An Inventory of Environmentally Sensitive Areas (ESAs) within the Cowichan Region

(A Foundation Component to an ESA Strategy)

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We would like to thank the Cowichan Valley Regional District (CVRD) for the opportunity and funding to present a summary and analysis of existing (mapped) Environmentally Sensitive Areas (ESAs) in the Cowichan Region, and to contribute to the development of a regional ESA Strategy. GIS data integration was completed by Ian Wright, and the detailed ESA mapping updates were conducted by Harry Williams. The report and associated products received a detailed in-house review by Tania Tripp. The team greatly appreciates the feedback provided by Kate Miller and Jeff Moore of CVRD Environmental Services, as well as other members of the Steering Committee for their input and guidance: Kyle Young (Municipality of North Cowichan), Felicity Adams (Town of Ladysmith), Ken Epps (Island Timberlands), and Keith Lawrence (CVRD).

We would also like to acknowledge that this study of environmentally sensitive areas falls within the traditional territories of Cowichan Tribes, Ditidaht First Nation, Halalt First Nation, Lake Cowichan First Nation, Lyackson First Nation, Malahat First Nation, Penelakut Tribe, and Stz'uminus First Nation.

Glossary of Key Terms and Acronyms

Biogeoclimatic system (BEC): Provincial ecosystem classification system used in forestry and natural sciences**.**

Cadastral mapping: Mapping that shows property lines, parks, jurisdictional lines, electoral lines, covenants, parks, First Nation lands, forest tenures etc.

Ecological community: This term may refer to a specific terrestrial plant community, or to the full range of ecosystems that occur in a given landscape. Ecological communities may be as small as pocket Garry oak woodlands, or as large as an entire river and flood plain.

Endangered: Facing possible extinction.

Environmentally Sensitive Area (ESA): An area that contains sensitive or rare ecosystems, or other environmentally sensitive values. Often used as a synonym for Sensitive Ecosystems (see below).

Fragmentation: Barriers to animal and plant movement across the landscape; may be highways, populated areas, transmission lines, or natural areas such as large lakes.

Landscape Unit (LU): Landscape units are crown forest management areas based on watersheds; in the CVRD they occur in the forest lands south-west of Cowichan Lake.

Old Growth Management Area (OGMA): Areas of crown land set aside to meet old growth management targets. In the CVRD they occur in the forest lands south-west of Cowichan Lake.

Riparian areas: Rivers and streams, and associated river bank and streamside vegetation.

Sensitive Ecosystem (SE): an ecosystem in the landscape that is at-risk or ecologically fragile.

Sensitive Ecosystem Inventory (SEI): the standardized method by which sensitive ecosystems are mapped and described. The scale of mapping can be variable, ranging from 1:1 000 to 1:20 000. SEI mapping coverage in the CVRD is only available in some areas.

Stream Order (SO): Stream order is a measure of the relative size of the stream. Small tributaries are referred to as first – or second- order streams, while the Cowichan, a larger river, is a seventh-order waterway.

Terrestrial Ecosystems Information System (TEIS). Standardized data base template that is compatible with the provincial ecosystems data storage.

Terrestrial Ecosystem Mapping (TEM): TEM refers to the mapping of ecosystems in BC following a provincially approved methodology. A typical TEM project will map all ecosystems in a given area - of which sensitive ecosystems are a subset. TEM is usually done to a map scale of 1:15 000. TEM mapping coverage in the CVRD is incomplete.

Vegetation Resource Inventory (VRI): Forestry based inventory that has data on forest stands including tree age, species and height. VRI coverage in the CVRD is pending in some areas, and incomplete in others.

Disclaimer

The intention of this document is to ensure a transparent outline of the data used and methods applied to create the CVRD ESA 2018 Inventory map product. Limitations include, but are not limited to:

- Reliability is limited by the accuracy and original purpose of the map product integrated into the ESA inventory layer. The ESA map product and associated data relies on imperfect data.
- The majority of ESA features have not been field verified, and represent various levels of reliability. The level of confidence that we place on a given ESA polygon depends on a number of factors, including the original scale of mapping, original purpose of the map product, and photos used for interpretation.
- The spatial product is largely based on a variety of scale that ranged from 1:1,000 (SEF mapping) to 1:20 000 scale TEM data. The detailed mapping priority pilot area (Shawnigan) represents a 1:5,000 scale product.
- There is a limit to how precise you can be in ecosystem mapping. When interpreting imagery, it is limited by the pixel size, the image viewing scale, and nature of what we are defining.

At this time, the ESA Inventory is best applied as a tool to inform management of this resource value (environmental sensitive areas) in the CVRD.

Executive Summary

There is growing awareness and concern for the overall status of environmentally sensitive areas (ESAs) in the Cowichan Valley Regional District (CVRD) and throughout British Columbia. ESAs are typically considered to be productive habitats important to biological diversity that are at risk of disappearing. Examples of ESAs familiar to many are wetlands, old forest and Garry oak woodlands. Some ESAs are also designated as ecosystems at-risk, or ecologically fragile (RISC 2006). With population growth and expanding land-use development, particularly along the Eastern portion of the region, pressures upon these ecosystems increases. These increased pressures are leading to progressive losses of ESAs that could significantly impact the biological diversity and ecological health of the area.

To address these concerns, the CVRD is in the process of developing a strategy for ESA management and conservation. As a foundational component on which to build an ESA strategy, the CVRD required an inventory of existing ESA data and mapping for the region. By mapping and maintaining an inventory of ESAs, the CVRD can track changes in ESAs over time, and implement effective strategies for ESA conservation. A contract was awarded to Madrone Environmental Services Ltd. (Madrone) to:

- Complete an inventory of existing mapping that can be used to identify known ESAs within the regions;
- Conduct a detailed ESA mapping update for a pilot area in consultation with the Steering Committee;
- Provide ESA network options, developed in consultation with the Steering Committee; and
- Provide recommendations for next steps related to the ESA map product.

The identification of sensitive ecosystems was based on a combination of data integration, analysis, and image interpretation. The resulting integrated CVRD ESA data indicated that ESAs cover 93,953 hectares or 26.9% of the CVRD. ESA types with the most representation were old forest (57,189 ha), mature forest (17,436 ha) and freshwater lakes and ponds (9,754 ha). Following those were riparian areas (3,242 ha), wetlands (2,777 ha), woodland (1,495 ha), sparsely vegetated (817 ha), and seasonally-flooded agricultural (691 ha). ESA representation was further analyzed and presented in this report by watershed unit, local government jurisdiction and biogeoclimatic unit. Results of this process are considered to be a “first pass” of identifying potential ESAs throughout the region.

In order to verify the spatial accuracy and attributes resulting from the integration of existing ESA data, detailed mapping was completed in a priority pilot area of the CVRD. The priority detailed mapping pilot area identified by the Steering Committee was the “south end” of the CVRD, otherwise described as the area surrounding Shawnigan Lake. This area was selected due to relatively high development pressure, and to dovetail with other CVRD initiatives. A total of 1,641 polygons covering 5,365 hectares were assessed and updated as needed within the detailed mapping pilot area. Overall, the detailed mapping effort resulted in simplified and more accurate linework, removed disturbed areas from the data, identified previously

unmapped ESAs, and refined the polygon attributes (sensitive ecosystem classification). Results of this process represent a “second pass” in the mapping process for the pilot area.

In addition to the integration of ESA map data, a series of interpretive map products related to ESA network options were produced. Creating a network that links ESAs across elevation or moisture gradients to allow dispersal of vegetation and animals in the face of climate change is becoming an important issue. ESA Network Option 1 is based on a 30m buffer applied to all ESA polygons, and includes a riparian buffer around streams and lakes to create connectivity across the landscape. Option 2 includes the riparian area buffers to provide connectivity between ESAs, but does not include a buffer around the ESA polygons. Option 3 does not include riparian areas based on stream mapping in the network, and therefore lacks connectivity between ESAs in comparison to the first two options.

Recommendations that resulted from this project include:

1. Integrate new ESA-related data as it becomes available (e.g. updated VRI mapping).
2. Apply the detailed mapping process to other priority areas, especially if the intended use of the mapped ESAs is to create a new development permit area.
3. Conduct disturbance mapping in priority areas, and regularly update the ESA map to track disturbances over time.
4. Consider predictive ESA modeling as a means to identify ESAs that aren’t already represented by the ESA data. This could help to fill in data gaps, and to identify smaller ESAs that may be missed through traditional aerial photo interpretation.
5. Field verification should be completed to assess the accuracy of the ESA mapping.
6. Track desktop and field verification efforts in the dataset to assign relative measure of confidence in the accuracy of the ESA data.

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1 Introduction

There is growing awareness and concern for the overall status of environmentally sensitive areas (ESAs) in the Cowichan Valley Regional District (CVRD) and throughout British Columbia. ESAs are typically considered to be productive habitats important to biological diversity that are at risk of disappearing. Examples of ESAs familiar to many are wetlands, old forest and Garry oak woodlands. Some ESAs are also designated as ecosystems at-risk, or ecologically fragile (RISC 2006). Ecosystems at-risk are those that support rare or unusual ecological communities as designated by the B.C. Conservation Data Centre (BC CDC)[1]. With population growth and expanding land-use development, pressures upon these ecosystems increases, leading to progressive losses of ESAs that could significantly impact the biological diversity and ecological health of the area; especially where pressures are particularly focused along the Eastern portion of the region. To address these concerns, the CVRD is in the process of completing an inventory of ESAs and developing a strategy for ESA management and conservation. As a first step in this process, the CVRD requires an inventory of existing ESA data and mapping for the region.

By mapping and maintaining an inventory of ESAs, the CVRD can track changes in ESAs over time, and implement effective strategies for ESA conservation. The mapping of sensitive ecosystems follows a standardized methodology established by the provincial government, set out in the *Standard for Mapping Ecosystems at Risk in British Columbia: An Approach to Mapping Ecosystems at Risk and Other Sensitive Ecosystems* (RISC, 2006). In addition to simply mapping ESAs, they can be grouped into a network to promote habitat connectivity and sensitive ecosystem representation across the landscape.

Objectives established for this project and addressed in this report are as follows:

i. Provide recommendations on methods for the identification of potentially sensitive lands, based on a comprehensive review of existing data;

ii. Complete an inventory of existing mapping that can be used to identify known ESAs within the regions (or selected portion of the region) in consultation with the Steering Committee; and

iii. Provide recommendations for an ESA network, with at least 3 options, developed in consultation with the Steering Committee.

Completion of these steps will provide a foundation on which to build an ESA strategy for the CVRD.

[1] BC Conservation Data Centre and BC Species and Ecosystems Explorer

1.1 Project Area

The CVRD project area is located between the Capitol Regional District (CRD), Alberni-Clayoquot Regional District (ACRD) and the Regional District of Nanaimo (RDN), on the south portion of Vancouver Island, British Columbia. It encompasses approximately 355,147 hectares of land extending from the east to west coast of Vancouver Island.

The CVRD is represented by ten biogeoclimatic ecosystem classification (BEC[2]) zones that range from the dry Coastal Douglas-fir (CDF) moist maritime (mm) (CDFmm) subzone on the east coast to the Coastal Western Hemlock (CWH) very wet hypermaritime variant (vh1) on the southwest coast. Figure 1 provides an overview of the project area and BEC zone locations, and Table 1 provides a brief description of the BEC zones in the CVRD.

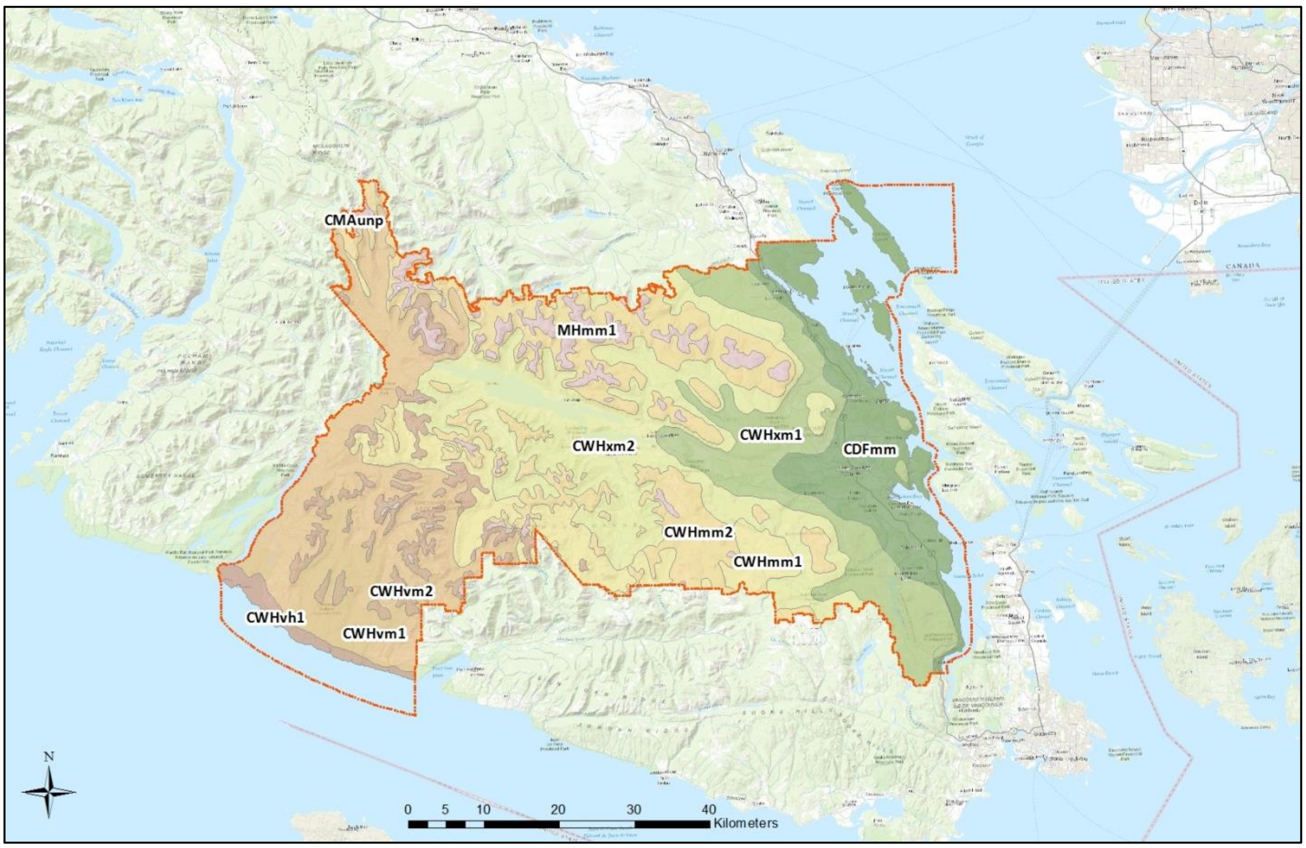

Figure 1. Overview of the Distribution of Biogeoclimatic Units in the CVRD

[2] https://www.for.gov.bc.ca/hre/becweb/

Table 1. Biogeoclimatic Zones in the CVRD.

BEC Label	BEC Name	Comments
CDFmm	Coastal Douglas-fir moist mild subzone	Stand-alone unit due to level of fragmentation and development pressure
CWHxm1	Coastal Western Hemlock very dry maritime subzones	These subzones occur on the leeward side of the CVRD, with the CWHxm1 occurring further east than the CWHxm2
CWHxm2		
CWHvm1	Coastal Western Hemlock submontane and montane very wet maritime subzones	The CWHvm subzones occur on the windward side of the CVRD
CWHvm2		
CWHmm1	Coastal Western Hemlock submontane and montane moist maritime subzones	These two leeward zones occur at higher elevations - above the CWHxm, but below the MH zone
CWHmm2		
CWHvh1	Coastal Western Hemlock southern very wet hypermaritime subzone variant	This “fog-belt” subzone occurs along the exposed Pacific Coast; it is a distinct zone but relatively small in size
MHmm1	Mountain Hemlock windward moist maritime subzone	These zones occur in the highest portions of the CVRD in the mountains north and west of Cowichan Lake; they are small in area so can be grouped together; they are considered to be leeward subzones due to the harsher climates at high elevation.
CMA	Coastal Mountain alpine	

1.1.1 Watersheds and Coastal Benchlands

Within the Cowichan region there are 12 major watersheds and seven (7) coastal benchland units. The benchlands are coastal areas that do not contribute flows to the major river systems. Examples of benchland units include the Malahat and Yellow Point Benchlands. Major watersheds and benchland units are shown in Figure 2, and listed in Table 2.

Of the 12 major watersheds, the Cowichan River watershed is the largest east-draining watershed at 92,674 hectares, followed by the Chemainus (35,569 hectares) and Koksilah (28,213 hectares). The largest west-draining watershed is the Nitinat River with a total area of 51,265 hectares. In contrast to these large watershed drainages, the largest benchland unit is the Malahat at 4,810 hectares. When combined, all of the Gulf Islands and coastal fringe benchlands within the CVRD total 5,200 hectares (Table 2).

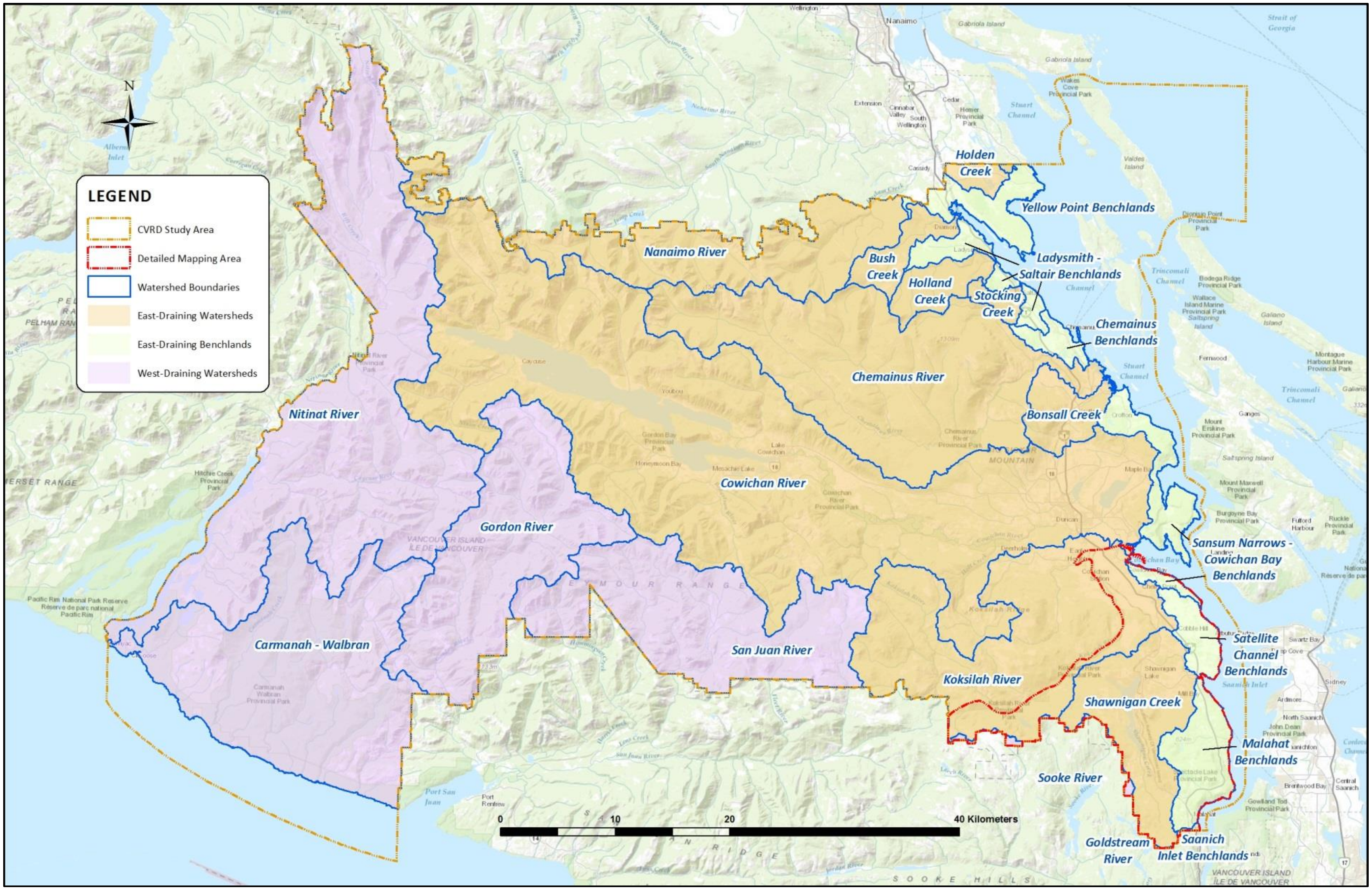

Figure 2. CVRD Watersheds and Coastal Benchlands

Table 2. Major Watershed and Coastal Benchland Units of the CVRD

Drainage Direction	Name	Area within CVRD Boundaries (ha)	Comments
East-draining Watersheds	Bonsall Creek	3,660	
	Bush Creek	2,814	
	Chemainus River	35,569	Includes Chipman, Solly and Banon Creeks
	Cowichan River	92,674	Consider dividing into east and west portions, by BEC zone
	Holland Creek	3,068	
	Koksilah River	28,213	
	Nanaimo River	18,067	Includes Jump and Green Creeks
	Shawnigan Creek	10,797	
	Stocking Creek	1,046	
East-draining Benchlands and Gulf Islands	Chemainus Benchlands	1,426	
	Coastal and Gulf Islands	5,200	
	Ladysmith - Saltair Benchlands	2,695	
	Malahat Benchlands	4,810	
	Sansum Narrows - Cowichan Bay Benchlands	4,644	
	Satellite Channel Benchlands	2,262	
	Yellow Point Benchlands	3,468	
West-draining Watersheds	Gordon River	24,062	Includes Hauk Creek
	Nitinat River	51,265	Includes Caycuse, Vernon, Seven Mile, and Wilson Creeks
	San Juan River	23,718	Includes Lens, Fleet, and Harris Creeks
	Carmanah Walbran	35,200	
Peripheral East-draining		152	
Peripheral West-draining		394	
	Total Area*	**355,203**	

*The above total area excludes ocean, but covers the entire landbase and freshwater within the CVRD.

1.1.2 Jurisdictions and Communities

In addition to a wide variety of biogeoclimatic units, watersheds, and benchlands, the Cowichan region has a number of jurisdictions, and a diverse mix of communities, land ownership, and land use. There are a total of nine electoral areas in the CVRD, as well as four municipalities, and multiple First Nations and bands. A map of local government jurisdictional boundaries is provided in Figure 3.

This study of environmentally sensitive areas falls within the traditional territories of:

- Cowichan Tribes
- Ditidaht First Nation
- Halalt First Nation
- Lake Cowichan First Nation
- Lyackson First Nation
- Malahat First Nation
- Penelakut Tribe
- Stz'uminus First Nation

Land ownership and use:

- First Nations
  - Reserve lands
  - Traditional territories and use areas
- Public
  - Provincial forestry lands
  - Local, Provincial and Federal Parks
- Private
  - Residential, commercial, industrial, agriculture, and forestry

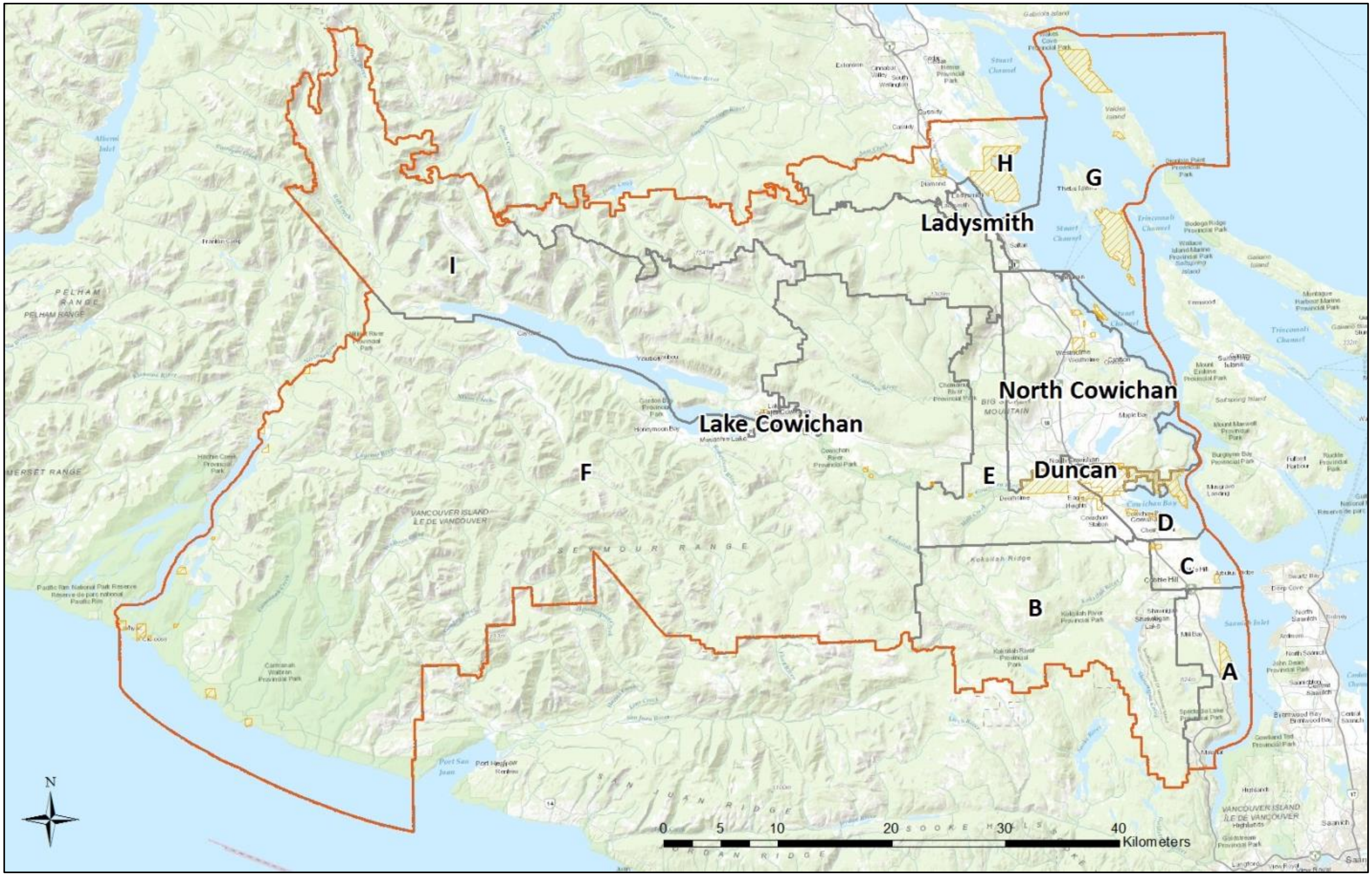

Figure 3. Local Government Jurisdictions in the CVRD

2 Methodology: Inventory and Integration of Existing ESA Data

As per the project objectives, an inventory and integration of existing ESA mapping was conducted. The identification of sensitive ecosystems was based on a combination of data integration, analysis, and image interpretation. By overlaying existing data, we were able to inventory and map potential ESAs within the CVRD. This is considered to be a "first pass" of identifying potential ESAs throughout the region. This step did not require specific interpretation by the mapper, other than in the conversion of the various datasets into standard sensitive ecosystem attribute format. As such, the coverage and quality of the outputs rely on that of the available input data.

