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Terrestrial Ecosystem Mapping of the Coastal Douglas-Fir Biogeoclimatic Zone

for:

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by:

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Executive Summary

This report presents the results of Terrestrial Ecosystem Mapping (TEM) of the Coastal Douglas-fir moist maritime (CDFmm) biogeoclimatic subzone in British Columbia. An expanded legend and map legend also accompany this document for interpreting the mapping deliverables.

The CDFmm subzone occupies about 252,000 hectares of land in the Georgia Depression on southwest portions of mainland BC, the central and southern Gulf Islands and southeastern Vancouver Island. This project excludes the Lower Fraser Valley and Gulf Islands National Park Reserve (GINPR). Therefore, the resultant study area covers 212,660 hectares for which TEM mapping was completed.

Elevation boundaries for the CDFmm range from sea level to approximately 150 m, except for in the Cowichan Valley where boundary elevations were raised to 380 m. There were isolated mountains around the Cowichan area and on Saltspring Island which extended above the CDFmm boundary; therefore small amounts of the Coastal Western Hemlock very dry maritime (CWHxm) subzone have also been included in the map deliverables.

The temperature and climate in the CDFmm is mild and warm, leading to unique assemblages of vegetation and ecosystems. The subzone covers less than 0.3% of the Province, yet contains a diverse set of landscapes, vegetation, and ecosystems.

The variation of ecosystems from north to south in the CDFmm is widespread. Ecosystems include sand dune communities in the central Gulf Islands, and large river estuaries along eastern Vancouver Island, to Garry oak sites in the Cowichan Valley, Saanich/Victoria and the southern Gulf Islands. A range of anthropogenic units are also common in the CDFmm, such as cultivated fields and urban townships.

Four ecosections span the CDFmm biogeoclimatic subzone from north to south, including the Strait of Georgia, Georgia Lowland, Nanaimo Lowland, and Southern Gulf Islands. Ecosections are based on differences in physiography and macro climatic process at a sub-regional level.

Soil and terrain types present in the CDFmm today are influenced by historical glaciation events and contemporary erosion and deposition. Therefore soils are mainly derived from marine, glacio-marine, morainal, and colluvial sources.

The Biogeoclimatic Ecosystem Classification system (BEC) groups similar sets of landscapes into site series. These are mainly forested site series which can repeat across biogeoclimatic subzones. Non-forested ecosystems, wetlands and sparsely-vegetated areas also occur, such as Garry-oak meadows, estuaries and rock outcrops. Non-forested and wetland ecosystems are also derived from the BEC system naming conventions. The Wetland and Riparian Ecosystem Classification system (WREC) is used for naming various wetland sites. The typical site conditions, such as soil, terrain and climate, combined with the interaction of vegetation, animals and insects, make up the ecosystems in the CDFmm. Two-letter TEM mapcodes are used for mapping upland sites and four-letter WREC codes are used for wetland ecosystems.

Site modifiers are applied to the TEM mapcodes to further describe atypical situations, such as shallows soils and steep slopes. The succession of forested and non-forested ecosystems can be partly described by their structural features and relative age. Numerical structural stage codes, ranging from 1 to 7 are therefore added to the TEM mapcode to explain vegetation structure.

Douglas-fir dominates the tree canopy in the upland CDFmm ecosystems with lesser amounts of grand fir, arbutus, bigleaf maple and western redcedar, depending on site position, moisture regime and nutrient status. The understory of a typical forested ecosystem is characterized by the shrubs salal, Oregon-grape and oceanspray along with scattered herbs, and a continuous layer of feathermosses depending on light conditions and slope position. Tree species and understory vegetation variability across the subzone is a result of numerous factors including soil type, slope position, moisture regime, nutrient status, as well as widespread natural and anthropogenic disturbances.

The Conservation Data Centre lists thirty-five ecological communities and 218 wildlife species and plants at risk in the CDFmm. Their rare status is due to the limited range of the CDFmm in the Provice and from past habitat loss arising from natural and anthropogenic disturbances.

The purpose of the project was to complete ecosystem mapping for the CDFmm study area in order to provide baseline information that can be used in support of future land-use planning initiatives.

The provincial TEM standards were followed for mapping and capturing the digital terrain and ecosystem data, using level-five survey intensity. Terrain and ecosystem mapping, field sampling and air photo interpretations were completed at a scale of 1:16,000 using the appropriate provincial standards and methods.

A stratified sampling strategy was designed to collect field data from as many types of ecosystems as possible throughout the study area. Field inspections were distributed across the study area on a wide range ecosystems and site conditions on accessible lands in the CDFmm. Field sampling resulted in over 1458 total plots, as well as 331 background plots, resulting in 1234 field checked polygons, which provided ecosystem information for final ecosystem mapping. Level-five survey intensity was accomplished with 9% polygon inspection (including background plot data).

