (e.g., field survey intensity) are important to assess. Policy, management restrictions, regulations, and partnership/funding opportunities, including associated timeframes and cost considerations, may also influence the final method(s) selected for identifying, delineating, and mapping ecosystems.

Provincial TEI ecosystem-based mapping and modelling types include, but are not limited to the following, and are described in more detail below:

- Broad ecosystem classification and mapping
  - Broad Ecosystem Inventory (BEI)
  - Broad Ecosystem Mapping (BEM)
  - Broad Ecosystem Mapping and Vegetation Resources Inventory (BEMVRI)
- Ecosystem inventory and mapping
  - Terrestrial Ecosystem Mapping (TEM)
  - Predictive Ecosystem Mapping (PEM)
  - Sensitive Ecosystem Inventory (SEI)
  - Wetland Mapping (WET)

Mapping and modelling approaches vary by the project type, and methods can also vary within project types (e.g., with respect to mapping scale, level of field sampling, attribute selection) to customize the end products to best suit project objectives and future uses. For example, projects conducted at higher levels of intensity (i.e., increased field sampling/QA) and at finer resolutions (i.e., ≤ 1:10 000) and thus with (expected) higher levels of accuracy are more appropriate for identifying sensitive ecosystem types, which are typically uncommon and occur in small patch sizes on the landscape. These considerations become increasingly important where there are management consequences (e.g., if maps are to be used for legal requirements for ecosystem representation or for delineating at-risk ecosystems). As such, users should be aware that mapping accuracy can vary considerably among different project types and individual projects, and that mapping done for one purpose may not be appropriate for other uses.

Figures 4 and 5 provide a comparison of options for determining the project type based on the key methods and factors for consideration outlined above.

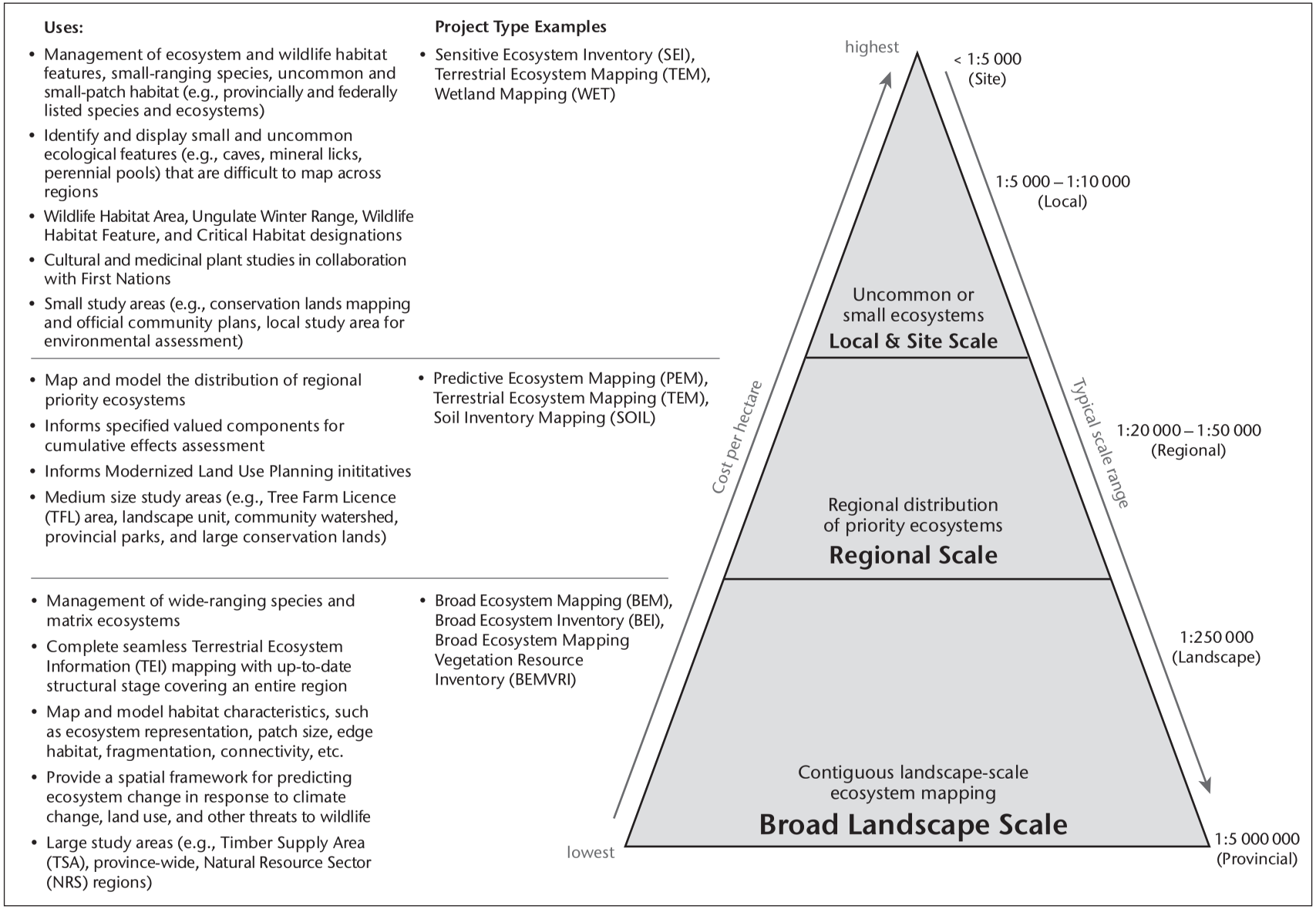
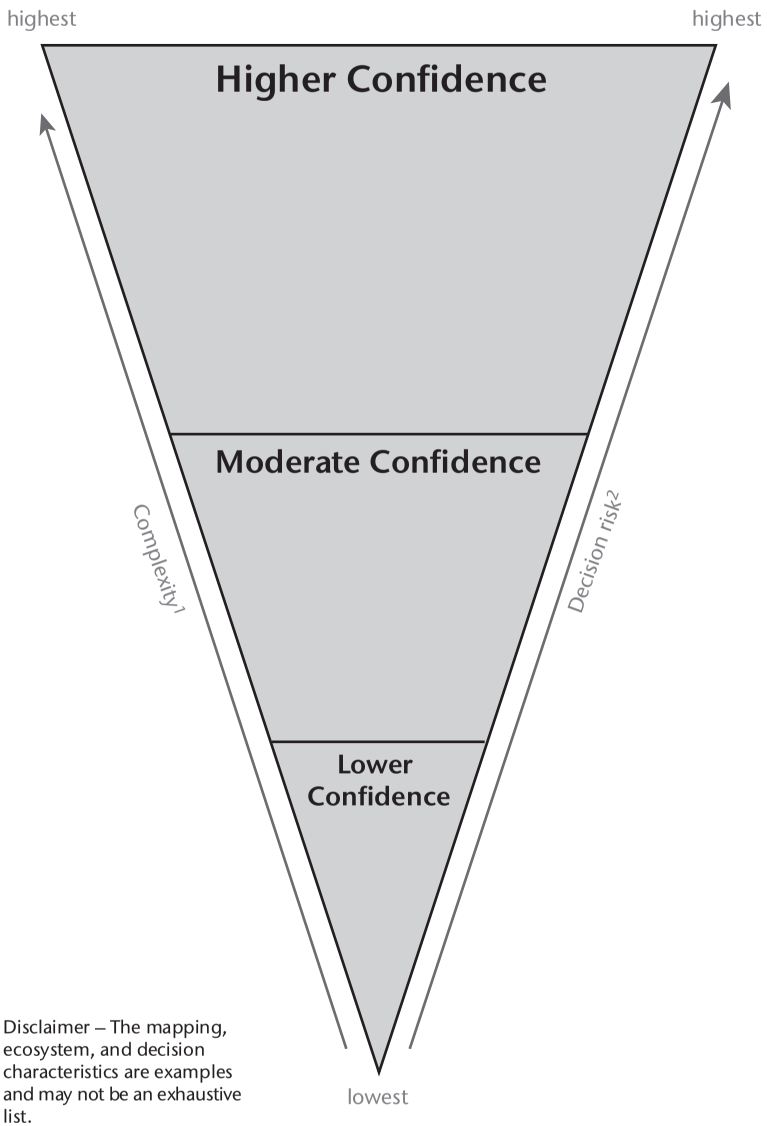


FIGURE 4 *Information to assist in deciding the appropriate scale for ecosystem mapping projects, with relative costs per hectare and appropriate uses.*



Disclaimer – The mapping, ecosystem, and decision characteristics are examples and may not be an exhaustive list.

Decision Characteristics	Ecosystem Characteristics	Mapping Characteristics
• High consequences/risk • High economic impacts • Competing land use needs/development pressures • High number of stakeholders • Uncertainty is high (e.g., lack or limited knowledge/data) • Well-defined values • Politically sensitive • Outcome of decision is highly sensitive to ecosystem information (i.e., critical influencing factor)	• Provides critical ecosystem services (e.g., biodiversity, water quality, climate resilience) • Complex landscapes (e.g., number of ecosystem types and spatial patterns) • Site-level variability and complexity is high (e.g., transitional ecosystems, temporal variations, seasonal patterns) • Uncommon, small or difficult to detect • Vulnerable	• Use-specific (i.e., targeted) mapping • Spatially explicit • High accuracy/reliability • Fine resolution/scale • Higher survey intensity level (observation densities) • Detailed classification (e.g., site-level)
• Allocate limited resources (e.g., restoration) • Regional and operational strategic and planning-level decisions and needs • Legislated requirements (e.g., land-use orders) • Unknown, vague, or poorly defined need • Multiple uses or needs	• All ecosystem types, sizes, patterns, variability, and complexity	• General purpose mapping • Multidisciplinary products (e.g., ecosystem, terrain, wildlife) • Seamless coverage • Serving several unknown needs
• Low consequences/risk • Low economic impacts • Provincial strategic and planning-level decisions • Simple, well-defined question or values • Broad-based decision making • Outcome of decision is less sensitive to ecosystem information	• Matrix, common, zonal and/or wide-ranging ecosystems • Resilient ecosystems and landscapes • Simple and predictable landscapes	• Large study area, low risk • Landscape-level proportions (e.g., percentage of watershed or Timber Supply Area) • Coarse resolution/scale • Broad-level classification

1. Complexity describes the variability of mapped characteristics and spatial patterns (e.g., attributes, spatial distribution, number of mapping categories, or ecosystem codes); for example, number of BEC zones or geology types.
2. Assess relative risk to evaluate available options in the context of multiple contributing factors (e.g., ecological value/rarity, legislation, and/or economic value) and the probability of the decision impacting those factors/values identified.

FIGURE 5 *Information to assist in selecting an appropriate confidence level for ecosystem mapping as a basis for decision-making, considering complexity and risk of the decision, and characteristics of the mapping and ecosystem.*

Broad Ecosystem Inventory and Broad Ecosystem Mapping

Broad Ecosystem Inventory (BEI) is a method of classifying and mapping broad ecosystem habitat units, as well as the **suitability** and **capability** of the landscape to support various wildlife species (RIC 2000). Broad ecosystem units have been mapped at a scale of 1:250 000 for the entire province but have been mapped at a finer resolution for some smaller project areas. The current spatial layer for the BEI classification in the **BC Data Catalogue** is loosely tied to the BEC system but has not been updated since 1998. Users of this information should be aware of the potential disconnect between BEI data and more recent information such as ongoing BEC updates.

Broad Ecosystem Mapping (BEM) is a desktop-based method that updates existing BEI data to a database structure similar to the TEI standard file geodatabase format (RISC 2023). Structural stage information is updated using **Vegetation Resources Inventory (VRI)** projected age information based on the dominant age class for each BEM polygon. Ecosection and BEC information are assigned to existing BEM polygons based on majority area of overlap with each polygon using current published information at the time of the project. No new linework is created during the update process. Slope and aspect information is also assigned to each BEM polygon using **Terrain Resource Information Management (TRIM)** and/or a digital elevation model (DEM). **Freshwater Atlas** large lakes, small lakes, and wetlands are added as new polygons or new components to existing polygons based on existing BEI standards.

Potential uses for Broad Ecosystem Inventory and Mapping, such as supporting development of wildlife capability and suitability products, are provided in Figure 4; some example decision, ecosystem, and mapping characteristics associated with these mapping methods are provided in Figure 5.

Broad Ecosystem Mapping and Vegetation Resource Inventory (BEMVRI) is a desktop method that takes an existing BEM or creates a new BEM and subsequently assigns the Broad Ecosystem Unit (BEU) label to existing VRI polygons based on majority area of overlap with each VRI polygon. Updates are made to improve consistency between the BEU labels and VRI polygons. Although reasonable effort is applied to updating ecosystem labels, many of the polygons likely reflect a false level of detail due to the majority-based assignment being inappropriately spatially assigned; therefore, this limitation should be acknowledged when using the ecosystem labels. After BEU labels are updated, structural stage and stand composition information from the VRI are assigned to each of the BEMVRI polygons. The TRIM DEM is used to assign site modifiers, such as slope and aspect, to the BEMVRI polygon. BEMVRI can be used to support wildlife habitat mapping when alternative mapping methods are too costly, and it benefits from regular updates to VRI polygons. BEMVRI is limited by the focus on forested landscapes and does not fully encompass non-forested ecosystems similar to other mapping products do.

Terrestrial Ecosystem Mapping

Terrestrial Ecosystem Mapping (TEM) is a multi-disciplinary approach to stratifying the landscape into map units according to ecological features. TEM is informed by BEC, geology, terrain, soils, vegetation, hydrology, slope, and aspect, among other attributes (RIC 1998), and uses a combination of spatial data layers (air photos, satellite imagery, provincial vegetation inventories, digital elevation models, **Light Detection and Ranging [LiDAR]** data, and ground sampling). TEM requires a mapper to directly interpret air photos or satellite imagery of ecosystem attributes and distribution of landscape features. Polygons are delineated by interpreting imagery of vegetation and landforms and assigned codes. The assignment of ecosystem, soil, and terrain classification attributes may occur before or after field verification. Typically, digital three-dimensional imagery, including terrain information—historically from the provincial DEM,[10] and more recently derived from LiDAR where it is available—is used in conjunction with other sources of spatial data to facilitate desktop identification of ecosystems. In addition, the mapper can directly use updated and emerging types of data (e.g., canopy height model layers from LiDAR) in TEM. Field sampling may result in refinement of both polygon delineation and attribution initially assigned to ecosystem polygons. TEM methodology follows established RISC standards and incorporates the BEC system attributes (e.g., site series). TEM is recommended for ecosystem mapping at scales of 1:5000 to 1:20 000 and is often the basis for producing other thematic derivatives such as Sensitive Ecosystem Inventory mapping or wildlife habitat models.

Traditional methods of classifying and mapping ecological units, such as TEM, can be labour-intensive, costly, and somewhat subjective, because they require expert knowledge and interpretation. However, these traditional methods are often considered more accurate and reliable in determining and delineating enduring features in the landscape and thus for supporting future

10 The digital elevation model (DEM) of British Columbia is a three-dimensional representation of the province's terrain. DEMs are derived from height or elevation data.

interpretations such as wildlife habitat mapping when compared to modelling approaches to mapping. Because of the (potential) influence of the individual mapper on delineation and attribution of polygons, experience in the region and expertise with the classification of the ecosystems being mapped is important for TEM.