Integration of multiple ESA map products was completed in ArcGIS 10.5. A geodatabase was created to contain all of the pertinent ESA base data. ESAs were delineated in a polygon feature class and each polygon was attributed following the coding in RISC (2006). Mapping conventions regarding polygon size and number of ecological components in a polygon followed SEI and TEM standards (RISC, 2006; RIC, 1998). The CVRD ESA database produced by Madrone is compliant with the Terrestrial Ecosystems Information System (TEIS) for ease of quality control and to be consistent with provincial data storage standards (RISC, 2010).

2.1 Data Acquisition and Integration

The first step in any mapping project is collecting data. There is a considerable amount of existing GIS data available to guide in the identification of ESAs in the CVRD. The data can roughly be divided into 3 categories: imagery (e.g. orthophotos); supporting data (e.g. BEC lines, contour lines, road), and the main ESA building blocks which were overlayed to create the base ESA layer. The CVRD provided all of the spatial data from their Watershed Atlas[3], and the remaining provincial data was downloaded from DataBC[4]. Many of the individual building blocks and reference layers are illustrated in a series of slides from the first Steering Committee Workshop, which are provided in Appendix A.

Spatial data (including source) that was used in the analysis or as reference layers, but not as ESA building blocks included:

- First Nations Lands (CVRD)
- Local Government Boundaries (CVRD)
- Watersheds (CVRD)
- Biogeoclimatic Zones (DataBC)
- Streams (CVRD)
- Freshwater Atlas (DataBC)
- Digital Elevation Models (CVRD)
- Floodplains (CVRD)

[3] CVRD Watershed Atlas

[4] DataBC: https://data.gov.bc.ca/

Existing ecosystem mapping datasets were integrated to complete an initial inventory of potential ESAs in the CVRD. Some of these datasets were originally created with a focus on sensitive ecosystems, while others provided information about potential ESAs as a secondary outcome or incidentally. Others were produced with a particular sensitive ecosystem or species at risk in mind. In all, ten existing datasets were used as the main building blocks to create an ESA dataset; several others were considered but left out for reasons explained below.

2.1.1 ESA Inventory Building Blocks

Three of the main building blocks were originally produced with the purpose of inventorying sensitive ecosystems – Sensitive Ecosystems Inventory (SEI), Special Ecological Features (SEF) and Species and Ecosystems at Risk (Publicly Available Occurrences). Two building blocks provided information about sensitive ecosystems as a secondary purpose or incidentally – Terrestrial Ecosystem Mapping (TEM) and Vegetation Resource Inventory (VRI). Those with a focus on specific sensitive ecosystems or species at risk included the Garry Oak Range, Old Growth Management Areas (OGMA), Critical Habitat for Federally-Listed Species at Risk, and Wildlife Habitat Areas (WHA). Since the SEF dataset included freshwater ponds and lakes, but only covered the eastern portion of the region, the CVRD Lakes layer was combined with the above layers to provide region-wide consistency.

In many ESA inventory layers, riparian features located outside of the typical SEI and TEM map products are included by way of a simple buffer from stream centerlines (or high water mark where available). However, for this project, it was decided by the Steering Committee that these additional riparian features should not be included in the ESA inventory layer at this time. This decision was based on the general agreement that the spatial accuracy of the existing stream mapping (TRIM) is often poor. There are concerns that the riparian default mapping based on TRIM could be misleading and result in false assumptions and errors (i.e., the map layer shows a stream that isn't actually there, or the map indicates no stream where one does in fact exist). These types of errors can result in a very low level of confidence in the overall ESA map product.

Wetland polygons from the provincial Freshwater Atlas were considered for inclusion as a building block; however, they were left out at this time due to the excessive overlap with other main building blocks – particularly in the eastern portion of the CVRD. In other words, wetlands in the priority eastern portion of the CVRD were already well-represented by the SEI and SEF layers. Wetland areas not represented by the other datasets were primarily located on private forestry lands, which is a considerable gap for all data sources. Due to those limitations, it was determined that the most appropriate use of the wetlands layer was as a reference for detailed ESA mapping updates (as a separate layer for consideration by the mapper).

Details of the main building blocks and their coverage in the CVRD are provided in Table 3.

Table 3. ESA Building Blocks for the CVRD – Integrated Datasets

ESA Building Blocks (Integrated Datasets)	Description	Coverage	Year	Source
Special Ecological Features (SEF)	Sensitive ecosystems mapped at a fine scale (1:5,000). Intended as a compliment to the SEI mapping, rather than a complete update.	East Portion	**2016**	CVRD
Sensitive Ecosystem Inventory (SEI)	Sensitive ecosystems	East Vancouver Island	**1997/ 2004**	Data BC
Species and Ecosystems At Risk (Publicly Available Occurrences)	Ecological communities at risk	CDFmm (based on 2008 CDFmm TEM)	**2008**	Data BC
Terrestrial Ecosystem Mapping	Terrestrial ecosystems with ESA components	Sparse / Partial: • CDFmm • Chemainus River Watershed • TFL 46 • TFL 39 • Others	**2008**	Data BC
Garry Oak Range	Extent of Garry oak woodlands and meadows	CDFmm	**2006**	CVRD
Old Growth Management Areas (OGMA)	Old forest	Full	**Current**	Data BC
Vegetation Resource Inventory (VRI)	Mature and old forest	Crown lands	**Various**	Data BC
Critical Habitat for Federally-Listed Species at Risk	Mainly old growth forest identified as critical habitat for Marbled Murrelet, as well as several other ESA types for other species.	Crown lands	**Current**	Data BC
Wildlife Habitat Areas (WHA)	Similar to Critical Habitat	Crown lands	**Current**	Data BC
Lakes	Freshwater ponds and lakes with full CVRD coverage, included for consistency with SEF (which included lakes in eastern watersheds).	Full	**Current**	CVRD

2.1.2 Spatial Data Overlay and Integration

In preparation for the spatial overlay, the datasets were queried to create new layers that only included potential ESAs. That data was then converted to TEIS (Terrestrial Ecosystem Inventory Standard) long table format consistent with the *Standards for Mapping Ecosystems at Risk* (RISC, 2006). When overlaying multiple spatial datasets, each layer was prioritized in terms of preserving polygon boundaries and attributes.

While Special Ecological Features (SEF) mapping was not specifically intended as an update to SEI mapping, it did update and refine the extents and attributes of sensitive ecosystems in the

CVRD (restricted to the east coast – select watersheds)[5]. The SEF mapping utilized more up-to-date imagery (2014), LiDAR elevation models, and was completed at a scale of 1:5,000 – much finer than SEI and TEM at 1:20 000. SEI mapping quality was somewhat limited by the imagery available at the time (in some areas airphotos from the 1980s were originally used). As such, it can benefit from an update, but still forms a useful baseline with which to track changes and disturbances over time. Although the SEF mapping was not specifically completed to RIC/RISC standards, given the advantage of higher quality recent data, and the fine scale of mapping, the SEF layer was assumed to be the highest quality spatial dataset available for sensitive ecosystems within the east portion of the CVRD. Therefore, the SEF data was given precedence where it overlapped with other datasets.

While there was potential for loss of SEI attributes, which could be more accurate in some cases of overlapping SEF and SEI polygons, only one SEF polygon completely contained a SEI polygon. In other words, the SEI polygons were typically larger and more generalized than the SEF polygons. So, even though the SEF polygons were given precedence in the overlay operation, there are remnants of the larger SEI polygons in the output dataset where the two overlapped. This effectively allowed mappers to consider both SEF and SEI attributes and linework when updating the ESA dataset in the detailed mapping area. At this stage, the SEF attributes were cross-walked into standard sensitive ecosystem mapcodes (refer to section 2.1.3 for further details).

TEM data was combined with the SEF and SEI overlay in a way that preserved the linework and attributes of both layers. However, prior to combining TEM with SEF and SEI, the Species and Ecosystems at Risk layer (queried for ecological communities) was combined with the TEM layer. This was done because the polygons of the former were clearly based on the latter, with an added buffer. These two datasets were combined with a spatial join, preserving the attributes of both datasets.

After combining the SEF, SEI and TEM layers, there was a considerable number of closely overlapping polygon lines that produced sliver polygons[6]. Many of these slivers (~28,000) were eliminated by calculating their thinness ratio, identifying them based on that ratio and their area, then merging them into the adjacent polygon with the longest shared border[7]. This process was repeated several times throughout the data integration. Although this may seem to be a minor detail, this process is both time consuming and essential to ensure a high quality GIS deliverable.

Garry Oak Range (2006) was the next dataset that was overlayed with the developing ESA layer. Where the Garry Oak Range polygons overlapped, attributes from the other datasets generally included some Garry oak woodland or meadow component. Therefore, it was only deemed necessary to preserve the linework and attributes of the Garry Oak Range where it covered areas not already represented by the other ESA building blocks.

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[5] The Special Ecological Features (SEF) layer can be viewed in the CVRD Watershed Atlas – methods and results are described in an unpublished memo by Integral Ecology Group (2016).

[6] Sliver polygon definition

[7] Sliver polygon elimination diagram

As with the Garry Oak Range, the linework and attributes of the OGMA, VRI and Lakes layers were only included in the output ESA dataset where these polygons did not overlap with other ESA polygons. Polygon linework and attributes from the ESA dataset, Critical Habitat and WHA were preserved in the final ESA layer.

2.1.3 Conversion to Sensitive Ecosystem Classification Standards

Mapcodes from the building block datasets that did not include ESA/SEI coding were cross-walked to the closest compatible sensitive ecosystem class and subclass mapcodes; namely TEM. Appendix B provides a full list of RISC standard SEI mapcodes as per RISC (2006). Appendix C summarizes the SEI mapcodes applied in the CVRD ESA 2018 Inventory product; while Appendix D provides descriptions of SEI classes and subclasses. The mapcode crosswalk process (assigning SEI coding to non-SEI products) was completed via a series of map database queries.

Some conversions were simple. For example, from the TEM dataset, all ecosystem components with structural stages 6 and 7 were assigned an SECL of “MF” for mature forest and “OF” for old forest, respectively. Then, non-forested and sparsely vegetated ecosystems were cross-walked, followed by site series consistent with various wetland and riparian sensitive ecosystem mapcodes.

SEF Category attributes were also straightforward conversions; “Wetlands”, “Riparian” or “Sparsely Vegetated” were given SECL_1 (Sensitive Ecosystem Class of Decile 1) attributes of “WN”, “RI” and “SV”, respectively. Or where polygons were identified as old growth forest in the SEF data, they were given “OF” as their SECL_1 attributes. Generally, the crosswalk from SEF to SEI (ESA) mapcodes was based on clear equivalents.

Other conversions required a finer degree of scrutiny to determine the appropriate equivalent SEI label. For example, there is no direct cross-walk from avalanche chute to an SEI label. The closest equivalent is “AP” for alpine. Avalanche chute features will need to be assessed via detailed mapping updates to determine the most appropriate sensitive ecosystem mapcode for each case. Minimal time was spent on identification of avalanche chutes at this time, as they are typically in remote locations of the CVRD, away from populated areas, and have no risk of site alteration other than by natural events.

2.1.4 Areas Excluded from the ESA Analysis and Map Products

At the request of the CVRD, ESAs on First Nations Reserve lands were not included in the analysis of ESA representation, and were not displayed on the maps presented in this report. It is understood that the CVRD has made information about this project available to First Nations in the region and has invited representatives to join the ESA Strategy Steering Committee and provide their input. However, the ESA data provided to the CVRD does include ESA mapping on First Nations Reserve lands, and it is available to be shared and used at the request and approval of the respective First Nations.

3 Results: Inventory and Integration of Existing ESA Data

The newly created CVRD ESA 2018 Inventory integrated multiple map products within the CVRD landbase of 348,723 hectares (excluding First Nations Reserve lands). ESAs in the 2018 inventory account for 93,953 hectares of the coverage layer that has a total area of 99,926 hectares. This discrepancy is primarily due to the fact that some polygons are not purely represented by ESAs, and include some non-sensitive components (e.g. young forest, developed area, etc.). A secondary reason is that in some cases, the queried input data suggested potential for the presence of sensitive ecosystems but could not be simply cross-walked to an equivalent sensitive ecosystem class. At this time, these were considered in our analysis and maps as “not classified” potential ESAs. An example from the VRI is non-productive forest lands, which could represent sparsely vegetated rock outcrops (SV:ro), herbaceous (HB:hb), swamp (WN:sp) or bog (WN:bg), etc. So these polygons may contain a sensitive ecosystem but require confirmation of which type (which was outside the scope of the data integration phase).

In other words, of the total polygon area in the ESA map product, 5,973 hectares represent non-sensitive ecosystems or non-classified ESAs. The non-sensitive components can be removed from the dataset via detailed mapping, as described in Section 4. Not classified ESAs are also classified during the detailed mapping process. The 93,953 hectares of mapped ESAs cover approximately 26.9% of the CVRD landbase included in this assessment.

ESA feature delineation (polygons) range in size of 0.1 hectares for the smallest to 22,177 hectares representing the largest polygon located in the Carmanah-Walbran Watershed (old forest leading SEI label). Lake Cowichan is the second largest polygon representing 6,280 hectares of freshwater lake “FW:la”.

Of the identified 93, 953 hectares of ESAs, the types with the most representation are old forest (57,189 ha), mature forest (17,436 ha) and freshwater lakes and ponds (9,754 ha). Following those are riparian areas (3,242 ha), wetlands (2,777 ha), woodland (1,495 ha), sparsely vegetated (817 ha), and seasonally-flooded agricultural (691 ha).

ESAs with the least overall representation are herbaceous (366 ha), and intertidal (178 ha). Very little alpine area (7 ha) has been mapped, which is a reflection of the fact that alpine areas are limited in the region (refer to Figure 1 and Table 1).

Representation of ESA types as a percentage of the 26.9% identified within the CVRD area are shown in Figure 4. For example, of the 26.9% ESA coverage in the CVRD identified to date, 16.1% is Old Forest. The distribution of ESAs mapped in the CVRD is shown in Figure 5.

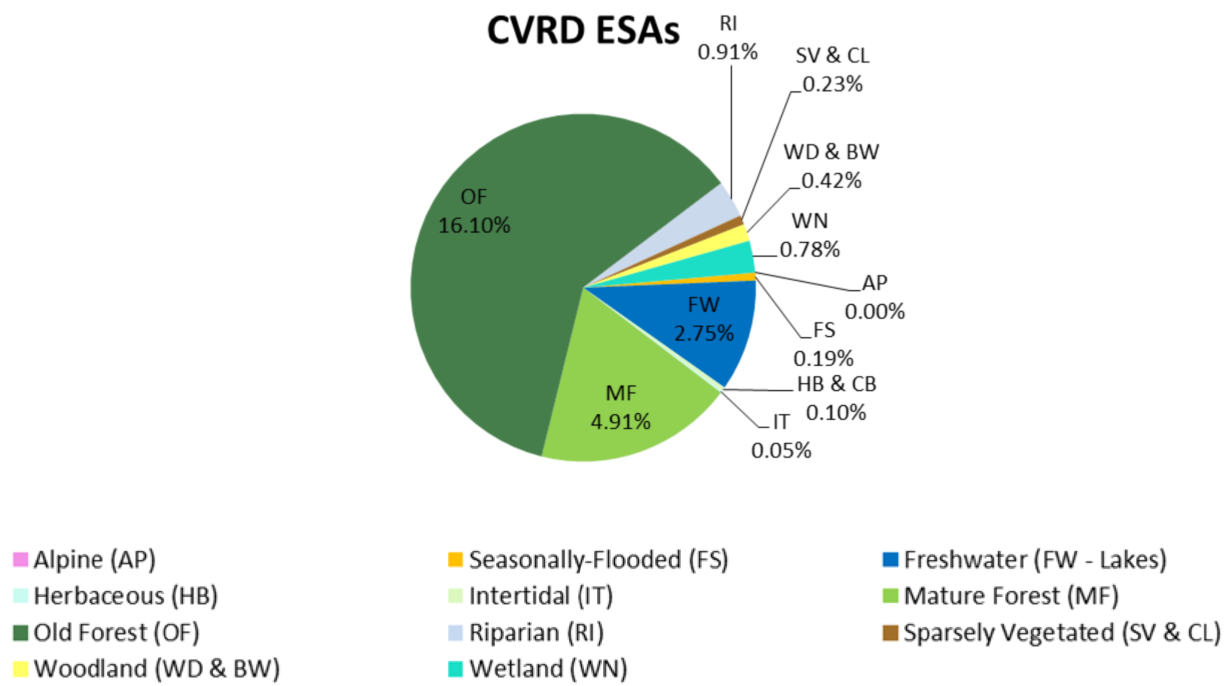


Figure 4. Overall Representation (%) of ESAs Identified in the CVRD

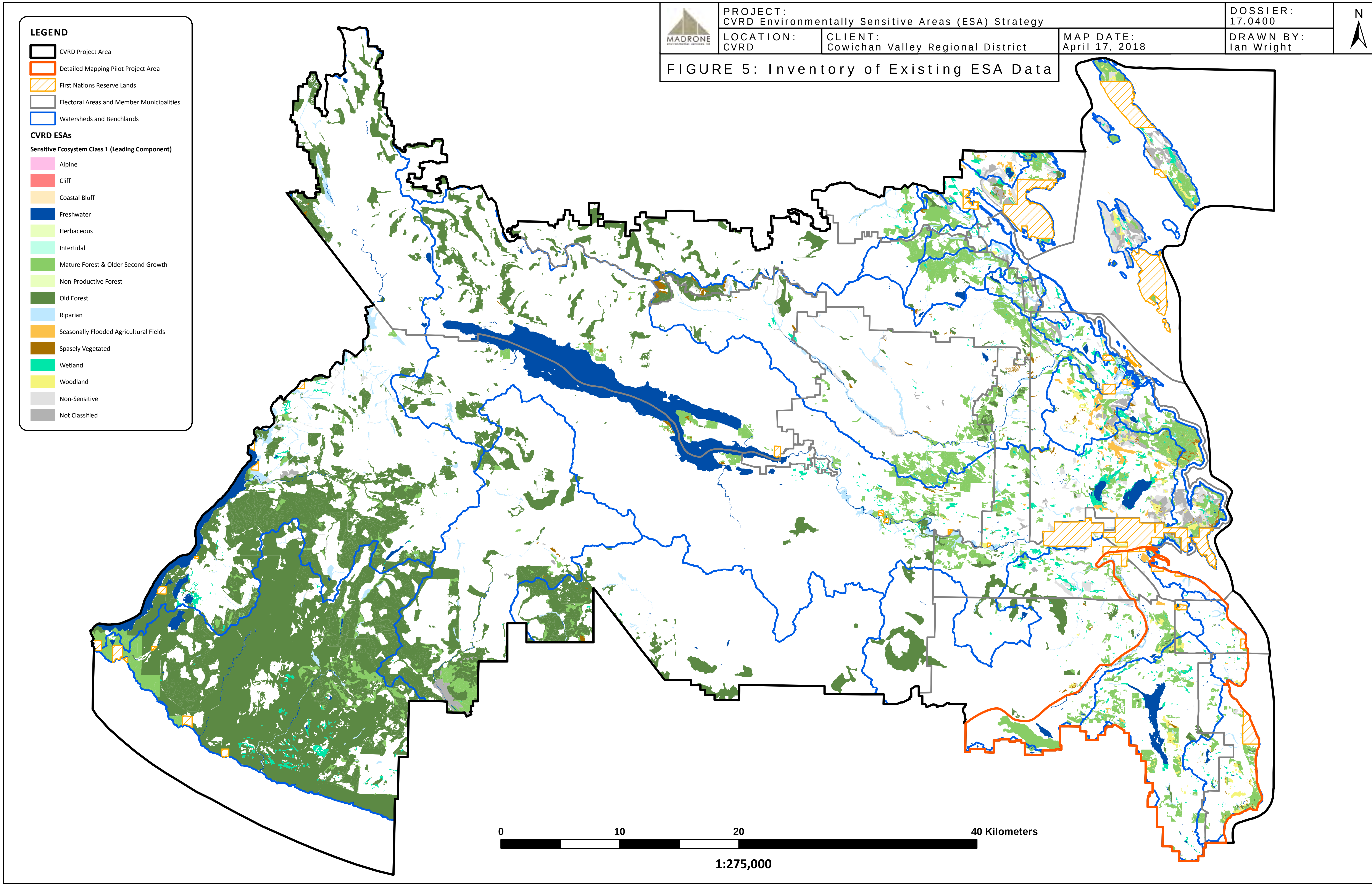


FIGURE 5: Inventory of Existing ESA Data

The following sections present the results of the ESA mapping by watershed, jurisdiction, electoral area, and biogeoclimatic zone. Analysis has been provided in all four formats to reach a broad range of audiences and interest groups. For example, one person may be interested in ESA distribution within their electoral area, while another person may want to know the distribution across an entire watershed in which their community is located. Examination of the data at different scales of relevance allows full flexibility of context. For full details of ESA representation by area, please refer to the results tables in Appendix E (Tables E-1 to E-6).

3.1 ESA Representation by Watersheds and Benchlands

East-draining watersheds with the highest ESA representation are Holland Creek (36.6% of the watershed area have been identified as ESAs), Stocking Creek (35.7%) and Bush Creek (30.4%). Bonsall Creek (22.7%) and Shawnigan Creek (21.8%) had moderate ESA representation among the east-draining watersheds, followed by the Cowichan River (18.4%), Chemainus River (14.5%), Koksilah River (13.8%) and Nanaimo River (13.3%). Freshwater lakes and ponds account for a significant portion of overall ESA representation in several watersheds, including the Cowichan (7.5% of ESAs identified in this watershed are freshwater lakes and ponds), Shawnigan (5.1%), Holland (2.1%) and Stocking (2.0%).

Of the east-draining benchlands and Gulf Islands, the coastal and Gulf Islands have the highest overall ESA representation (53.7%), followed by Sansum Narrows – Cowichan Bay (34.1%), Ladysmith – Saltair (24.9%), Chemainus (20.5%), Malahat (18.0%), Yellow Point (17.3%) and Satellite Channel (5.9%).

West-draining watersheds and their overall ESA representation include the Nitinat River (32.4%), Gordon River (23.9%) and San Juan River (13.3%). Nitinat Lake accounts for about 3% of the overall ESA representation in the Nitinat watershed.

Figure 6 depicts the ESA representation for each of the watersheds, benchland and Gulf Island areas in the CVRD.

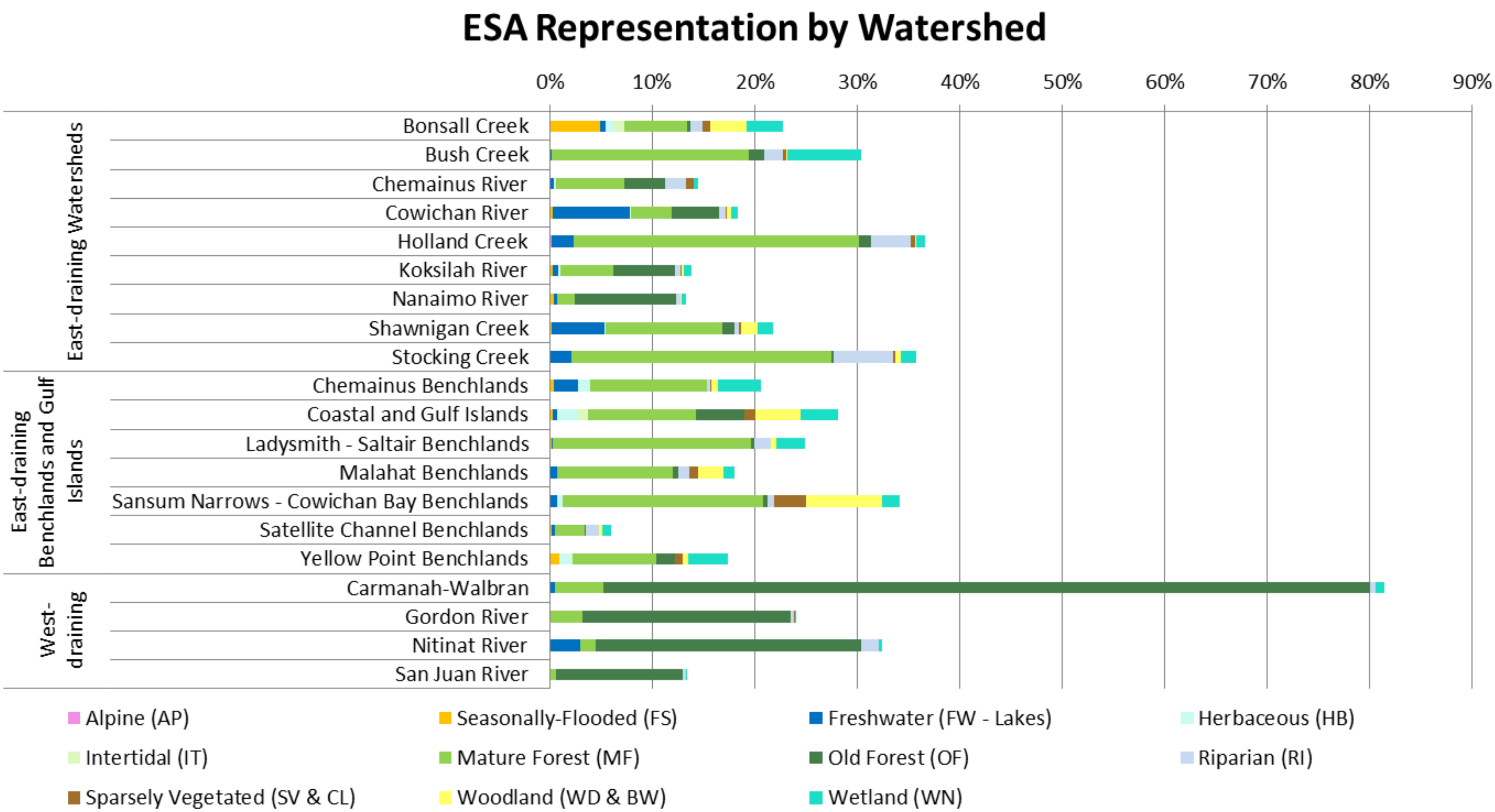


Figure 6. ESA Representation in the CVRD by Watersheds and Benchlands

3.1.1 East-draining Watersheds

Of the east-draining watersheds, the Nanaimo River has the greatest representation of old forest (9.8%), followed by the Koksilah River (6.0%), Cowichan River (4.5%) and Chemainus River (4.0%). Those with the least amount of old forest representation include Stocking Creek (0.2%), Bonsall Creek (0.4%) and Shawnigan Creek (1.25%).

Mature forest is most represented in the Holland Creek watershed (27.9%), followed by Stocking Creek (25.4%) and Bush Creek (19.2%). East-draining watersheds with the least representation of mature forest are the Nanaimo River (1.7%), Cowichan River (4.0%) and Koksilah River (5.1%).

Wetland representation was greatest in the Bush Creek (7.2%) and Bonsall Creek (3.5%) watersheds, and lowest in the Chemainus (0.4%) and Nanaimo River (0.5%) watersheds.

Figure 7 provides the representation of all ESA types in each of the east-draining watersheds.