Within the CDFmm, forest ecosystem and anthropogenic units cover 61% and 33% of the landscape, respectively, while non-forested ecosystems and wetlands encompass the remaining 6%. The most common forested unit is the Douglas-fir—Salal site series, which makes up 37% of the study area. The dominant wetland ecosystem is the Pink spirea—Sitka sedge swamp representing only 0.6% of the study area. Garry oak ecosystems occupy about 0.5% of the study area, but would increase to around 1% with the GINPR mapping incorporated.

Anthropogenic and natural disturbances have altered the forest age structure of the CDFmm ecosystems over time, mainly from urban development, agriculture, forestry, and fire. Young forests, between the ages of 40 and 50 years, occur over 20,026 ha or 12% of the CDFmm landscape. Immature (pole/sapling) forests, less than 40 years old, cover 71,562 ha or 45% of the study area. Mature forest ecosystems, between 80 and 250 years old, occupy 20,519 ha or 13% of the subzone. Old forests over 250 years old only occur on 610 ha of the study area.

Twenty-five at-risk ecosystems were mapped in the study area, twenty-one red-listed and four blue-listed communities; however rare plant field sampling was limited by survey timing.

Over 30% of the land area has been converted to urban, rural, agricultural, and industrial use in the CDFmm. However, this value probably under-estimates the actual conversion as of 2008; our mapping was based on aerial photos taken at various times in the past 15 years.

Consequently we have missed more recent disturbances. Approximately two-thirds of these anthropogenic sources represent non permeable surfaces with the remaining third as permeable surface, such as cultivated fields. Most of these patterns are associated with land use.

Overall, with the addition of ecosystem mapping results from the lower Fraser Valley and the Gulf Islands National Park Reserve, land use planning in the CDFmm can be integrated into a single database and used to guide priorities for regional outcomes for conservation and management.

ACKNOWLEDGEMENTS

This project was the result of the co-operation, organization, and dedication of many people and organizations. Funding for this project was provided by the Integrated Land Management Bureau (ILMB), under the administrative direction of Mr. Bill Zinovich (currently Land & Resource Specialist with Crown Lands and Resources, Nanaimo) and through the B.C. Ministry of Environment (MOE) via Ms. Mary Jo Hamey (Ecosystem Specialist, Nanaimo).

Islands Trust provided additional funding for higher field sampling intensity and additional map products on Saltspring Island, carried by the vision of Ms. Ardice Todosichuk (Ecosystem Protection Specialist).

BC Parks provided an additional support for even more detailed sampling and additional field and interpretive data collection and extension products on current and proposed provincial parks and ecological reserves of Saltspring Island under the auspices of Karen MacDowell and Peggy Burfield. In addition to the funding provided by the B.C. Government, this project was also sponsored by the Bulkley Valley Research Centre, a not-for-profit society based out of Smithers, BC.

Project management was led by Jane Thomson, assisted by Tania Tripp and Jackie Churchill. Bioterrain mapping was done by Wanda Miller, Michelle Trommelen, Pamela Williams, and Sonia Meili, with internal quality assurance (QA) provided by Gordon Butt and Brian Roberts, and external QA by Sid Tsang and Deepa Spaeth-Filatow (MoE). Ecosystem mapping and report writing were done by Jodie Krakowski, Helen Reid, Claudia Houwers, Chris Clement, Caroline Astley, Jackie Churchill, and Tyler Innes with external QA and feedback by Jo-Anne Stacey, Corey Erwin, Kim Everett, Ted Lea, and Carmen Cadrin (MoE). Field crews included the bioterrain and ecosystem mappers mentioned above. Andrew Neale Digital Mapping provided cascade control. Photos were monorestituted by Chartwell Consultants Ltd. Data entry was supported by Jackie Churchill, Kyle Rezansoff, and Jenny Reid. Julie Cowie provided database QA, VENUS data entry for year 2 and queries to support the results section of this report. GIS applications and final map products were completed by Jane Thomson, Dana Luxmoore, and Brett Korteling. Additional discussions with Andy MacKinnon, Sari Saunders, Todd Golumbia, regional district staff and many others provided valuable insight and clarification.