Potential uses for TEM are provided in Figure 4; some example decision, ecosystem, and mapping characteristics associated with this mapping method are provided in Figure 5.

Other commonly used TEM-based project types[11] include:

- NEM: Terrestrial Ecosystem Mapping without Bioterrain includes projects where mapped ecosystem polygons are usually derived from bioterrain polygons, but terrain attributes are not included in the database.
- TEMNSS: Terrestrial Ecosystem Mapping with no Structural Stage consists of ecosystem mapping projects completed to RISC standards with mapped ecosystem and bioterrain attributes that do not include structural stage attributes.

Predictive Ecosystem Mapping

Similar to TEM, Predictive Ecosystem Mapping (PEM) is a multidisciplinary approach to mapping site series. In contrast to TEM, PEM uses the current knowledge of relationships between ecosystems and biophysical criteria to predict BEC site series on the landscape. The process produces maps of site series in rasters (two-dimensional square pixels) or vector polygons in a spatial layer. PEM follows established RISC data standards that govern data submission and accuracy assessment but allows for flexibility in the methods used for generating the model and map results (RIC 1999). Many PEM products, particularly those completed before 2020, integrate terrain and topographic information based on the provincial 25-m DEM and are recommended for planning and management at scales of 1:20 000 to 1:50 000. More recently, data-driven and machine learning approaches to ecosystem modelling that incorporate data such as LiDAR (e.g., for terrain and topography at finer resolutions, and for understanding vegetation structure) and satellite imagery are being explored within PEM projects. The potential utility of different types and scales of resource management of these newer approaches to PEM versus earlier PEM or TEM is an area of active research. Modelled approaches to ecosystem mapping allow for repeatable updates to the models and maps using different or updated parameters with new data sources to improve accuracy or adapt to changing conditions. The comparative accuracy, cost, or utility of different mapping approaches (e.g., PEM versus TEM) depend on multiple factors, including the resolution and vintage of base data, complexity and accessibility of terrain being mapped, experience of the mappers, and application or question for which the mapping is being used.

Potential uses for PEM are provided in Figure 4; some example decision, ecosystem, and mapping characteristics associated with this mapping method are provided in Figure 5.

Sensitive Ecosystem Inventory

Sensitive Ecosystem Inventory (SEI) is an approach to mapping generalized groups of ecosystems that share characteristics such as ecosystem processes, at-risk conservation status, ecological sensitivities (e.g., sensitivity to soil disturbance), and/or wildlife habitat values. The information is derived from aerial photography or satellite imagery, supported by selective field verification of the mapping. SEI mapping may be based on original air photo interpretation for SEI polygons or may be an SEI theme derived from TEM polygons or PEM rasters. SEI ecosystem types vary from region to region according to the natural ecosystems found there, but usually include mature and old forest ecosystems, woodlands, wetlands, riparian areas, rocky bluffs, and natural meadows and grasslands. The purpose of SEI projects is to identify remnants of rare and fragile terrestrial ecosystems and encourage land use decisions that will ensure the continued integrity of those ecosystems (RISC 2006). Few and easily understood classes make SEI appealing to non-government organizations for conservation planning, and local governments for community planning and zoning.

Potential uses for SEI are provided in Figure 4; some example decision, ecosystem, and mapping characteristics associated with this mapping method are provided in Figure 5.

Wetland Mapping

Wetland Mapping (WET) projects identify and delineate (map) wetland ecosystems. Wetlands can be identified from photo interpretation by experts using supporting data layers (such as LiDAR, DEMs, historical imagery, or ground-based ecosystem plots) to produce linework, or by using an expert opinion/data-driven approach to model wetland ecosystems on larger areas of the landscape. Identifying the distribution, abundance, and connectivity of wetland and riparian ecosystems is

11 Note that in some cases, such as NEM, what appear to be acronyms are project type codes.

critical to supporting ecosystem, habitat, and water management. Many wetland associations occur across BEC units, and wetlands and riparian ecosystems are included in other TEI inventory and mapping projects. However, there is a need for standardized regional and provincial mapping. Consistent data on wetland extent and type facilitates analysis of ecosystem function and condition at broader scales, and trends in these factors over time. The TEI Unit is working toward creating cost-effective, consistent, defensible, and repeatable wetland maps with supporting documentation. An example of a current product related to wetland inventory is the Williston Wetland Explorer Tool; it is available in the BC Data Catalogue and provides online access to recent wetland mapping products completed for the area.

Potential uses for WET are provided in Figure 4; some example decision, ecosystem, and mapping characteristics associated with this mapping method are provided in Figure 5.

3.1.2 Classifications and coding used in ecosystem mapping and modelling

Approved **ecosystem mapping codes**, such as site series, map code, and realm/group/class, are a requirement of provincial standards for a variety of TEI ecosystem mapping projects (TEI Unit 2023). These codes have been compiled from the BGC units and site series information for forested, non-forested, and sparsely vegetated ecosystems from the BEC site series – attribute table (BEC Database v12 – 2021), various regional Land Management Handbooks, the *Biogeoclimatic Ecosystem Classification of Non-forested Ecosystems (nBEC) in British Columbia* (MacKenzie 2012), and the TEI natural non-vegetated and anthropogenic codes as per the coding updates for non-vegetated, sparsely vegetated, and anthropogenic units (TEI Unit 2020). A diagram of the TEI ecosystem mapping code assignment typically used for TEM and PEM projects is presented in Figure 6.

Several other ecosystem classifications exist depending on mapping type (e.g., within BEM and SEI). Coding is currently contained in the following resources, and integration into the TEI ecosystem mapping codes list is under way (TEI Unit 2023):

- *Standards for Broad Terrestrial Ecosystem Classification and Mapping for British Columbia: Classification and Correlation of the Broad Habitat Classes used in 1:250 000 Ecological Mapping.* Version 2.0 (RIC 2000)
- *Standard for Mapping Ecosystems at Risk in British Columbia: an Approach to Mapping Ecosystems at Risk and Other Sensitive Ecosystems.* Version 1.0 (RISC 2006)

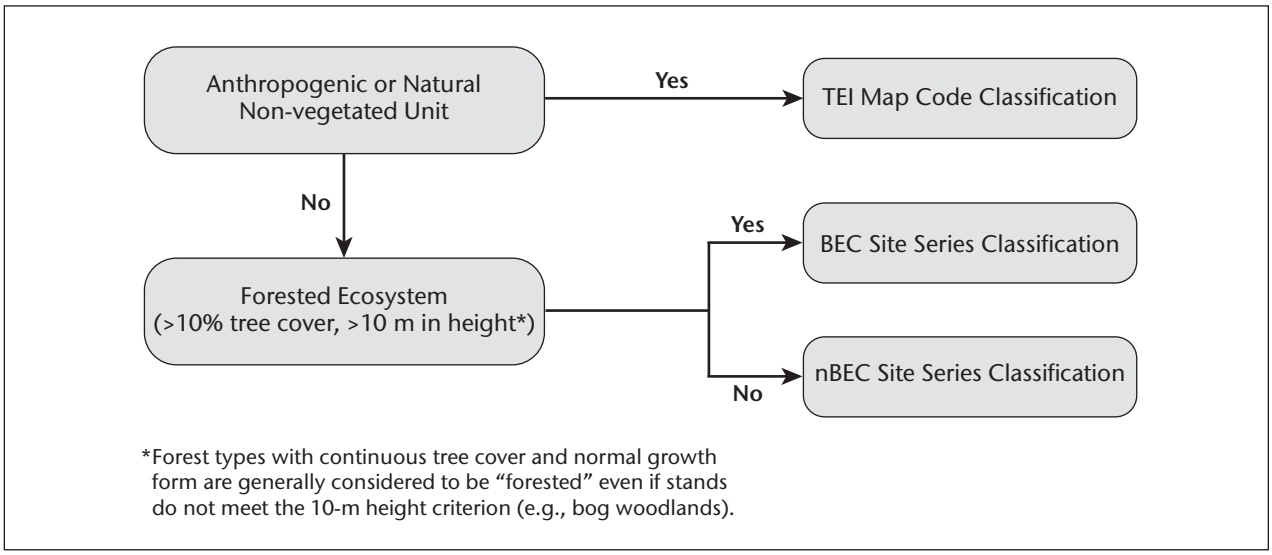


FIGURE 6 *Workflow and decision points for assignment of Terrestrial Ecosystem Information (TEI) ecosystem mapping codes to ecosystem units.*

4.1 B.C. Conservation Data Centre Element Occurrences

The B.C. CDC maps known occurrences of at-risk species and ecological communities following the NatureServe mapping methodology (NatureServe 2002). An **element occurrence** (EO) is an area of land and/or water where a species or ecosystem (i.e., element) is known or very likely to occur, or has been known to occur, persistently or with regularity. An EO is not simply an observation; it is intended to be a value-added product that includes an assessment of conservation significance, verification of the information source, and monitoring through (ideally repeated) visits or assessments (B.C. CDC 2023). Because of this emphasis on conservation significance, the B.C. CDC may map EOs for ecological communities that are in relatively poor condition in situations where there are very few known occurrences of that ecological community. Conversely, the B.C. CDC may choose not to map EOs for ecological communities that are in poor condition if there are many occurrences of that ecological community in good or excellent condition.

The B.C. CDC database includes the best available information on EOs the program has received and is updated on a regular basis (B.C. CDC 2023). Mapped EOs are not comprehensive, meaning occurrences that meet criteria for mapping may exist, but they have not yet been included in public databases provided by the B.C. CDC.[12] However, EOs can be useful for many reasons, including:

- flagging areas of value for conservation of ecological communities at risk
- providing opportunities for learning and education by identifying representative examples of ecological communities at risk
- providing information that is useful for assessing the conservation status of ecological communities, such as their range extent, number of occurrences with good or excellent ecological integrity, and area of occupancy, and as a basis for analysis of threats or trends.

In the context of mapping EOs, ecological communities are described as having a spatial pattern (sometimes referred to as "patch type"), which describes the context of the ecological community in relation to other ecological communities on the landscape (Table 3).

Understanding spatial patterns is important because they can provide information on the ecological integrity of extant occurrences of an ecological community. For example, ecological communities expected to occur in a matrix spatial pattern may be at risk if they can be found only in small patches.

An EO can consist of one or more mapped polygons.[13] For ecological communities, the complete EO may represent a stand or patch of an ecological community, or a cluster of stands or patches of an ecological community created by combining several occurrences (B.C. CDC 2023). Polygons are combined or separated into a single element occurrence using a series of documented and repeatable rules that include separation distances or features based on ecologically significant criteria such as barriers to dispersal (e.g., 1 km, a major road, a lake, or >200 m of urban development). The size of the mapped polygon(s) may also reflect the locational uncertainty associated with the source data (e.g., from older or inaccurate GPS devices or historical accounts with imprecise locations), represented with buffers that vary in size. Element occurrences based on newer data are generally more precise. Some historical and older mapped EOs appear as large polygons or circles due to greater uncertainty if they were initially digitized from points on paper maps (B.C. CDC 2023).

Many EOs of ecological communities are mapped from polygons in TEM, which can represent up to three different site series per polygon (refer to Section 3.1). Therefore, polygons used to represent EOs may contain more than one ecosystem, and EOs of different ecological communities may spatially overlap if the underlying polygons from which they were derived consist of multiple ecological communities. To help users interpret EOs, the B.C. CDC provides comments or estimates of how much of the EO contains the ecological community of interest based on the area of the EO and the deciles of the target ecosystem in the TEM polygons.[14] If the precise boundaries of an ecological community are required, qualified professionals will need to complete additional mapping at a finer scale and/or conduct field verification.

12 Examples would be occurrences for which data have not been collected, have not been provided to the Province, or contain sensitive information that cannot be publicly shared. As a public resource, element occurrences can benefit from contributions of community or citizen science to ensure that they are correct and up to date. Instructions for submitting new data to the B.C. CDC are available at https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre/submit-data.

13 In the jargon of mapping element occurrences, these may be referred to as "source features."

14 An example from the BC Species and Ecosystems Explorer reads, "Occurrence Data: This ecological community occupies approximately 5.27 ha or 22.3% of the area shown."

TABLE 3 *Spatial patterns (or patch types) of ecological communities (definitions adapted from NatureServe)*

Spatial pattern	Definition
Matrix	Ecological communities that form extensive and contiguous cover, occur on the most extensive landforms for the region, and typically have wide ecological tolerances. Disturbance patches typically occupy a relatively small percentage (e.g., < 5%) of the total occurrence. In undisturbed conditions, typical occurrences range in size from 2000 to 10 000 ha (100 km^2) or more. An example is the dominant mesic coniferous forest Douglas-fir / dull Oregon-grape ecological community found on southern Vancouver Island (B.C. CDC 2012).
Large patch	Ecological communities that form large areas of interrupted cover and typically have narrower ranges of ecological tolerances than matrix types. Individual disturbance events tend to occupy patches that can encompass a large proportion of the overall occurrence (e.g., > 20%). Given common disturbance dynamics, these types may tend to shift somewhat in location within large landscapes over time spans of several hundred years. In undisturbed conditions, typical occurrences range from 50 to 2000 ha. An example is the Douglas-fir – western hemlock / salal Dry Maritime ecological community found on Vancouver Island, the Sunshine Coast, and parts of the Lower Mainland (B.C. CDC 2019).
Small patch	Ecological communities that form small, discrete areas of vegetation cover, typically limited in distribution by localized environmental features. Examples include some hydrologically isolated wetlands such as the sweet gale / Sitka sedge ecological community or ecological communities on dry sites driven by bedrock such as the arbutus / hairy manzanita ecological community (B.C. CDC 2023). In undisturbed conditions, typical occurrences range from 1 to 50 ha.
Linear	Ecological communities that occur as linear or long, narrow strips. They are often transitional between terrestrial and aquatic ecosystems (i.e., ecotonal) and may be riparian or dependent on flooding. In undisturbed conditions, typical occurrences range in linear distance from 0.5 to 100 km. Examples include the Sitka spruce / false lily-of-the-valley and Sitka spruce / salmonberry ecological communities associated with floodplains (B.C. CDC 2023).

4.2 B.C. Conservation Data Centre Ranking of Element Occurrences

An EO rank is used to describe the probability of persistence of the ecological community at a particular location (an EO). Because EO mapping has not been completed for most ecological communities, EO ranking is a useful framework mainly for understanding and communicating the relative conservation value of *individual EOs* of an ecological community at risk, as opposed to the provincial conservation status of an ecological community. EO ranks are based on available data such as ecosystem mapping, field visits, and imagery. The rank provides an assessment of the (relative) likelihood that, if current conditions prevail, the EO will persist for a defined period, typically 20–100 years[15] (NatureServe 2002; B.C. CDC 2023).

EO ranks can be used to:

- prioritize EOs for conservation planning or action, both locally and range-wide; and
- prioritize which EOs should be mapped and monitored.

EO ranks are assigned by assessing three factors for each EO: condition, size, and landscape context. These factors are weighted differently depending on the type of ecological community and are documented in element occurrence specifications that outline definitions and thresholds based on established standards, ecological criteria, and analysis of known occurrences (see NatureServe 2002). Ecological communities with little to no disturbance in and around the element occurrence generally have the highest ecological integrity, higher EO ranks, and higher conservation value. However, where there are few or no occurrences of ecological communities with good or excellent EO ranks, occurrences in fair condition become important for conservation actions. In the most extreme cases where ecological communities are close to being lost (e.g., Garry oak ecosystems), even poor occurrences may be high priorities for conservation and restoration action due to the severity and spatial extent of historical disturbance and ongoing threats. Basic ranks used in prioritizing EOs for conservation planning purposes are listed in Table 4.