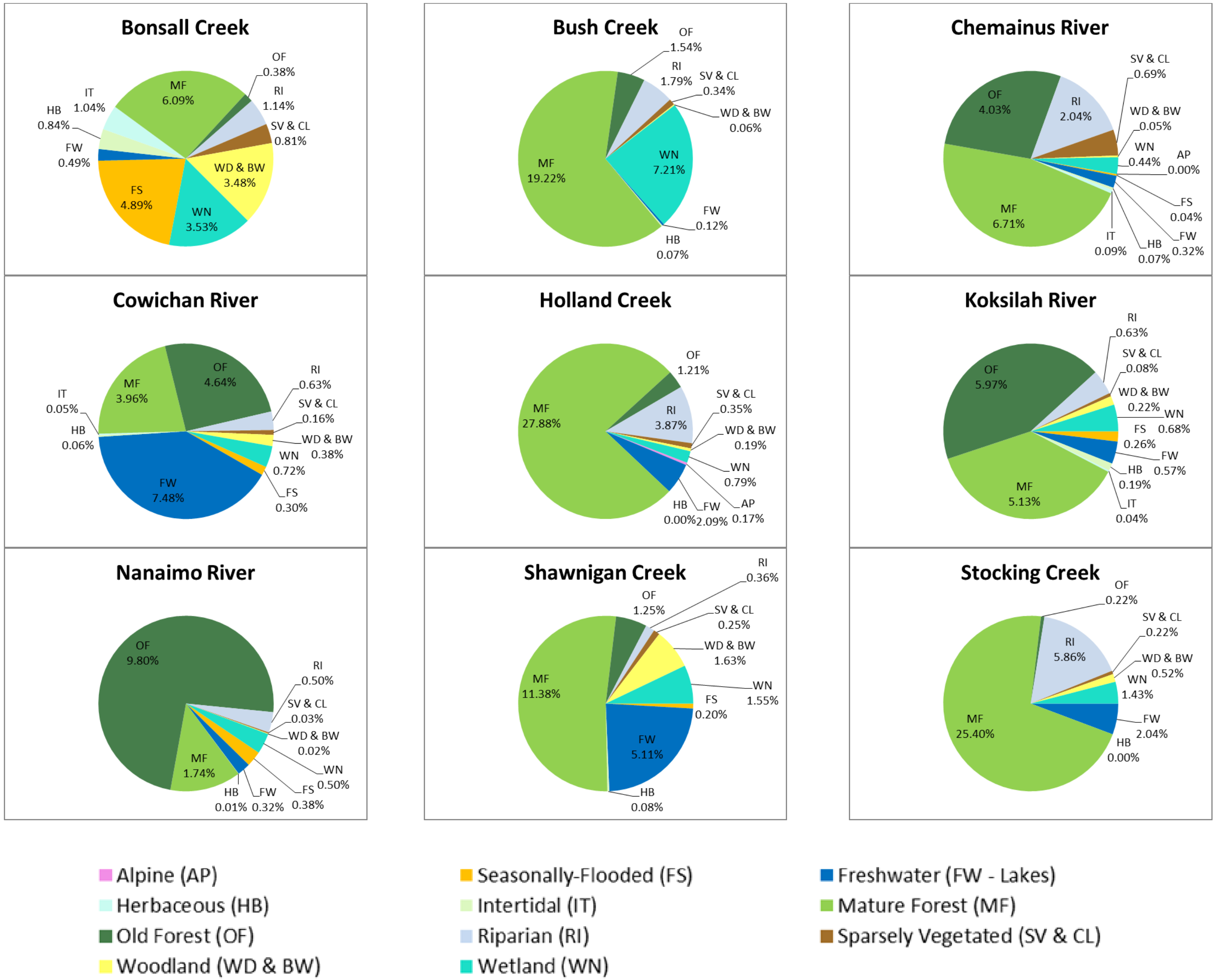


Figure 7. ESA Representation for East-Draining Watersheds in the CVRD

3.1.2 East-draining Benchlands and Gulf Islands

Among the east-draining benchlands and Gulf Islands, old forest is best represented in the coastal and Gulf Islands (9.1%) and Yellow Point (1.8%), whereas the remaining areas have 0.5% or less. Mature forest representation was greatest in the coastal and Gulf Islands (20.1%), Sansum Narrows – Cowichan Bay (19.5%) and Ladysmith – Saltair (19.4%) benchlands, followed by Chemainus (11.4%), Malahat (11.3%), Yellow Point (8.1%) and Satellite Channel (3.0%). Wetland representation is highest in the coastal and Gulf Islands (7.0%), Chemainus (4.2%) and Yellow Point (3.9%) benchlands. The greatest representation of woodlands in the region are in the coastal and Gulf Islands (8.4%) and Sansum Narrows – Cowichan Bay benchlands (7.4%). Herbaceous ecosystems are best represented region-wide in the coastal and Gulf Islands (4.0%), followed by Yellow Point (1.2%) and the Chemainus (1.1%) benchlands.

Figure 8 provides the representation of all ESA types in each of the east-draining benchlands and Gulf Islands.

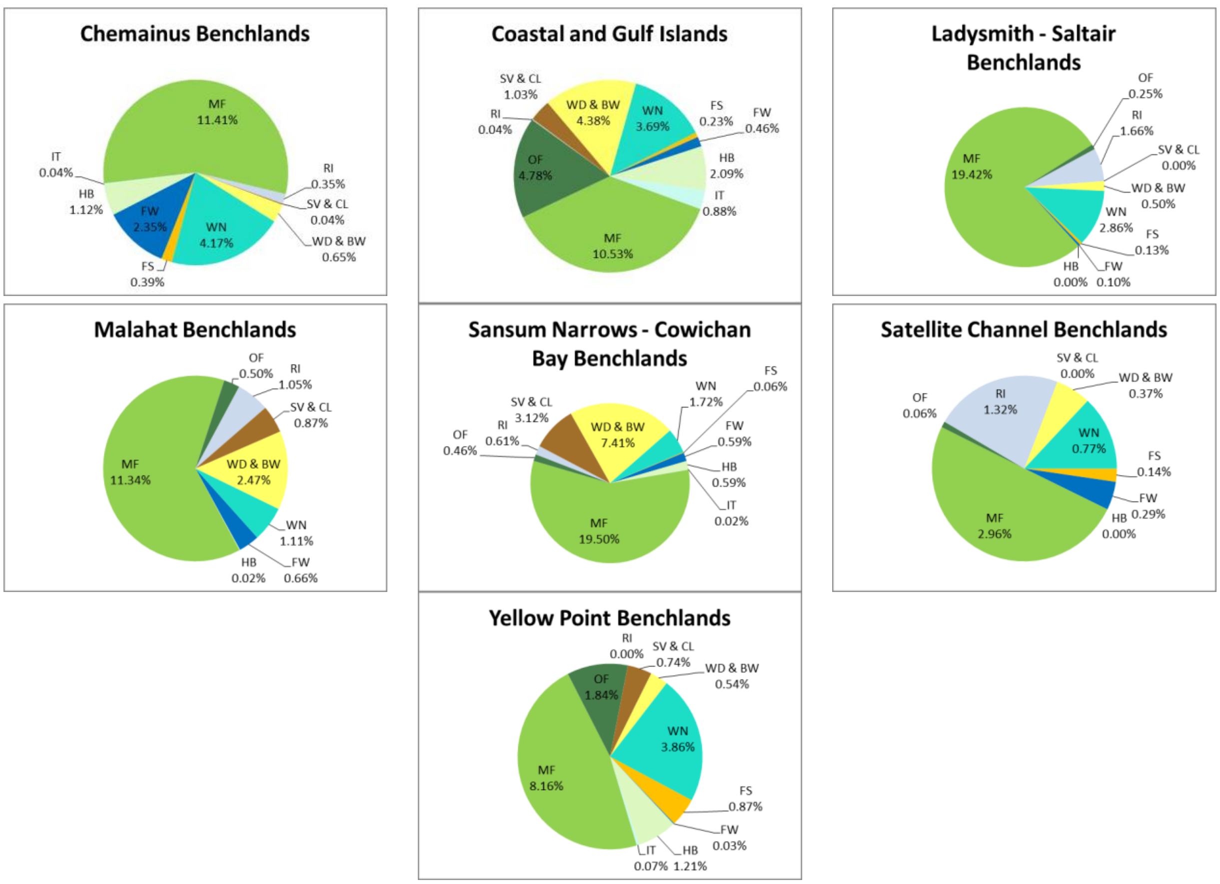


Figure 8. ESA Representation for East-Draining Benchlands and Gulf Islands in the CVRD

3.1.3 West-draining Watersheds

West-draining watersheds have a higher proportion of old forest compared to their east-draining counterparts, with 25.8% in Nitinat, 20.2% in Gordon and 12.3% in San Juan. Riparian ecosystems account for 1.7% of the Nitinat River watershed, followed by 0.4% of the Gordon and 0.3% of the San Juan. Apart from the freshwater cover of Nitinat Lake, all other ESAs represent less than 0.4% of these watersheds. Figure 9 provides the representation of all ESA types in each of the west-draining watersheds.

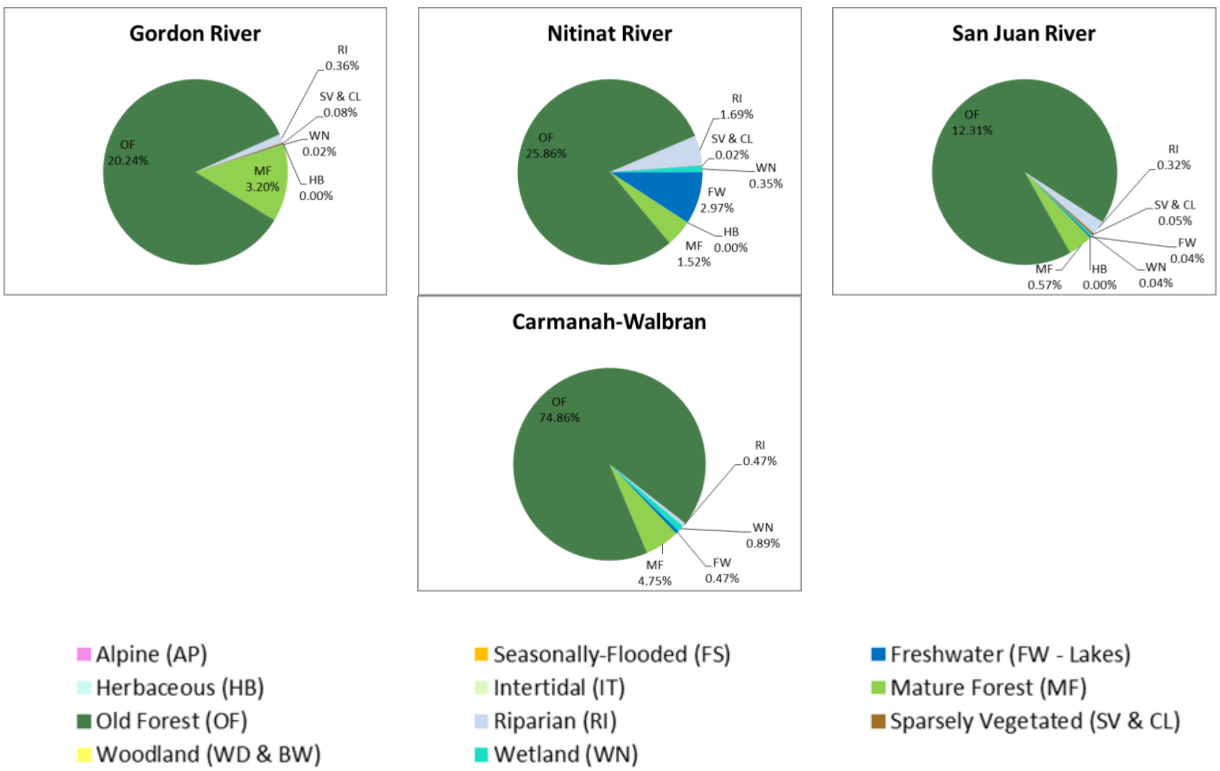


Figure 9. ESA Representation for West-Draining Watersheds in the CVRD

3.2 ESA Representation by Jurisdiction

The electoral area with the greatest overall ESA representation is Area F – Cowichan Lake South / Skutz Falls (33.0%). This is due to the significant area of remaining old forest in the west-draining watersheds of the CVRD.

Overall ESA representation in all other electoral areas is provided in descending order as follows: Area E – Cowichan Station / Sahtlam / Glenora (20.5%), Area G – Saltair / Gulf Islands (20.3%), Area H – North Oyster / Diamond (19.9%), Area I – Youbou / Meade Creek (19.0%), Area A – Mill Bay / Malahat (15.9%), Area B – Shawnigan Lake (15.5%), Area C – Cobble Hill (9.2%) and Area D – Cowichan Bay (8.3%). Note that Cowichan and Shawnigan Lakes account for a significant portion of ESA representation in Area I (~7%), Area B (~2%) and Area F (~2%).

Of the member municipalities, the Municipality of North Cowichan has the greatest overall representation of ESAs (28.7%), followed by the Town of Ladysmith (19.5%), Town of Lake Cowichan (16.9%) and City of Duncan (6.3%). Cowichan Lake accounts for the majority of ESA representation in the Town of Lake Cowichan (12.6%), and freshwater lakes and ponds cover 2.8% of the Municipality of North Cowichan. Figure 10 depicts ESA representation for each of the local government jurisdictions in the CVRD.

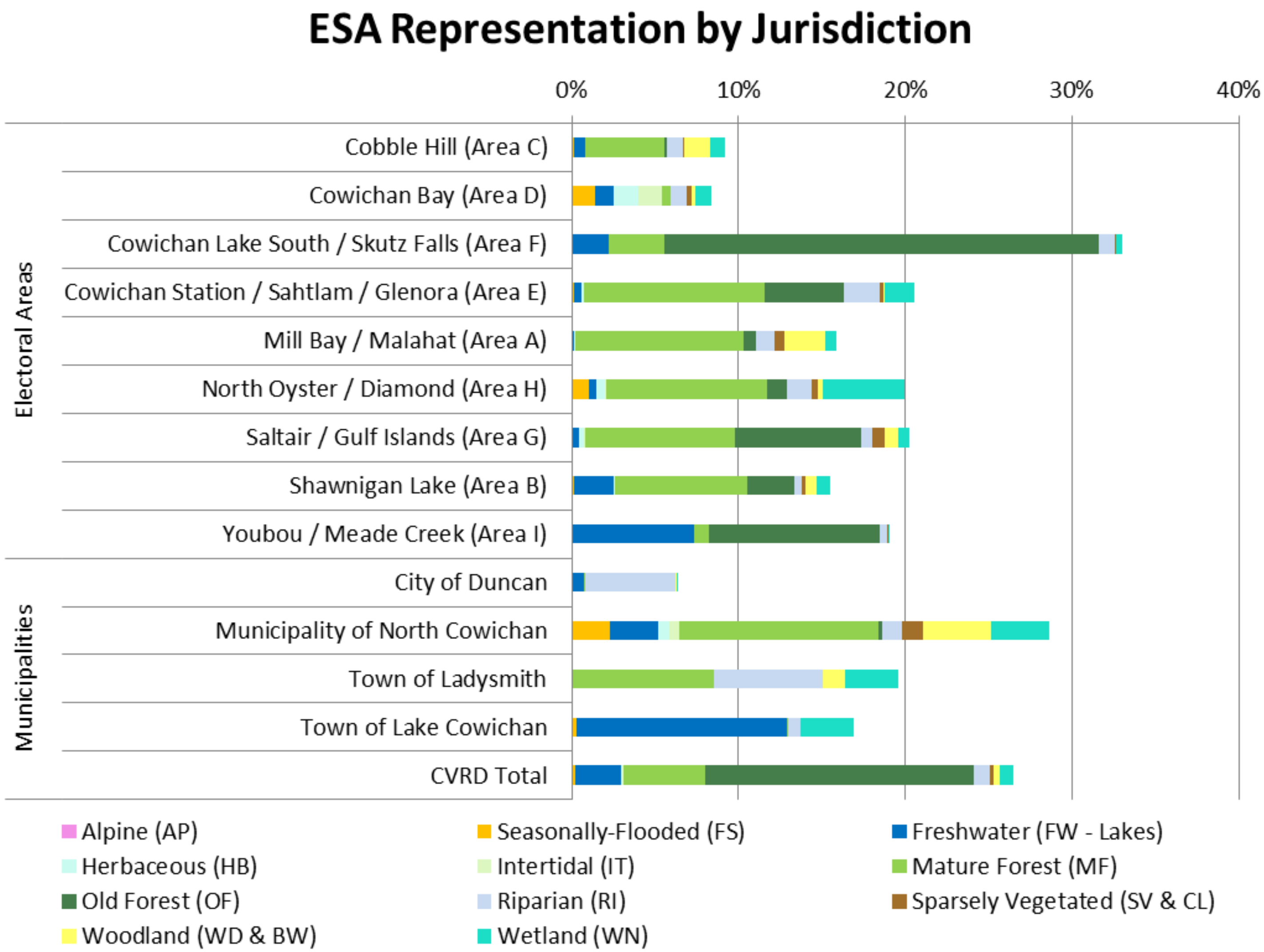


Figure 10. ESA Representation in the CVRD by Jurisdiction (Electoral Areas and Member Municipalities)

3.2.1 ESA Representation by Electoral Areas

Of the electoral areas, old forest is most represented in Area F (26.0%), due to the significant area of remaining old forest on the west coast. Apart from Area F, old forest is most represented in Area I (10.2%), Area G (7.6%) and Area E (4.8%). Relative old forest cover is lower in Area B (2.8%), Area H (1.2%), Area A (0.7%) and Area C (0.15%), and none is present in Area D. Mature forest representation is greatest in Area E (10.8%), Area A (10.1%), Area H (9.7%) and Area G (9.0%), followed by Area B (8.0%), Area C (4.7%), Area F (3.4%), Area I (0.9%) and Area D (0.5%). Wetland representation is highest in Area H (4.9%) and Area E (1.8%), while wetlands cover less than 1% of the remaining electoral areas. Woodlands cover 2.4% of Area A, 1.6% of Area C and less than 1% elsewhere. The representation of the remaining ESA types is generally low for each electoral area (less than 2%, and most less than 1%).

Of note in terms of total area, Area G has the most herbaceous (102 ha), sparsely vegetated (225 ha) and woodland (233 ha) ecosystems. The rarest elements in terms of total area (up to 5 hectares), in the electoral areas are as follows:

- 0.2 ha of intertidal in Area G;
- 0.7 ha of herbaceous in Area C;
- 0.9 ha of sparsely-vegetated in Area C;
- 1.1 ha of herbaceous in Area A;
- 1.2 ha of herbaceous in Area F;
- 2.2 ha of seasonally-flooded agricultural fields in Area A;
- 2.5 ha of intertidal in Area H;
- 3.3 ha of seasonally-flooded agricultural fields in Area A; and
- 3.4 ha of old forest in Area C.

Also, the following are other notable lowest total areas for ESA types in the electoral areas:

- 7.5 ha of woodland in Area D;
- 15 ha of mature forest in Area D; and
- 20 ha of wetland in Area C.

Figure 11 depicts the representation of all ESA types in each of the electoral areas.

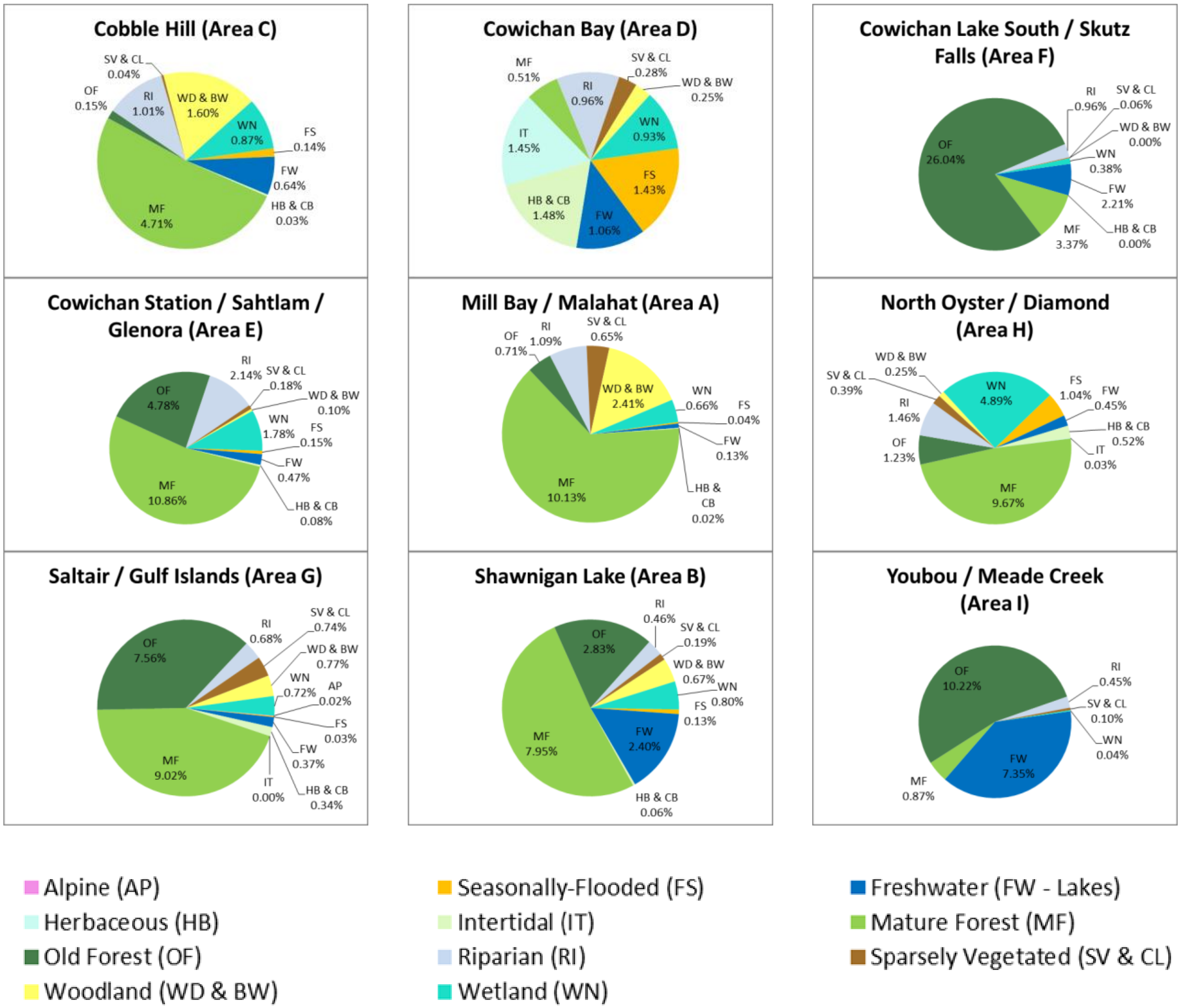


Figure 11. ESA Representation for CVRD Electoral Areas

3.2.2 ESA Representation in Member Municipalities

Among the member municipalities, old forest is only present in the Municipality of North Cowichan, covering 59 hectares or 0.3%. Mature forest is most represented in North Cowichan (11.9%), followed by the Town of Ladysmith (8.5%), City of Duncan (0.07%) and Town of Lake Cowichan (0.03%). Woodland representation is greatest in North Cowichan (4.1%), followed by Ladysmith (1.3%), Duncan (0.06%) and there is no mapped woodland in Lake Cowichan. As with old forest, North Cowichan is the only municipality with mapped herbaceous ecosystems (0.7%). Sparsely vegetated ESAs cover 1.3% of North Cowichan and 0.03% of Ladysmith, with none elsewhere. The rarest elements in terms of total area (up to 5 hectares), in the member municipalities are as follows:

- 0.1 ha of woodland in Duncan;
- 0.1 ha of wetland in Duncan;
- 0.2 ha of mature forest in Duncan;
- 0.3 ha of mature forest in Lake Cowichan;
- 0.4 ha of sparsely vegetated in Ladysmith; and
- 2.5 ha of seasonally-flooded agricultural fields identified in the Town of Lake Cowichan.

Figure 12 provides the representation of all ESA types in each of the member municipalities.

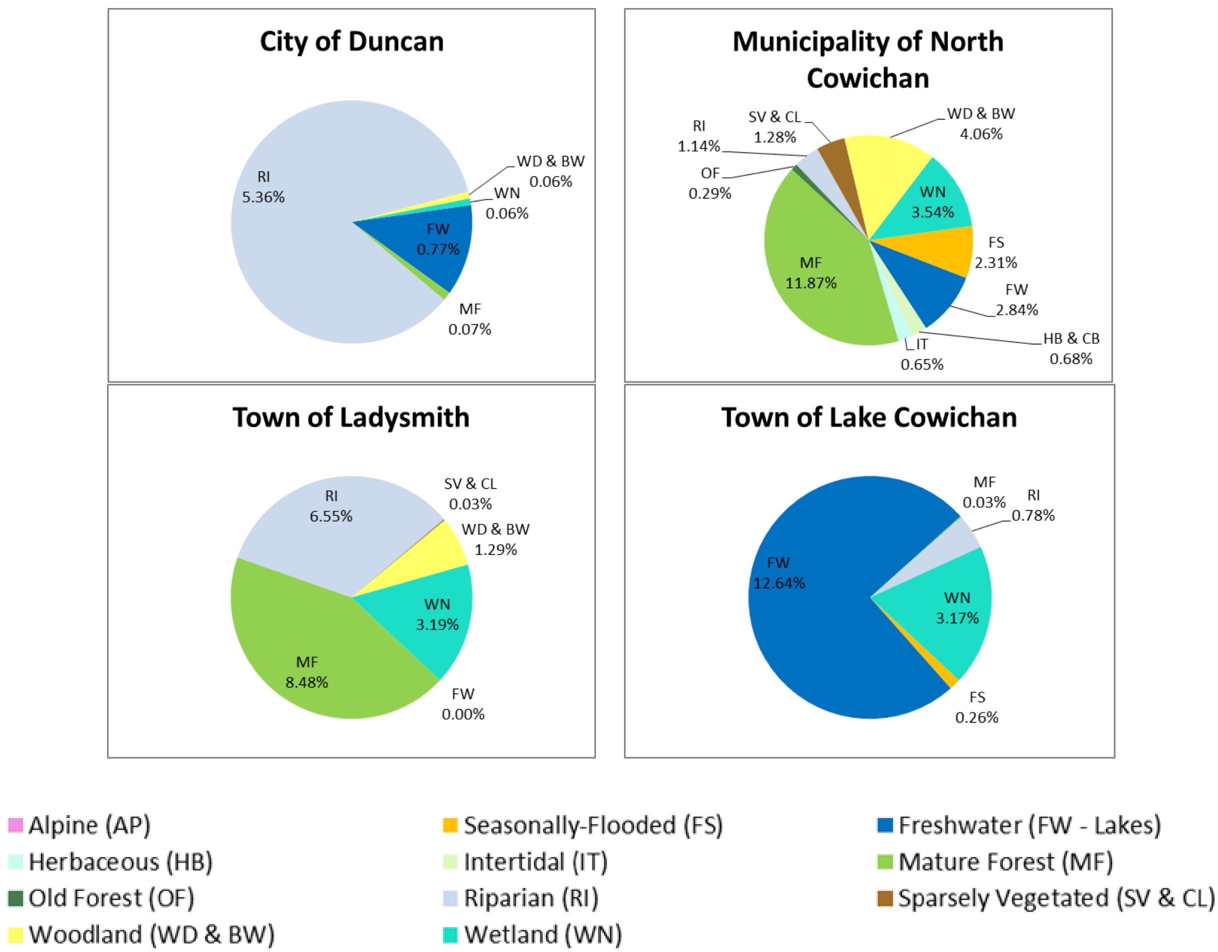


Figure 12. ESA Representation for CVRD Member Municipalities

3.3 ESA Representation by Biogeoclimatic Zone

Overall ESA representation is greatest in the Coastal Western Hemlock very hyper-maritime (CWHvh – 89%) and Coastal Western Hemlock very moist maritime zones (CWHvm – 52%), due to the significant area of remaining old forest on the west coast. Following those are the Coastal Douglas-fir (CDFmm – 22%), Coastal Western Hemlock very dry maritime (CWHxm – 19%), Mountain Hemlock moist maritime and Alpine (MHmm and CMAunp – 12%) and Coastal Western Hemlock moist maritime (CWHmm – 11%). The CDFmm and CWHxm zones have the greatest diversity of ESA types (10 and 9, respectively). Figure 13 depicts the ESA representation for each biogeoclimatic zone in the CVRD.