LIST OF ACRONYMS

Acronym	Description
asl	Above Sea Level
B.C.	British Columbia
BEC	Biogeoclimatic Ecosystem Classification
CDC	Conservation Data Centre, a unit within the B.C. Ministry of Environment
CDF	Coastal Douglas-Fir biogeoclimatic zone
CDFmm	Coastal Douglas-Fir biogeoclimatic zone, moist maritime subzone
CWH	Coastal Western Hemlock biogeoclimatic zone
CWHxm	Coastal Western Hemlock biogeoclimatic zone, dry maritime subzone
GEL	Georgia Lowland
GIF	Ground Inspection Form
GINPR	Gulf Islands National Park Reserve
GIS	Geographic Information System
GPS	Global Positioning System
ILMB	Integrated Land Management Bureau
MAL	Ministry of Agriculture and Lands
MOE	Ministry of Environment
MOFR	Ministry of Forests and Range
NAL	Nanaimo Lowland
QA	Quality Assurance
RISC	Resource Information Standards Committee
RIC	Resource Inventory Committee
SEI	Sensitive Ecosystem Inventory
SGI	Southern Gulf Islands
SOG	Strait of Georgia
SSI	Saltspring Island
TEM	Terrestrial Ecosystem Mapping
TRIM	Terrain Resource Information Management
WREC	Wetland and Riparian Ecosystem Classification

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1.0 INTRODUCTION

This project was initiated by Integrated Land Management Branch (ILMB) and the Ministry of Agriculture and Lands (MAL) (together referred to in this report as the client) as a means to characterize the ecosystems of the Coastal Douglas-Fir moist maritime (CDFmm) biogeoclimatic subzone. This area has been identified as a high priority for comprehensive land-use planning and conservation initiatives. Accordingly the client needs accurate and comprehensive baseline information that can be used to support these initiatives.

We used Terrestrial Ecosystem Mapping (TEM) methodology to achieve this goal. TEM is a standardized set of protocols for bioterrain and ecosystem mapping supported by field data collection and geographic information systems (GIS) mapping and interpretation. Final deliverables for this project include

1. Digital TEM maps for the study area.

2. A set of hardcopy TEM maps themed by structural stage.

3. An expanded legend showing all mapped ecosystems.

4. All field data.

5. This technical report.

The report starts with an introduction of the study area location followed by a description of the biophysical setting in section two. The project objectives and deliverables are expressed in section three and the ecosystem mapping methods are explained in section four. The results of the CDFmm mapping project are presented in section five, including ecosystem and terrain descriptions for ten geographic areas progressing north to south. The results are summarized into tables and graphical representations and discussed further in sections six and seven. The map legend (Appendix IV) and expanded legend (Appendix VI) can be found appended to the end of the report along with other relevant reference material.

1.1 Location

The CDFmm occurs in southwestern B.C., covering ecosystems along the eastern coastline of Vancouver Island, the southern Gulf Islands, parts of the Sunshine Coast and a portion of the Fraser Valley. However, for this TEM project and report, the Fraser Valley and the Gulf Islands National Park Reserve were excluded.

On Vancouver Island, Deep Bay marks the northern extent of the CDFmm while Metchosin marks the southern boundary. From Deep Bay moving south, the subzone extends along the Strait of Georgia from sea level to an approximate elevation of 150 m above sea level (asl) and includes the major centres of Nanaimo, Duncan, and Victoria. The CDFmm covers or partially covers all of the Gulf Islands south of Cortes Island including: Texada, Hornby, Denman, Lasqueti, Gabriola, Valdes, Galiano, Thetis, Kuper, Saltspring, North Pender, South Pender, Mayne, Saturna, Sidney, and smaller islets in between. Across the Strait of Georgia, the CDFmm covers portions of Lund, Powell River, Sechelt, and the Fraser Valley for a total area of approximately 252,000 hectares (Figure 1).

Figure 1. Geographic extent of the CDFmm biogeoclimatic subzone.

1.2 Background

The CDFmm covers only a very small proportion of the land mass of B.C., yet it falls within one of the most densely populated areas of the province. Its mild, warm climate makes it attractive for residential, agricultural, commercial and industrial development. The cool-Mediterranean climate and ecosystem conditions that characterize the CDFmm continue south through Puget Sound, with only the northernmost tip in Canada.

The extent and condition of naturally-occurring ecosystems and wildlife have been directly impacted by anthropogenic disturbances such as logging, agriculture, invasive species, land alienation, resource extraction, altered drainage patterns, urban sprawl, and fire suppression. The continuing pressure for disturbance, combined with the restricted distribution of the subzone and its ecosystems, has resulted in mounting interest for comprehensive conservation planning.

Logging has historically been one of the primary industries in the region. With its proximity to population centres and markets, and gentle topography, the productive, accessible Douglas-fir forests of the CDFmm were the first to be harvested in BC. Around the same time logging began, the fertile lowland soils were cleared for agriculture. Growth of commercial and industrial activities contributed to land use changes (BCMELP, 1999a).