Additional information on EO mapping and ranking is available from the B.C. CDC website and NatureServe (2002). Because of the large (and increasing) number of EOs and quality of information required to assign a precise rank, many mapped EOs do not have detailed

15 The appropriate period should be linked to biological or ecological criteria, such as several generations of species that make up an ecological community, or several expected natural disturbance cycles for the ecological community of interest. For example, an early seral community adapted to annual disturbances from avalanches might disappear on a smaller timeframe than a mature forest community in a very wet hypermaritime climate with multiple centuries between fires.

TABLE 4 *Simplified examples of B.C. Conservation Data Centre element occurrence ranks applied to ecological communities in British Columbia. Additional codes and definitions are provided on the B.C. CDC website.*

Element occurrence rank	Description
A	Excellent estimated ecological integrity
B	Good estimated ecological integrity
C	Fair estimated ecological integrity
D	Poor estimated ecological integrity
E	Verified extant (integrity not assessed)
H	Historical
X	Extirpated
NR	Not ranked

element occurrence ranks. Instead, they are often labelled as not ranked (NR) or are supplied with a basic rank to help users understand whether they fall into broad categories such as verified extant (E) or extirpated (X).

4.3 Assessing the Conservation Status of Ecological Communities

The B.C. CDC uses methods and standards established by NatureServe (Faber-Langendoen et al. 2012; Master et al. 2012a; Master et al. 2012b) to assign conservation status ranks to ecological communities at the provincial ("S" for subnational) level. Subnational conservation status ranks express the level of risk of an ecological community being lost at the provincial level.

Search results on the BC Species and Ecosystem Explorer (BCSEE) display provincial conservation status ranks with the year the status was last reviewed (shown in parenthesis after the ranking code). The prefix on the code indicates the geographic level at which the rank is applied—S: subnational (provincial), N: national, or G: global. The modifier code is either a letter or number depending on the ranking (Table 5). The BCSEE also provides links to conservation status reports, with information on the factors that were assessed when assigning a conservation status rank to a community, where available. This information can be useful for informing land management because it often highlights the reasons why an ecological community may be considered at risk of being lost, identifies knowledge gaps, and supports development of stewardship recommendations.

The methods used for assessing conservation status in British Columbia build on the NatureServe methodology by taking advantage of the BEC and ecosystem mapping products, such as TEM, PEM, and SEI. National and global ranks may be based on subnational ranks

TABLE 5 *Modifier codes associated with B.C. Conservation Data Centre provincial conservation status ranks*

Modifier code	Meaning
X	Presumed extirpated
H	Historical (species)/possibly extirpated (ecological communities)
1	Critically imperiled
2	Imperiled
3	Special concern, vulnerable to extirpation or extinction
4	Apparently secure, with some cause for concern
5	Demonstrably widespread, abundant, and secure
NA	Not applicable
NR	Not yet assessed
U	Unrankable
##	Range rank—Used to indicate the range of uncertainty about conservation status (e.g., S2S3)
?	Inexact or uncertain—Denotes inexact or uncertain numeric rank

for ecological communities known to be endemic to British Columbia or may require collaborative efforts with other organizations in the NatureServe network to compile data across borders and crosswalk among different ecosystem classification systems.

The B.C. CDC prioritizes ecological communities for ranking or re-ranking according to criteria such as the stability of an ecological community's taxonomy,[16] number of years since last assessment, estimated impact from ongoing threats, availability of information, and previous estimates of conservation status. The steps to complete a conservation status assessment for an ecological community are as follows:

1. Review literature and compile data.
2. Complete the NatureServe Conservation Rank Calculator for rarity factors.
3. Complete a NatureServe assessment of threats.
4. Complete the NatureServe Conservation Rank Calculator for long- and short-term trends.
5. Assign and confirm a conservation status rank (typically the same as the rank provided by the completed rank calculator).
6. Conduct quality control through peer or expert review, and iteratively address outstanding issues.

16 Ecological communities based on older concepts that are expected to be reviewed or updated within 1–2 years (e.g., to correspond with the release of a new regional field guide) are generally considered lower priorities for ranking because the ranks are best updated when new concepts are finalized and published.

7. Publish new or updated conservation status ranks through the BC Species and Ecosystems Explorer.

Assembling and preparing appropriate data are typically the most challenging, time-consuming, and important aspects of status ranking. The availability and quality of data can often reveal the precision and accuracy of the final rank well before it is complete. Spatial information about ecological communities is needed to estimate rarity and trends, as well as the scope of threats.

The B.C. CDC uses conservation status factors consistent with NatureServe to complete status ranks of ecological communities (Faber-Langendoen et al. 2012). The factors are organized into three broad categories—rarity, trends, and threats (further defined in Table 6).

Further discussion on how each of the conservation status factors is applied in British Columbia is available from the B.C. CDC (Anderson et al. 2024).

4.3.1 Communicating the conservation status of ecological communities

The B.C. CDC uses subnational (S) ranks for ecological communities to group them into Red, Blue, or Yellow Lists as a way of simplifying status ranks for communication purposes (Table 7). The NatureServe methodology for conservation status ranking was designed to incorporate uncertainty that can occur when data regarding the ranking factors are incomplete. Ranking factors can be assigned to a range of categories, though the methodology emphasizes using the most plausible range of values and excluding extreme or unlikely values (Faber-Langendoen et al. 2012). Status ranks can show an expression of uncertainty in the form of split ranks that span several categories, such as a rank of S3S4 for an ecological community that cannot be assigned a rank of either S3 or S4 with sufficient certainty. If there are insufficient data to produce a robust status ranking with a range of likely values, ecological communities are labelled SNR (for subnational, not ranked).

In British Columbia, ecological communities at risk are those that have been assigned a status rank corresponding to the Red or Blue List. Ecological communities assigned a Yellow List status rank are apparently secure and not at risk of extinction. While the "colour"

TABLE 6 *Factors that may be evaluated in a NatureServe conservation status assessment for ecosystems (adapted from Faber-Langendoen et al. 2012)*

Category	Subcategory	Factor	Definition
Rarity	Range/ distribution	Range extent	The area contained within the shortest continuous imaginary boundary that can encompass all present occurrences, excluding outliers. Typically measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).
		Area of occupancy	The area within the range extent (see definition above) that is occupied by a taxon, measured or estimated directly based on the best available information (e.g., site series identified in Terrestrial Ecosystem Mapping).
	Abundance/ condition	Number of occurrences	Number of extant locations of an ecosystem.
		Number of occurrences or percent area with good or excellent ecological integrity	(1) Number of occurrences that have excellent-to-good ecological integrity (A or B occurrence ranks in Table 4), such that there is the likelihood of persistence if current conditions prevail, or (2) percent of the total area occupied by an ecosystem that has good-to-excellent ecological integrity.
		Environmental specificity	The degree to which an ecosystem depends on a relatively scarce set of habitats, substrates, or other abiotic and/or biotic factors within its overall range. Relatively narrow requirements are thought to increase the vulnerability of an ecosystem.
Threats		Overall threat impact	Degree to which the integrity of an ecosystem is affected by extrinsic factors (stressors) that degrade integrity, and which are characterized in terms of scope and severity. Threats are typically anthropogenic, having either direct (e.g., habitat destruction) or indirect (e.g., introduction of invasive species) impact.
		Intrinsic vulnerability	Degree to which intrinsic or inherent characteristics, such as likelihood of regeneration or recolonization for ecosystems, make an ecosystem susceptible or resilient to natural or anthropogenic stresses or catastrophes.
Trends		Long-term trend	Degree of past directional change in range extent, area of occupancy, number of occurrences, and/or ecological integrity of occurrences over the long term (ca. 200 years).
		Short-term trend	Degree of past directional change in range extent, area of occupancy, number of occurrences, and/or ecological integrity of occurrences in the short term, considered to be typically within 50 years for ecosystems.

TABLE 7 *Red, Blue, and Yellow Lists as they relate to conservation status ranks of ecological communities in British Columbia. A full list of possible subnational (S) ranks, codes, and definitions is available on the B.C. CDC website or from NatureServe.*

List	Subnational (provincial) status ranks	Definition
Red	SX, SH, S1, S1S2, S2	Any ecological community that is at risk of being lost (extirpated, endangered, or threatened) in British Columbia.
Blue	S2S3, S2S4, S3, S3?	Any ecological community that is of special concern in British Columbia.
Yellow	S3S4, S3S5, S4, S4S5, S5	Any ecological community that is apparently secure or is secure (least risk of being lost) in British Columbia.

lists can be useful for a general understanding of the conservation status of an ecological community, S ranks contain more information because (a) they can indicate uncertainty (e.g., an ecological community on the Blue List that is ranked S3 has a more certain ranking than an ecological community on the Blue List ranked S3? or S2S4), or (b) they can differentiate among special situations where ecological communities on the Red List are known to be at risk (S1) versus extirpated (SX) or historically present (SH).

4.4 Field Verification of Ecological Communities

It is always recommended that field verification be conducted to confirm the presence of ecological communities at risk. As described in Section 3.1, TEM polygons can include up to three map units that may vary by site series, site modifiers, and/or structural stage, so field verification may be necessary to confirm the actual location of the ecological community within a mapped area. Furthermore, as described in Sections 2.2 and 3, not all ecological communities are associated with site series that will appear in TEM or other mapping products because of varying levels of detail in those products. Where plot data are available to confirm the identification of an ecological community mapped by the B.C. CDC, this is indicated in the database record of the mapped element occurrence of the ecological community. In this regard, the presence of an ecological community at risk in a mapping product such as TEM or SEI or in an element occurrence based solely on TEM or SEI is often more appropriately viewed as a flagging tool.

When preparing for field work or returning from the field, it is useful to know that site series identified from field forms and/or found in mapping products prepared in accordance with RISC standards can usually be crosswalked to ecological communities using the BC Species and Ecosystems Explorer (BCSEE). Newer, older, or retired site series not found in the BCSEE can often be found in crosswalk tables in Land Management Handbooks (LMHs) such as regional field guides (e.g., *A Field Guide to Ecosystem Classification and Identification for the Southern Thompson–Okanagan* [LMH76; Ryan et al. 2022], *Wetlands of British Columbia: a Guide to Identification* [LMH52; MacKenzie and Moran 2004]), or tables that present the correlation between old and new biogeoclimatic and site units (e.g., *A Field Guide to Ecosystem Classification and Identification for Haida Gwaii* [LMH68; Banner et al. 2014]). Complex cross-walking may require assistance from BEC, TEI, or B.C. CDC ecologists who have access to documentation of historical ecosystem classification including definitions of codes that are required to interpret historical mapping products. Regional field guides in conjunction with LMH52 (MacKenzie and Moran 2004) and *Biogeoclimatic Ecosystem Classification of Non-forested Ecosystems in British Columbia* (Technical Report 068; MacKenzie 2012) should be used for site classification and information for identifying ecosystems. These regional field guides also provide information that is valuable for gaining a deeper understanding of the context and factors affecting the condition of ecosystems likely to be encountered in the field.

Once in the field, verification that an ecological community is present should follow procedures for data collection set out in the *Field Manual for Describing Terrestrial Ecosystems* (B.C. Ministry of Forests and Range and B.C. Ministry of Environment 2010). It provides several forms (FS882 and FS1333) that can be used to collect and share field data for ecosystem classification and mapping, and wildlife habitat assessments (see Section 3.1 for more information). The Site, Soil, and Vegetation forms are specifically related to identifying ecosystems to the site series or plant association level and provide the best possible data to confirm the presence of an ecological community. The Site Visit (SIVI, or FS1333) is a shortened version of these three forms. The full Ecosystem Field Form (FS882) can be found here.

When assessing ecological communities at risk in the field, the Condition Evaluation Form can be used to apply the B.C. CDC criteria for assessing the condition of an occurrence and evaluating ecological integrity. The Condition Evaluation Form can be found here.

Healthy and functioning ecosystems and ecological communities are key components of biodiversity. Management and conservation are important to ensure that biodiversity is maintained in these systems, thereby allowing associated species and ecological processes to persist. Maintaining diversity of ecosystems also benefits humans by providing services such as food, fresh water, and natural resources. Retention of ecosystems can be supported by both informed management (e.g., best management practices) and conservation actions (e.g., protecting ecological communities at risk). To effectively manage and conserve ecosystems, we need to be able to identify and delineate them and understand their conservation value.

Protecting ecosystems can be a "coarse-filter" approach to protecting species by maintaining their habitats and the ecological processes that support those habitats (Noss 1987). Ecosystem conservation can complement a "fine-filter" approach of protecting individual species (Noss 1987). Because different species are found in different ecosystems and many species use multiple ecosystems or habitat types across their life cycles, protecting the full range of ecosystems is desired in planning for species conservation. Ecosystem conservation is also critical for conserving ecological processes and functions that provide diversity and resilience for adaptation to climate change in the face of multiple land use pressures (i.e., cumulative effects[17]).

By classifying and identifying ecosystems, valuable data and knowledge can be gained to inform decision-making. Ecosystem inventory and mapping provide a baseline of existing conditions that can be used to understand the potential for sites to support certain ecosystems and provide services; this information informs multiple natural resource initiatives in British Columbia, including, but not limited to:

- land use planning, including
  - local government official community plans and development permit applications
  - modernized land use plans
  - forest landscape plans
  - strategic land use plans
- Biodiversity and Ecosystem Health Framework
- Cumulative Effects Framework
- Timber Supply Review
- ecosystem-based management
- species-at-risk recovery
- old-growth forest management
- acquisition and management of protected areas
- environmental assessments/major project reviews (e.g., mines, hydro projects, and oil and gas projects)
- Forest and Range Evaluation Program
- climate-change adaptation and mitigation (trends/future conditions)
- British Columbia wildfire safety assessments and fuel management prescriptions
- wetland and water demand modelling
- environmental mitigation and offsets
- ecological restoration and enhancement
- conservation of hunted and trapped wildlife
- wildlife habitat modelling and planning
- forest certification regimes

17 Cumulative effects are defined in the B.C. Cumulative Effects Framework as "changes to environmental, social and economic values caused by the combined effect of past, present and potential future human activities and natural processes" (Province of British Columbia 2016).

5.1 Legislation, Regulations, and Land Use Policy

Legislation, regulations, and land use policy that contribute to the protection of ecosystems and ecological communities vary across coastal British Columbia. The Red and Blue Lists published by the B.C. CDC offer no legal protection to ecological communities (or species) but rather flag them as being at risk, which may qualify them for subsequent actions, such as recovery planning and/or being eligible for protection, conservation, or management under provincial legislation, regulations, or land use policy.

Provincial conservation status reports and recovery plans provide scientific advice and important management recommendations but do not trigger a legal requirement to implement those recommendations. In some cases, legal requirements are provided through legislation or land use policy specific to certain sectors or regions. Legal mechanisms to compel direct management of ecological communities are limited. However, the following sections describe where provincial legislation, regulations, or land use policy pertain directly or indirectly to ecological communities.

5.1.1 *Forest and Range Practices Act*

The *Forest and Range Practices Act* (FRPA) and its supporting regulations govern forest and range activities on public lands in British Columbia. The term "ecological community" is now defined under FRPA as "a group of different species occupying a particular area."