Apart from the CWHvh and CWHvm zones, old forest representation is highest in CWHmm (11%) and MHmm (10%), followed by CWHxm (1.7 to 3.3%) and old forest covers 394 ha (0.9%) in the CDFmm zone. Mature forest representation is greatest in CWHvh (22.4%), followed by CWHxm1 (15.7%), CDFmm (9.6%), and is less than 5% in each of the other subzones.

Notable rare elements in terms of total area in the CDFmm and CWHxm1 (in which the data coverage is most complete) are as follows:

- 30 ha of herbaceous in CWHxm1;
- 49 ha of seasonally-flooded agricultural fields in CWHxm1;
- 188 ha of sparsely vegetated in CWHxm1;
- 293 ha of sparsely vegetated in CWHxm1;
- 326 ha of herbaceous in CDFmm;
- 373 ha of woodland in CWHxm1; and
- 394 ha of old forest in CDFmm.

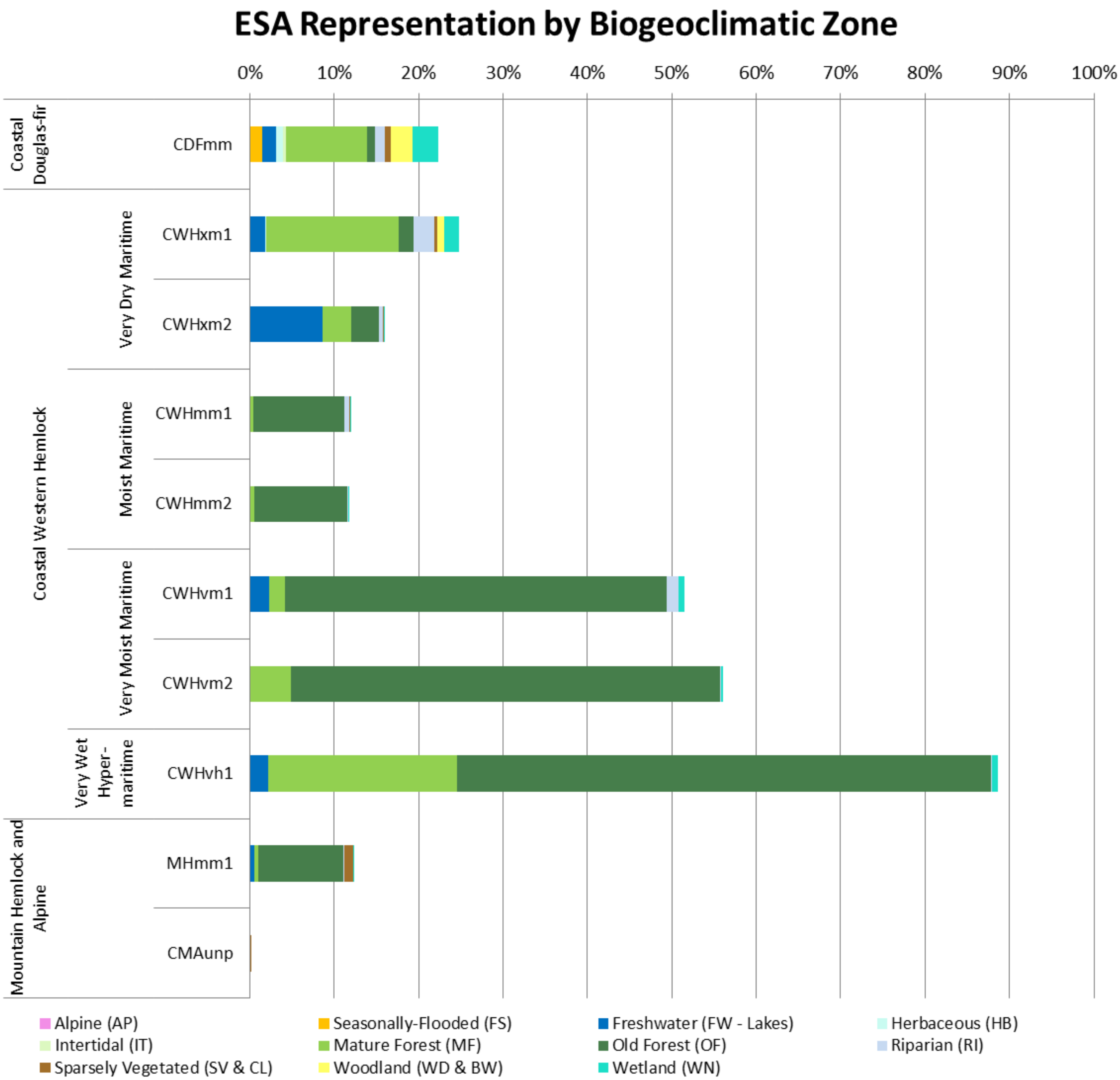


Figure 13. ESA Representation by BEC Unit in the CVRD

4 Detailed ESA Mapping

In order to verify the spatial accuracy and attributes resulting from the integration of existing ESA data (described above), detailed mapping was completed in a priority pilot area of the CVRD. Orthophoto interpretation was applied to verify existing ESA data at a scale of 1:5,000. Attributes were revised where needed, and inaccuracies of ESA polygon delineation were addressed through linework edits. In effect, this process represented a “second pass” in the mapping process that built upon and improved the quality of the “first pass” of ESA data integration.

As an added benefit to this process, some ESAs that were not represented from the “first pass” were added during detailed mapping where they were observed by the mapper nearby the polygons being verified. However, the detailed mapping process did not exhaustively seek out new ESAs that weren’t captured by the “first pass”, as the primary focus was to verify and update the existing ESA data[8].

4.1 Pilot Area

The priority detailed mapping pilot area identified by the Steering Committee was the “south end” of the CVRD, otherwise described as the area surrounding Shawnigan Lake. This area was selected due to relatively high development pressure, and to dovetail with other CVRD initiatives. The area of detailed ESA mapping covers Electoral Area A, B, C, D & E, or portions thereof, extending from the southeast corner of the CVRD up to and including the Koksilah River. This detailed mapping area covers 25,687 hectares, within which the 5,365 hectares of ESA were reviewed and updated as required.

Watersheds and coastal benchlands (or portions thereof) within the detailed mapping area are shown in Figure 14 and include:

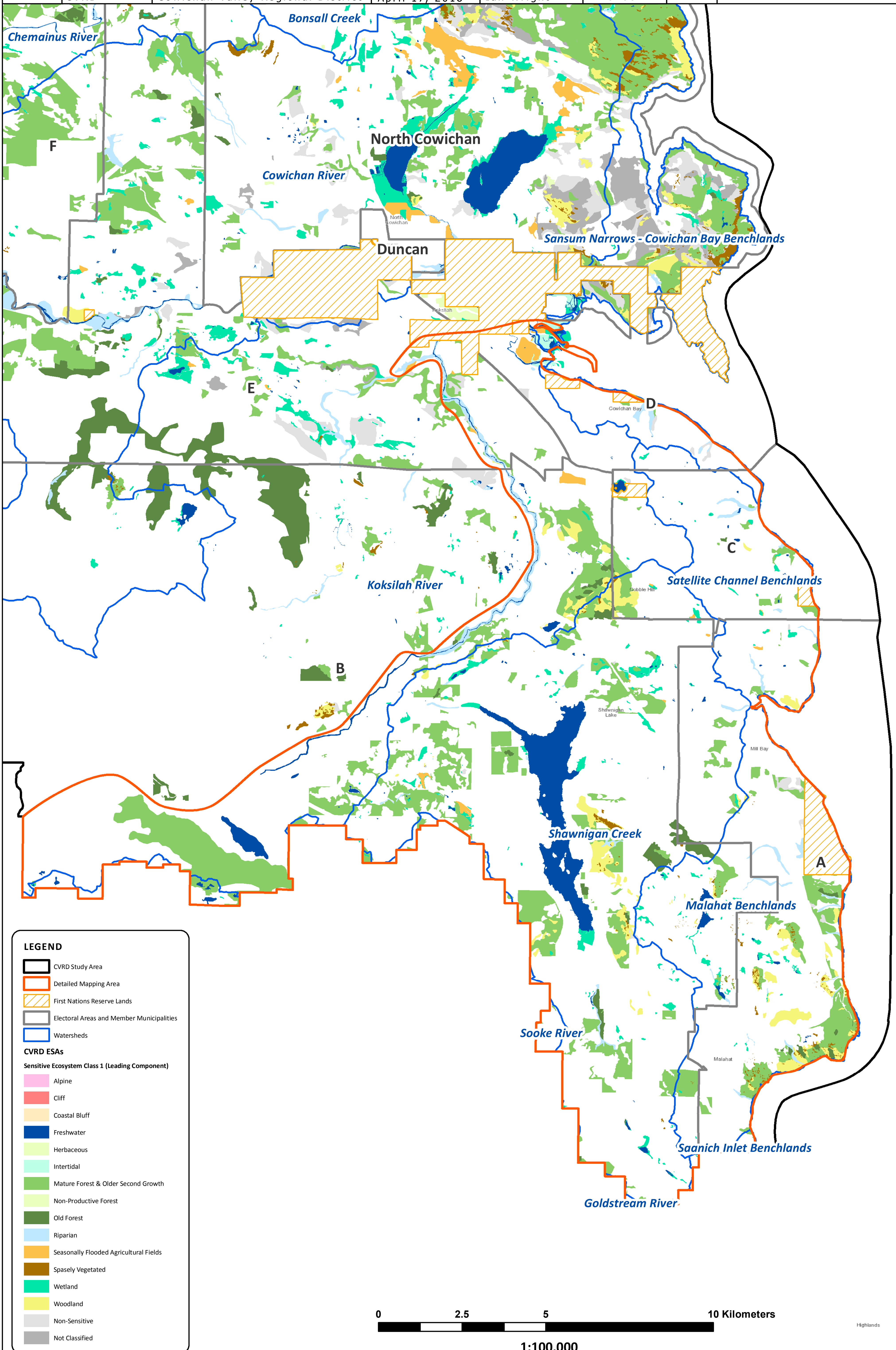
- Shawnigan Creek (all within CVRD)
- Koksilah River (south and east portions)
- Malahat Benchlands (all)
- Satellite Channel Benchlands (all)
- Sansum Narrows – Cowichan Bay Benchlands (south portion)

[8] Note that the ESA representation results presented in Section 3 were calculated after the detailed mapping updates were completed.

MADRONE environmental services ltd

PROJECT: CVRD Environmentally Sensitive Areas Strategy					
LOCATION: CVRD	**CLIENT:** Cowichan Valley Regional District	**MAP DATE:** April 17, 2018	**DRAWN BY:** Ian Wright	**DOSSIER:** 17.0400	N

FIGURE 14: Detailed Mapping



4.2 Detailed Mapping Process

The detailed mapping process involved visually assessing and updating the ESA inventory data, to ensure its accuracy. Specifically, the mapper completed the following tasks:

Visual Assessment

- Visually assessed each ESA polygon in reference to 2014 orthophotos (most recent aerial imagery) and digital elevation models (where available), at a scale of 1:5,000.

Polygon Linework Updates

- Merged small adjacent polygons that originated from separate datasets, but represented the same ESA feature.
- Deleted small polygons where the adjacent polygon linework was more accurate in representing the same ESA feature.
    - Polygons were only deleted after their attributes were considered, as part of the attribute verification and update.
- Edited polygon lines manually to provide a spatially accurate representation of each ESA feature at the assessed scale (1:5,000).
- Sub-divided polygons where it was practical to separate out two or three ESA types, to produce pure ESA polygons.
- Sub-divided polygons where it was practical to separate out disturbances (i.e. subdivision development, deforestation, etc.) that were visible within the polygons.

Attribute Verification and Update

- Verified whether each polygon's sensitive ecosystem attributes appeared correct.
- Updated the attributes where a more accurate ESA classification could be applied.
- Only the sensitive ecosystem attributes were edited – existing SEF, TEM and fields from input datasets were not altered, and remain in their original format within the spatial layer database provided for future reference.
    - The sensitive ecosystem attributes include Sensitive Ecosystem Class 1 through 3 (SECL_1, SECL_2 and SECL_3) and Sensitive Ecosystem Subclass 1 through 3 (SESUBCL_1, SESUBCL_2, SESUBCL_3).
    - Standard codes were used from the Standards for Mapping Ecosystems at Risk (RISC, 2006), which are provided in Appendix B.
- As noted above, polygons were subdivided to ideally represent only one ESA type (a "pure" polygon), such that only SECL_1 and SESUBCL_1 were populated. However, not all of the polygons could be separated into pure ESA types, particularly where two or three types were intermixed and splitting them out would result in very small polygons, or was not possible due to polygon complexity.

- Where disturbances were subdivided out of existing ESA polygons, the sensitive ecosystem class for disturbances was changed to 'NS' (Non-Sensitive).
- The sensitive ecosystem class was also changed to 'NS' (Non-Sensitive) where the forest stand age (structural stage) in the original mapping was incorrect (i.e. originally mapped as mature forest, but interpreted by the mapper as young forest).
- Pure non-sensitive polygons were deleted from the final ESA dataset.
- If there was any doubt about whether to change the attributes or not, we defaulted to the original attributes (as the original mapper may have had field data to inform their work).

Creation of New ESA Polygons

- Created new polygons where additional ESAs were identified nearby the existing polygons being assessed (i.e., typically within field of view of detailed review at 1:5,000 scale).
- Note that this was only done where unmapped ESAs were seen by the mapper while they were assessing and panning between the existing polygons – the imagery was not assessed exhaustively outside of the existing ESA polygons.

4.3 Detailed Mapping Results

A total of 1,641 polygons covering 5,365 hectares were assessed and updated if/when needed within the detailed mapping pilot area (Figure 14). Overall, the detailed mapping effort resulted in:

- simplified the polygon linework,
- improved linework accuracy (due to adjustments applied at a fine scale of viewing; 1:5,000 or less),
- adjusted linework for recent disturbances (updated features and labels),
- reduced number of complex polygons (e.g., 84% of the detailed map area ESA polygons have only one component; compared to 69% for the total ESA inventory layer), and
- identified some cases of new ESAs (previously unmapped).

A representative example of the linework before and after the detailed map edits is shown in Figure 15. Another example of the resultant, streamlined linework is apparent along the Koksilah River, as shown in Figure 16. In the following figures, the original ESA polygons are shown in orange, and the green polygons represent the final dataset after the detailed map updates were complete.

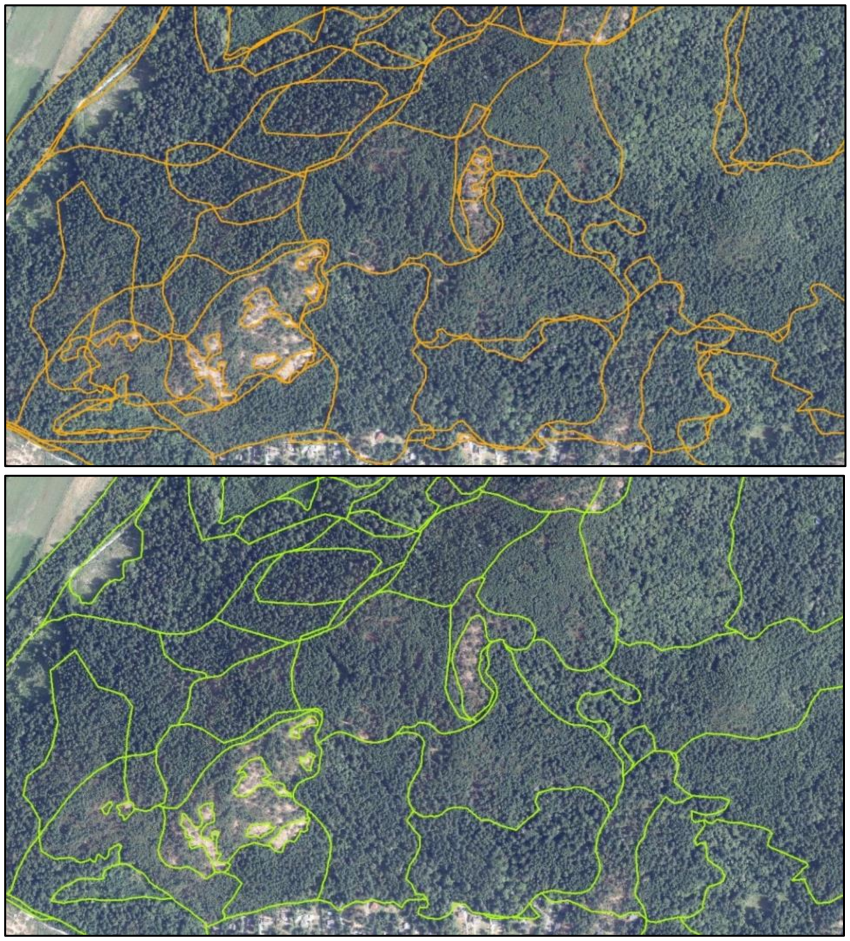


Figure 15. A representative example of the polygon linework before (orange) and after (green) the detailed mapping updates.

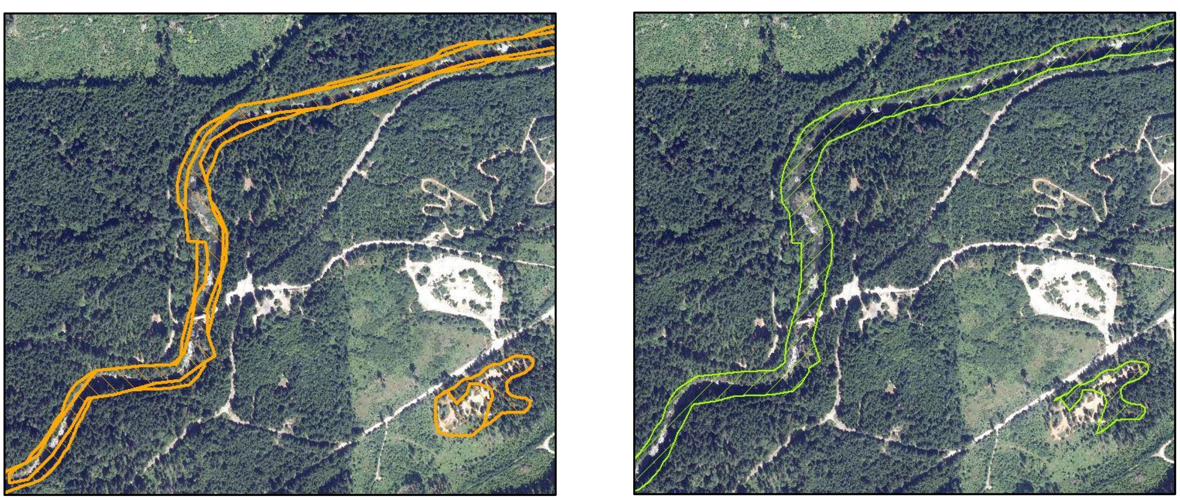


Figure 16. Simplified linework along the Koksilah River. ESA polygons before and after detailed mapping are shown in orange and green respectively.

Approximately 150 polygons representing a total area of 428 hectares were deleted, for the reasons explained above (disturbances or incorrect forest age). Approximately 5 hectares of the originally mapped ESAs were eliminated through edits of inaccurate linework. Figure 17 shows examples of ESA loss due to land development, deforestation, and incorrect original forest age classification. ESA polygons before and after detailed mapping are shown in orange and green respectively.

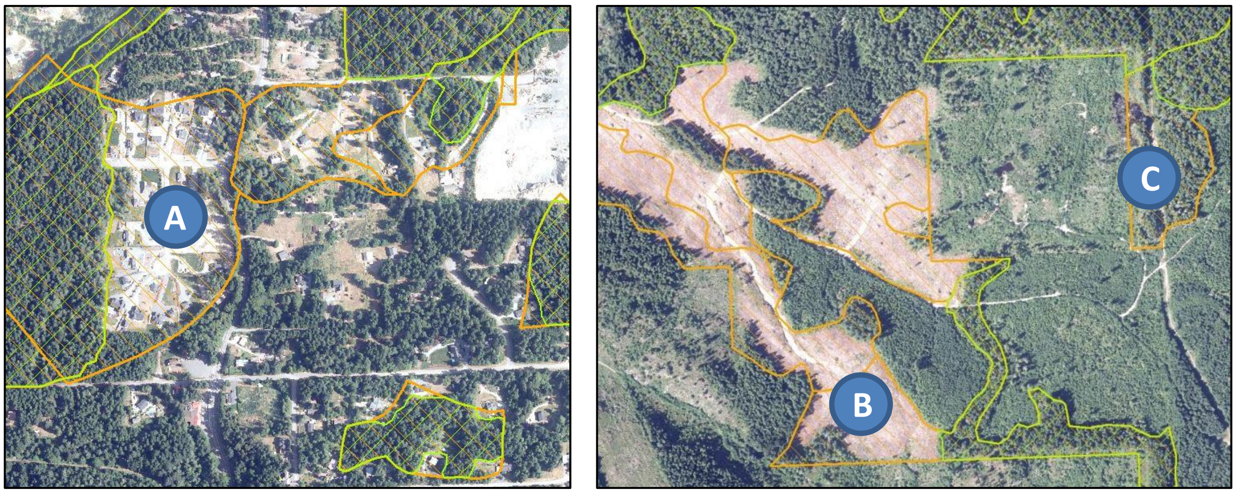


Figure 17. Examples of land development (A) and deforestation (B) disturbances, as well as incorrect original forest stand age classification (C) that were accounted for through the detailed ESA mapping process (polygons were deleted or linework was adjusted).

Some gains in ESA areas also resulted from the detailed mapping process, including an additional 120 hectares of ESAs that were newly mapped by extending the boundaries of 64 existing ESA polygons. ESA representation was further increased with the creation of 43 new ESA polygons with a total area of 302 hectares. An example of newly-mapped mature forest is shown in Figure 18 below.

Figure 18. Examples of new mature forest ESA polygons that were created during the detailed mapping updates. ESA polygons before and after detailed mapping (appearing yellow where they overlap).

In general, the sensitive ecosystem attributes that resulted from the ESA data integration were accurate and the majority did not require editing during the detailed mapping. In some cases the visual examination of ESA polygons resulted in refining the existing attributes, but usually in minor ways - such as changing SV:ro to SV:sh (Sparsely Vegetated subclass from rock outcrop to shrub); or changing WN:fn to WN:sp (Wetland type of fen to swamp). While the refinement of attributes was a relatively minor component of the edits performed during the detailed mapping (as compared to the linework edits), their verification ensured a high quality map product within the detailed mapping area.

5 ESA Network Options

An ESA network connects geographically separate ESAs. Creating a network that links ESAs across elevation or moisture gradients to allow dispersal of vegetation and animals in the face of climate change is becoming an important issue. A variety of ESA polygon sizes is important, both large ones that provide interior forest conditions, and smaller ones that provide edge habitat and can be used as stepping stones between larger ESAs.

Riparian areas are the most obvious ESA components that can provide connectivity in an ESA network, as they follow the existing stream network. Riparian areas are already protected by local government watercourse protection bylaws consistent with the provincial Riparian Areas Regulation (RAR), as well as on private and public forest lands[9]. Riparian protection and enhancement is also encouraged on agricultural lands through the Environmental Farm Plan[10].

Several options for developing an ESA network have been considered, taking into account the ecological, geographic, land use and development context of the CVRD. These options are described below.

5.1 Option 1 – Buffered ESA Polygons and Riparian Areas

ESA Network Option 1 is shown in Figure 19. This was based on a 30m buffer applied to all ESA polygons, and includes a riparian buffer around streams and lakes to create connectivity across the landscape. An average riparian buffer of 15m was applied to all of the streams and lakes, and a 30m buffer was applied to larger streams such as the Cowichan and Koksilah Rivers. This buffer approach is a straightforward and effective way to produce an ESA network, and the buffer helps account for spatial inaccuracies in the mapped ESAs. Based on the CVRD 2018 ESA Inventory map layer, and accounting for all features within that layer[11], the ESA Network Option 1 covers ~130,000 hectares (~30,000 hectares of this area is a result of the applied buffers to ESAs and riparian areas).

5.2 Option 2 – ESA Polygons and Riparian Areas

This option includes the riparian area buffers to provide connectivity between ESAs, but does not include a buffer around the ESA polygons. The lack of a buffer places more reliance on the accuracy of the ESA mapping, and there is a greater potential that the ESAs on the ground may extend outside of the network boundary (Figure 20). ESA Network Option 2 covers ~115,000 hectares with ~15,000 hectares a result of the riparian buffers.

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[9] Riparian Areas Regulation Assessment Methods
Managed Forest Council Field Practices Guide (see pages 20-24)
Forest Planning and Practices Regulation (see Part 4 Division 3)

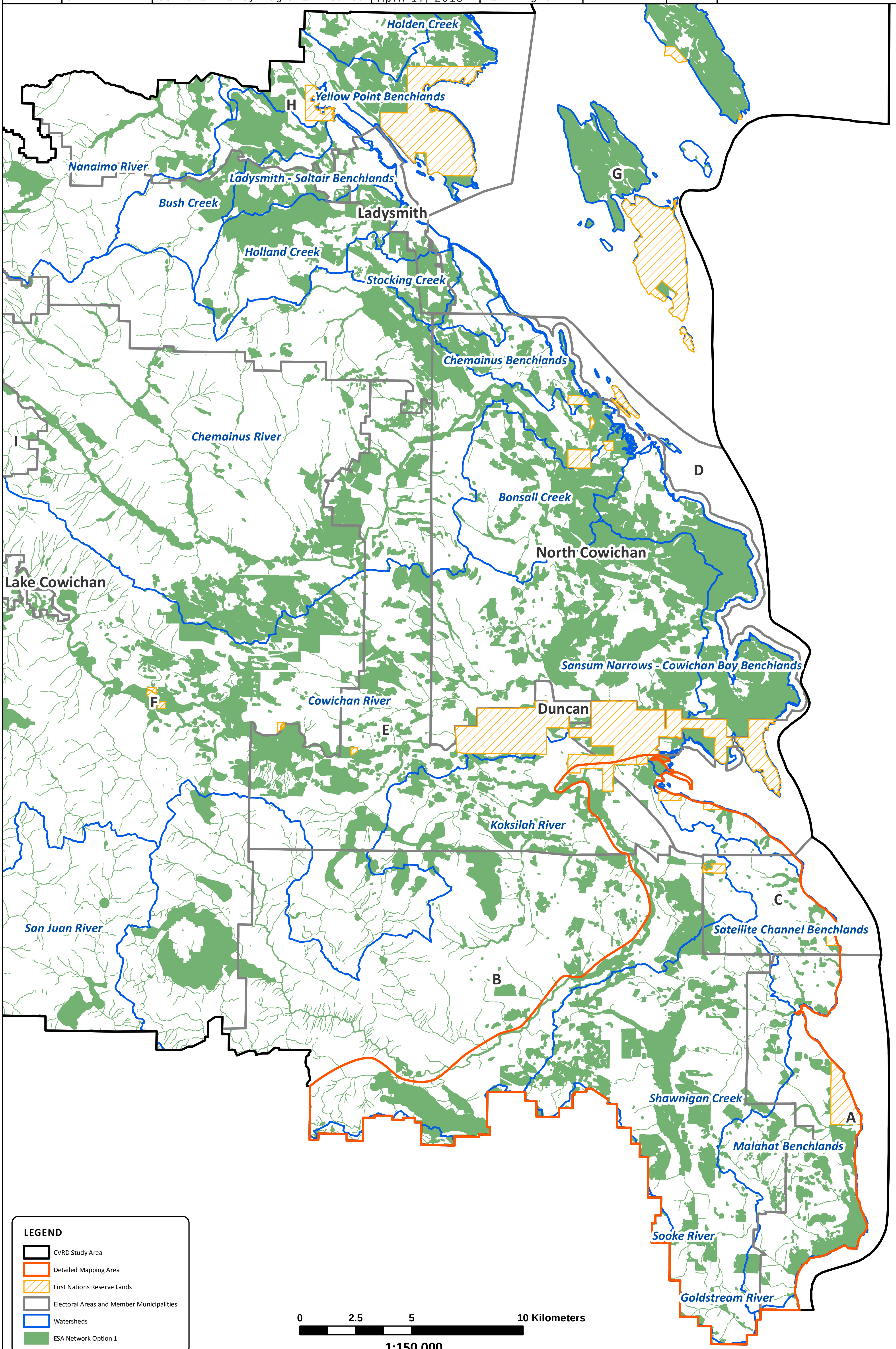
[10] Environmental Farm Plan

[11] ESA and non-ESA combinations occur within some of the ESA features included in the product. Non-ESA features such as young forest account for approximately 6,000 hectares (6%) of the total layer area.