The area has experienced extensive land use changes associated with agriculture (namely forest clearing, drainage alteration, draining of wetlands) and forest harvesting (namely conversion of old-growth to second-growth forest). Now however, the area supports a rapidly growing population, drawn by the relatively mild climate and natural beauty. Today the spread of urban and suburban development is the most significant factor affecting the remaining low-elevation CDF ecosystems.

Accompanying the impacts of urban development is the loss of biodiversity due to the suppression of wildfire. Mature Douglas-fir trees are adapted to have thick bark that protects the tree from low-intensity fires which historically occurred in the CDFmm area every 100 to 300 years (Stoffels, 2000).

Fires have been largely eliminated from the landscape over the past century and as a result many of the fire-adapted indigenous plant species and communities are being replaced by an influx of non-native invasive plants which thrive in this modified disturbance regime (i.e., fire suppression).

Ecosystems throughout the CDFmm are currently listed as critically imperiled in a global context by the B.C. Conservation Data Centre (CDC). Currently, 35 plant communities are provincially red or blue-listed in the CDFmm (B.C. C.D.C. 2008) (Appendix I). Most forested site series and wetlands are on these lists, including 28 red-listed forested communities, herbaceous meadows, woodlands, and wetlands and 7 blue-listed herbaceous and forested wetlands. Of these 35 communities, 17 are listed as globally "imperiled" (S2) or "critically imperiled" (S1), while 3 are secure or apparently secure (where their occurrence in B.C. represents the northernmost extent of a larger range), and 11 are not yet ranked.

A similar search of the database for red and blue-listed species occurring in the CDFmm yielded 218 records, including unique populations and subspecies or varieties (Appendix I). Several marine species, including fish, mollusks, and marine mammals, were listed since their range falls within or overlaps the CDFmm. Of the 218, 30 occurrences were endemic to B.C., including six populations of genetically unique stickleback. There were 101 blue-listed taxonomic units and 117 red-listed units, including the six stickleback populations. Of the total, 16 were globally listed S1 or S2, with the vast majority having secure or apparently secure populations in terms of their global occurrence. Several subspecies or varieties were lacking in information on that specific taxonomic unit, but the species overall were ranked as globally secure.

The CDFmm portion of the lower mainland and southern Vancouver Island is unique in the province in that a relatively large portion of the landbase is privately owned. This contributes to the complexity of developing an overall strategy for managing the landbase.

1.3 Project Study Area

The study area for this project includes the entire CDFmm excluding the Gulf Islands falling within the Gulf Islands National Park Reserve (GINPR) and approximately 42,000 hectares within the Fraser Valley.

The islands within the GINPR (North and South Pender Islands, Saturna Island, Prevost Island, Mayne Island, Sidney Island and surrounding islets) were not included in this project because they were recently TEM mapped by Parks Canada and will complement this project. The CDFmm in the Fraser Valley was considered a lower priority and is already heavily modified, so was not included in the study area. The total area TEM mapped by Madrone totals 212,660 hectares (Figure 2).

In some cases, particularily on warm aspects, the CDFmm extends above 150 m. The adjacent biogeoclimatic unit above the CDFmm on eastern Vancouver Island and the Gulf Islands is the the eastern variant of the very dry maritime subzone of the Coastal Western Hemlock zone (CWHxm1). The western (slightly cooler and wetter) variant, CWHxm2, is directly above the CWHxm1 in the study area. Within the study area CWHxm1 and CWHxm2 were mapped on peaks of Saltspring Island and Cowichan Valley (Figure 2).

Figure 2. Project study area and biogeoclimatic subzones.

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1.4 Project Timeline

The CDFmm TEM project was initiated by ILMB (the client) in fall 2006. The ILMB was the primary sponsor of the project; however, co-sponsors included Islands Trust Fund and The Bulkley Valley Centre. In-kind contributions were made by Ministry of Environment and B.C. Parks. The project was divided into two years of work, described in more detail below in sections 1.4.1 and 1.4.2. Year 1 of the project was scheduled from October 2006 to March 31st 2007. Year 2 commenced in October 2007 and was completed June 2008.

1.4.1 Year 1

From the onset of this project it was determined by all sponsoring parties that a CDFmm TEM pilot project should be completed prior to mapping the entire CDFmm sudy area. Saltspring Island (SSI) was chosen as the pilot project study area and was allocated priority for mapping, field work, reporting, and map production. The deliverables for year one included a preliminary TEM map and technical report for SSI, 15% field verification of Crown land TEM polygons on SSI, 10% field verification of private land TEM polygons on SSI, preliminary bioterrain and ecosystem pretyping, and a summary report for the remainder of the study area, excluding the Saanich Peninsula and Greater Victoria where current air photos were unavailable. A total of $175,000 was funded by ILMB and $60,000 by Islands Trust for year one of the project.