Under FRPA, the Government Actions Regulation (GAR) directs the establishment of land designations and

mechanisms for stewardship of forest and range values. The Regulation includes authorities to manage ecological communities in a fashion similar to the management of categories of species at risk, regionally important wildlife, or specified ungulate species.[18] Under the Regulation:

- The Minister responsible for the *Wildlife Act* may, by order, establish one or more categories identifying ecological communities at risk, if satisfied that the ecological communities are endangered, threatened, or of special concern[19]
- The Minister responsible for the *Wildlife Act* may, by order, establish one or more categories identifying ecological communities as regionally important
- The Minister responsible for the *Wildlife Act* may, by order, establish a general measure for a category of ecological communities to be applied to a specified area

The GAR provides a mechanism for managing and conserving ecological communities that require special management that is not otherwise provided. The procedure for listing ecological communities and establishing general measures follows existing processes established under the GAR.

Within the FRPA framework, the intended conservation measures and steps for protecting ecological communities are available in accounts and measures for plant communities.[20] Within these policy documents there are several standard recommendations that apply to each ecological community:

- maintain or recover at least 20 occurrences in good condition across the range of the plant community;
- maintain or restore occurrences to as close to natural condition as possible and practical;
- maximize connectivity across forest or grassland communities and between remaining occurrences of listed communities; and
- for forested ecological communities, protect remaining occurrences through the placement of Old Growth Management Areas.

The GAR orders may include a spatially defined area and a list of practice requirements that apply to that area. In the case of ecological communities, the location is referred to as a specified area, and the practice requirements that apply to that location are referred to as general measures. *Forest and Range Act* agreement holders are legally required to follow all general measures that apply to the specified areas for ecological communities that overlap their tenure areas. There are provisions for tenure holders to seek an exemption to general measures where the intent of the measure will be achieved regardless of the proposed activity or where compliance with the general measure is not practicable. An exemption approval may include conditions such as timing restrictions or similar constraints to mitigate impacts.

FRPA also allows for the establishment of other types of reserves and management areas that can provide indirect protection to ecological communities, including ungulate winter ranges, fisheries-sensitive watersheds, and wildlife habitat areas. In addition, other forestry management provisions for riparian areas, wildlife-tree retention, visual quality, and other values can contribute to the conservation of ecological communities.

5.1.2 *Water Sustainability Act*

The *Water Sustainability Act* (WSA) was brought into force to ensure a sustainable supply of fresh, clean water for the people of British Columbia. A major component of the WSA is to ensure that any modification to the nature of a stream, including any modification to the land, vegetation, and natural environment of a stream or the flow of water in a stream is regulated. Therefore, terrestrial ecosystems such as flood ecosystems (as defined by the Flood Group in MacKenzie 2012), when they occur within the stream boundary, and other, adjacent riparian ecosystems, where designated by a Statutory Decision Maker, are regulated. Swamp, marsh, and fen wetlands are also included in the definition of a "stream" under the WSA; therefore, these ecosystems are also regulated under the Act.

Applicants seeking permission to make a change in and about a stream under the WSA are expected to first avoid and then minimize environmental impacts, and where avoidance or minimization are not feasible, compensatory mitigation measures may be required. If an ecological community at risk is associated with a stream, the requirement for avoidance and minimization of environmental impacts may increase, or alternatively, greater compensatory mitigation may be required. The Environmental Mitigation Policy for B.C., which is used by decision makers, provides guidance on how applicants can assess and mitigate environmental impacts.

18 In 2018, the Province initiated changes to improve the *Forest and Range Practices Act*. They included new protections for ecological communities that allow for the classification and designation of specific ecological communities at risk, including their locations.

19 For ecological communities in British Columbia, this corresponds to subnational status ranks that place the community on the Blue List (S2S3, S2S4, S3, S3?) or Red List (SX, SH, S1, S1S2, S2). See Table 7 in Section 4.3.1.

20 When the "Accounts and Measures" were developed, they were called "Accounts and Measures for Managing Identified Wildlife" but also included ecological communities (referred to at the time as plant communities) (MELP and MOF 1999; MWLAP 2004).

To help mitigate and avoid impacts to streams, stream channels, wetlands, and other aquatic ecosystems, the Province produced *Requirements and Best Management Practices for Making Changes in and about a Stream in British Columbia* (Province of British Columbia 2022). This document describes mandatory requirements and best management practices for making changes in and about a stream in accordance with the *Water Sustainability Act* and Water Sustainability Regulation.

5.1.3 *Riparian Areas Protection Regulation*

The *Riparian Areas Protection Regulation* (RAPR) was enacted under Section 12 of the *Fish Protection Act*, which was subsequently re-titled the *Riparian Areas Protection Act*. Although the Regulation's primary purpose is not protection of ecological communities, it enables local governments to protect riparian areas surrounding streams, lakes, and wetlands during residential, commercial, and industrial development. On the coast, the RAPR applies only to local governments on the east side of Vancouver Island and the Lower Mainland and does not apply on private managed forest land. Section 12 of the *Riparian Areas Protection Act* directs local governments to use their zoning or other land use management bylaws and permits under the *Local Government Act* to implement the riparian area protection provisions.

The purpose of the RAPR is to protect the many and varied features, functions, and conditions that are vital for maintaining stream health and productivity, including:

- sources of large organic debris, such as fallen trees and tree roots;
- areas for stream channel migration;
- vegetation cover to help moderate water temperatures;
- provision of nutrients and organic matter to the stream;
- streambank stabilization; and
- buffers from excessive silt and surface runoff pollution.

The RAPR requires a qualified environmental professional to conduct a science-based assessment of proposed activities to determine riparian setbacks where development is restricted. Indirectly, ecological communities that are associated with riparian areas and wetlands become protected within a *streamside protection and enhancement area* (SPEA) defined under the RAPR. It is important to note that while ecological communities within the SPEA are protected, the communities may extend past the SPEA and be subject to development. Isolated wetlands that do not contain fish or are not connected by surface water to fish habitat at least 1 day per year are not subject to the RAPR and therefore not protected by a SPEA. In these cases, the Province defaults to best management practices that recommend that all wetlands, whether fish-bearing or not, be protected by a minimum 30-m setback in urban areas and 150 m in undeveloped areas (Develop with Care: Environmental Guidelines for Urban and Rural Land Development 2014).

5.1.4 Strategic land use plans

Strategic land use plans provide resource management direction for provincial public land in most areas on the coast, including Haida Gwaii, the Great Bear Rainforest, Vancouver Island, and the Sea to Sky subregion. These plans have legal objectives, usually as Land Use Orders under the *Land Act* for the purposes of FRPA. Land use plans can require the legal protection of ecological communities, and within each plan, specify considerations such as levels of protection for red- and blue-listed ecological communities, attention to riparian communities, or special management zone requirements for ecological communities. A summary of each of the coastal regional and subregional strategic land use plans is provided below; further information is provided on the provincial government website:

- https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/west-coast/haidagwaii-slua
- https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/west-coast/great-bear-rainforest
- https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/south-coast-region-plans/seatosky-lrmp
- https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/west-coast/clayoquot-sound-watershed-plans
- https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/west-coast/vancouverisland-lup

Haida Gwaii Land Use Objectives Order

The Haida Gwaii Strategic Land Use Agreement (2007) established zoning to support the creation of new conservancies (protected areas), which have since been established. The Agreement also established a commitment to ecosystem-based management, which is intended to balance cultural, ecological, social, and economic objectives. These objectives were legally established in

the Haida Gwaii Land Use Objectives Order in 2010 (amended in 2014 and 2017) for several cultural values and features, aquatic habitats, biodiversity, wildlife, and forest reserves.

Biodiversity objectives include old forest and ecological representation met through site series targets and the protection of red- and blue-listed ecological communities identified in Schedule 13, with a potential variance for safety and road access. However, not all blue-listed ecological communities that exist on Haida Gwaii are listed in Schedule 13. Other ecological communities managed under the Order include riparian areas, wetlands, and swamps.

Great Bear Rainforest Land Use Objectives Order

Planning for the Great Bear Rainforest Land Use Objectives Order (GBRLUOO; 2016, amended in 2023) was initiated in 1996 and then implemented under the Central Coast Land and Resource Management Plan and North Coast Land and Resource Management Plan in 2006. These plans set the foundation for the GBRLUOO, which defines objectives for implementing ecosystem-based management on the north and south-central coast mainland (Great Bear Rainforest) and includes objectives related to ecological communities that are similar to those for Haida Gwaii.

Forest biodiversity is protected through representation in landscape reserves of old forest by site series or groups of (relatively similar) site series at levels expected to impart low ecological risk to the communities. All red-listed plant communities and 70% of occurrences of blue-listed plant communities (as per lists within the Schedules for the GBRLUOO [these are not fully aligned with B.C. CDC lists]) are conserved. Other objectives that directly or indirectly protect ecological communities include objectives for riparian areas, forested swamps, some marsh and fen wetland ecosystems, and habitat of focal wildlife species.

As of 2016, the GBRLUOO and *Great Bear Rainforest (Forest Management) Act* intended to conserve 85% of the forest and 70% of old forest over time, to promote a high level of ecological integrity (Province of British Columbia 2023a).

Vancouver Island Land Use Plan

In 1994, the Province announced the Vancouver Island Land Use Plan (VILUP), which endorsed the recommendations from the Commission on Resources and Environment. Subsequently, the Province established several new parks and protected areas on Vancouver Island, and in 2000, the VILUP Higher Level Plan Order was legally established. The Order established resource management zones across Vancouver Island, including enhanced forestry zones where forestry development is prioritized and special management zones where biodiversity objectives are prioritized. The Order provides additional guidance for landscape unit planning related to old-growth forests (Section 5.1.4.4) and ecosystem representation, and contains provisions for cutblock size and visual quality objectives. The VILUP does not reference ecological communities directly, but special management zones include objectives for old forest and ecosystem representation at the site series/surrogate level of representation, and an emphasis on regionally rare and underrepresented ecosystems.

Order Establishing Provincial Non-Spatial Old Growth Objectives

In 1999, the Province released the Landscape Unit Planning Guide, which outlined direction and procedures for the retention of old-growth forest and wildlife trees on provincial Crown lands in British Columbia.

In 2004, the Province created the Order Establishing Provincial Non-Spatial Old Growth Objectives, which identified the amount of old forest to be maintained to address biodiversity values across the province. The Order established biodiversity emphasis and old-growth objectives for all landscape units in the province, with direction to maintain targets (percentages) of old forest by biogeoclimatic variant within each landscape unit according to the age of old forest and natural disturbance type of the BEC unit, and the biodiversity emphasis option of the landscape unit being managed.

Old Growth Management Areas, along with other reserves and protected areas on Crown land, are designed to meet targets identified in the Non-spatial Old Growth Order and objectives identified in the higher-level plan orders (e.g., VILUP), and to provide protection to forested ecological communities.

Ministerial Order – Coastal Douglas-fir Moist Maritime (CDFmm) Biogeoclimatic Subzone

In 2010, a Ministerial Order for the Coastal Douglas-fir Moist Maritime (CDFmm) biogeoclimatic subzone established objectives to protect plant communities on approximately 1600 ha of Crown land. The Order was established under Section 93.4 of the *Land Act* and outlines land use objectives for the purpose of FRPA. The Order was amended in 2018 and increased the lands under protection by approximately 1000 ha. Plant communities were defined to mean "vegetation that possesses a similar vegetation structure and native species

composition and occurs repeatedly on similar habitat within the CDFmm biogeoclimatic subzone." While ecological communities are not referenced in the Order, nearly all ecological communities within the CDFmm are considered ecological communities at risk.

Clayoquot Sound Land Use Decision

In 1993, the Province announced the Clayoquot Sound Land Use Decision, which increased the number of protected areas within the Sound and provided guidance on integrated resource management, including forestry. In addition, the Province created the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound to provide recommendations for land and resource management. In 1995, the Province agreed to implement the Panel's recommendations, which included commitments to ecosystem-based management, biodiversity conservation, and First Nations cultural values. The Province then worked with First Nations to complete watershed plans that included spatial reserve networks that were intended to reflect the Panel's recommendations for sustainable forest management. Watershed reserve networks were designed to protect watershed integrity, biological diversity, and human values.

In the Panel's reports, ecological communities are not mentioned by that term, but the spirit of protecting them is included in the Panel's guidelines; and in some cases, may protect locations where ecological communities are represented. All watershed plans produced following the Panel's guidelines include:

- guidelines that state that watershed-level reserves should represent all ecosystems (site series or site series surrogates), and that rare ecosystems (covering < 2% of a planning unit) should be represented in greater proportion than their representation in the area
- protection of hydroriparian systems, including streams, lakes, wetlands, and marine shores, all of which will protect many important ecological communities
- site-level protection of red-listed, blue-listed, and old growth-associated species (e.g., Marbled Murrelet).

In 2008, the Province established legal objectives for Clayoquot Sound that enabled the watershed plans and Scientific Panel's recommendations to be implemented under FRPA.

Sea to Sky Land and Resource Management Plan

The Sea to Sky Land and Resource Management Plan (LRMP) was initiated in 2001 to provide greater certainty for economic development and sustainability of ecological, social, and cultural values in the Sea to Sky plan area. Government-to-government land use agreements were negotiated with several First Nations to harmonize the LRMP with their stewardship interests and existing land use plans. The LRMP was approved in 2008 and amended in 2009 and 2010. In 2011, 45 wildland areas were established in the LRMP area. Wildland areas prohibit commercial forestry and establishment of works for power development within their boundaries but may allow for other resource development and activities such as subsurface mining and recreation. Objectives for First Nations cultural places and management areas, floodplain management areas, and riparian areas were legally established through a Land Use Objectives Regulation Order. Objectives for floodplains include maintaining a fully representative suite of forest types, plant communities, and wildlife habitats. There is no other mention of ecological communities (broadly or specifically) in the plan. However, other objectives in the plan contribute to the conservation of some ecological communities through goals to maintain sustainability and resiliency of forested ecosystems by identifying and implementing strategies to minimize losses from damaging insects, diseases, and abiotic disturbances.

5.2 Other Management Strategies

In the context of this guide, other management strategies include best management practices (BMPs), guidelines, environmental assessments, status reports and recovery strategies, and certifications. While examples of these other management strategies are presented in the following sections, the list is not exhaustive.

Best management practices, guidelines, and standard operating procedures help development projects and resource management activities meet necessary legislation, regulations, and policies. For example, legislation might dictate that projects cannot harm a stream, whereas best management practices provide practical methods to avoid harming a stream.

Environmental assessment requirements for proposed development projects may be triggered at all levels of government, each with its own process. The provincial and local government processes are discussed below. Status reports are associated with conservation planning for species and ecological communities. The federal government, through the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), produces status reports for plant and wildlife species only, whereas the B.C. CDC produces status reports for species and

ecological communities. A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of species listed in Canada's *Species at Risk Act* (Government of Canada 2022). Sustainable Forest Management certification, a management strategy associated with the forest industry, may have objectives for ecosystems and ecological communities.