PROJECT: CVRD Environmentally Sensitive Areas Strategy

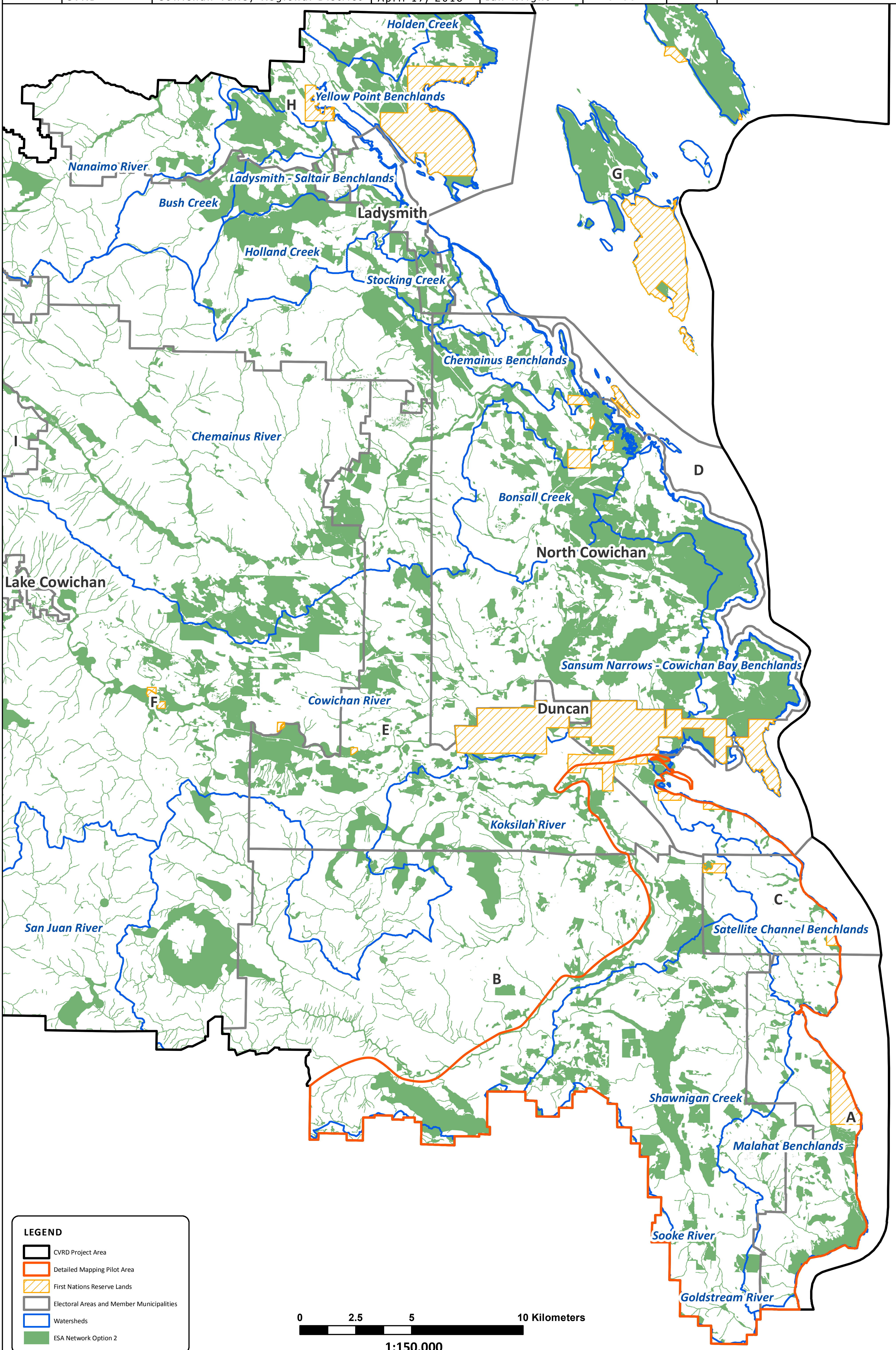
LOCATION: CVRD | CLIENT: Cowichan Valley Regional District | MAP DATE: April 17, 2018 | DRAWN BY: Ian Wright | DOSSIER: 17.0400

FIGURE 19: ESA Network Option 1



MADRONE environmental services ltd.

PROJECT: CVRD Environmentally Sensitive Areas Strategy					**FIGURE 20: ESA Network Option 2**
LOCATION: CVRD	**CLIENT:** Cowichan Valley Regional District	**MAP DATE:** April 17, 2018	**DRAWN BY:** Ian Wright	**DOSSIER:** 17.0400	



5.3 Option 3 – ESA Polygons Only

Without the inclusion of riparian areas in the network, this option will lack connectivity between ESAs in comparison to the first two options. However, it is recognized that bylaws and regulations for protecting riparian areas are already in place, and the CVRD may prefer to deal with riparian areas separately from other ESAs. Network Option 3 covers ~100,000 hectares with no ESA or riparian buffers (Figure 5).

Riparian areas are an important type of ESA that can provide fish habitat as well as natural corridors. Therefore, Network Option 3 would result in limited connectivity amongst CVRD ESA areas.

5.4 Option 4 - Limit to Specific Jurisdictions or Land Uses

This option could be applied to any of the above three options (an adaptation of Option 1, 2 or 3), but would only keep portions of those networks within specified jurisdictions or land use zoning designations. For example, the network could be limited to CVRD electoral areas and only on parcels zoned for residential, commercial or industrial use. This network option could serve as a new environmental development permit area (EDPA) for the CVRD, and could be further limited by removing urban containment areas from the resulting network. An area has not been estimated for this network option as it could vary widely depending on the area selected.

5.5 Additional Considerations

5.5.1 Participatory Mapping

An ESA network could be created through community and stakeholder engagement during participatory mapping sessions. One advantage of this approach is the identification of ESAs that are of particular importance to community members, and that ESAs not yet included in the current ESA inventory may be identified through the sharing of local ecological knowledge. In isolation, this option would likely miss some ESAs. However, this process would be a great compliment to Option 1, or any other options that are pursued.

5.5.2 Identify and Include Recruitment Areas

With the scarcity of ESAs in some areas of the CVRD, recruitment is worth considering. The idea is identify gaps where ESAs are relatively disconnected, and seek opportunities to “recruit” ESAs in those gaps to improve the overall connectivity of the network. An example of this would be including some TEM forest polygons with a structural stage of 5 (young forest), with the intention of allowing these to grow into mature forest.

6 Discussion and Recommendations

The ESA mapping produced through this inventory “CVRD ESA 2018 Inventory” should be viewed as a dynamic product on two fronts:

1) update as new data becomes available, and as new analyses are done, and

2) refine through detailed mapping and field verification to increase reliability and “public trust” in the product.

The CVRD ESA 2018 Inventory is based on existing mapping available at this time (refer to Table 3 of ESA building blocks). The resulting dataset does not represent an exhaustive region-wide inventory. Results of the ESA representation analyses do not account for all ESAs in the CVRD. There are significant data gaps, notably on private lands. As well, the ESA inventory excludes ESAs mapped on First Nations lands, and riparian zones (stream networks).

As new or updated ESA-related data becomes available, it should be used to update the 2018 CVRD ESA dataset. For example, future VRI mapping is expected to provide complete coverage of the CVRD. This will facilitate the incorporation of mapped mature and old forest region-wide, serving to fill the considerable data gap on private lands. As well, the riparian areas network could be added to the ESA layer as per existing TRIM data until replaced with higher quality stream mapping.

6.1 Detailed Mapping

When integrating numerous spatial datasets that overlap in many areas, which were produced for different purposes using different base data and imagery at different scales, the output cannot be considered a final map product until it has been verified and cleaned up through detailed mapping. Overlapping polygons from the various input datasets resulted in over-complicated linework after the data integration, and some of the polygon lines were more spatially accurate than others. To clean this up and preserve the most accurate linework, a mapper must review, merge and delete polygons as appropriate. This process also applies to updating linework to reflect recent disturbances. Examples of improvements to the linework are demonstrated and described in the detailed mapping Section 4.

The post-crosswalk sensitive ecosystem attributes were not completely error-free immediately after the existing ESA data was integrated, and should be subject to mapper verification. For the most part, the sensitive ecosystem attributes for polygons in the detailed mapping area were found to be accurate, or only required minor refinements. Some attribute inaccuracies had resulted where the cross-walked mapcodes were best-fit but not perfect equivalents, as well as where the input data was out of date and the sensitive ecosystems have since been lost to disturbances.

For these reasons, detailed mapping updates should be applied to other areas in the CVRD. Priority could be assigned to management units (such as watersheds and benchlands) based on development pressures. Detailed review of the ESA map layer is particularly important if the CVRD plans to use the ESA mapping to delineate new development permit areas (DPAs). For a DPA approach to be successful, there must be public and stakeholder buy-in and trust in the quality of the product. Although it is challenging to convince everyone that the ESA map layer is of high quality and accurate in the linework delineation, steps can be taken and documented to indicate where the product is most reliable. Transparent communications regarding the limitations of the map product are essential.

6.2 Disturbance Mapping and ESA Monitoring

Recent disturbances have yet to be taken into account in the 2018 CVRD ESA inventory, apart from those that were associated with the existing ESA polygons in the detailed mapping area. To aid in future detailed mapping updates for priority areas, we recommend mapping disturbances that occurred within a set time frame, such as between 2004 and 2014 (ten years previous to the most recent orthophotos available). Standard disturbance codes are established by BCMOF and BCMELP (1998), and the most likely disturbance codes of relevance in the CVRD are provided in Table 4.

Table 4. Most likely relevant disturbance codes (see Field Manual for Describing Terrestrial Ecosystems for additional codes)

Code	Description
Hbad	buildings or structures (adjacent)
Hbw	buildings or structures (within)
Hmv	modified vegetation (e.g. agriculture, playing fields, etc.)
Hrad	roads (adjacent)
Hrw	roads (within)
Htw	trails (within polygon)
Huad	utility right-of-way (adjacent)
Huw	utility right-of-way (within)
Ll	land clearing (including logging)
Ls	selective logging

With a map product of recent disturbances, the CVRD will have an additional tool to quantify recent development and the loss of sensitive ecosystems. Visually scanning the entire study area for disturbances is very time consuming and the likelihood of missing disturbances less than one hectare in size is relatively high. Therefore, to make the process of identifying disturbances more efficient, we recommend classifying land cover within the study area using multispectral satellite imagery from 2004 and 2014 and comparing the land cover results using raster analysis tools. The result of this method is a disturbance model that provides direction to mappers on where to focus their assessment efforts (i.e., where disturbances are most likely), allowing them to quickly skim over areas where the model does not predict disturbances. Madrone applied this approach to sensitive ecosystem mapping updates for the Islands Trust (Williams and Wright, 2017). In addition to efficiently detecting relatively small disturbances, another advantage of this approach is the prediction of disturbance type (deforestation, new buildings and roads, wetland loss, etc.). Ideally, disturbance mapping classifies the disturbance type so that the primary contributors to ESA loss can be determined.

After an up-to-date ESA dataset has been produced and major data gaps have been addressed, we recommend repeating disturbance mapping on a regular basis to monitor gains and losses of ESAs over time. Ideally, disturbance mapping would be completed on an annual basis to consistently track changes and help prioritize conservation efforts on an ongoing basis. Another approach could be to update the mapping concurrently with development permit approvals that define some loss in ESAs on particular parcels.

6.3 Predictive ESA Modeling

Predictive ecosystem modeling and interpretation of imagery could be conducted to fill in the gaps for many ESA types. These techniques range from relatively simple to complex. Predictive ESA modeling is beneficial for identifying smaller ESAs, as well as being able to cover large areas and minimizing manual mapping time (visual interpretation of aerial imagery). Two options for identified for predictive modeling of ESAs are summarized as follows:

- Land cover classification using multispectral satellite imagery to identify mature and old forest cover. Landsat and Sentinel satellite imagery is limited in spatial resolution (15-30m wide pixels); however, this process can be further refined by performing an object-based image analysis (OBIA) on high quality orthophotos. OBIA produces polygons based on objects identified in the imagery, clearly outlining buildings, roads, shorelines and forest edges[12]. The OBIA results can be merged with multispectral land cover classification to produce a more spatially accurate representation of the extent of mature forest, as well as other features such as disturbances.
- Predictive modeling of surface hydrology for areas with detailed elevation data (digital elevation models) can be used to identify potential locations of streams and wetlands that have yet to be mapped. Ideally, to produce a reasonably accurate stream model, the digital elevation models should provide full watershed coverage.

Obvious data gaps aside, there are likely ESAs on the ground that aren't currently represented by the existing ESA mapping. Particularly, smaller ESAs are often not captured by traditional ecosystem mapping methods, especially when aerial imagery is interpreted at a scale of 1:20,000. Some of these smaller ESAs have been identified through the SEF mapping (1:5,000) and the updates in the detailed mapping area (1:5,000). Predictive ESA modeling can identify potential ESAs that have yet to be mapped.

6.4 Reliability of the Mapping

Field verification is an important aspect of ecosystem mapping projects, and although much of the input data was supported with field verification at the time it was produced, up-to-date field work is warranted. We recommend that field verification is completed for priority areas to ensure the accuracy of the ESA map product where accuracy is deemed most important (such as the development of a new DPA). Typically a subset of the mapped ESAs would be selected

[12] Example of output from object based image analysis

for field visitation based on the type of ESA, land tenure, access, status (disturbed or undisturbed) and distance from other ESAs.

Once on site, ecosystems would be described following (MOF, MOE, 1998), as well as Green and Klinka (1994). Wetlands would be described according to MacKenzie and Moran (2004), and plant names would follow Pojar and McKinnon (2005). In a typical ecosystem mapping project, field verification would aim to sample 15% of the map polygons. To put this into perspective, assuming an average size of 15 ha for a mapped ecosystem polygon, about 335 ESA polygons would be created in a mapped area of 5,000 ha. Therefore 50 ESA polygons would be field verified to achieve 15% polygon visitation. Verification of 15% of the polygons is associated with the lowest end of sampling required for survey intensity level (SIL) 4, which ranges between 15-25% (RISC, 1998). The following paragraph regarding survey intensity and scale is adapted from the TEM standards (RISC, 1998).

The survey intensity used in the preparation of an ecosystem map should be determined by project objectives and the proposed us of the map. If the map is to be used for making specific management decisions about portions of land (e.g., building footprints, sub-divisions, site preparation, conservation, etc.), then the map needs to be very reliable. Increased reliability is usually achieved through a higher survey intensity and selection of a finer map scale (e.g., 1:5,000 instead of the broader 1:20,000 scale). However, both of these factors increase the cost of the mapping project. If the map is to be used only for general land planning, then a lower survey intensity is appropriate and mapping can be done at a broader scale.

A low survey intensity (e.g., 0-4% is the lowest level and is referred to in the standards as “R” for reconnaissance or preliminary mapping) does not necessarily mean that a map will be less reliable, although this is generally the case. Other factors influencing reliability are ecosystem complexity, relationship of ecological variation to readily identifiable aerial photo attributes, and surveyor knowledge and experience (RISC, 1998).

For a region-wide ESA strategy, a detailed review and assessment of the mapping by a qualified ecologist/mapper should provide a moderate to high level of reliability in the delineation and description of the ESA features. We recommend a minimum viewing scale of 1:5,000 for the mapping in order to provide a moderate to high level of confidence in the delineation and therefore location of the features. The following table provides generic examples of digital image viewing scales and associated confidence in the location of the delineated linework[13].

The detailed mapping of the pilot area used 0.5 m resolution 2014 imagery that was viewed at 1:5,000. For the majority of ESAs in the detailed map area, we can imply an accuracy of +/- 5 m to either side of the line that delineates the ESA features. However, the level of confidence will also depend on the type of ESA. For example, it is easier to see and therefore delineate a line along a pond or lake edge compared to the gradual change between a shrubby wetland and swamp. Part of the logic behind application of buffers to ESAs is to account for uncertainty in delineation of the features.

[13] https://www.esri.com/arcgis-blog/products/product/imagery/on-map-scale-and-raster-resolution/

Table 5. Image viewing scale and associated confidence in linework location

Image Viewing Scale	Location of linework (in meters)	Confidence in the location of the linework that delineates the ESA
1:1,000	+/- 1	High
1:5,000	+/- 5	Moderate to High
1:10,000	+/- 10	Moderate
1:20,000	+/- 20	Low to Moderate

6.5 ESA Polygon Verification Tracking

To provide an indication of the level of reliability (confidence) that we have in the mapping, it would be beneficial to track the level of verification applied to each ESA polygon. A field could be populated with information that indicates whether it was verified through visual interpretation of aerial imagery (detailed mapping method), or by assessment in the field. This will provide users of the ESA map product (such as planners) with a means to gauge relative confidence in accuracy of the ESA polygon linework and attributes.

Five levels of ESA polygon verification are identified below that could be assigned to each identified ESA feature:

1. **Unknown (U)** – at the lowest level of reliability, a "U" can be assigned to indicate that the level of reliability is unknown. This does not mean that the polygon linework and label couldn't still be quite accurate. It just means that no recent (within the last 5 years) verification has taken place to verify current condition and accuracy of the linework.

2. **Imagery Inspection via Desktop (I)** – using the most recent or best available imagery for the feature of interest as a tool to verify label class and subclass. These polygons would be assigned "I" in the verification column (SMPL_TYPE) to indicate that a desktop review of imagery was used for verification; and would include a source column to specify imagery used. In many cases the imagery can provide a more accurate delineation of the feature, but miss out on the detailed plant assemblages. We recommend that the desktop review of imagery be conducted at a fine scale of 1:5,000 or larger (1:1,000 to 1:5,000) to increase confidence in interpretation of the imagery. The quality of available imagery will dictate what scale one can "zoom" into and still maintain an equivalent level of detail.

   [Note: ESA polygons in the detailed mapping pilot area can all be assigned "I" at this time. A qualified ecosystem mapper has checked each of the 1,641 polygons.**]**

3. **Field Inspection - Visual Check (FV)** – visiting a polygon in the field, but not always being able to physically access it. If access is possible for a portion of the polygon, record dominant plant species and site notes. If access is not possible, essentially looking from a nearby location (i.e. road, path) and verifying the ESA label with minimal inspection

(Unique plot ID assigned to field card, edits made to database if required; “FV” assigned to type of verification with initials of mapper that made final edit, check, label, etc.).

4. **Field Inspection - Detailed (FD)** – visiting a polygon in the field (with physical access) to be able to ground-truth and verify SEI label while walking around a portion of the site. Record dominant and co-dominant plant species with total percent covers. Provide sketch of site and breakdown of multiple SEI classes/subclasses.

5. **Surveyed (S) -** At the highest level of accuracy, a qualified ecologist can walk the boundary of the ESA polygon either accompanied by a land surveyor, or with a technician trained in the use of survey grade GPS units with sub-metre accuracy (+/- 0.5m). This approach has been applied for the purpose of ESA delineation associated with a given development permit or covenant.

Polygons that were field verified in the creation of the existing input datasets (e.g. SEI, TEM, etc.) should be identified as such in the ESA data, using a verification tracking field. Compilation of field verification plot data was not within the scope of the ESA inventory undertaken by Madrone. Recovery of plot data would be of greatest value for recent map products such as SEF (conducted in 2016). Use of older plot data (collected prior to 2010) could still provide an increased confidence in ESA labels (because they were confirmed on-site), but the linework may be out-of-date for the verified polygon. This would be most applicable to urban and rural areas where development is most likely to have taken place within or adjacent to a previously identified ESA.

6.6 Inclusion of Stream Networks

The 2018 CVRD ESA inventory product only contains a partial representation (coverage) of riparian features; where they were captured in existing map products. It is our opinion that all riparian features be included in the ESA coverage within a specific timeframe. In the meantime, we advise inclusion of the same stream mapping used by planners for addressing RAR. Each of these features could have be designated as “U” for low level of reliability until replaced with an “F” or “S” indicating a high level of reliability (e.g. following stream mapping with GPS Trimble units or equivalent with sub-meter accuracy). These steps have been and are being undertaken by many local governments in order to reduce the unknown and “surprise” factor associated with TRIM.

We recommend public engagement in the process proposed for conducting highly accurate, reliable riparian mapping. It will be important to demonstrate the benefit of dedicating resources to this task.

The key benefits to completing stream mapping to a verification level of “F” or “S” include:

1. High level of confidence in the riparian map layer (reduces the potential cost to land owners; while also reducing the likelihood of stream and riparian zone damage); and
2. It can be combined with Stream Classification to determine likelihood of fish presence (again, this reduces the guess-work and costly surveys being carried by landowners; while also protecting our valued fisheries resource).

6.7 Summary of Recommendations

Recommendations were provided on the methods for identifying potential ESAs, and an inventory of ESAs throughout the CVRD was completed using available data. The resulting ESA mapping was updated in a priority pilot area manually with detailed mapping. Recommendations that resulted from this project include:

1. Integrate new ESA-related data as it becomes available (e.g. updated VRI mapping).
2. Apply the detailed mapping process to other priority areas, especially if the intended use of the mapped ESAs is to create a new development permit area.
3. Conduct disturbance mapping in priority areas, and regularly update the ESA map to track disturbances over time.
4. Consider predictive ESA modeling as a means to identify ESAs that aren't already represented by the ESA data. This could help to fill in data gaps, and to identify smaller ESAs that may be missed through traditional aerial photo interpretation.
5. Field verification should be completed to assess the accuracy of the ESA mapping.
6. Track desktop and field verification efforts in the dataset to assign relative measure of confidence in the accuracy of the ESA data.

7 Literature Cited

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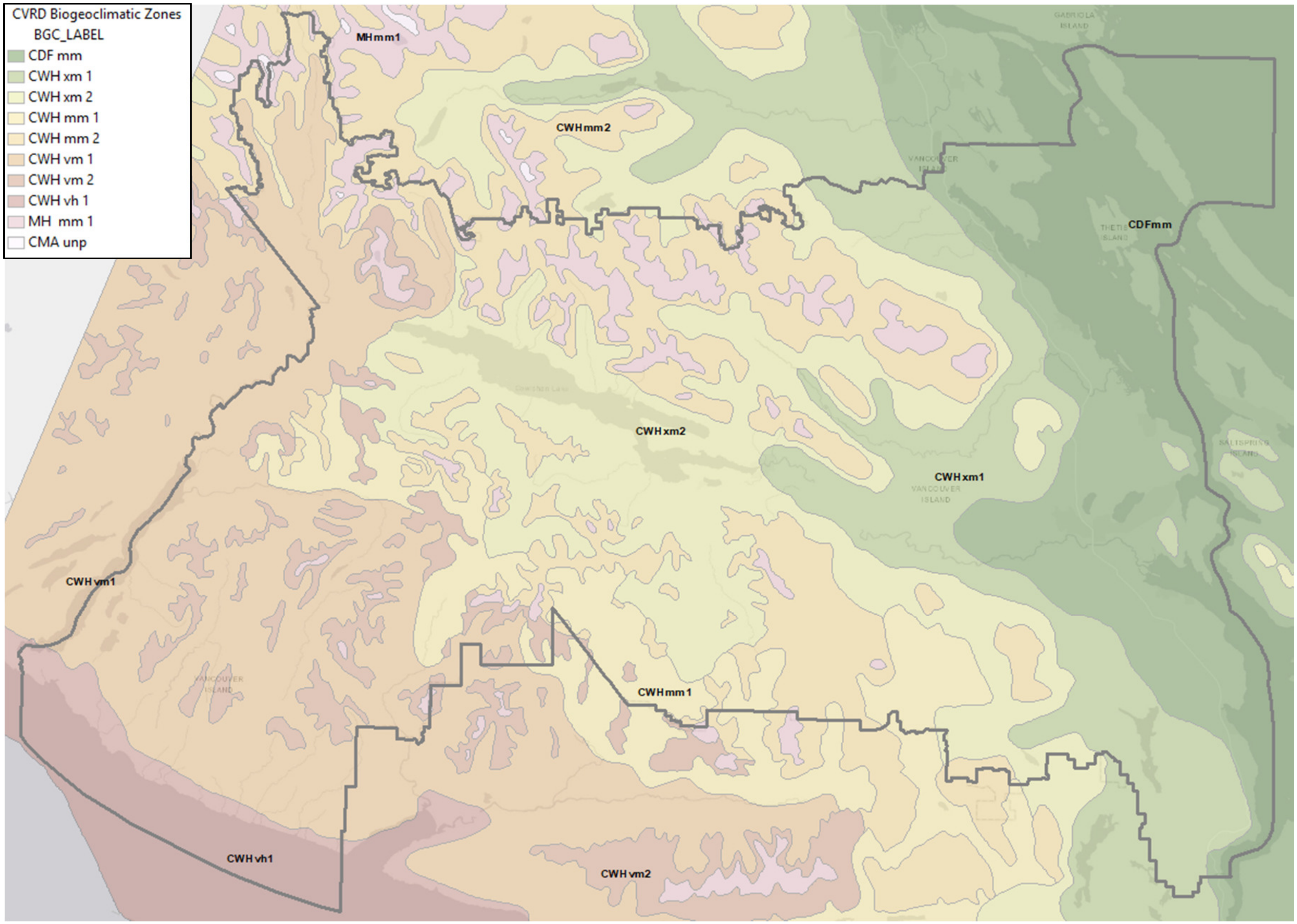
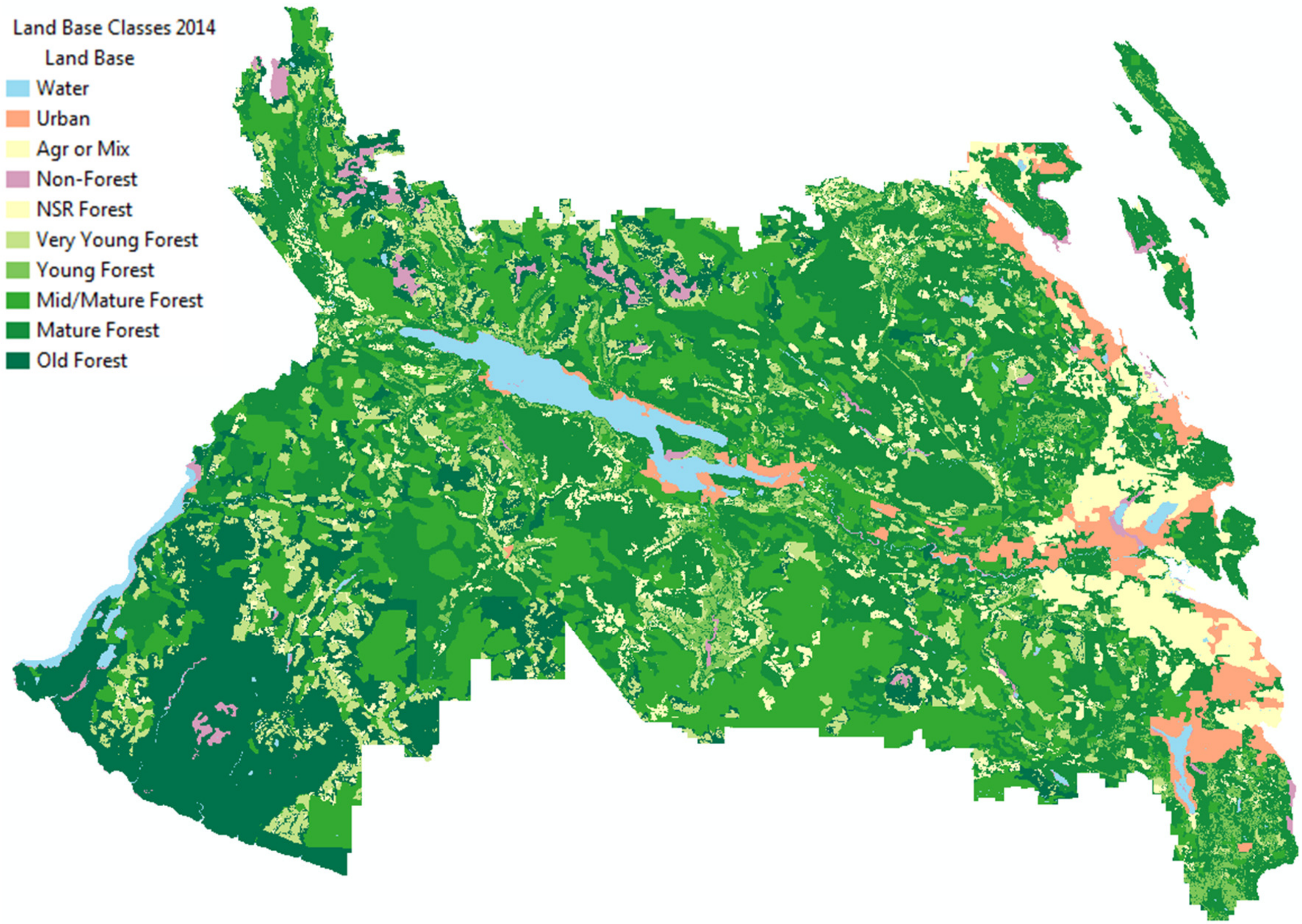
Appendix A: Building Blocks and ESA Inventory Reference Layers