1.4.2 Year 2

Year 2 of this project began in late October 2007. The project continued with 7% field verification of TEM polygons on Crown lands and 17% verification of TEM polygons on privately owned land within Islands Trust jurisdiction. Madrone field staff completed over 930 field plots throughout the entire study area (excluding SSI) between October 2007 and February 2008. Madrone also contacted private landowners for permission to access areas on the Gulf Islands. The deliverables for year two included final Resourse Information Standards Committee (RISC) standard digital TEM deliverables for the entire study area, a set of TEM maps and this accompanying technical report. A total of $285,000 was funded by ILMB, $160,000 by the Bulkley Valley Centre and $26,000 by the Islands Trust.

2.0 BIOPHYSICAL SETTING

The ecosystems mapped in the CDFmm include forested units and non-forested units, wetlands, and sparsely-vegetated ecosystems. There is a great diversity and variability of ecosystems in the CDFmm subzone as a result of the interactions between climate, terrain, and vegetation. Two classification schemes in B.C. help to place the ecosystems into their respective vegetative, terrain and climatic context. The Ecoregion Classification and the Biogeoclimatic Ecosystem Classification (BEC) systems offer a framework for describing the variation of vegetation, climate and topography in the CDFmm subzone.

2.1 Ecoregion Classification

The CDFmm is situated within the Georgia Depression ecoprovince, which lies between the Vancouver Island Mountains and Coast Mountains. Within this ecoprovince, the CDFmm covers four ecosections: the Strait of Georgia (SOG) ecosection and portions of the Georgia Lowland (GEL), Nanaimo Lowland (NAL) and Southern Gulf Islands (SGI) ecosections. The climate in this sub-region is cool mesothermal with long dry, warm summers and relatively mild, wet winters during which temperatures seldom fall significantly below freezing.

Localized meso- and micro-scale effects create some fine-scale variability relative to the regional mean values. Aspect has a pronounced effect on growing season duration and moisture availability. Perhaps the most important factor affecting terrestrial ecology is the summer moisture deficit, which arises from the relatively dry summers from July through September.

2.2 Biogeoclimatic Ecosystem Classification

The BEC system is a framework that groups similar sets of landscapes into a site classification. Sites are classified on their potential to produce similar vegetation communities within similar environmental site conditions. Site series are representative ecosystems in each biogeoclimatic subzone in the Province. Site series are specific to a subzone and primarily correspond to forested ecosytems that repeat across each biogeoclimatic subzone.

The typical site conditions, such as soil, terrain and climate combined with the interaction of vegetation, animals and insects make up the ecosystems in the CDFmm (Green & Klinka, 1994). Additional non-forested ecosystems, such as wetlands, are also based on the BEC system (Mackenzie & Moran, 2004).

Although the focus of this mapping exercise is the CDFmm, we also mapped adjacent areas in the CWHxm subzone, which lies above and along the western edge of the CDFmm. In the project area, the CWHxm was mapped on the peaks of Saltspring Island and Cowichan Valley however the full extent of the CWHxm was not mapped (Figure 2).

The CDFmm is in the rainshadow of the Vancouver Island Mountains as well as the Olympic Mountains in Washington. It therefore receives less precipitation than adjacent biogeoclimatic units. The Pacific Ocean moderates temperatures throughout the area, creating long growing seasons and pronounced growing season water deficits on zonal and drier sites. The CDFmm represents the mildest climate in Canada.

The adjacent CWH zone is characterized by a cooler, wetter climate during the growing season. The CWHxm (dry maritime) subzone, adjacent to the CDFmm in the project area, is further subdivided into eastern and western variants (CWHxm1 and CWHxm2, respectively), with the CWHxm2 slightly wetter and cooler than the CWHxm1, and mapped immediately above it at the highest points on Saltspring Island (Mount Sullivan and Hope Hill), above approximately 600 m.

Table 1 includes some representative climate station data from Environment Canada stations throughout the CDFmm to provide an indication of the variability and mean values for temperature and precipitation.

Table 1. Climate Normal Data (1971-2000) for Stations Throughout the CDFmm.