5.2.1 Guidelines to Support Implementation of the Great Bear Rainforest Order with Respect to Old Forest and Listed Plant Communities

The Great Bear Rainforest Order (GBRO), discussed in Section 5.1.4, presents legal objectives for the protection of old forests and red- and blue-listed plant communities (i.e., ecological communities). The Guidelines to Support Implementation of the Great Bear Rainforest Order with Respect to Old Forest and Listed Plant Communities (Banner et al. 2019) provide field assessment criteria to facilitate consistent application of ecological concepts to ensure that the management and conservation objectives of the GBRO are met. A set of field keys is provided, beginning with an old forest assessment key and then a key to determine if an ecological community is sufficiently established.[21] The keys incorporate initial minimum criteria for certain ecological features, and an index that integrates a suite of old forest attributes (the Forest Attribute Score) based on features that reflect the complexity of these older, coastal, forested ecosystems. Both keys either provide a final decision or direct the user to the Forest Attribute Score procedure for making a final decision. The keys require the field practitioner to determine stand age and occurrence of a veteran overstorey tree layer. To evaluate the requirement for protection of listed communities, the level of understorey development must also be evaluated. Currently, this guidance document is specific to the GBRO, but the methods and criteria established to meet the objectives related to management of old forest and ecological communities may inform future guidance for other areas of the province.

5.2.2 BC Timber Sales at-risk ecological communities programs

BC Timber Sales (BCTS), an independent organization within the Ministry of Forests, has legal, stewardship, and certification requirements to manage and conserve ecosystems and habitats that may occur within BCTS operating areas. All BCTS operations are certified under the Sustainable Forestry Initiative Forest Management Standard. To meet Sustainable Forestry Initiative objectives, BCTS has developed corporate resources to support the development of a program to ensure that at-risk ecological communities are identified and adequately protected during forestry operations. Components of this program include a focal list of ecological communities that could be present within BCTS operating areas that are to be managed, field confirmation procedures, a stand-level management procedure, objectives, and reporting requirements. Details of BCTS at-risk ecological communities programs are available on the Environmental Management System and Sustainable Forest Management website, organized by business area.

5.2.3 Garry Oak ecosystem best management practices

In Canada, Garry oak ecosystems occur only in British Columbia, along southeast Vancouver Island, the nearby Gulf Islands, and in two areas of the Fraser River valley (GOERT 2013). Garry oak ecosystems include savannahs (open grasslands with widely scattered trees) as well as woodlands with many Garry oak trees. Garry oak ecosystems, as a concept, may also include areas that have very few to no trees, such as coastal bluffs, maritime meadows, vernal pools and seeps, and rock outcrops with very thin soils. Garry oak ecosystems also include forested areas with Garry oak trees interspersed with Douglas-fir (*Pseudotsuga menziesii*) and arbutus (*Arbutus menziesii*). Underlying soil conditions and other limiting factors affect what each ecosystem looks like, but they are all rare and ecologically valuable. Currently, 11 ecological communities associated with Garry oak ecosystems are included on British Columbia's Red and Blue Lists (B.C. CDC 2023):

- Garry oak – arbutus *(Quercus garryana – Arbutus menziesii)*
- Garry oak/California brome *(Quercus garryana/Bromus carinatus)*
- Garry oak/oceanspray *(Quercus garryana/Holodiscus discolor)*
- Wallace's selaginella/reindeer lichens *(Selaginella wallacei/Cladina* spp.)
- tiny mousetail – montias – Macoun's meadow-foam *(Myosurus minimus – Montia* spp. *– Limnanthes macounii)*
- arbutus/hairy manzanita *(Arbutus menziesii/Arctostaphylos columbiana)*
- Roemer's fescue – junegrass *(Festuca roemeri – Koeleria macrantha)*
- Douglas-fir – arbutus *(Pseudotsuga menziesii – Arbutus menziesii)*
- Douglas-fir/dull Oregon-grape *(Pseudotsuga menziesii/Mahonia nervosa)*

21 The term "sufficiently established" is being used specific to the implementation of definitions within the GBRO and not as a general ecological concept outside the GBRO.

- Douglas-fir/Alaska oniongrass *(Pseudotsuga menziesii/Melica subulata)*
- Douglas-fir – lodgepole pine/reindeer lichens *(Pseudotsuga menziesii – Pinus contorta/Cladina* spp.)

First Nations across southern British Columbia have relied on Garry oak ecosystems as food gardens for thousands of years, and biologically, these ecosystems are some of the most biodiverse in coastal British Columbia. Land conversion for agricultural, residential, and industrial development has vastly reduced the extent of these ecosystems; less than 10% of those present pre–European settlement remain (Lea 2006).

Since its founding in 1999, the Garry Oak Ecosystems Recovery Team (GOERT) has led the development of recovery strategies and BMPs for Garry Oak ecosystems (all found on the GOERT website):

- Best Management Practices for Garry Oak & Associated Ecosystems (GOERT 2013)
- Restoring British Columbia's Garry Oak Ecosystems: Principles and Practices (GOERT 2011)
- Model Bylaws for the Protection of Garry Oak & Associated Ecosystems (GOERT 2014)

These documents have been prepared to assist planners, developers, land managers, government employees, landowners, and stewardship groups with activities that may interact with Garry oak ecosystems. Further information and additional BMPs can be found on the GOERT website (GOERT 2023).

5.2.4 Develop with Care: Environmental Guidelines for Urban and Rural Land Development

The document Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia (2014) outlines how to maintain environmental values during urban and rural land development. The document includes information on:

- priorities of the provincial government and other agencies
- green alternatives to standard urban development practices
- riparian protection
- climate change
- waste management
- protection of environmentally valuable resources
- streamlining review processes

Information related to ecological communities at risk and other important ecosystems is provided in Section 5 of the document, where each of the eight British Columbia Natural Resource Regions are examined. Appendix B of the document provides a framework for conducting a biological inventory to inform municipal planning and development decisions. The biological inventory includes assessment of sensitive ecosystems and ecological communities at risk.

5.2.5 Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in British Columbia

Wetlands are among the most biologically diverse, productive, and important life support systems on Earth. They are integral to many important ecosystems and life forms in British Columbia, and they provide beneficial services, such as flood control, water supply, or recreation. Currently in British Columbia, 58 ecological communities at risk are in the wetland realm (B.C. CDC 2023), though many more (such as floodplains, vernal pools, and alkaline grasslands) are closely related to wetlands. Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in British Columbia (2009) provides guidelines and best management practices for development activities to:

- avoid or minimize impacts on wetlands;
- maintain high ecological values in wetland areas; and
- address sector-specific needs or management and regulatory considerations.

5.2.6 Provincial environmental assessments

The British Columbia environmental assessment process ensures that any potential environmental, economic, social, cultural, and health effects that may occur during the lifetime of major projects are thoroughly assessed. However, not all projects are assessed. Projects are assessed if they meet sufficient criteria described in the Reviewable Projects Regulation or have been designated by the Minister of Environment and Parks, or if a proponent chooses to opt into the assessment process. Environmental assessments are managed by the Environmental Assessment Office (EAO), a regulatory agency within the provincial government that works with and seeks input from scientific professionals, Indigenous groups, proponents, the public, local governments, and federal and provincial agencies on potential project effects.

The EAO follows a clearly defined process through the *Environmental Assessment Act* to conduct the assessment of a major project and produce a detailed assessment report. That report is then given to provincial ministers to decide whether the project should proceed. One of the key components of the environmental assessment process is the determination and assessment of Valued Components, which are identified from comprehensive issues scoping and engagement. The EAO's

Application Information Requirements Guidelines provide a standard list of Valued Components that may be used for the assessment of a project (EAO 2020).

Ecosystems and ecological communities are captured in the vegetation Valued Component, and if determined applicable, applicants are expected to describe the location, extent, and condition of ecological communities, wetland ecosystems, and old forest ecosystems using ecosystem mapping that is consistent with provincial standards. Applicants need to show how the project will affect these components, how management actions will be used to mitigate effects, and how residual effects will be characterized. Significant negative effects, such as direct losses of ecological communities at risk, may contribute to a final decision to not approve a project, especially where ecological communities may be endemic to a particular project location.

5.2.7 Local government environmental assessments

Local governments may have their own environmental assessment process, established through an official community plan and bylaws, that can be used to make objective decisions about proposed developments in their jurisdictions. The standards for local government environmental assessments can vary from region to region, but in practice, they are used to understand the environmental values that will interact with the project, and in some cases, provide mitigation measures to minimize environmental damage. Several local governments in coastal British Columbia include requirements to assess projects for interactions with ecological communities at risk. For example, the City of Courtenay requires an environmental impact assessment for most developments. It includes determining the presence of environmentally sensitive areas, which, by their definition, include ecological communities at risk (City of Courtenay 2022). Courtenay maintains a map of environmentally sensitive areas but requires proponents to confirm the presence or absence of such areas because not all may have been mapped.

5.2.8 Status reports and recovery strategies

At the federal level, COSEWIC produces status reports for plant and wildlife species; the reports describe the species' life history, population size and trends, distribution, and habitat availability. These status reports are used to support species assessments and conservation status designations. For ecological communities, the provincial government leads conservation status assessments at the subnational (provincial) and national scales because there is not an established national process for describing ecological communities and assessing their conservation status at the national scale. NatureServe methodologies outline procedures for assessing conservation status at the global scale, and several ecological communities tracked by the B.C. CDC have been assessed and ranked as globally at risk.

The federal *Species at Risk Act* requires recovery strategies for all endangered species (Government of Canada 2015). Each recovery strategy sets goals and objectives, identifies critical habitat to the extent possible, and describes the research and management activities that are needed. Strategies are prepared in co-operation and consultation with provincial and territorial governments, wildlife management boards, Indigenous organizations, and stakeholders. The federal government recognizes the importance and efficiency of taking an ecosystem-based approach to the recovery of species at risk, and co-operates on or leads recovery strategies that concern "multi-species" management and may benefit the ecological integrity of ecological communities. Examples of federally led and co-led multi-species recovery strategies that are geographically connected to coastal British Columbia include the following:

- Recovery Strategy for Multi-Species at Risk in Garry Oak Woodlands in Canada (Parks Canada Agency 2006a)
- Recovery Strategy for Multi-Species at Risk in Maritime Meadows Associated with Garry Oak Ecosystems in Canada (Parks Canada Agency 2006b)
- Recovery Strategy for Multi-Species at Risk in Vernal Pools and Other Ephemeral Wet Areas Associated with Garry Oak Ecosystems in Canada (Parks Canada Agency 2006c)

The B.C. CDC produces conservation status reports for ecological communities, as discussed in Section 4.3, primarily to provide details on assessment and status ranking at a provincial level. Outside of the B.C. CDC, detailed status reports for select ecological communities or groups of ecological communities have been prepared to support ecosystem-based recovery planning and identify knowledge gaps. Examples include the following:

- Ecosystem Status Report for *Pseudotsuga menziesii/Mahonia nervosa* (Douglas-fir/dull Oregon-grape) Ecological Community in British Columbia (de Groot and Cadrin 2018)
- Status Report on Coastal Sand Ecosystems in British Columbia[22] (Page et al. 2011)

22 Comprises eight ecological communities from coastal British Columbia.

5.2.9 Forest management certification

In addition to meeting legislation requirements that apply to Crown or private land, most forestry companies on the coast are certified according to one of three forest management certification standards: Forest Stewardship Council, Program for the Endorsement of Forest Certification Canada, or Sustainable Forestry Initiative. This third-party management certification complements legal requirements and provides globally recognized sustainable forestry management standards. All three standards have objectives related to the conservation of biodiversity, which may include requirements to have programs in place to locate and protect viable occurrences of critically imperiled and imperiled ecological communities, defined as forests with exceptional or high conservation value. Typically, certification requires management of red- and blue-listed ecological communities, and often includes additional requirements related to special habitats, riparian zones, and overall representation of ecosystem types.

6 HOW DO WE FIND INFORMATION AND RESOURCES TO SUPPORT MANAGEMENT OF ECOLOGICAL COMMUNITIES?

6.1 Finding Classification, Coding, and Community Information

6.1.1 Biogeoclimatic Ecosystem Classification

The BEC system and its associated units are described in a series of regional field guides/Land Management Handbooks developed by the provincial government. Field guides contain detailed information on BEC (climatic) units (zones, subzones, and variants), and site units (site series, site series phases, and site series variations) within the BEC units. The site series descriptions include vegetation and environmental data, such as soils and terrain. Many of the guides also contain wildlife habitat and silviculture interpretations. BEC regional field guides are available to download as a pdf document or to purchase in hardcopy from the King's Printer.

Provincial classifications for wetlands and non-forested ecosystems have also been published. The guide to wetland identification (MacKenzie and Moran 2004) presents a site classification and interpretative information for wetlands and related ecosystems across British Columbia using realm, group, class, and site association. There is also a technical report describing the classification for non-forested ecosystems in British Columbia (MacKenzie 2012). However, regional field guides/Land Management Handbooks should be checked for more recent updates to wetlands and non-forested ecosystem classifications.

All current BEC units and codes are provided in the BEC database BECdb (v12, published in 2021) and existing inventory data within the BEC Master VPro[23] database; additional information is available from the B.C. Ministry of Forests BEC program website (BECWeb).

Requests for BEC plot data, the best source of detailed, classified, ecosystem plot data for British Columbia, can be made through the BECWeb site by filling out the Plot Data Requests form. BEC mapping at the zone and subzone/variant scale can be found in the BEC Map data set through the BC Data Catalogue and is available to download from the BECWeb site. BEC program staff, including the BEC regional ecologists, should also be contacted for confirmation of current BEC, site series classification, and ecological communities in each region (refer to Section 7 for Ministry contact information).

6.1.2 Terrestrial Ecosystem Information data and ecosystem mapping codes

Background information on TEI data and coding as well as additional guides and information on related classification standards and guidelines, such as BEC, ecoregions, terrain, and soils are provided on the TEI Standards website.

Ecosystem mapping codes for use during most TEI ecosystem mapping projects are contained within the TEI Ecosystem Codes database, which includes a list of provincial standard approved codes based on BEC units and site series information for forested, non-forested, and sparsely vegetated ecosystems (TEI Unit 2023).

Other ecosystem classifications and associated coding exist for specific mapping types, including BEM and SEI. Coding is currently contained in the following resources, and integration into the TEI ecosystem mapping codes list is under way (TEI Unit 2023):

- *Standards for Broad Terrestrial Ecosystem Classification and Mapping for British Columbia: Classification and Correlation of the Broad Habitat*

23 VPro is an ACCESS© database developed by the B.C. Ministry of Forests, Research Branch for data entry, management, and analysis of the provincial ecological (BEC) data. It allows users to manipulate, summarize, and analyze data in hierarchical classifications.

Classes Used in 1:250 000 Ecological Mapping. Version 2.0 (RIC 2000)
- *Standard for Mapping Ecosystems at Risk in British Columbia: an Approach to Mapping Ecosystems at Risk and Other Sensitive Ecosystems*. Version 1.0 (RISC 2006)

Additional resources for historical context include the following:
- TEI Coding Updates for Non-Vegetated, Sparsely Vegetated, and Anthropogenic Units, which contains the current TEI-approved natural non-vegetated and anthropogenic map codes for use with TEI mapping projects. It also contains a list of retired TEI map codes.
- TEI historical and retired ecosystem codes (Master code list – DRAFT), which contains a list of historical codes, including retired codes. Requests for access to this list may be sent to TEI_Mail@gov.bc.ca.

The TEI Contractor Package contains the most up-to-date metadata and code information. Within the Contractor Package documentation there are links to metadata for the TEI long table and other fields, along with the digital standards (RISC 2023), which also define the fields used and can be an easier format to look up information. Domain tables and lookup tables for attributes and codes are also provided in the Tools_and_Templates.gdb.