Biogeoclimatic Zones



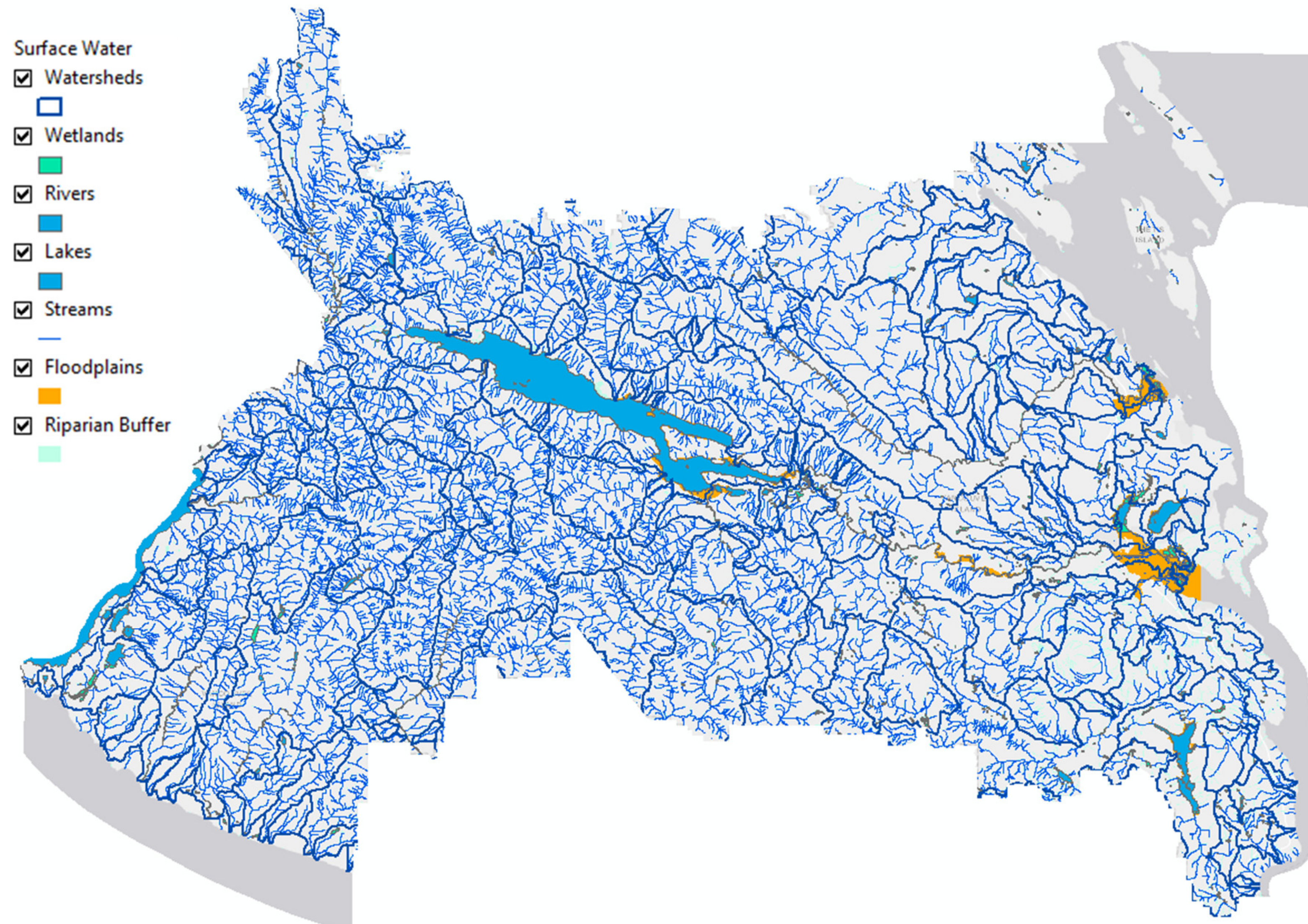
Orthophotos

Land Cover (2014)

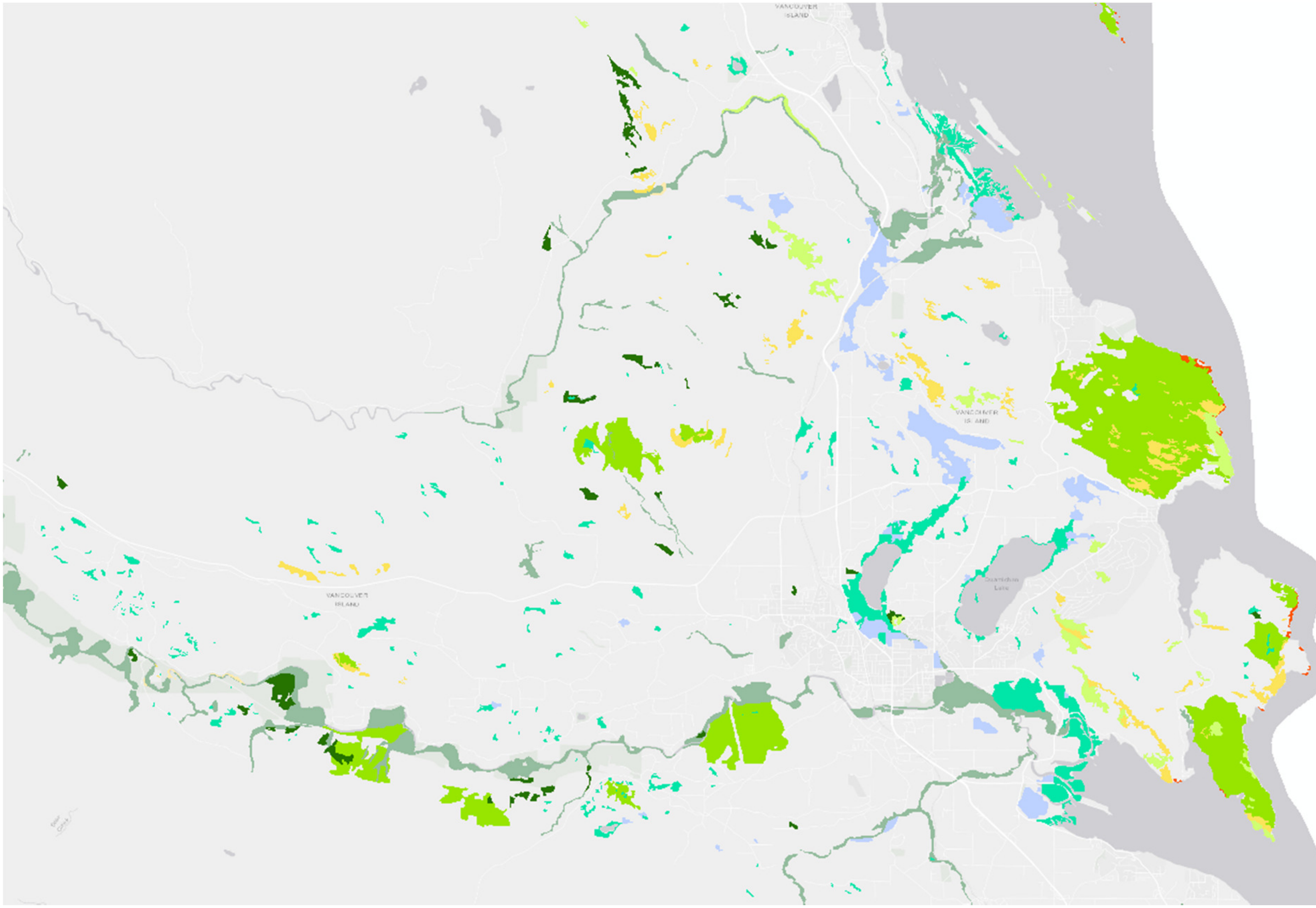


Full Coverage!

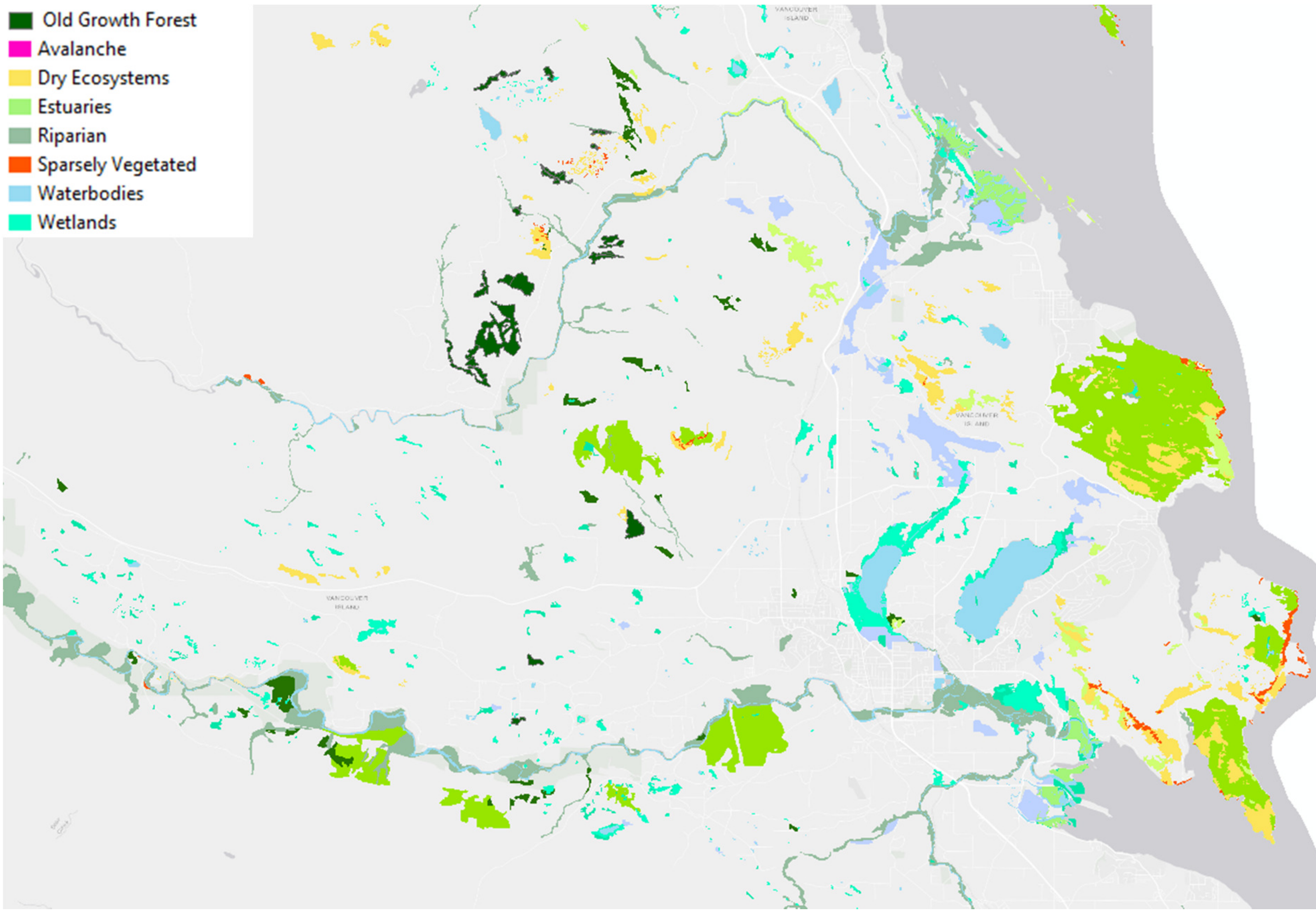
Water Features



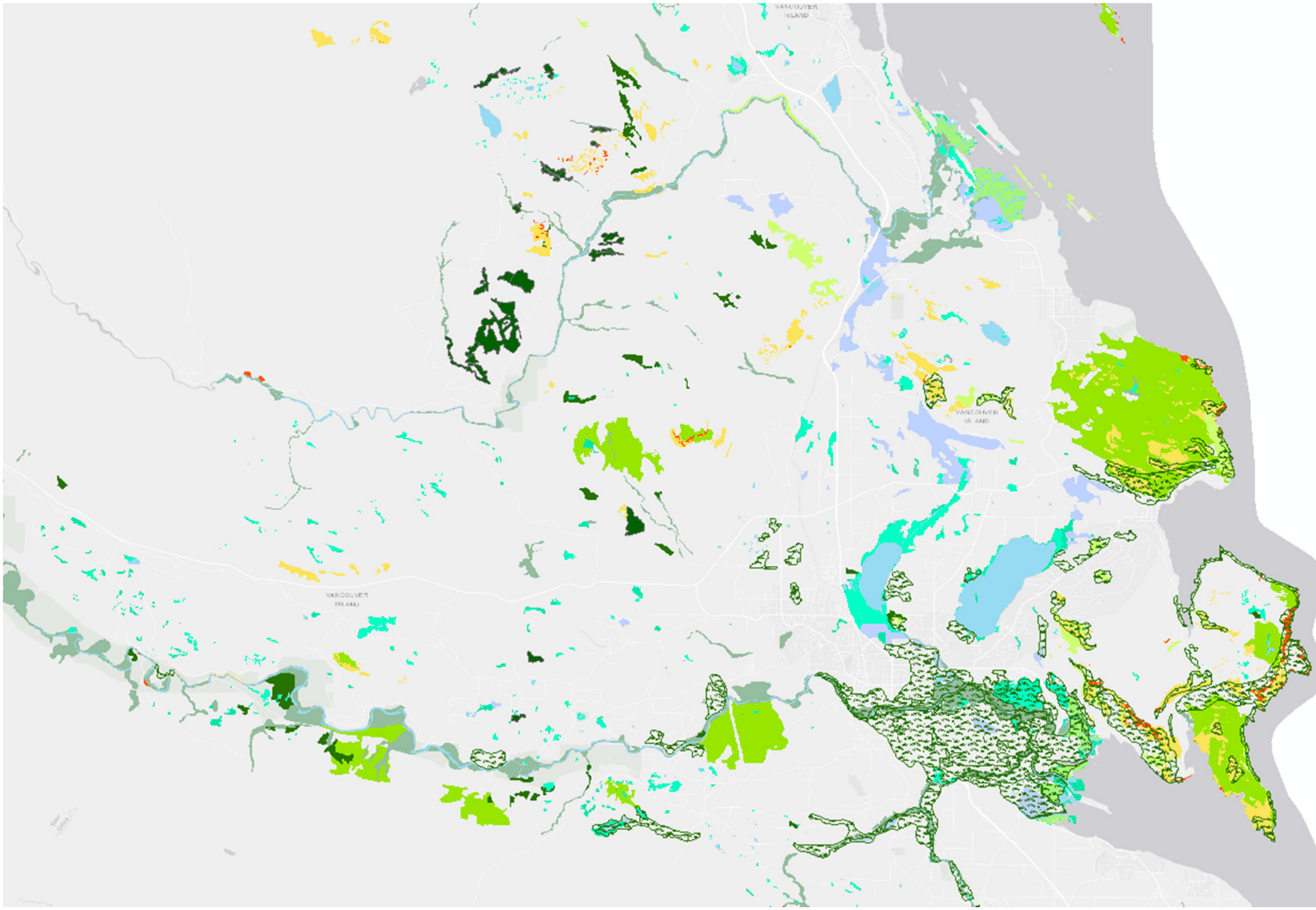
Sensitive Ecosystems Inventory (SEI, 1998/2004)



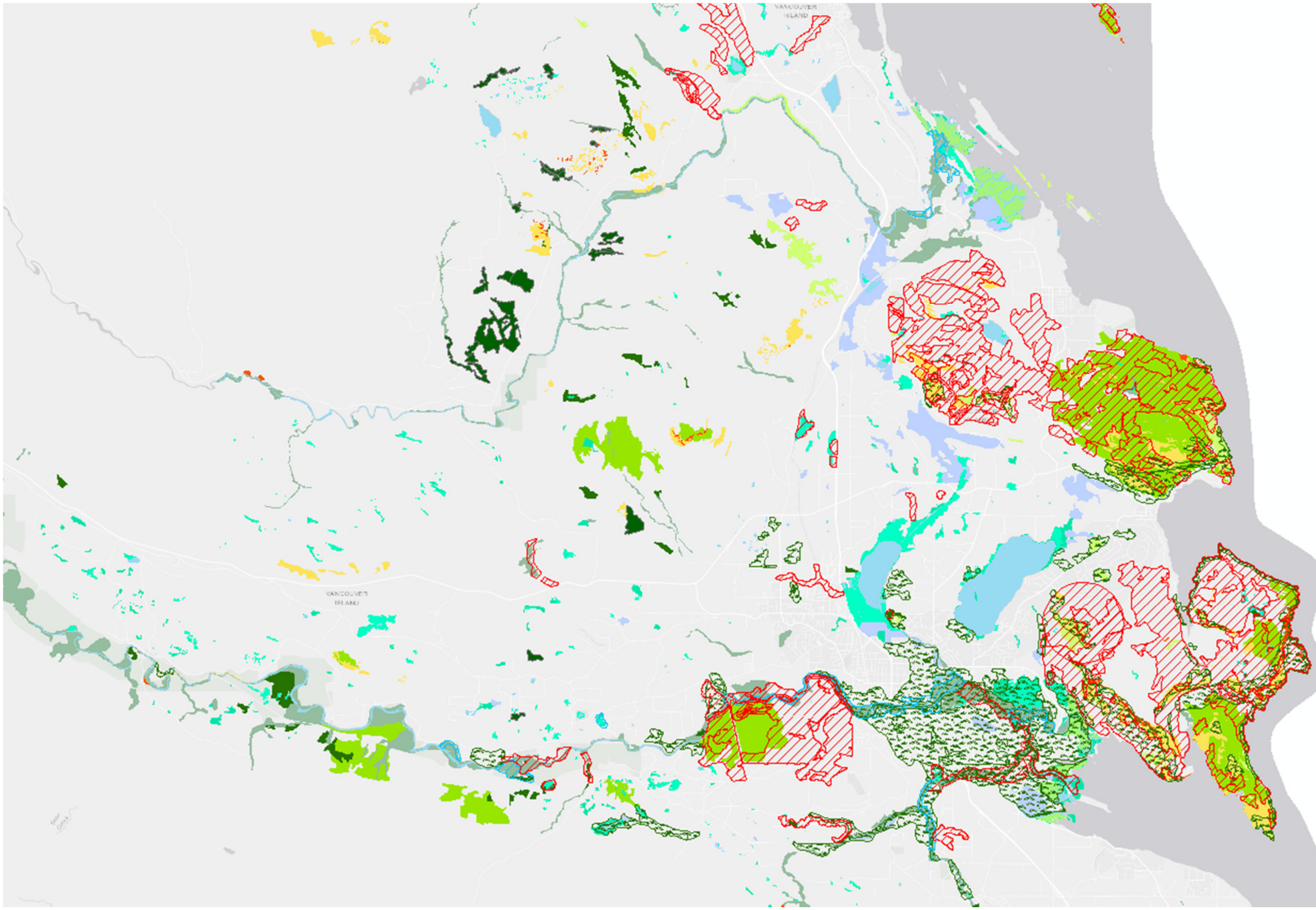
SEI & Special Ecological Features (IEG, 2016)



SEI & SEF & Garry Oak Range (2006)