Station	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Cortes Island	Daily mean (°C)	3.4	4.6	6.5	9.1	12.7	15	18	18	15	10.1	5.9	3.7	10.2
50° 4.800' N	Std. Dev. (°C)	1.7	1.4	1.3	1.2	1.1	1.1	1.1	1.1	1.2	0.8	1.5	1.6	1.3
125° 1.800' W	Daily max (°C)	5.4	7	9.4	13	16.6	19	22	22	18	12.7	8	5.5	13.2
06.10 m	Daily min (°C)	1.4	2.2	3.5	5.6	8.8	12	14	14	11	7.4	3.8	1.8	7.0
Station ID	Rainfall (mm)	148	121	111	89	70.2	65	51	59	72	150	207	168	1308.8
1021950	Snowfall (cm)	24.8	12.2	5.5	2	0	0	0	0	0	0.6	4.9	19.9	69.9
Delta Ladner South	Daily mean (°C)	2.8	4.5	6.6	8.9	12.2	15	17	17	14	9.5	5.4	3.1	9.6
49° 4.200' N	Std. Dev. (°C)	1.8	1.5	1.1	1.1	0.7	1	0.8	1	1	1	1.9	1.9	0.5
123° 4.800' W	Daily max (°C)	5.8	7.9	10.5	14	17.2	20	23	22	19	13.8	8.7	6	13.9
02.00 m	Daily min (°C)	-0.3	1	2.6	4.2	7.2	9.9	11	11	8.6	5	2	0.2	5.3
Station ID	Rainfall (mm)	104	102	92.2	70	56.8	45	34	33	57	93.2	155	134	976.5
1102417	Snowfall (cm)	10.6	7.9	0.7	0	0	0	0	0	0	0.1	2.7	9.5	31.6
Gabriola Island	Daily mean (°C)	3.7	4.3	6.1	8.5	11.7	14	17	17	14	9.3	5.6	3.3	9.5
49° 9.000' N	Std. Dev. (°C)	1.3	1.7	0.9	0.8	1.3	1	1.1	0.8	1.1	0.9	1.7	1.5	0.7
123° 43.800' W	Daily max (°C)	6.6	7.7	10	13	16.6	19	22	22	19	13.4	8.8	6	13.8
46.00 m	Daily min (°C)	0.8	0.8	2.2	4	6.6	9.6	11	11	8.4	5.1	2.4	0.6	5.3
Station ID	Rainfall (mm)	116	96.8	85.1	57	44.9	41	26	28	39	80.9	143	127	884.3
1023042	Snowfall (cm)	13.7	9.1	1.8	0	0	0	0	0	0	0.3	3.9	10.9	39.7
Nanaimo A	Daily mean (°C)	2.7	4.2	6.1	8.8	12.3	15	18	18	15	9.7	5.4	2.9	9.8
49° 3.000' N	Std. Dev. (°C)	1.6	1.5	1.1	1	1.2	1.1	1.1	1.1	1.2	0.8	1.6	1.7	0.6
123° 52.200' W	Daily max (°C)	6.2	8.2	10.9	14	17.8	21	24	24	21	14.6	9.1	6.1	14.7
28.40 m	Daily min (°C)	-0.8	0	1.3	3.4	6.7	9.7	12	12	8.6	4.8	1.5	-0.4	4.9
Station ID	Rainfall (mm)	142	123	106	63	49.9	45	26	32	39	97	191	166	1078
1025370	Snowfall (cm)	27.2	16.3	5.6	0.2	0	0	0	0	0	1.1	7.8	22.8	80.9
Saanichton CDA	Daily mean (°C)	4	5.1	6.7	9	12	15	17	17	14	10.2	6.4	4.3	10
48° 37.200' N	Std. Dev. (°C)	1.6	1.4	1.2	1	1	1	0.9	1	1	0.8	1.5	1.5	0.5
123° 25.200' W	Daily max (°C)	6.7	8.1	10.2	13	16.4	19	22	22	19	13.8	9.2	6.8	13.8
61.00 m	Daily min (°C)	1.3	2.1	3.2	4.9	7.5	9.9	12	12	9.8	6.6	3.6	1.8	6.2
Station ID	Rainfall (mm)	127	98.7	75.5	47	38.9	35	21	28	32	79.3	154	145	879.8
1016940	Snowfall (cm)	10.9	4.5	1.2	0	0	0	0	0	0	0.3	1.2	8.2	26.2
Victoria Airport	Daily mean (°C)	3.8	4.9	6.4	8.8	11.8	14	16	16	14	9.8	6.1	4	9.7
48° 39.000' N	Std. Dev. (°C)	1.6	1.5	1.1	1	1.1	0.9	0.7	0.9	1	0.7	1.5	1.5	0.6
123° 25.800' W	Daily max (°C)	6.9	8.4	10.5	13	16.6	19	22	22	19	14.2	9.5	6.9	14.1
19.20 m	Daily min (°C)	0.7	1.4	2.3	4.1	6.9	9.3	11	11	8.4	5.3	2.7	1	5.3
Station ID	Rainfall (mm)	122	98.8	75.8	45	36.5	32	20	24	30	75.6	144	138	841.4
1018620	Snowfall (cm)	15.2	9	2.4	0	0	0	0	0	0	0.2	3.3	13.8	43.8
Qualicum River	Daily mean (°C)	3	4	5.6	8.3	11.7	15	17	17	13	9.1	5.4	3.3	9.3
49° 23.400' N	Std. Dev. (°C)	1.6	1.5	1	0.9	1	0.9	0.9	1	1	0.7	1.6	1.6	0.5
124° 37.200' W	Daily max (°C)	5.7	7.3	9.5	13	16.4	19	22	22	18	13	8.3	5.8	13.3
07.60 m	Daily min (°C)	0.3	0.8	1.6	3.9	7	9.9	12	11	8.4	5.2	2.4	0.7	5.2
Station ID	Rainfall (mm)	177	151	115	69	50.9	47	28	37	52	137	214	186	1264
1026565	Snowfall (cm)	16.2	12.4	3.5	0.2	0	0	0	0	0	0.4	3.7	13.8	50