6.1.3 Using the BC Species and Ecosystems Explorer to query ecological communities

The BC Species and Ecosystem Explorer (BCSEE) provides information on more than 600 ecological communities in British Columbia. Lists of ecological communities can be generated based on several search options using multiple parameters, including conservation status or legal designation (e.g., B.C. list, global status), area-based (e.g., Natural Resource Districts, ecoregions, national parks), and ecological criteria (e.g., BEC units/site series/ecological communities, habitat types). A search generates a results table that provides information, including the full name of the ecological community, links to the BEC unit (if applicable), conservation status rank, legal status, and links to spatial data and reports of element occurrences. In addition, the reports and references include descriptions of the ecological communities and detailed conservation status ranks for some ecological communities.

Additional information on ecological community classification, element occurrence mapping and ranking, and provincial conservation status ranks are available from the B.C. CDC website.

6.2 Finding Ecosystem Mapping Data for an Area

The recommended source for spatial TEI data, including ecosystem mapping projects, is the Data Distribution Package for the region of interest. These packages are available for download and contain all currently loaded Terrestrial Ecosystem Mapping, Predictive Ecosystem Mapping, Sensitive Ecosystems Inventory, Terrain Mapping, Soil Inventory Mapping (project boundaries only), Species Distribution Mapping, and Wildlife Habitat Rating projects. The TEI data sets in the packages have been split into PEM and non-PEM projects, and further split by region, to address file size issues. The index map can be used to assist with identifying the region(s) of interest. TEI Data Distribution Packages include:
- the project boundaries feature class containing project-level metadata and hyperlinks to reports or other sources of related data;
- the "short table" with key and concatenated attributes (< 30) designed for ease of viewing and map labelling;
- the complete RISC standard attribute table (i.e., long table), which contains the source attribute fields from which key and concatenated fields in the "short table" are derived;
- "user-defined attribute data" (non-standard project data); and
- sample site and symbols (e.g., landslides), point, line, and polygon data (feature classes).

To confirm that all recent data for the area of interest are available within the Data Distribution Packages, requests should be sent to TEI_Mail@gov.bc.ca with a spatial boundary for areas of interest (i.e., shapefiles).

Project-specific TEI, such as reports, data, or legends, can be obtained from the Ecological Reports Catalogue (EcoCat) by searching via keyword (i.e., project name) or the unique project identifier (i.e., Business Area Project Identifier [BAPID] number).

The following is a recommended workflow for searching and accessing TEI data for an area of interest:
1. Use the provincial "Project Boundaries" spatial layer to determine which projects overlay your area of interest and note the BAPID associated with those projects. This layer is included in the TEI Data Distribution Packages but can also be viewed on iMap or downloaded from the **BC Geographic Warehouse**.

The project boundary layer does not include detailed ecosystems information but provides an overview of TEI projects across British Columbia.

2. Apply a definition query for project type on the project boundaries layer to narrow the search criteria.
3. Review the attribute fields of the overlaying project boundaries for information on where the reports and detailed polygons are located for those projects. Links to EcoCat records, and overarching project information are provided. In cases where the EcoCat link associated with a project is broken or missing, conduct searches in EcoCat using the BAPID number or key words associated with the project.
4. Download one of the spatial distribution packages to access detailed polygon information for TEI projects. The Data Distribution Packages contain a full TEI data set split into Predictive Ecosystem Mapping data and non-PEM data, which includes Terrestrial Ecosystem Mapping, Terrain Mapping, Bioterrain Mapping, Terrain Stability Mapping Sensitive Ecosystems Inventory, Soil Inventory Mapping (project boundaries only), and Wildlife Habitat Ratings (project boundaries only) by natural resource sector region (see TEI Index Maps available on the TEI distribution site).
5. Occasionally, there is a delay in publishing all submitted TEI data. Contact TEI Mail (TEI_Mail@gov.bc.ca) to verify that there is no new or unpublished data available for the area of interest.
6. View detailed polygon information for specific projects, and query the operational data by BAPID for projects of interest.

TEI layers are also available for viewing in iMapBC and are downloadable through the BC Data Catalogue; however, these are derived products of the TEI Data Distribution Package. Spatial-based searches for project locations and information available on EcoCat can also be conducted using iMapBC (refer to EcoCat – TEI information points).

Because information on soils is often an important consideration for determining ecological communities, a Soil Mapping Data Distribution Package is available; it contains all currently loaded TEI soil mapping projects. Also, the Soil Information Finder Tool is an online mapping application that allows users to explore soil data for British Columbia. Note that these data contain simplified attribute names, and have been edited to display a seamless product (no overlaps).

6.3 Finding the Location and Extent of Ecological Communities

6.3.1 Known locations

While not all ecological communities in the province have been mapped, known locations of mapped element occurrences (see Section 4.1) can be viewed using the following:

- BCSEE has information on all ecological communities, including generalized locations of mapped EOs. Filters can be applied for a variety of items, including biogeoclimatic unit (if applicable), ecoregions, forest districts, and regional districts/municipalities.
- B.C. CDC iMap can be used to conduct a spatial search of EOs in an area of interest. Spatial boundaries for areas of interest (i.e., shapefiles) can be uploaded to iMap. Mapped EOs can be viewed, printed, and exported (to CSV or shapefile) using this online mapping service.
- DataBC Connect allows access to spatial layers of B.C. CDC element occurrences from the BC Geographic Warehouse in Web Map Service format. The layers can be viewed using a user's geospatial software or as KML files in Google Earth. Data from the B.C. CDC are included in the "Wildlife and Plant Species" service.

In addition, known locations of ecological communities are captured in B.C. CDC element occurrence data, which can be downloaded from the BC Data Catalogue as ArcView shapefiles, ESRI geodatabase, CSV, GeoRSS, or GeoJSON, or through connection to the Web Map Service URL. The search term "CDC Occurrences" can be used to find the B.C. CDC spatial layers.

B.C. CDC's publicly available element occurrence layers include the following:

- Publicly available occurrences: Element occurrences of species and ecological communities at risk that are publicly available. Most B.C. CDC data are displayed in this layer.
- (Historical) publicly available occurrences: Element occurrences are deemed historical if the last observation was more than 40 years ago, or the element occurrence is considered to be possibly extirpated.
- (Masked secured) publicly available occurrences: A public view of element occurrences that are secured appear as large blurred polygons that hide the actual location of the element occurrence and contain no associated information.

A small number of mapped element occurrences are withheld from the public, as set out in the Species and Ecosystems Data and Information Security Policy. The most common reasons that an element occurrence would be secured are:

- the species or ecological community is considered to be susceptible to persecution or harm[24] if the data are publicly available; or
- the data are proprietary.

Requests for additional information about an ecosystem, including access to secure data, can be requested by contacting the B.C. CDC (cdcdata@gov.bc.ca).

6.3.2 Potential locations

An area-based search can be used in the BCSEE to generate a list of species or ecological communities that may occur in an area. Results are based on known locations and expert opinion. Conversely, the Species or Ecosystems Summary Report in the search results can be viewed to determine areas in which the ecological community of interest may occur.

TEI data can also be searched for areas with potential occurrences of ecological communities at risk. Ecosystem mapping projects such as TEM, PEM, or SEI can be used to determine what ecosystems have been mapped in an area and if red- or blue-listed at-risk ecological communities also occur. Determining the mapped extent of an ecological community requires examining TEM projects in the potential range of that ecological community and determining if the site series from the BCSEE search results occurs within the mapping. The mapped site series name or site series code may not be identical to that of the ecological community, but a review may indicate that the ecological community is the same or is similar enough to warrant further investigation. The TEM data from the Data Distribution Packages, as well as the associated report and other documentation, which is available on EcoCat, should indicate the BEC units and the site series mapped within the project area.

It is important to note that ecological communities at risk are not always mapped to their full extent in mapping products such as terrestrial ecosystem mapping (TEM), sensitive ecosystem inventory (SEI), or element occurrences (EOs); field verification is required to map the extent of ecological communities at risk in a project area so that appropriate management actions can be determined. Ecosystem mapping polygons can include up to three map units (by ecosystem, site modifiers, and/or structural stage), and field verification is necessary to confirm the ecological community's location within a mapped polygon (see Section 4.4).

[24] Currently, no ecological communities are considered to be susceptible to persecution or harm.

6.4 Resource Stewardship Tools

Resource stewardship tools can be used to set objectives and management recommendations for priority natural resource values. Technology advancements in creating visualization tools and interactive mapping applications have allowed for increased, efficient sharing and communication of objectives and management recommendations for priority natural resource values between all levels of government, Indigenous governments, communities, and stakeholders. Examples of resource stewardship tools are provided below, but they are not intended to represent a comprehensive or complete list of all tools available for coastal British Columbia.

6.4.1 Metro Vancouver Sensitive Ecosystem Inventory mapping application

The Metro Vancouver Regional District conducted a sensitive ecosystem inventory from January 2010 to May 2012 across a 367 000-ha study area covering Metro Vancouver and Abbotsford. This work resulted in the production of the Sensitive Ecosystem Inventory Mapping Tool, an interactive map of ecologically significant and relatively unmodified sensitive ecosystems, including wetlands, older forests, and woodlands. It also includes human-modified ecosystems that retain ecological value, such as seasonally flooded agriculture fields or young forests (Meidinger et al. 2014).

The application is intended to inform various environmental planning initiatives, such as:

- conservation efforts, such as protected area acquisition and management
- restoration programs
- environmental site assessments
- corridor mapping
- landscaping, including tree planting and cutting
- development planning and permitting
- stream setbacks
- invasive species bylaws
- sediment control
- urban forestry

Updates to the inventory (2009–2014) have been conducted to track changes over time (Clark and Meidinger 2020).

6.4.2 Community Mapping Network

The Community Mapping Network helps communities map sensitive habitats and species distributions in British Columbia and Canada. Since 2000, the Network has created community-based atlases with customized data entry and reporting tools. The atlases integrate many different data sources, including local and remote data sets, geo-referenced videos, and sensitive habitat mapping projects. The Atlas Gallery has more than 60 user-friendly atlases that use Mapguide Open Source. By providing accurate and up-to-date information, the Community Mapping Network and its many partners help plan sustainable communities (CMN 2018).

Ecological mapping projects from provincial mapping initiatives, such as the BC Wetlands Atlas, as well as those from many coastal community projects, are part of the Community Mapping Network. For example, Comox, Cowichan, the Fraser Valley, Powell River, the Sunshine Coast, and the Southern Gulf Islands have mapping projects, some of which contain mapping pertinent to ecological communities.

6.5 Other Resources

Numerous resources provide information and reports on ecological communities, and other ecosystem-based information. These resources can generally be found by searching the Cross-Linked Information Resources website.

The site allows users to:

- use keywords and advance search features to search for documents in the following databases:
  - BCSEE – BC Species and Ecosystems Explorer: contains data and information about plants, animals, and ecosystems.
  - EcoCat – Ecological Reports Catalogue: includes reports from a variety of disciplines on water quality and quantity, reservoirs, floodplain mapping, groundwater, fish and fish habitat, wildlife and wildlife habitat, terrestrial information, soils, and vegetation.
  - EIRS BDP – Environmental Information Resources for Biodiversity e-library: captures a range of environmental and natural resource information, including publications on British Columbia species and their habitats.
  - EIRS EP – Environmental Information Resources for Environmental Protection e-library: includes a range of information on environmental protection in British Columbia, including publications on air quality, water quality, climate change, solid and liquid waste, recycling, and product stewardship.
  - J.T. Fyles Natural Resources Library – a multiple-ministry natural resource sector library.
- sort, print, and export search results
- download files

Below are a few examples of documents that apply to coastal ecological communities and provide very useful information on ecosystem characteristics, and in some cases, suggestions for management. It should be noted that these documents are not intended to represent a comprehensive or complete list of all those available for coastal British Columbia.

- Coastal Douglas-fir Ecosystems brochure (MELP 1999)
- Coastal sand dune ecosystems
  - Coastal Sand Dune Ecosystems in British Columbia brochure (MOE 2006a)
  - *Status Report on Coastal Sand Ecosystems in British Columbia* (Page et al. 2011)
- Garry oak ecosystems
  - Garry Oak Ecosystems brochure (MELP 1993)
- Estuaries
  - Estuaries in British Columbia brochure (MOE 2006b)
  - Estuaries on the North Coast of British Columbia: a Reconnaissance Survey of Selected Sites (MacKenzie et al. 2000)
- Karst ecosystems
  - What is karst? (Province of British Columbia 2023b). Government website that provides information on coastal karst ecosystems, including guides to karst management.

6.6 Other Partners and Programs

Within coastal British Columbia, many other groups and conservation initiatives work to raise awareness of local species and ecosystems. These organizations, programs, and partners often have valuable information on ecological communities. Examples are provided below; however, it should be noted that this is not a comprehensive or complete list of all groups within coastal British Columbia.

6.6.1 Federal, regional, municipal, and local governments

Federal, regional, municipal, and local governments often have ecosystem-based requirements for planning and management initiatives and conservation programs

in their areas. For example, municipal and local governments often include this information in official community plans, local bylaws, and community mapping. As well, many government organizations lead or assist in the co-ordination of volunteer environmental stewardship activities, such as removing invasive plants in ecological communities at risk within public protected areas.

6.6.2 Professional organizations and educational institutions

Professional organizations, such as the College of Applied Biologists, and educational institutions often offer resources, training, and certifications related to resource management, including those related to ecosystem stewardship. For example, the University of British Columbia's Geography Department website offers many resources for coastal conservation, including information on some local projects, and Vancouver Island University's Natural Resources Extension Program offers numerous training and certification options.

6.6.3 Other organizations, programs, and teams

Several non-governmental groups, from federal to local levels, have information on ecosystem and ecological community conservation and stewardship in their areas. The following are examples:

- Nature Conservancy of Canada
- Nature Trust of British Columbia
- South Coast Conservation Program
- Coastal Douglas-fir Conservation Partnership
- Garry Oak Ecosystem Recovery Team
- Malaspina Land Conservancy Society
- Bowen Island Conservancy
- Salt Spring Island Conservancy
- Galiano Conservancy Association
- Sunshine Coast Conservation Association
- Gulf Islands Alliance
- Comox Valley Land Trust
- Habitat Acquisition Trust
- Islands Trust
- Savary Island Land Trust Society
- The Land Conservancy of British Columbia
- Friends of Ecological Reserves

Additional information is provided below on existing programs and groups within coastal British Columbia that have resources at varying levels, ranging from mapping of broader areas to teams with a specific focus on mapping ecological communities.

South Coast Conservation Program

The South Coast Conservation Program (SCCP) was established in 2005 to fill co-ordination gaps between various levels of government, conservation groups, land use interests, and local communities in order to conserve species and ecosystems at risk. The program area covers three natural resource districts—Chilliwack, Sea to Sky, and Sunshine Coast, and includes five regional districts: Fraser Valley, Metro Vancouver, Powell River, Sunshine Coast, and Squamish–Lillooet). The SCCP assists various stakeholders in navigating the complexities regarding species-at-risk conservation and recovery by offering workshops, providing guidelines on stewardship practices and recovery tools, networking through social media, and supporting on-the-ground applied science on priority species and their habitats (SCCP 2023).

The SCCP has information on ecological community types, including arbutus, coastal Douglas-fir, coastal western hemlock, coastal sand ecosystems, bogs, eelgrass, Garry oak, lodgepole (shore) pine, old fields, marshes, and swamps (SCCP 2023).