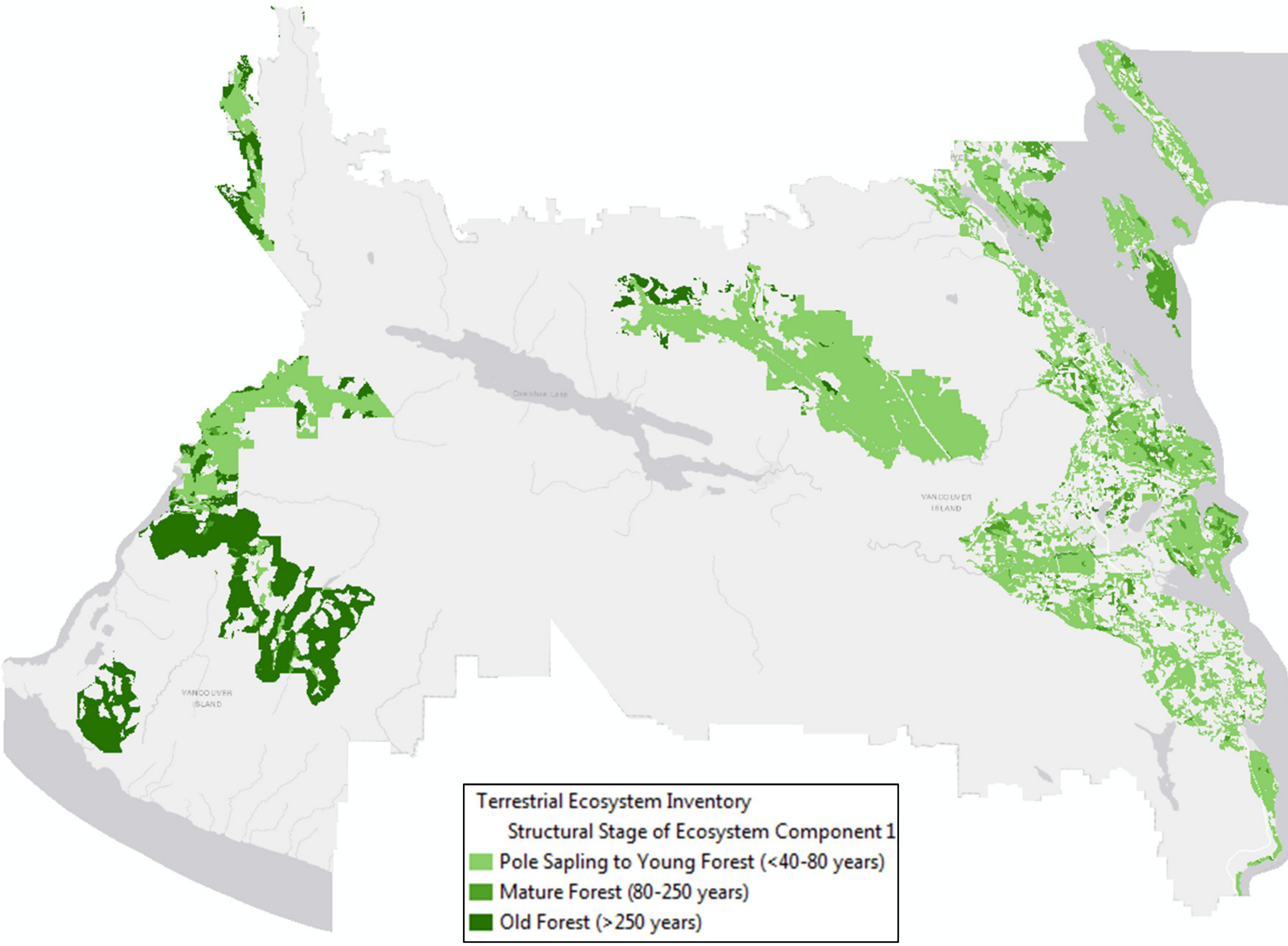


SEI & SEF & GO & Red and Blue-Listed Ecosystems

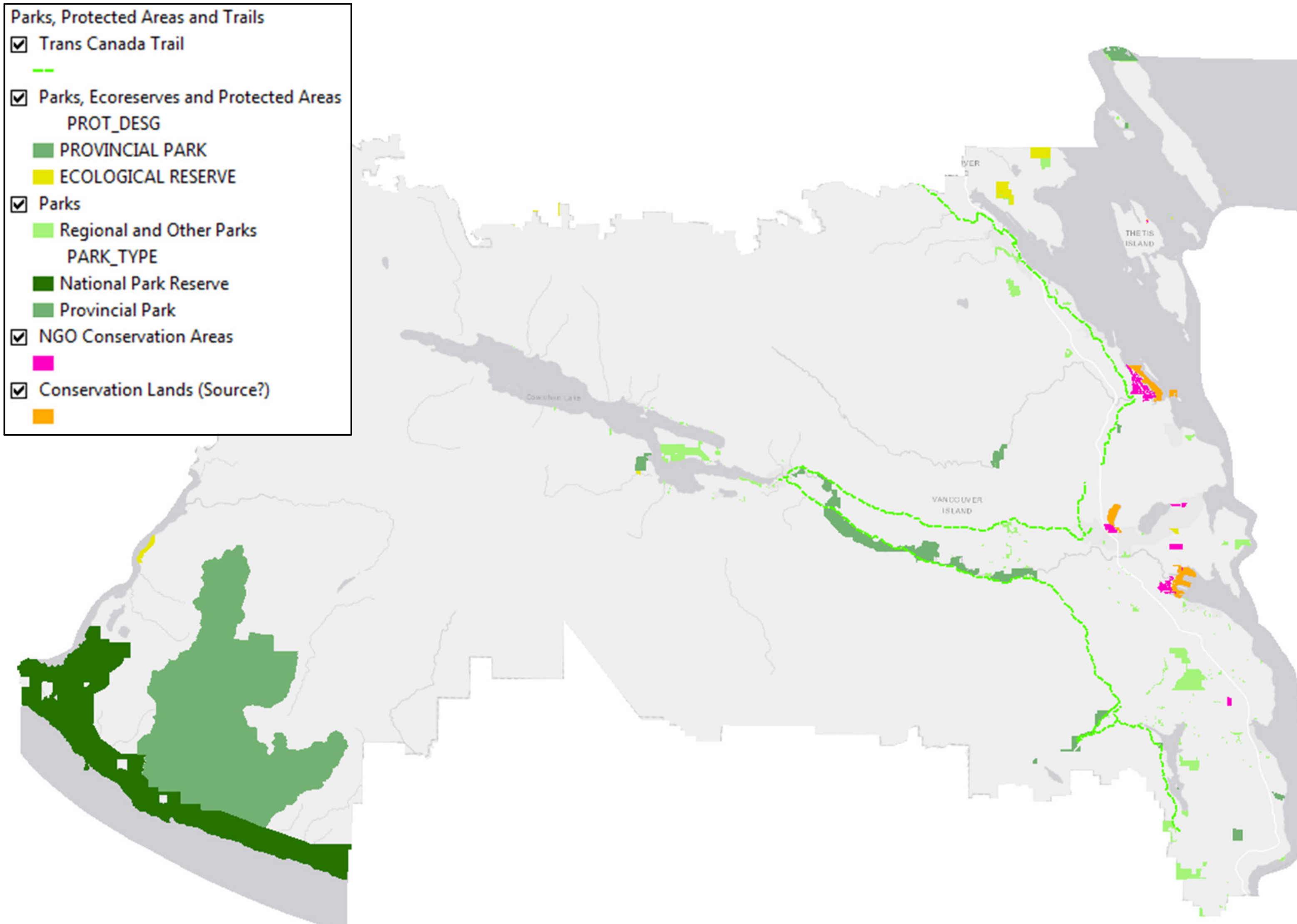


All of these areas are east of Cowichan Lake and primarily in the CDFmm BEC Zone

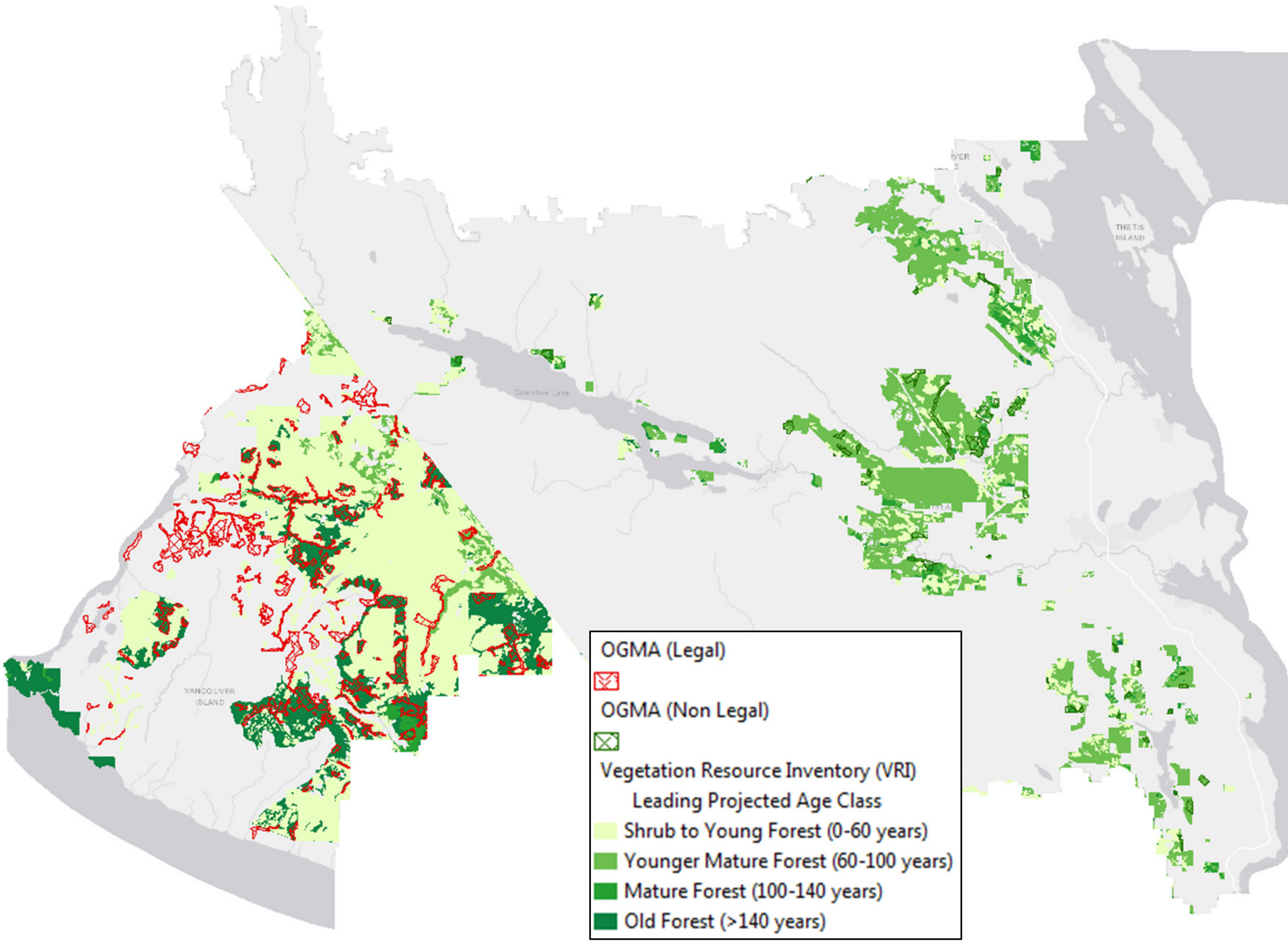
Terrestrial Ecosystem Mapping (TEM)



Parks and Protected Areas



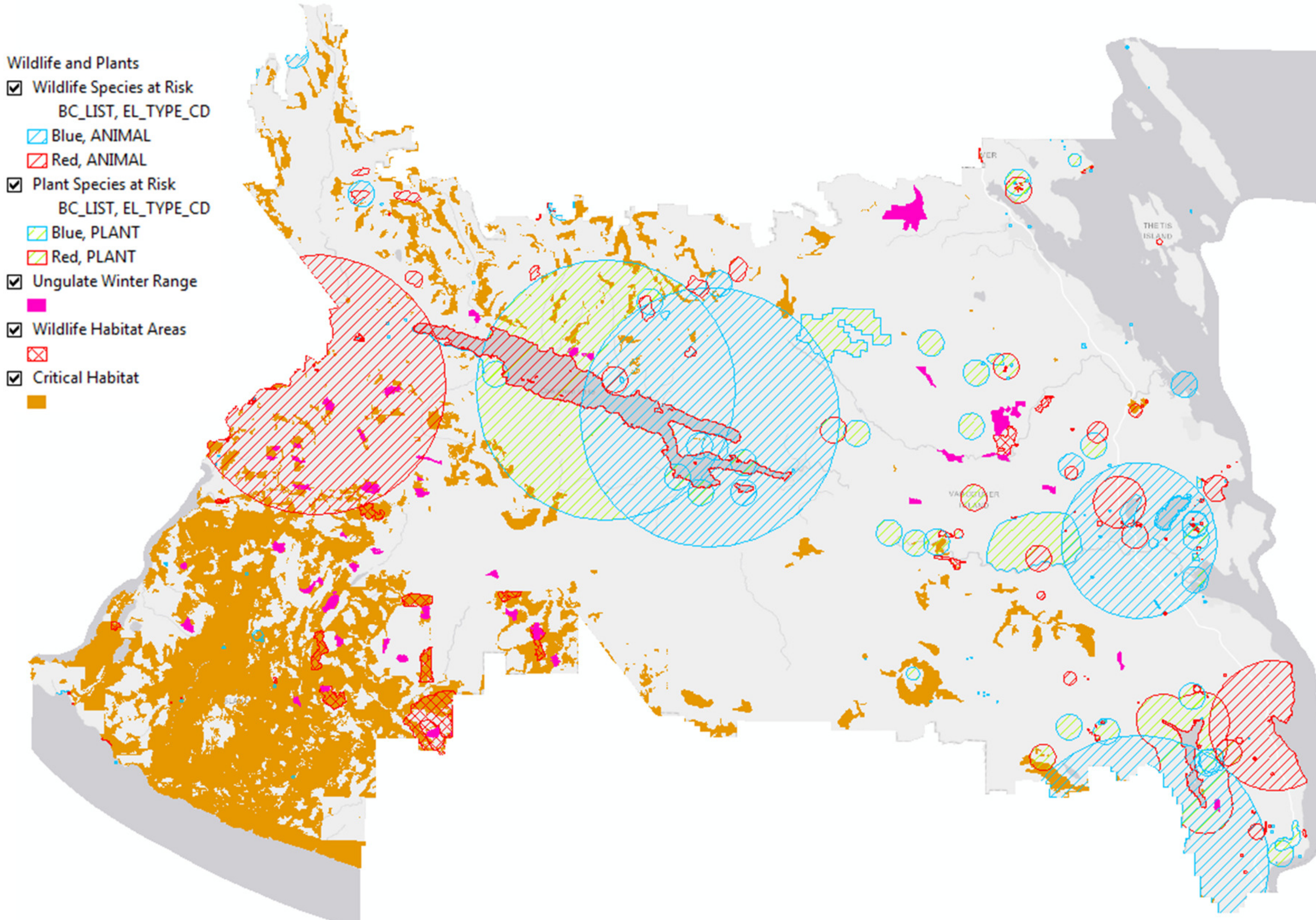
Vegetation Resources Inventory (VRI) & Old Growth Management Areas (OGMAs)



VRI update with full coverage is expected in 2018!

Wildlife and Plant Species of Importance

Species at Risk, Wildlife Habitat Areas, Critical Habitat & Ungulate Winter Range



Appendix B: SEI Map Codes from the Standards for Mapping Ecosystems at Risk (2006)

Appendix D: SEI Map Codes, Map Units and Descriptions

Below is a table of approved Sensitive and Other Important Ecosystems map codes and descriptions. Units that are no longer mapped (historical use) are shown in *italics*. Projects named 'Central & North Okanagan' refers to the Central Okanagan, Bella Vista – Goose Lake Range, Lake Country, and Vernon Commonage SEIs. New classes, subclasses and their accompanying codes must be approved by the CDC ecologist.

Class Code	Subclass Code	Sensitive Ecosystem (SE) / Other Important Ecosystem (OIE) / Non-Sensitive (NS)	Class:subclass name	Description	Project	Coastal / Interior / Either
AP	hb	SE	Alpine:herbaceous	Alpine ecosystems dominated by forbs or graminoid vegetation.	South Okanagan	Either
AP	kr	SE	Alpine:krummholz	Alpine ecosystems dominated by krummholz trees.	n/a	Either
AP	pf	SE	Alpine:parkland forest	Ecosystems at the transition between alpine and subalpine where trees occur in distinct clumps.	South Okanagan	Either
AP	sh	SE	Alpine:shrub	Alpine ecosystems dominated by dwarf shrubs.	South Okanagan	Either
AS		SE	Antelope-brush Steppe	Shrub ecosystems dominated by antelope-brush	South Okanagan	Interior
AS	as	SE	Antelope-brush Steppe	Shrub ecosystems dominated by antelope-brush in fair to good condition.	South Okanagan	Interior
AS	ds	SE	Antelope-brush Steppe: disturbed	Shrub ecosystems dominated by antelope-brush in poor condition	South Okanagan	Interior
BW		SE	Broadleaf Woodland	Ecosystems dominated by deciduous species at climax	Central Okanagan	Interior
BW	ac	SE	Broadleaf Woodland:aspen copse	Permanent aspen ecosystems in moist depressions in grasslands	Central Okanagan	Interior
BW	as	SE	Broadleaf Woodland:aspen seepage	Permanent aspen ecosystems on seepage slopes, usually in forested areas	Central Okanagan	Interior
CB		*SE*	*Coastal Bluff*	*Vegetated rocky islets and shorelines. Historical use only, now mapped as HB:cs or HB:vs.*	*Vancouver Island*	*Coastal*
CB	*cl*	*SE*	*Coastal Bluff:cliff*	*Vegetated coastal cliffs and bluffs. Historical use only, now mapped as CL:cc*	*Vancouver Island*	*Coastal*
CL		SE	Cliff	Steep slopes, often with exposed bedrock.	Sunshine Coast	Coastal
CL	cc	SE	Cliff:coastal	coastal cliffs	Sunshine Coast	Coastal
CL	ic	SE	Cliff:inland	inland cliffs	Sunshine Coast	Coastal

Class Code	Subclass Code	Sensitive Ecosystem (SE) / Other Important Ecosystem (OIE) / Non-Sensitive (NS)	Class:subclass name	Description	Project	Coastal / Interior / Either
DG		*OIE*	*Disturbed Grasslands*	*Grasslands with 20-60% noxious weeds or invasive alien plants. This unit was used only in the Central and North Okanagan. Historical use only, now mapped as Gr:dg.*	*Central Okanagan*	*Interior*
FS		OIE	Seasonally Flooded Agricultural Fields	Annually flooded cultivated fields or hay fields	Sunshine Coast/ Vancouver Island/ South Okanagan	Either
FW		SE	Freshwater	Freshwater ecosystems include bodies of water such as lakes and ponds that usually lack floating vegetation	Islands Trust	Either
FW	la	SE	Freshwater: lake	Naturally occurring, static body of open water greater than 2 m deep and generally greater than 50 ha, with little to no floating vegetation.	Islands Trust	Either
FW	Pd	SE	Freshwater: pond	Small body of open water, greater than 2 m deep and generally less than 50 ha, with little to no floating vegetation.	Islands Trust	Either
GR		SE	Grasslands	Ecosystems dominated by bunchgrasses and shrubland ecosystems that occur in a grassland matrix	Central & North Okanagan / South Okanagan	Interior
GR	dg	SE	Grasslands:disturbed	Greater than 60% of plant cover is comprised of invasive alien species; **overrides all other grassland subclasses where it occurs**.	South Okanagan	Interior
GR	ge	SE	Grasslands:gentle slope	Mixed grass/forb grassland ecosystems on slopes <25%. Optional subclass for use where it helps meet project objectives.	South Okanagan	Interior
GR	gr	SE	Grasslands:grasslands	Ecosystems dominated by bunchgrasses; less than 10% tree cover	Central & North Okanagan/ South Okanagan	Interior
GR	sh	SE	Grasslands:shrublands	Moist ecosystems dominated by shrubs (usually rose and snowberry); occur in a grassland matrix	Central & North Okanagan	Interior
GR	ss	SE	Grasslands:steep slope, shallow soils	Mixed grass/forb grassland ecosystems on slopes >25%; shallow soils. Optional subclass for use where it helps meet project objectives.	South Okanagan	Interior
GR	st	SE	Grasslands:steep slope, deep soils	Mixed grass/forb grassland ecosystems on slopes >25%; deep soils. Optional subclass for use where it helps meet project objectives.	South Okanagan	Interior
HB		SE	Herbaceous	Non-forested ecosystems with less than 10% tree cover. Most have shallow soils and bedrock outcrops.	Sunshine Coast	Coastal
HB	cs	SE	Herbaceous:coastal	Influenced by proximity to the ocean: > 20% vegetation cover of grasses, herbs, mosses and lichens.	Sunshine Coast	Coastal

Class Code	Subclass Code	Sensitive Ecosystem (SE) / Other Important Ecosystem (OIE) / Non-Sensitive (NS)	Class:subclass name	Description	Project	Coastal / Interior / Either
HB	du	SE	Herbaceous:dune	Ridge, hill or beach area created by windblown sand; variable vegetation cover	Sunshine Coast	Coastal
HB	hb	SE	Herbaceous:herbaceous	Inland sites dominated by herbaceous vegetation; shrubs account for less than 20% of the vegetation: >10% tree cover, generally shallow soils.	Sunshine Coast	Coastal
HB	sh	SE	Herbaceous:shrub	Shrubs account for more than 20% of the vegetation, with grasses and herbs.	Sunshine Coast	Coastal
HB	sp	SE	Herbaceous:spit	Sand and gravel deposits with low to moderate cover of salt-tolerant grasses and herbs	Sunshine Coast	Coastal
HB	vs	SE	Herbaceous:vegetated shoreline	Low-lying rocky shorelines with less than 20% vegetation	Sunshine Coast	Coastal
HT		*SE*	*Terrestrial Herbaceous*	*Sites with continuous herbaceous dominated vegetation cover. Historical unit, now mapped as HB:hb.*	*Vancouver Island*	*Coastal*
HT	*ro*	*SE*	*Terrestrial Herbaceous:rock outcrop*	*Sites with rock outcrops. Historical unit, now mapped as Sv:ro*	*Vancouver Island*	*Coastal*
HT	*sh*	*SE*	*Terrestrial Herbaceous:shrub*	*Sites with more than 20% shrub cover. Historical unit, now mapped as HB:sh*	*Vancouver Island*	*Coastal*
IT		SE	Intertidal	Mudflats, beaches and rocky shorelines that link the marine and terrestrial environments	Islands Trust	Coastal
MF		OIE	Mature Forest	Large patches of conifer-dominated forest where stand structure includes vertical heterogeneity and the average tree age is generally 80 years or more (Sunshine Coast). Forests dominated by mature trees (Okanagan).	Sunshine Coast/ Central & North Okanagan/ South Okanagan	Either
MF	bd	OIE	Mature Forest:broadleaf	Dominated by broadleaf trees (>75%)	Central & North Okanagan / South Okanagan	Interior
MF	co	OIE	Mature Forest:coniferous	Dominated by coniferous trees (>75%)	Central & North Okanagan	Interior
MF	mx	OIE	Mature Forest:mixed	Dominated by a mixture of coniferous and broadleaf trees (<75% coniferous and > 25% broadleaf)	Central & North Okanagan	Interior
NS		NS	Non-Sensitive	Used when displaying non-sensitive ecosystems themed from TEM/PEM		

Class Code	Subclass Code	Sensitive Ecosystem (SE) / Other Important Ecosystem (OIE) / Non-Sensitive (NS)	Class:subclass name	Description	Project	Coastal / Interior / Either
OF		SE	Old forest	Patches of conifer-dominated forest with complex vertical structure, where the average tree age is generally 250 years or more (Sunshine Coast). *Historically defined as forests older than 100 years for Vancouver Island.*	Sunshine Coast/ Vancouver Island	Coastal
OF	bd	SE	Old forest: broadleaf	Forests dominated by large old broadleaf trees.	n/a	Either
OF	co	SE	Old forest:coniferous	Forests dominated by large old coniferous trees (Central Okanagan); coniferous forests that appear to be older than 140 years (South Okanagan). Conifer-dominated (>75%) forests generally >250 years (Sunshine Coast)	Central & North Okanagan/ South Okanagan/ Sunshine COast/ Vancouver Island	Either
OF	mx	SE	Old forest:mixed	Forests dominated with a mixture of coniferous and broadleaf trees (<75% coniferous and > 25% broadleaf).	Central & North Okanagan/ Vancouver Island	Either
RI		SE	Riparian	Ecosystems associated with and influenced by water. Includes areas along creeks, streams, gullies, canyons and larger floodplains. Includes fringes along ponds, lakeshores, and some sites with significant seepage.	Sunshine Coast/ Central & North Okanagan/ South Okanagan/ Vancouver Island	Either
RI	ff	SE	Riparian:fringe	Fringe ecosystems associated with streams, pond or lake shorelines or sites with significant seepage but no floodplain.	Sunshine Coast/ Central & North Okanagan/ South Okanagan	Either
RI	fh	SE	Riparian:high bench	High bench floodplain terraces (only periodically and briefly inundated by high waters but lengthy subsurface flow in the rooting zone.	Sunshine Coast	Coastal
RI	fl	SE	Riparian:low bench	Low bench floodplain terraces (flooded at least every other year)	Sunshine Coast	Coastal
RI	fm	SE	Riparian:medium bench	Medium bench floodplain terraces (flooded every 1-5 years for short periods).	Sunshine Coast	Coastal
RI	fp	SE	Riparian:bench or Riparian:forested floodplain	Benches along creeks and rivers (high, medium, or low benches in the Central Okanagan); forested floodplain (South Okanagan)	Central & North Okanagan/ South Okanagan	Interior
RI	*g*	*SE*	*Riparain:gully*	*Gullies. Historical unit, now mapped as RI:gu*	*Vancovuer Island*	*Coastal*

Class Code	Subclass Code	Sensitive Ecosystem (SE) / Other Important Ecosystem (OIE) / Non-Sensitive (NS)	Class:subclass name	Description	Project	Coastal / Interior / Either
RI	gu	SE	Riparian:gully	Watercourse is in a steep V-shaped gully (Sunshine Coast); gullies with intermittent or permanent creeks (Central Okanagan/ South Okanagan)	Sunshine Coast/ Central & North Okanagan/ South Okanagan	Either
RI	ri	SE	Riparian:river	Large river watercourses including gravel bars	Central & North Okanagan/ South Okanagan	Either
RI	sh	SE	Riparian:shrub floodplain	Shrub dominated floodplain or lakeshore.	South Okanagan	Interior
SG	*co*	*OIE*	*Older Second Growth Forest: coniferous*	*Conifer forests 60-100 years old with <15% deciduous. Historical unit, now mapped as MF:co.*	*Vancovuer Island*	*Coastal*
SG	*mx*	*OIE*	*Older Second Growth Forest: mixed*	*Older forests 60-100 years old with >15% deciduous. Historical unit, now mapped as MF:mx.*	*Vancovuer Island*	*Coastal*
SS			Sagebrush steppe	Optional class where sagebrush dominated ecosystems are separated from grasslands	South Okanagan	Interior
SS	ds	SE	Sagebrush steppe: disturbed	Shrub steppe ecosystems where greater than 60% of plant cover is comprised of invasive alien species; **overrides all other shrub steppe subclasses where it occurs**.	South Okanagan	Interior
SS	ss	SE	Sagbrush steppe:sagebrush steppe	Typical sagebrush steppe ecosystems. Optional subclass for use where it helps meet project objectives.	South Okanagan	Interior
SS	ss	SE	Sagebrush steppe	Shrub steppe ecosystems on slopes <25% in fair to good condition. Variable soil depth.	South Okanagan	Interior
SS	st	SE	Grasslands:steep slope, deep soils	Shrub steppe ecosystems on slopes >25%; deep soils. Optional subclass for use where it helps meet project objectives.	South Okanagan	Interior
SV		SE	Sparsely Vegetated	Areas with 5-10% cover of vascular vegetation	Central & North Okanagan/ South Okanagan/ Vancouver Island	Interior
SV	cl	SE	Sparsely Vegetated:cliff	Steep rock slopes, often near vertical, with exposed bedrock; may have <5% vegetation cover	Central & North Okanagan/ South Okanagan/ Vancouver Island	Interior
SV	gr	SE	Sparsely Vegetated:shallow soil	Sparse grassland vegetation on very shallow soils (<20cm deep)	Naramata	Interior

Class Code	Subclass Code	Sensitive Ecosystem (SE) / Other Important Ecosystem (OIE) / Non-Sensitive (NS)	Class:subclass name	Description	Project	Coastal / Interior / Either
SV	ro	SE	Sparsely Vegetated:rock outcrop	Rock outcrops not dominated by shrubs (was HB:ro)	Central & North Okanagan	Interior
SV	*sd*	*SE*	*Sparsely Vegetated:coastal sand dunes*	*Sand dunes. Historical unit, now mapped as HB:du.*	*Vancouver Island*	*Coastal*
SV	sh	SE	Sparsely Vegetated:shrub	Shrub dominated rock outcrop areas	Central & North Okanagan/ South Okanagan	Interior
SV	*sp*	*SE*	*Sparsely Vegetated: sand spits*	*Coastal gravels and sand spits. Historical unit, now mapped as HB:sp.*	*Vancouver Island*	*Coastal*
SV	ta	SE	Sparsely Vegetated:talus	Areas dominated by rubbly blocks of rock (talus)	Central & North Okanagan/ South Okanagan	Interior
WD		SE	Woodland	Dry, open stands generally with between 10 and 25% tree cover (Sunshine Coast). Open stands of Douglas-fir or ponderosa pine, often on shallow soils, 10-20% canopy cover in unaltered state (Central & North Okanagan). *Historically defined as less than 50% canopy cover for Vancouver Island*.	Sunshine Coast/ Central & North Okanagan/ South Okanagan/ Vancouver Island	Either
WD	*bd*	*SE*	*Woodland:broadleaf*	*Broadleaft (Garry oak and trembling aspen) dominated woodland stands. Historical unit, now mapped as BW*	*Vancouver Island*	*Coastal*
WD	co	SE	Woodland:coniferous	Conifer dominated woodland stands including open stands on shallow soils, steep warm aspects or high elevations where climate restricts tree productivity.	Sunshine Coast/ Central & North Okanagan/ South Okanagan	Either
WD	mx	SE	Woodland:mixed	Mixed conifer and broadleaf stands. Greater than 25% coniferous and >25% broadleaf trees.	Sunshine Coast	Coastal
WN		SE	Wetland	Areas characterized by daily, seasonal or year-round water at or above the surface.	Sunshine Coast/ Central & North Okanagan/ South Okanagan/ Vancouver Island	Either
WN	bg	SE	Wetland:bog	Bog. Nutrient-poor peat wetlands on organic (sphagnum) soils; water source from precipitation.	Sunshine Coast / Vancouver Island	Either
WN	fn	SE	Wetland:fen	Fen. Groundwater-fed peat (sedge) wetlands; primary water source is groundwater or runoff.	Sunshine Coast/ South Okanagan/ Vancouver Island	Either

Class Code	Subclass Code	Sensitive Ecosystem (SE) / Other Important Ecosystem (OIE) / Non-Sensitive (NS)	Class:subclass name	Description	Project	Coastal / Interior / Either
WN	ms	SE	Wetland:marsh	Marsh. Graminoid or forb-dominated freshwater, estuarine or saline nutrient-rich wetlands that are permanently or seasonally inundated.	Sunshine Coast/ Central & North Okanagan/ South Okanagan/ Vancouver Island	Either
WN	sc	SE	Wetland:shrub carr	Shrub carr. Shrub-dominated ecosystems with moist soils on frost-prone depressions.	n/a	Interior
WN	sp	SE	Wetland:swamp	Swamp. Shrub or tree-dominated wetlands with temporary shallow flooding and significant above or below ground water flow	Sunshine Coast/ Central & North Okanagan/ South Okanagan/ Vancouver Island	Either
WN	sw	SE	Wetland:shallow water	Shallow water. Permanently flooded, less than 2m deep mid-summer and less than 10% cover of emergent vegetation.	Sunshine Coast/ Central & North Okanagan/ South Okanagan/ Vancouver Island	Either
WN	wm	SE	Wetland:wet meadow	Wet meadow. Briefly inundated, graminoid-dominated meadows.	Sunshine Coast/ Central & North Okanagan/ South Okanagan/ Vancouver Island	Either

Appendix C: Commonly Used Environmentally Sensitive Areas (ESAs) / Sensitive Ecosystem Mapcodes for the CVRD ESA Inventory

SEI Class	SEI Subclass	Brief Description	Allowed Structural Stages
WN: Wetland		**Terrestrial – freshwater transitional areas.**	
WN	bg: bog	Nutrient-poor wetlands on peat-moss organic soils	2b, 3a, 3b, 4, and 5
WN	fn: fen	Groundwater-fed sedge-peat wetlands	2b, and 3a
WN	ms: marsh	Graminoid or forb-dominated nutrient-rich wetlands	2b
WN	sp: swamp	Shrub or tree-dominated wetlands	2b, 3a, 3b, 4 and 5
WN	sw: shallow water	Permanently flooded, water less than 2m deep at mid-summer.	2c
FW: Lakes and Ponds			
FW	pd: pond	Open water > 2 m deep and generally < 8 ha	Not applicable
FW	la: lake	Open water generally > 8 ha	Not applicable
IT: Intertidal & shallow sub-tidal		**Ecosystems at marine and terrestrial interface**	Not applicable
OF: Old Forest		**Forests > 250 yrs**	
OF	co: coniferous	Conifer > 75% of stand	7
MF: Mature Forest		**Forests > 80 yrs, < 250 yrs, ≥ 5 ha**	
MF	co: coniferous	Conifer-dominated (> 75% of stand composition)	6
MF	mx: mixed	Stand composition > 25% conifer and > 25% broadleaf	6
WD: Woodland		**Dry site, open stands with <50% tree cover**	
WD	co: coniferous	Conifer > 75% of stand	5, 6, and 7
WD	bd: broadleaf**	Broadleaf > 75% of stand	5 and 6
HB: Herbaceous		**Non-forested ecosystems; usually shallow soils, often with bedrock outcrops.**	
HB	cs: coastal herbaceous	Influenced by proximity to the ocean: > 20% vegetation cover of grasses, herbs, mosses and lichens	1b, and 2b
HB	sh: shrub	Shrubs > 20% cover, with grasses and herbs.	3a and 3b
SV: Sparsely Vegetated		**Areas with 5 – 10% vascular vegetation (may be greater in patches); often with mosses, liverwort and lichen cover**	
SV	cl: cliff	Steep slopes, often with exposed bedrock.	1a, and 1b
SV	ro: rock outcrop	Rock outcrops – areas of bedrock exposure, variable vegetation cover.	1a, 1b, 2b, and 3a

SEI Class	SEI Subclass	Brief Description	Allowed Structural Stages
RI: Riparian		**Ecosystems associated with and influenced by freshwater**	
RI	fh: high bench	High bench floodplain terraces	5, 6 and 7
RI	fm: medium bench	Medium bench floodplain terraces	4, 5, and 6
RI	fl: low bench	Low bench floodplain terraces	2b, 3a, and 3b
RI	ri: river	Large river watercourses including gravel bars	Not applicable

* Structural stages were not assigned to the CVRD ESA Inventory features, but were maintained in the dataset when provided in the original map product.
**Woodland (WD) SEI coding has recently been updated to include "BW" to indicate broadleaf woodland.
Note: Not Applicable indicates assumption that no vegetation is present or associated with that subclass.