2.3 Geologic Setting

The CDFmm straddles the Georgia Strait, occupying a broad physiographic unit called the Georgia Depression by Holland (1976). Within this unit, Holland further identified three areas, namely the Nanaimo Lowland, Georgia Lowland, and Fraser Lowland.

The Nanaimo Lowland is located on the western side of the Georgia Strait, and includes southeast Vancouver Island and the Gulf Islands. The area is composed of flat to gently tiled sedimentary rocks of the Nanaimo Group. The northeast-southwest orientation of the Gulf Islands reflects the southeast dip of these rocks; the ridges generally consist of harder sandstones, and the valleys in between are typically mudstones or shales.

The Georgia Lowland forms a narrow coastal strip on the eastern side of the Georgia Depression, including the Sunshine Coast up to Powell River. It is a diverse landscape shaped by complex tectonic activity, bedrock structure, glacial events and post-glacial deposits.

A third subdivision of the Georgia Depression is the Fraser Lowland which includes the Fraser Valley.

Bedrock outcrops mapped by the B.C. Geological Survey[1] and in part, observed in the field inspections include:

- Upper Cretaceous Nanaimo Group: undivided sedimentary rocks occurring along the eastern coast of Vancouver Island and the majority of the Gulf Islands.

- Middle to Upper Triassic Karmutsen Formation: basaltic rock occurring predominantly on Texada Island, Lasqueti Island, and North and South Thormanby Islands, and in pockets along the east coast of Vancouver Island and other lesser islands.

- Late to Early Cretaceous unnamed dioritic intrusive rocks along the west coat of the mainland in the Sunshine Coast and Powell River areas.

[1] *The Map Place – BCGS Geology Map: http://webmap.em.gov.bc.ca/mapplace/minpot/bcgs. Accessed March 25, 2008.*

- Middle to Upper Triassic Vancouver Group: limestone, marble and calcareous rocks of the Quatsino Formation occuring in pockets on Texada Island.

- Middle to Upper Devonian Mount Sicker Group: Nitnat and Maclaughlin Ridge Formations – calc-alkaline volcanics and volcaniclastics occurning in pockets in the Cowichan Valley area and on Saltspring Island.

- Late Devonian Saltspring Plutonic Suite: granodioritic intrusive rocks occuring in pockets on southern Saltspring Island and in the Greater Victoria area.

- Late Triassic Mount Hall Gabbro: gabbroic to dioritic intrusives occuring in pockets on southern Saltspring Island, in the Greater Victoria area, and on lesser islands nearby.

2.4 Glacial History

The Georgia Depression experienced multiple episodes of glaciation and deglaciation during the Pleistocene Epoch (beginning 1.8 million years ago and ending 10,000 years ago) of the Quaternary Period (Bichler *et al*., 2002). The most recent glacial cycle was Fraser Glaciation (Clague, 1994). The early phases of this glaciation were characterized by the growth of alpine glaciers on both sides of the Georgia Depression, as well as the expansion of the Cordilleran Ice Sheet, covering much of western Canada. At the peak Glaciation, the Cordilleran Ice Sheet overrode Georgia Strait and enveloped Vancouver Island. Quaternary sediments associated with this glaciation cover the majority of the study area.

Approximatley 15,000 years before present, the climate began to warm and the ice sheets slowly melted and retreated. The retreat of Fraser Glaciation ice was essentially complete by about 10,000 years, which coincides with the beginning of the Holocene Epoch. Sediments deposited during this non-glacial period are typically formed by modern processes still observable in the study area today.

Sea levels fluctuated above and below present levels during the Quaternary Period due to subsidence of the land surface related to the weight of overlying ice, isostatic uplift associated with the removal of the ice, global sea level changes, and tectonism. The land mass of Vancouver Island has risen (relative to sea level) by 50 m – 300 m in elevation due to isostatic rebound since deglaciation. Within the study area, this uplift has resulted in marine and glaciomarine deposits at elevations up to180 m asl.