Coastal Douglas-fir Conservation Partnership

The Coastal Douglas-fir Conservation Partnership (CDFCP) is a collaboration of agencies, organizations, and land managers who are interested in promoting and protecting healthy coastal Douglas-fir and associated ecosystems into the future (CDFCP 2022). Its Conservation Strategy sets a 30-year vision and goals for the organization, with objectives and actions identified for 2020–2025. The intent is to review and update the strategy at least every 5 years. The Conservation Strategy outlines three core goals for working toward a vision of ecological integrity for coastal Douglas-fir and associated ecosystems (CDFAE):

- CDFAE values (including species and ecosystems at risk) are incorporated into local and regional policy and planning processes and are integrated into nature-based solutions for climate change mitigation and adaptation.
- Additional protection and stewardship of CDFAE are secured.
- CDFCP capacity to deliver the above goals is enhanced and sustained (CDFCP 2022).

Garry Oak Ecosystems Recovery Team

The Garry Oak Ecosystems Recovery Team (GOERT) was formed in 1999 to co-ordinate efforts to protect and restore endangered Garry oak and associated ecosystems, including the species at risk that are found within them (GOERT 2023).

GOERT uses science-based information to promote ecosystem and species recovery, minimize ongoing site and species losses, and encourage protection and stewardship activities (GOERT 2023). Specific tasks completed include:

- mapping and classifying plant communities
- increasing protection of priority sites through covenants, stewardship, and acquisition
- restoring Garry oak habitat through invasive species removal and propagation of native plants
- assessing the population of species at risk, including writing status reports, recovery strategies, and recovery action plans
- guiding research on Garry oak and associated ecosystems
- conducting engagement and outreach (GOERT 2023)

7 WHO TO CONTACT FOR ADDITIONAL SUPPORT?

Advice from specialists can facilitate finding, accessing, and evaluating information on ecological communities and their management and stewardship. Ministry contacts are listed below.

For information on BEC, ecosystem classification, and forest management, please contact:

B.C. Ministry of Forests
Regional Operations Division, Coast Area
Contact: Research Ecologist
Office (c/o Front Counter BC Nanaimo):
250-751-7220

For data requests, see BECWeb (gov.bc.ca)

For information on TEI data and systems, including ecosystem mapping methods, classifications, and standards, please contact:

B.C. Ministry of Water, Land and Resource Stewardship
Natural Resource Information and Digital Services Division
Ecosystem Information Services
Contact: Ecosystem Mapping Ecologist
Email: TEI_Mail@gov.bc.ca

To receive TEI data and program announcements (approximately once per year), please click here.

For information on B.C. CDC ecological communities and their classification, element occurrences, status rankings, and the BC Species and Ecosystems Explorer tool and data, please contact:

B.C. Ministry of Water, Land and Resource Stewardship
Natural Resource Information and Digital Services Division
Conservation Data Centre
Contact: Program Ecologist
Email: cdcdata@gov.bc.ca

For information on ecosystem-related land use planning, please contact:

B.C. Ministry of Water, Land and Resource Stewardship
Land Use Planning and Cumulative Effects Division
Strategic Land Use – Coast Area
Contact: Ecosystems Biologist
West Coast Email: WestCoast.Ecosystems@gov.bc.ca
South Coast Email: Frontcounterbc.surrey@gov.bc.ca

Term	Definition
British Columbia Data Catalogue (BC Data Catalogue)	Data in the BC Geographic Warehouse is described in the BC Data Catalogue. The catalogue allows users to search for data of interest, view metadata, access web mapping services, and directly download data available in the BC Geographic Warehouse. The BC Data Catalogue is powered by CKAN open-source software and is managed by DataBC.
BC Geographic Warehouse	A central government repository of spatial and non-spatial data. The data include base mapping information, such as heights of land, rivers, lakes, roads, place names, and administrative boundaries, as well as government program information, such as forest cover, ecosystems, and economic and health indicators.
Biogeoclimatic Ecosystem Classification (BEC)	A hierarchal classification system that combines four components: climate, site, vegetation, and seral to classify ecosystems.
Biogeoclimatic subzone	The basic unit in the hierarchy of climatic units, which can be grouped into zones and divided into variants. Each biogeoclimatic subzone has a distinct and characteristic combination of plant species (plant association) in mature to old forests on zonal sites.
Biogeoclimatic unit	Geographic areas with relatively uniform climate and patterns of vegetation, soils, and topography. Considered the regional-level scale of ecological integration and can be used for mapping regional climate, broad-scale conservation planning, and modelling climate change scenarios. Most often used in reference to a BEC subzone variant.
Biogeoclimatic variant	Generally recognized for areas that are slightly drier, wetter, snowier, warmer, or colder than other areas within a subzone.
Biogeoclimatic zone	A large geographic area with a broadly similar type of climate.
Capability	For example, wildlife or habitat capability (rating). Potential for a site or habitat, under optimal conditions, including best possible vigour of species characteristic of the site type, to support various wildlife species.
Crosswalk	A document (e.g., tables) that shows the relationships between equivalent terms in two or more classifications or other databases. Also, the action of linking two classifications or databases using the list (tables) of equivalent terms.
Ecological community	This term is used by the B.C. Conservation Data Centre and the NatureServe network. In British Columbia, it incorporates plant associations from the vegetation classification of the Biogeoclimatic Ecosystem Classification and other natural plant communities, including both forested and non-forested ecosystems. Sources include ecosystem mapping projects, ecological reserve records, special inventory projects, and other available literature. Ecological communities are used in conservation status assessments and reporting, management of at-risk communities and protection under forestry and land use planning, municipal development and decision-making, and identification of key biodiversity areas.
Ecological community at risk	An ecological community with a NatureServe conservation status assessment corresponding to the British Columbia Red or Blue List. Includes ecological communities that are extirpated, endangered, threatened, or of special concern in British Columbia.
Ecological equivalence	The concept that different combinations of interacting site (e.g., slope position, soil characteristics) and climate conditions result in similar moisture and nutrient availability and thus vegetation community.
Ecological integrity	The condition of an ecosystem when its dominant characteristics, including structure, composition, function, and connectivity, occur within the bounds of natural or historical range of variability for that ecosystem type. Aspects of resilience and recovery are also often incorporated into definitions of integrity; for example, the dominant ecological characteristics are maintained or will recover under (most) natural or anthropogenic disturbances.
Ecosystem	A dynamic complex of plant, animal, and micro-organism communities under specific conditions of climate, topography, and soils, all influenced by large- and small-scale natural disturbance events and interacting as a functional unit. Ecosystems vary enormously in size: a temporary pond in a tree hollow and an ocean basin are both ecosystems. Ecosystem is used as a holistic term to describe broad components of the natural world (e.g., terrestrial or marine ecosystems) versus specific elements, such as plants or animals.
Ecosystem map unit	Map units represent mappable portions of the landscape (Valentine 1986) that are established by applying a classification to mapped polygons. Ecosystem map units include site series, site modifiers, and vegetation developmental units (structural stages and seral community). An ecosystem map unit contains either predominantly one mapping individual (simple map unit) or more than one (compound map unit). Each may contain a certain proportion of other ecosystem units that are unmappable at the scale of mapping (Valentine 1986).
Ecosystem mapping codes	Provincial standard approved codes for a variety of Terrestrial Ecosystem Information ecosystem mapping projects, such as site series, map code, and realm/group/class.

Term	Definition
Ecosystem services	Ecosystem services are the benefits people obtain from ecosystems. Examples include provisioning services (e.g., food derived from plants and fresh water), regulating services (e.g., water filtration, carbon storage), cultural services (e.g., natural landscapes that inspire people to participate in outdoor activities), and supporting services (provision of habitat, nutrient cycling).
Ecosystem unit	Local, spatially discrete combinations of vegetation and developmental stage within the biogeoclimatic zones, subzones, or variants. Ecosystem units are generally derived from the site series of the Biogeoclimatic Ecosystem Classification system by further differentiating the units based on more specific site conditions (e.g., site modifiers) to define more homogeneous site units, and vegetation developmental units, to define more homogeneous structural stages.
Element occurrence	An area of land and/or water in which a species or ecological community is, or was present. An element occurrence (EO) should have practical conservation value for the element as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location. For species elements, the EO often corresponds to the local population, but when appropriate, may be a portion of a population (e.g., long-distance dispersers) or a group of nearby populations (e.g., metapopulation). For ecological community elements, the EO may represent a stand or patch of an ecological community, or a cluster of stands or patches of an ecological community.
Freshwater Atlas	A standardized data set for mapping British Columbia's hydrological features. The atlas defines watershed boundaries and provides a connected network of streams, lakes, and wetlands. This network serves as the foundation for sophisticated analysis and modelling.
Habitat	An ecosystem(s) that supports the life history stages and needs of a particular species; all habitats are ecosystems. Used in habitat suitability modelling, and general communication about and assessments of ecosystem function for supporting species (e.g., wildlife).
Light Detection and Ranging (LiDAR)	A laser-based remote sensing technology used to map the Earth's surface. Point clouds may be used to generate digital elevation models.
Non-forested ecosystem units (nBEC)	A classification of units with < 10% tree cover incorporated into the Biogeoclimatic Ecosystem Classification system. A hierarchy for non-forested (and forested) wetlands and related ecosystems is presented by MacKenzie and Moran (2004). The classification was expanded across multiple groups and classes of the terrestrial, estuarine, and wetland realms by MacKenzie (2012).
Plant association	A recurring plant community with a characteristic range in species composition, specific diagnostic species, and a defined range in environmental requirements (site and soil characteristics, hydrology, localized climate, etc.) and physical appearance or structure. Generally equivalent to an ecological community; in the BEC system, this is a characteristic and diagnostic combination of plant species restricted to a set of moisture and nutrient conditions. A plant association can occur on multiple site series (different site series in different BEC subzone/variants), but each site series can produce only a single plant association. Used in building classifications and linking among classifications from different jurisdictions (e.g., BEC and NatureServe).
Plant community	A collection of plant species that characteristically occur together in specific geographic and site conditions; within the BEC system, this is synonymous with plant association and ecological community. Used in some literature to refer to an ecological community that is identified based solely on plants (as opposed to other components of ecosystems, such as soils).
Seral plant associations	Plant communities at earlier ages and stages of development following a natural or anthropogenic disturbance.
Site association	Ecosystems capable of producing the same mature plant association at the late successional (older forest) stage (even if plant associations never fully develop). It is the fundamental unit of site classification and provides a linkage between vegetation and climatic classifications at the subzone level.
Site class	The site class describes ecosystems with similar basic underlying environmental attributes that support similar characteristic vegetation physiognomy and species adaptation guilds at climax.
Site group	The site group designates a broad association of functionally similar ecosystems based on a dominant cluster of ecologically relevant environmental features. The site group joins site classes that may have different physiognomy but common adaptations to a dominant environmental factor(s).
Site modifier	Used in Terrestrial Ecosystem Mapping to describe atypical conditions of an ecosystem unit. Each site series within the Biogeoclimatic Ecosystem Classification system has been described by a typical set of environmental conditions focussed specifically on important site, soil, and terrain characteristics (RIC 1998). The variation within some site series may be well described by the typical conditions; for others, the typical conditions may describe only one possible set. Site modifiers provide additional descriptors for an ecosystem, and, if applicable, are displayed as the second component of an ecosystem unit.
Site realm	Broadest site unit in the BEC system. The site realm delineates major biotic types that reflect gross differences in water abundance, quality, and source. Example units include the Terrestrial, Wetland, and Estuarine realms.

Term	Definition
Site series	Sites within a specific climatic unit—for example, biogeoclimatic subzone or variant—capable of producing mature plant communities that would belong to the same plant association and represent the same soil moisture and nutrient conditions. Used in mapping ecosystems, modelling ecosystems, and crosswalking from BEC to identify ecological communities (plant communities) characteristic of specific site conditions.
Site series phase	Applied when the same plant community is found on different site conditions (e.g., slope, parent material, soil, climate) that have management implications.
Site series variation	Applied where mature vegetation differs on similar site conditions, and the differences are not a result of successional development stages of the ecosystem.
Structural stage	Used to describe the appearance of a stand or community using the characteristic life form and certain physical attributes. Forest structure describes the horizontal and vertical arrangement of elements such as trees, other plants, and logs.
Suitability	For example, wildlife or habitat (suitability) rating. The ability for a site to support wildlife under current conditions, including with present vegetation.
Survey intensity levels	A code representing the level of sampling intensity characterized according to percentage of polygons that have been field inspected or density of inspections by area. Described in more detail in RIC (1998).
Terrain Resource Information Management (TRIM)	A series of 1:20 000-scale topographic base maps that provide the base data for British Columbia. TRIM is a set of three-dimensional digital files that support development and management of land-related information.
Terrestrial ecosystem	A unit or portion of the landscape and the life on and in it. It is a landscape segment relatively uniform in composition, structure, properties of both the biotic and abiotic environments, and in their interactions.
Vegetation Resources Inventory (VRI)	A photo-based, two-phased vegetation inventory design consisting of photo interpretation and ground sampling.
Zonal site	A site that is intermediate in soil moisture and nutrient conditions, generally occurring on a mid-slope position, on moderately deep soils of medium texture, and not overly influenced by local site conditions such as slope, aspect, cold air drainage, etc.

LITERATURE CITED

Anderson, I., Straka, J.R., and A.J. de Groot. 2024. Conservation status assessment of ecosystems in British Columbia: A provincial guide to the application of NatureServe methods.

Andreasen, J.K., R.V. O'Neill, R. Noss, and N.C. Slosser. 2001. Considerations for the development of a terrestrial index of ecological integrity. Ecol. Indicators 1:21–35.

Banner, A., D. Meidinger, B. Green, and S. Saunders. 2019. Guidelines to support implementation of the Great Bear Rainforest Order with respect to old forest and listed plant communities. Prov. B.C., Victoria, B.C. Land Manag. Handb. 72.

Banner, A., W.H. MacKenzie, J. Pojar, A. MacKinnon, S.C. Saunders, and H. Klassen. 2014. A field guide to ecosystem classification and identification for Haida Gwaii. Prov. B.C., Victoria, B.C. Land Manag. Handb. 68. www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh68.htm.

British Columbia Conservation Data Centre (B.C. CDC). 2012. BC ecological community summary: *Pseudotsuga menziesii/Mahonia nervosa*. B.C. Min. Environ. Victoria, B.C. https://a100.gov.bc.ca/pub/eswp/speciesSummary.do?id=20601 (Accessed Feb. 16, 2024).

_____. 2019. BC conservation status report: *Pseudotsuga menziesii – Tsuga heterophylla/Gaultheria shallon* Dry Maritime. B.C. Min. Environ. https://a100.gov.bc.ca/pub/eswp/esr.do?id=20545 (Accessed Feb. 16, 2024).

_____. 2023. BC Species and Ecosystems Explorer. B.C. Min. Environ., Victoria, B.C. https://a100.gov.bc.ca/pub/eswp/ (Accessed June 29, 2024).

British Columbia Ministry of Environment (MOE). 2006a. Coastal sand dune ecosystems in British Columbia. Victoria, B.C. https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/species-ecosystems-at-risk/brochures/coastal_sand_dunes_ecosystems.pdf (Accessed July 2023).

_____. 2006b. Estuaries in British Columbia. Victoria, B.C. https://www.env.gov.bc.ca/wld/documents/Estuaries06_20.pdf (Accessed July 2023).

British Columbia Ministry of Environment, Lands and Parks (MELP). 1993. Garry oak ecosystems. Victoria, B.C. https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/species-ecosystems-at-risk/brochures/garry_oak_ecosystems.pdf (Accessed July 2023).