Other Important Ecosystems

Other Important Ecosystem Class	OIE Subclass	Brief Description	Typical Structural Stages
MF: Mature Forest		**Small patches of forest – stands > 80 yrs, < 250 yrs, <5ha and broadleaf, any size**	
MF	co: coniferous	Conifer > 75% of stand	6
MF	mx: mixed	Stand composition > 25% conifer and > 25% broadleaf	6
MF	bd: broadleaf	Stand composition >75% broadleaf	6

Appendix D: ESA/SEI Class and Subclass Descriptions for the CVRD ESA Inventory

Riparian (RI)

Ecosystems associated with and influenced by freshwater, generally along rivers, streams, and creeks, but for SEI, also includes fringes around lakes. Ecosystems are influenced by factors such as erosion, sedimentation, flooding and/or subterranean irrigation due to proximity to the water body. This Class includes all vegetation developmental stages, i.e., structural stages 1 through 7, but only in a natural or semi-natural state.

Subclasses:

fl – low bench floodplain: flooded at least every other year for moderate periods of growing season; plant species adapted to extended flooding and abrasion, low or tall shrubs most common (up to structural stage 3b, as anything more developed than that indicates less frequent flooding).

fm – medium bench floodplain: flooded most years for short periods (10-25 days); deciduous or mixed forest dominated by species tolerant of flooding and periodic sedimentation (structural stage varies depending on level of disturbance).

fh – high bench floodplain: only periodically and briefly inundated by high waters, but lengthy subsurface flow in the rooting zone; typically conifer-dominated floodplains of larger coastal rivers (typically older structural stages reflective of reduced flooding frequency; structural stage 3-7 depending on level of disturbance).

ri – river: river and associated gravel bars, if wide enough to be mapped.

Wetland (WN)

Wetland ecosystems are found where soils are saturated by water for enough time that the excess water and resulting low oxygen levels influence the vegetation and soil. The water influence is generally seasonal or year-round and occurs either at or above the soil surface or within the root zone of plants. Wetlands are usually found in areas of flat or undulating terrain. They encompass a range of plant communities that includes western redcedar/skunk cabbage swamps, cattail marshes, and peat-moss dominated bogs. Estuarine vegetation is in a separate Class for this SEI to emphasize the different flooding frequency (mostly diurnal) and water chemistry (brackish). Therefore, the wetland class is for freshwater wetlands.

Subclasses:

bg – bog: acidic, nutrient-poor wetlands that characteristically support peat-mosses and ericaceous shrubs such as Labrador tea and bog-rosemary. Being generally isolated from mineral rich groundwater or surface water, their primary source of water and nutrients is from rainfall.

fn – fen: underlain by sedge or brown moss peat, fens are closely related to bogs. In addition to rainfall, fens receive mineral and nutrient-enriched water from upslope drainage or groundwater. Thus a broader range of plants, including shrubs and small trees, is able to grow.

ms – marsh: characterized by permanent or seasonal flooding by nutrient-rich waters. May include some areas of diurnal flooding of fresh water above the normal high high-tide, due to high river water levels. Examples include freshwater marshes that are dominated by rushes, sedges or grasses.
sp – swamp: wooded wetlands dominated by 25% or more cover of flood-tolerant trees or shrubs. Characterized by periodic flooding and nearly permanent sub-surface waterflow through mixtures of mineral and organic materials, swamps are high in nutrient, mineral and oxygen content.
sw – shallow water: wetlands characterized by water less than 2 m in depth in mid-summer; transition between deep water bodies and other wetland ecosystems (i.e. bogs, swamps, fens, etc.); often with vegetation rooted below the water surface.

Freshwater (FW)

Freshwater ecosystems include bodies of water such as lakes and ponds that usually lack floating vegetation.

Subclasses:
la - lake
pd - pond: naturally occurring, small body of open water, greater than 2 m deep and generally less than 8 ha, with little to no floating vegetation; shallower water than a lake.

Old Forest (OF)

Generally conifer-dominated forest with complex vertical structure, where the canopy tree ages are mostly 250 years old or older, but may include older mixed coniferous stands. Old broadleaf stands are unlikely to occur in the CVRD.

Subclasses:
co – conifer-dominated forest stands (>75% conifer composition) where canopy tree ages mostly 250 – 400 years old.

Mature Forest (MF)

Forests generally >80 yrs old and < 250 yrs old. Mature forests are not as structurally complex as old forests, but can function as essential habitat areas for many wildlife species and as primary connections between ecosystems in a highly fragmented landscape.

Subclasses:
co – conifer dominated (> 75% coniferous species).
mx – mixed conifer and deciduous (<75% coniferous and < 75% broadleaf composition).

Woodland (WD)

Woodlands are open forests, generally less than 50% tree cover, as a result of site conditions, i.e., they are ecological woodlands. They are found on dry sites, mostly on south facing slopes of rocky knolls and bedrock-dominated areas. The stands can be conifer dominated or mixed conifer and arbutus (or deciduous hardwoods, e.g., Garry oak) stands and because of the open canopy, will often include non-forested openings, generally on shallow soils and bedrock outcroppings.

Subclasses:

co – conifer dominated ecological woodlands (greater than 75% coniferous composition).
bd – broadleaf dominated ecological woodlands (greater than 75% broadleaf composition).

Herbaceous (HB)

This class comprises non-forested ecosystems (i.e., less than 10% tree cover), generally associated with shallow soils, often with bedrock outcroppings, coarse-textured soils, or natural disturbances (wind or wave action); includes a variety of natural ecosystems such as large, bedrock-controlled openings within forested areas, coastal headlands, shorelines vegetated with grasses and herbs, sometimes low shrubs, and moss and lichen communities on rock outcrops.

Subclasses:
cs – coastal herbaceous: criteria as for ‘hb’ but influenced by proximity to ocean; windswept shoreline and slopes; > 20% vegetation of grasses, herbs, mosses and lichens.
sh – shrub component: > 20 % of total vegetation cover is shrub cover, with grasses and herbs.

Sparsely Vegetated (SV)

Areas of low vascular vegetation cover, generally 5 – 10 percent, but may be greater in some patches; may have high cover of mosses, liverworts and lichens.

Subclasses:
cl – cliff: steep to very steep slopes, often with exposed bedrock; may include steep-sided sand bluffs**.**
ro – rock outcrop: exposed bedrock, usually at the top of knolls or on portions of steeper slopes.

Intertidal & Shallow sub-tidal (IT)

Mudflats, beaches and rocky shorelines influenced by diurnal tidal cycles with little to no freshwater input (primarily through rainfall runoff). The intertidal ecosystems link the marine and terrestrial environments.

Other Important Ecosystems

Other Important Ecosystems are mapped to identify important elements of biodiversity or recruitment sites for ecosystems at risk or important wildlife habitat requiring recovery or restoration.

Mature Forest (MF)

Forests generally >80 yrs old and < 250 yrs old. These mature forests are not as valuable as old forests as far as representing the at-risk ecosystems, but can be important habitat areas for many wildlife species, and serve as primary connections between ecosystems in a highly fragmented landscape. They also represent recruitment for old forest where that feature is limited or lost (this is especially common within the CDF biogeoclimatic zone).

Subclasses:
co – conifer dominated (> 75% coniferous species).
mx – mixed conifer and deciduous (<75% coniferous and < 75% broadleaf composition).
bd – broadleaf dominated (greater than 75% broadleaf composition).

Appendix E: Results of Inventory and Analyses of ESA Mapping in the CVRD (Summary Tables - Representation by Watersheds, Benchlands, Jurisdictions, Electoral Areas, and Biogeoclimatic Zones)

Table E-1: Results of Inventory of Existing ESA Mapping of the CVRD – Summary by % of Watershed Area.

		Environmentally Sensitive Areas by Watershed (% of watershed area)											
Watershed Group	**Watershed Name**	**Alpine (AP)**	**Seasonally-Flooded (FS)**	**Freshwater (FW - Lakes)**	**Herbaceous (HB)**	**Intertidal (IT)**	**Mature Forest (MF)**	**Old Forest (OF)**	**Riparian (RI)**	**Sparsely Vegetated (SV & CL)**	**Woodland (WD & BW)**	**Wetland (WN)**	**Total ESAs**
East-draining Watersheds	Bonsall Creek		4.89%	0.49%	0.84%	1.04%	6.09%	0.38%	1.14%	0.81%	3.48%	3.53%	22.68%
	Bush Creek			0.12%	0.07%		19.22%	1.54%	1.79%	0.34%	0.06%	7.21%	30.35%
	Chemainus River	0.00%	0.04%	0.32%	0.07%	0.09%	6.71%	4.03%	2.04%	0.69%	0.05%	0.44%	14.48%
	Cowichan River		0.30%	7.48%	0.06%	0.05%	3.96%	4.64%	0.63%	0.16%	0.38%	0.72%	18.37%
	Holland Creek	0.17%		2.09%	0.00%		27.88%	1.21%	3.87%	0.35%	0.19%	0.79%	36.56%
	Koksilah River		0.26%	0.57%	0.19%	0.04%	5.13%	5.97%	0.63%	0.08%	0.22%	0.68%	13.76%
	Nanaimo River		0.38%	0.32%	0.01%		1.74%	9.80%	0.50%	0.03%	0.02%	0.50%	13.30%
	Shawnigan Creek		0.20%	5.11%	0.08%		11.38%	1.25%	0.36%	0.25%	1.63%	1.55%	21.81%
	Stocking Creek			2.04%	0.00%		25.40%	0.22%	5.86%	0.22%	0.52%	1.43%	35.69%
East-draining Benchlands and Gulf Islands	Chemainus Benchlands		0.39%	2.35%	1.12%	0.04%	11.41%		0.35%	0.04%	0.65%	4.17%	20.53%
	Coastal and Gulf Islands		0.44%	0.88%	3.99%	1.69%	20.10%	9.12%	0.08%	1.97%	8.36%	7.04%	53.67%
	Ladysmith - Saltair Benchlands		0.13%	0.10%	0.00%		19.42%	0.25%	1.66%	0.00%	0.50%	2.86%	24.92%
	Malahat Benchlands			0.66%	0.02%		11.34%	0.50%	1.05%	0.87%	2.47%	1.11%	18.02%
	Sansum Narrows - Cowichan Bay Benchlands		0.06%	0.59%	0.59%	0.02%	19.50%	0.46%	0.61%	3.12%	7.41%	1.72%	34.08%
	Satellite Channel Benchlands		0.14%	0.29%	0.00%		2.96%	0.06%	1.32%	0.00%	0.37%	0.77%	5.91%
	Yellow Point Benchlands		0.87%	0.03%	1.21%	0.07%	8.16%	1.84%	0.00%	0.74%	0.54%	3.86%	17.32%
West-draining	Gordon River				0.00%		3.20%	20.24%	0.36%	0.08%		0.02%	23.91%
	Nitinat River			2.97%	0.00%		1.52%	25.86%	1.69%	0.02%		0.35%	32.41%
	San Juan River			0.04%	0.00%		0.57%	12.31%	0.32%	0.05%		0.04%	13.34%

Table E-2: Results of Inventory of Existing ESA Mapping of the CVRD – Summary by Watershed Area (hectares).

		Environmentally Sensitive Areas by Watershed (hectares)												
Watershed Group	**Watershed Name**	**Alpine (AP)**	**Seasonally-Flooded (FS)**	**Freshwater (FW - Lakes)**	**Herbaceous (HB)**	**Intertidal (IT)**	**Mature Forest (MF)**	**Old Forest (OF)**	**Riparian (RI)**	**Sparsely Vegetated (SV & CL)**	**Woodland (WD & BW)**	**Wetland (WN)**	**Total ESAs**	**Total Watershed Area (ha)**
East-draining Watersheds	Bonsall Creek		179.0	17.8	30.6	38.1	222.8	13.9	41.6	29.8	127.4	129.2	830.2	3660.1
	Bush Creek			3.2	1.8		540.8	43.3	50.4	9.6	1.8	203.0	853.9	2813.7
	Chemainus River	1.5	16.0	114.7	23.3	33.2	2385.8	1432.3	724.5	244.7	17.2	157.5	5150.7	35569.1
	Cowichan River		275.7	6928.2	53.3	44.9	3672.9	4295.7	579.7	152.2	354.7	667.7	17024.9	92674.0
	Holland Creek	5.1		64.1	0.0		855.5	37.2	118.8	10.9	5.9	24.2	1121.7	3068.1
	Koksilah River		73.2	159.8	52.9	11.3	1446.2	1683.4	177.8	23.8	63.3	190.9	3882.6	28212.8
	Nanaimo River		68.8	58.3	1.2		314.1	1770.4	90.6	5.3	2.7	90.5	2402.0	18066.6
	Shawnigan Creek		21.6	552.0	8.4		1229.1	135.4	39.2	27.1	175.5	166.8	2355.1	10797.1
	Stocking Creek			21.3	0.0		265.6	2.3	61.3	2.3	5.5	14.9	373.2	1045.8
East-draining Benchlands and Gulf Islands	Chemainus Benchlands		5.5	33.5	15.9	0.6	162.7		5.0	0.6	9.3	59.4	292.6	1425.6
	Coastal and Gulf Islands	12.0	24.0	108.6	46.0	547.4	248.6	2.1	53.6	227.8	191.9	1462.0	1438.0	5200.0
	Ladysmith - Saltair Benchlands		3.5	2.8	0.0		523.3	6.8	44.8	0.0	13.4	77.0	671.6	2694.6
	Malahat Benchlands			31.7	1.1		545.6	24.1	50.4	41.8	118.9	53.3	866.8	4810.1
	Sansum Narrows - Cowichan Bay Benchlands		2.8	27.4	27.2	1.0	905.6	21.5	28.6	144.7	344.2	79.8	1582.7	4644.4
	Satellite Channel Benchlands		3.1	6.6	0.0		67.0	1.4	29.9	0.0	8.3	17.4	133.7	2261.9
	Yellow Point Benchlands		30.2	0.9	41.9	2.5	283.1	63.9	0.0	25.5	18.9	133.9	600.7	3468.4
West-draining	Carmanah-Walbran			164.8			1671.7	26350.3	166.4			315.0	28668.3	28503.5
	Gordon River				0.0		770.2	4870.9	87.0	19.3		4.8	5752.2	24061.7
	Nitinat River			1521.3	0.0		778.3	13255.0	866.7	11.6		180.0	16612.9	51264.8
	San Juan River			8.9	0.0		135.9	2918.6	77.1	12.8		9.5	3162.8	23717.9
Peripheral East-draining	Goldstream, Saanich Inlet, Holden Creek													152.2
Peripheral West-draining	Franklin, Sooke													394.4
													Total Area	**355,202.7**

Table E-3: Results of Inventory of Existing ESA Mapping of the CVRD – Summary by percent (%) within each Jurisdiction.

	Environmentally Sensitive Areas by Jurisdiction (% of jurisdiction area)												
	ESAs by Jurisdiction (%)	**Alpine (AP)**	**Seasonally-Flooded (FS)**	**Freshwater (FW - Lakes)**	**Herbaceous (HB)**	**Intertidal (IT)**	**Mature Forest (MF)**	**Old Forest (OF)**	**Riparian (RI)**	**Sparsely Vegetated (SV & CL)**	**Woodland (WD & BW)**	**Wetland (WN)**	**Total ESAs**
Electoral Areas	Cobble Hill (Area C)		0.14%	0.64%	0.03%		4.71%	0.15%	1.01%	0.04%	1.60%	0.87%	9.18%
	Cowichan Bay (Area D)		1.43%	1.06%	1.48%	1.45%	0.51%		0.96%	0.28%	0.25%	0.93%	8.35%
	Cowichan Lake South / Skutz Falls (Area F)			2.21%	0.00%		3.37%	26.04%	0.96%	0.06%	0.00%	0.38%	33.03%
	Cowichan Station / Sahtlam / Glenora (Area E)		0.15%	0.47%	0.08%		10.86%	4.78%	2.14%	0.18%	0.10%	1.78%	20.53%
	Mill Bay / Malahat (Area A)		0.04%	0.13%	0.02%		10.13%	0.71%	1.09%	0.65%	2.41%	0.66%	15.85%
	North Oyster / Diamond (Area H)		1.04%	0.45%	0.52%	0.03%	9.67%	1.23%	1.46%	0.39%	0.25%	4.89%	19.91%
	Saltair / Gulf Islands (Area G)	0.02%	0.03%	0.37%	0.34%	0.00%	9.02%	7.56%	0.68%	0.74%	0.77%	0.72%	20.26%
	Shawnigan Lake (Area B)		0.13%	2.40%	0.06%		7.95%	2.83%	0.46%	0.19%	0.67%	0.80%	15.49%
	Youbou / Meade Creek (Area I)			7.35%			0.87%	10.22%	0.45%	0.10%		0.04%	19.04%
Municipalities	City of Duncan			0.77%			0.07%		5.36%		0.06%	0.06%	6.31%
	Municipality of North Cowichan		2.31%	2.84%	0.68%	0.65%	11.87%	0.29%	1.14%	1.28%	4.06%	3.54%	28.65%
	Town of Ladysmith			0.00%			8.48%		6.55%	0.03%	1.29%	3.19%	19.54%
	Town of Lake Cowichan		0.26%	12.64%			0.03%		0.78%			3.17%	16.89%
CVRD Total		**0.00%**	**0.19%**	**2.75%**	**0.10%**	**0.05%**	**4.91%**	**16.10%**	**0.91%**	**0.23%**	**0.42%**	**0.78%**	**26.45%**

Table E-4: Results of Inventory of Existing ESA Mapping of the CVRD – Summary by Jurisdiction (area in hectares).

	Environmentally Sensitive Areas by Jurisdiction (hectares)													
	ESAs by Jurisdiction (%)	**Alpine (AP)**	**Seasonally-Flooded (FS)**	**Freshwater (FW - Lakes)**	**Herbaceous (HB)**	**Intertidal (IT)**	**Mature Forest (MF)**	**Old Forest (OF)**	**Riparian (RI)**	**Sparsely Vegetated (SV & CL)**	**Woodland (WD & BW)**	**Wetland (WN)**	**Total ESAs**	**Total Jurisdiction Area**
Electoral Areas	Cobble Hill (Area C)		3.3	14.9	0.7		109.1	3.4	23.3	0.9	37.0	20.1	212.6	2315
	Cowichan Bay (Area D)		42.3	31.5	44.0	43.1	15.0		28.5	8.4	7.5	27.5	247.7	2965
	Cowichan Lake South / Skutz Falls (Area F)			4032.7	1.2		6147.1	47545.5	1758.0	112.4	9.1	696.2	60302.3	182583
	Cowichan Station / Sahtlam / Glenora (Area E)		21.9	67.7	11.5		1580.8	695.5	311.1	26.0	14.2	259.5	2988.3	14556
	Mill Bay / Malahat (Area A)		2.2	6.6	1.1		522.2	36.7	56.1	33.6	124.3	33.8	816.8	5154
	North Oyster / Diamond (Area H)		99.0	43.1	49.8	2.5	923.7	117.5	139.5	37.1	23.4	467.5	1903.1	9557
	Saltair / Gulf Islands (Area G)	6.5	10.6	112.8	102.3	0.2	2730.3	2289.9	207.4	224.8	233.0	218.0	6135.9	30281
	Shawnigan Lake (Area B)		39.3	728.9	17.8		2413.9	858.2	138.5	59.0	205.0	241.9	4702.4	30364
	Youbou / Meade Creek (Area I)			4017.2			475.7	5583.2	247.6	55.1		24.2	10402.8	54638
Municipalities	City of Duncan			1.6			0.2		11.2		0.1	0.1	13.2	209
	Municipality of North Cowichan		470.4	576.4	137.9	131.9	2412.8	58.9	231.9	259.6	825.5	718.7	5824.0	20327
	Town of Ladysmith			0.0			105.2		81.2	0.4	16.0	39.6	242.4	1241
	Town of Lake Cowichan		2.5	120.9			0.3		7.5			30.3	161.4	956
CVRD Total		**7**	**691**	**9,754**	**366**	**178**	**17,436**	**57,189**	**3,242**	**817**	**1,495**	**2,777**	**93952.9**	**355147**

Table E-5: Results of Inventory of Existing ESA Mapping of the CVRD – Summary by percent (%) within each biogeoclimatic unit (representation within each BEC unit).

Environmentally Sensitive Areas by Biogeoclimatic Zone (% of BEC land area)														
BEC Name	**BEC Subzone**	**ESAs by BEC Zone (%)**	**Alpine (AP)**	**Seasonally-Flooded (FS)**	**Freshwater (FW - Lakes)**	**Herbaceous (HB)**	**Intertidal (IT)**	**Mature Forest (MF)**	**Old Forest (OF)**	**Riparian (RI)**	**Sparsely Vegetated (SV & CL)**	**Woodland (WD & BW)**	**Wetland (WN)**	**Totals**
Coastal Douglas-fir	**Moist Maritime**	**CDFmm**		1.49%	1.63%	0.75%	0.41%	9.60%	0.91%	1.17%	0.68%	2.59%	3.14%	22.37%
Coastal Western Hemlock	**Very Dry Maritime**	**CWHxm1**		0.11%	1.71%	0.06%		15.74%	1.73%	2.46%	0.41%	0.82%	1.78%	24.83%
		CWHxm2			8.65%	0.01%		3.36%	3.30%	0.44%	0.16%	0.00%	0.09%	16.01%
	Moist Maritime	**CWHmm1**			0.02%			0.37%	10.81%	0.59%	0.07%		0.01%	11.89%
		CWHmm2	0.001%		0.10%			0.40%	10.99%	0.18%	0.03%		0.03%	11.74%
	Very Moist Maritime	**CWHvm1**			2.24%			1.89%	45.29%	1.42%	0.01%		0.64%	51.48%
		CWHvm2			0.04%			4.79%	50.84%	0.14%	0.07%		0.21%	56.09%
	Very Wet Hyper-maritime	**CWHvh1**			2.11%	0.005%		22.43%	63.29%	0.13%			0.69%	88.66%
Mountain Hemlock and Alpine		**MHmm1**	0.04%		0.47%			0.43%	10.15%	0.06%	1.12%		0.05%	12.33%
		CMAunp							0.002%		0.003%			0.005%

Table E-6: Results of Inventory of Existing ESA Mapping of the CVRD – Summary by percent area (hectares) within each biogeoclimatic unit.

Environmentally Sensitive Areas by Biogeoclimatic Zone (hectares)														
BEC Name	**BEC Subzone**	**ESAs by BEC Zone (%)**	**Alpine (AP)**	**Seasonally-Flooded (FS)**	**Freshwater (FW - Lakes)**	**Herbaceous (HB)**	**Intertidal (IT)**	**Mature Forest (MF)**	**Old Forest (OF)**	**Riparian (RI)**	**Sparsely Vegetated (SV & CL)**	**Woodland (WD & BW)**	**Wetland (WN)**	**Totals**
Coastal Douglas-fir	**Moist Maritime**	**CDFmm**		642.6	704.0	326.0	177.7	4,152.5	394.3	507.1	292.5	1,117.9	1,359.8	9,674
Coastal Western Hemlock	**Very Dry Maritime**	**CWHxm1**		48.7	781.5	29.5		7,194.0	792.6	1,126.3	188.2	373.8	815.7	11,350
		CWHxm2			6,486.9	10.6		2,516.6	2,472.8	328.2	116.8	3.5	69.2	12,005
	Moist Maritime	**CWHmm1**			6.5			96.6	2,815.0	153.6	19.5		3.5	3,095
		CWHmm2	0.3		62.8			240.1	6,604.3	110.8	17.8		15.7	7,052
	Very Moist Maritime	**CWHvm1**			1,534.1			1,295.7	31,077.9	976.7	3.7		437.6	35,326
		CWHvm2			6.3			797.7	8,470.3	23.2	11.3		35.3	9,344
	Very Wet Hyper-maritime	**CWHvh1**			101.6	0.2		1,078.7	3,043.6	6.4			33.2	4,264
Mountain Hemlock and Alpine		**MHmm1**	6.2		70.5			64.4	1,517.9	9.5	167.5		7.3	1,843
		CMAunp							0.001		0.002			0.003