_____. 1999. Coastal Douglas-fir ecosystems. Victoria, B.C. https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/species-ecosystems-at-risk/brochures/coastal_douglas_fir_ecosystems.pdf (Accessed July 2023).

British Columbia Ministry of Environment, Lands and Parks (MELP) and British Columbia Ministry of Forests (MOF). 1999. Managing Identified Wildlife: procedures and measures. Vol. 1. Victoria, B.C. https://www.env.gov.bc.ca/wld/documents/iw.pdf (Accessed June 2023).

British Columbia Ministry of Forests and Range and British Columbia Ministry of Environment. 2010. Field manual for describing terrestrial ecosystems. Version 2023. Victoria, B.C. https://www.crownpub.bc.ca/Product/Details/7610003455_S#/?statesave=true.

British Columbia Ministry of Water, Land and Air Protection (MWLAP). 2004. Identified Wildlife Management Strategy: procedures for managing Identified Wildlife. https://www.env.gov.bc.ca/wld/documents/identified/IWMS%20Procedures.pdf (Accessed June 2023).

City of Courtenay. 2022. Official community plan bylaw no. 3070, 2022. https://www.courtenay.ca/assets/Departments/Development~Services/OCP~Update/CourtenayOCP-June2022interactive-with-bylaw.pdf (Accessed July 2023).

Clark, J. and D. Meidinger. 2020. Update of the Metro Vancouver sensitive ecosystem inventory (2009–2014). Vancouver, B.C. Tech. rep.

Coastal Douglas-Fir Conservation Partnership (CDFCP). 2022. Promoting conservation and stewardship of Coastal Douglas-fir ecosystems. https://www.cdfcp.ca/ (Accessed July 2023).

Community Mapping Network (CMN). 2018. About CMN. https://www.cmnbc.ca/about-cmn/ (Accessed July 2023).

de Groot, A. and C.M. Cadrin. 2018. Ecosystem status report for *Pseudotsuga menziesii/Mahonia nervosa* (Douglas-fir/dull Oregon-grape) ecological community in British Columbia. Prepared for B.C. Min. Environ. Climate Change Strategy, Conservation Data Centre, Victoria, B.C.

DeLong, C., A. Banner, W.H. MacKenzie, B.J. Rogers, and B. Kaytor. 2011. A field guide to ecosystem identification for the Boreal White and Black Spruce zone of British Columbia. B.C. Min. For. Range, For. Sci. Prog., Victoria, B.C. Land Manag. Handb. 65. www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh65.htm.

Environmental Assessment Office (EAO). 2020. Application information requirements guidelines. Version 1.0. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/environmental-assessments/the-environmental-assessment-process/application_information_requirements_guidelines.pdf (Accessed June 2023).

Ermine, W. 2007. The ethical space of engagement. Indigenous Law J. 6:193–203.

Faber-Langendoen, D., L. Master, J. Nichols, K. Snow, A. Tomaino, R. Bittman, G. Hammerson, B. Heidel, L. Ramsay, A. Teucher, and B. Young. 2012. NatureServe conservation status assessments: methodology for assigning ranks. NatureServe, Arlington, Va.

Faber-Langendoen, D., W. Nichols, J. Rocchio, K. Walz, and J. Lemly. 2016a. An introduction to NatureServe's ecological integrity assessment method. NatureServe, Arlington, Va.

Faber-Langendoen, D., W. Nichols, J. Rocchio, K. Walz, J. Lemly, R. Smyth, and K. Snow. 2016b. Rating the condition of reference wetlands across states: NatureServe's ecological integrity assessment method. Natl. Wetlands Newsl. 38(3):12–16.

First Nations-BC Wildlife and Habitat Conservation Forum. 2018. Cultivating abundance: First Nations perspectives from the BC-First Nations Wildlife and Habitat Conservation Forum. https://www.firstnationsbcwildlifeforum.ca/app/uploads/sites/688/2021/07/Cultivating-Abundance-FINAL-Nov-15.pdf.

Garry Oak Ecosystem Recovery Team (GOERT). 2011. Restoring British Columbia's Garry oak ecosystems: principles and practices. Victoria, B.C.

https://goert.ca/wp/wp-content/uploads/GOERT-Restorating-BC-GOE-2011.pdf.

_____. 2013. Best management practices for Garry oak & associated ecosystems. Victoria, B.C. Version 1.1. https://goert.ca/wp/wp-content/uploads/GOERT-Best-Management-Practices-2013.pdf.

_____. 2014. Model bylaws for the protection of Garry oak & associated ecosystems. Victoria, B.C. Version 1.0. https://goert.ca/wp/wp-content/uploads/GOERT-Model-Bylaws-2014.pdf.

_____. 2023. Key publications: https://goert.ca/key-publications/ (Accessed June 2023).

Government of Canada. 2015. Recovery of species listed under the *Species at Risk Act:* backgrounder. https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery/recovery-species-listed-backgrounder.html/ (Accessed Mar. 2024).

_____. 2022. *Species at Risk Act:* recovery strategies. https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery-strategies.html (Accessed Mar. 2024).

Green, R.N. and K. Klinka. 1994. A field guide for site identification and interpretation for the Vancouver Forest Region. Prov. B.C., Victoria, B.C. Land Manag. Handb. 28. https://www.for.gov.bc.ca/hfd/pubs/docs/Lmh/Lmh28.pdf.

Holling, C.S. 1973. Resilience and stability of ecological systems. Annu. Rev. Ecol. Syst. 4:1–23.

Jennings, M.D., D. Faber-Langendoen, O.L. Loucks, R.K. Peet, and D. Roberts. 2009. Standards for associations and alliances of the U.S. National Vegetation Classification. Ecol. Monogr. 79:173–199.

Lea, T. 2006. Historical Garry oak ecosystems of Vancouver Island, British Columbia, pre-European contact to the present. Davidsonia 17:34–50.

MacKenzie, W. 2011. New coding schemes for biogeoclimatic site units. B.C. Min. For., Lands Nat. Resource Ops., Smithers, B.C. Exten. Note 106. https://www.for.gov.bc.ca/hfd/pubs/Docs/En/En106.pdf.

_____. 2012. Biogeoclimatic Ecosystem Classification of non-forested ecosystems in British Columbia. Prov. B.C., Victoria, B.C. Tech. Rep. 068. https://www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr068.htm.

MacKenzie, W.H. and D.V. Meidinger. 2017. The Biogeoclimatic Ecosystem Classification approach: an ecological framework for vegetation classification. Phytocoenologia 48(2):203–213.

MacKenzie, W.H. and J.R. Moran. 2004. Wetlands of British Columbia: a guide to identification. B.C. Min. For., Res. Br., Victoria, B.C. Land Manag. Handb. 52. https://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh52.htm.

MacKenzie, W., D. Remington, and J. Shaw. 2000. Estuaries on the North Coast of British Columbia: a reconnaissance survey of selected sites. Draft. Smither B.C. https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/ecosystems/bec/north20coast20estuaries.pdf (Accessed July 2023).

MacKillop, D.J., A.J. Ehman, K.E. Iverson, E.B. McKenzie, M. Ryan, and M. Machmer. 2021. A field guide to ecosystem classification and identification: Boundary–eastern Okanagan–Shuswap–southern Arrow. Prov. B.C., Victoria, B.C. Land Manag. Handb. 75. https://www.for.gov.bc.ca/hre/BECWeb/Downloads/Downloads_LMHs/LMH75.pdf.

Master, L.L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, L. Ramsay, K. Snow, A. Teucher, and A. Tomaino. 2012a. NatureServe conservation status assessments: factors for evaluating species and ecosystem risk. NatureServe, Arlington, Va.

Master, L.L., K. Snow, A. Tomaino, R. Bittman, G. Hammerson, B. Heidel, L. Ramsay, A. Teucher, and B. Young. 2012b. NatureServe conservation status assessments: methodology for assigning ranks. NatureServe, Arlington, Va.

Meidinger, D., J. Clark, and D. Adamoski. 2014. Sensitive ecosystem inventory for Metro Vancouver and Abbotsford 2010–2012. Vancouver, B.C. Tech. Rep.

Meidinger, D. and J. Pojar (editors). 1991. Ecosystems of British Columbia. B.C. Min. For., Res. Br., Victoria, B.C.

NatureServe. 2002. Element occurrence data standard. NatureServe and the Network of Natural Heritage Programs and Conservation Data Centers, Arlington, Va. http://downloads.natureserve.org/conservation_tools/element_occurence_data_standard.pdf.

_____. 2023. Ecological integrity assessment. Arlington, Va. https://www.natureserve.org/products/ecological-integrity-assessment.

Noss, R.F. 1987. From plant communities to landscapes in conservation inventories: a look at the Nature Conservancy (USA). Biol. Conserv. 41:11–37.

Page, N., P. Lilley, I.J. Walker, and R.G. Vennesland. 2011. Status report on coastal sand ecosystems in British Columbia. Prepared for the Coastal Sand Ecosystems Recovery Team.

Parks Canada Agency. 2006a. Recovery strategy for multi-species at risk in Garry oak woodlands in Canada. Ottawa, Ont.

_____. 2006b. Recovery strategy for multi-species at risk in maritime meadows associated with Garry oak ecosystems in Canada. Ottawa, Ont.

_____. 2006c. Recovery strategy for multi-species at risk in vernal pools and other ephemeral wet areas in Garry oak and associated ecosystems in Canada. Ottawa, Ont.

Parminter, J. 1995. Biodiversity guidebook. B.C. Min. For. and B.C. Min. Environ., Victoria, B.C. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/frep/frep-docs/biodiversityguidebook.pdf.

Parrish, J.D., D.P. Braun, and R.S. Unnasch. 2003. Are we conserving what we say we are? Measuring ecological integrity within protected areas. BioScience 53:851–860.

Peterson, G., C.R. Allen, and C.S. Holling. 1998. Ecological resilience, biodiversity, and scale. Ecosystems 1:6–18.

Pojar, J., K. Klinka, and D. Meidinger. 1987. Biogeoclimatic Ecosystem Classification in British Columbia. For. Ecol. Manag. 22:119–154.

Province of British Columbia. 2014. Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia. https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices/develop-with-care.

_____. 2016. Cumulative effects framework: interim policy for the natural resource sector. Version 2022.01. Victoria. B.C. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/cumulative-effects/cef-interimpolicy-oct_14_-2_2016_signed.pdf (Accessed Nov. 2023).

_____. 2022. Requirements and best management practices for making changes in and about a stream in British Columbia. Victoria. B.C. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/wsa-cias-requirements-bmps.pdf.

_____. 2023a. Great Bear Rainforest – Coastal Land Use Decision Update. Victoria. B.C. https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/west-coast/great-bear-rainforest (Accessed June 2023).

_____. 2023b. What is karst? Victoria. B.C. https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/managed-resource-features/introduction-to-karst#Plant%20and%20animal%20habitat (Accessed July 2023).

Resources Inventory Committee (RIC). 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Ecosys. Work. Group Terrestrial Ecosys. Task Force, Resource Inventory Committee, B.C. Min. Environ., Victoria, B.C. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/tem_man.pdf.

_____. 1999. Standards for Predictive Ecosystem Mapping: inventory standard. Version 1.0. Prov. B.C., Victoria, B.C. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/pem_1.pdf.

_____. 2000. Standards for broad terrestrial ecosystem classification and mapping for British Columbia: classification and correlation of the broad habitat classes used in 1:250,000 ecological mapping. Ecosys. Work. Group Terrestrial Ecosys. Task Force. Version 2.0. Prov. B.C., Victoria, B.C. https://a100.gov.bc.ca/pub/eirs/finishDownloadDocument.do?subdocumentId=4194.

Resources Information Standards Committee (RISC). 2006. Standard for mapping ecosystems at risk in British Columbia: an approach to mapping ecosystems at risk and other sensitive ecosystems. Version 1.0 B.C. Min. Environ., Ecosys. Br., Victoria, B.C. https://www.env.gov.bc.ca/fia/documents/standards_for_mapping_ear_version1.pdf.

_____. 2023. Terrestrial ecosystem information digital data submission standard. Database and GIS data standards. Version 3.0. Prov. B.C., Victoria, B.C. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/tei_digital_submission_standards_v3.pdf.

Ryan, M., D. Lloyd, and K. Iverson. 2022. A field guide to ecosystem classification and identification for the Southern Thompson–Okanagan. Prov. B.C., Victoria, B.C. Land Manag. Handb. 76. https://www.for.gov.bc.ca/hre/BECWeb/Downloads/Downloads_LMHs/LMH76.pdf.

Salafsky, N., D. Salzer, A.J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S.H.M. Butchart, B. Collen, N. Cox, L.L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conserv. Biol. 22:897–911.

Shae, M.A., V. Myers, T. Young, A. Bartuska, N. Gassman, J.H. Gentile, C.C. Harwell, S. Appelbaum, J. Barko, B. Causey, C. Johnson, A. McLean, R. Smola, P. Templet, and S. Tosini. 1999. A framework for an ecosystem integrity report card. BioScience 49:543–556.

South Coast Conservation Program (SCCP). 2023. About the SCCP. https://www.sccp.ca/about-south-coast-conservation-program (Accessed July 2023).

Terrestrial Ecosystem Information (TEI) Unit. 2020. Terrestrial ecosystem information (TEI): coding updates for non-vegetated, sparsely vegetated, and anthropogenic units. Version 1.1. B.C. Min. Environ. Climate Change Strategy, Knowledge Manag. Br., Victoria, B.C. https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/ecosystems/tei_mapcodes_anthro_nonveg_sparseveg.pdf.

_____. 2023. Terrestrial ecosystem information (TEI): ecosystem mapping code list. Version 2.2. B.C. Min. Environ. Climate Change Strategy, Knowledge Manag. Br., Victoria, B.C. https://www.env.gov.bc.ca/esd/distdata/ecosystems/TEI/Docs/TEI_EcosystemCodes.xlsx.

Unnasch, R.S., D.P. Braun, P.J. Comer, and G.E. Eckert. 2018. The ecological integrity assessment framework: a framework for assessing the ecological integrity of biological and ecological resources of the national park system. Report to the National Park Service.

Valentine, K.W.G. 1986. Soil resource survey for forestry: soil, terrain and site mapping in boreal and temperate forests. Monogr. Soil Resources Surv. No. 10. Oxford University Press, Oxford, UK.

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Resources Information Standards Committee (RISC) standards
https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/inventory-standards

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https://www.env.gov.bc.ca/wld/frpa/iwms/accounts.html#ninth_

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https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/legislation-regulation/forest-range-practices-act/frpa-improvement-initiative/new-protections-for-ecological-communities

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https://goert.ca/

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Restoring British Columbia's Garry Oak Ecosystems: Principles and Practices
https://goert.ca/wp/wp-content/uploads/GOERT-Restorating-BC-GOE-2011.pdf

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https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/best-management-practices/develop-with-care

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https://www.registrelep.gc.ca/virtual_sara/files/plans/rs_Garry_Oak_Vernal_Pool_0206_e.pdf

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https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/libraries-publication-catalogues/eirs-biodiversity

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https://www.env.gov.bc.ca/wld/documents/Estuaries06_20.pdf

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https://www.for.gov.bc.ca/hre/becweb/Downloads/Downloads_Wetlands/North Coast Estuaries.pdf

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https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/managed-resource-features/introduction-to-karst#Coastal%20forest%20karst%20ecosystems

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