The majority of the study area is covered by glacial and related sediment deposits laid down during a period of high sea level between 19,000 and 13,000 years ago (Bichler *et al*., 2002). These glacial-related sediments originated largely from marine, deltaic, and fluvial environments near the margins of Pleistocene glaciers (Clague, 1994).

Several deposits have been characterized. Quadra sands are outwash sediments that typically consist of cross-stratified, well-sorted glaciofluvial sands. These sediments were deposited in front of advancing glaciers, and can now be found up to 100 m asl. Vashon Drift consists of silty sandy till and sandy gravelly glaciofluvial and glaciolacustrine sediments initially deposited along the margins of overriding ice lobes. As the study area started to become ice-free some 13,000 years ago, thick deposits of the Capilano Sediments marked the ice retreat with glaciomarine and marine sediments deposited on the seafloor. These deposits are now seen as raised deltas and intertidal beach sediments. The Capilano Sediments also consist of glaciofluvial deposits and can be found up to 180 m asl in the study area.

In a general cross-section from the coast to inland uplands, low-lying areas adjacent to shorelines commonly consist of glaciomarine and marine deposits, and may also include finer textured deposits possibly associated with impounded lakes or locally protected marine embayments. Glaciofluvial sands and gravels are also common throughout low-lying areas, river valleys, and where streams exit confined gully systems forming fans. On middle and upper slopes, surficial material commonly includes silty, sandy diamictic till deposits, with colluvial deposits and exposed bedrock outcrops.

2.5 CDFmm Vegetation

The coastal variety of Douglas-fir is the principal tree species in the CDF. Douglas-fir forests originally blanketed most of the area, with the exceptions of scattered bedrock outcrops, wetlands, meadows and a small number of non-forested sites. This productive forest has provided the foundation for industrial forestry.

Natural and anthropogenic disturbances have changed the vegetation structure and stand age of upland ecosystems in the study area. When the tree canopy is removed in this subzone a characteristic succession of pioneer vegetation establishes.

Other tree species found in the CDFmm include redcedar, grand fir, bigleaf maple, arbutus, and Garry oak. Hundreds of plant species occur in the subzone, including a variety of shrubs, herbs, mosses and lichens. A more detailed description of ecosystems in the CDF are provided later in this report and in the expanded legend.

3.0 OBJECTIVES AND DELIVERABLES

The purpose of this project was to complete ecosystem mapping for the CDFmm study area. The mapping was to be completed at a scale of 1:16,000 using Resource Information Standards Committee (RISC) standards at modified survey intensity 5, following the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RISC, 1998b). In addition to the standard attributes collected for TEM, ILMB and MOE requested that further TEM parameters be collected, including continuous riparian polygons, disturbance history, separating smaller pure polygons containing sensitive ecosystems, and completion of conservation evaluation forms during collection of ground inspections and full plots.

The final project objective was to produce the following deliverables:

- A complete set of organized, boxed, and labeled hardcopy air photos with field plot locations identified and final ecosystem and terrain polygons delineated.

- A complete ecosystem and terrain attribute database for all mapped polygons.

- A field sampling program following a modification of the Survey Intensity Level 5 using a combination of Ecosystem Field Forms (FS882), Ground Inspection Forms (GIFs, FS212) and visual checks in a ratio of 5:20:75, With sampling on Crown land over a minimum 7% of polygons and 15% on Islands Trust lands.

- A seamless GIS layer of the final mapped ecosystem polygons merged with the GINPR TEM polygons (if available) in ArcInfo coverage format (RISC, 2000, 2002, 2003.

- A GIS layer of the field plot locations in ArcInfo coverage format.

- A complete error-free VENUS database containing all field data.

- A GIS layer and associated database containing all background plots from relevant ecosystem mapping projects that were used to support mapping.

- A database of Conservation Data Centre (CDC) Conservation Evaluation forms (BCMOE, 2006) completed at each full and ground inspection plot.

- A final expanded legend and report summarizing methods, results, interpretations, conservation recommendations and a detailed description of each mapped ecosystem.

- A TEM map legend.

- Final thematic maps depicting the spatial distribution of old, mature, young and immature forests, Garry oak ecosystems, non-forested areas, riparian/wetland areas, and anthropogenic or urban areas.

4.0 METHODOLOGY

Mapping was completed according to the methodology outlined in the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RISC, 1998b). The TEM method utilizes the hierarchical biogeoclimatic ecosystem classification system approach. Ecoregions and biogeoclimatic zones represent the broad scale regional and climatic landscape units. Ecoregions are further subdivided into ecosections; biogeoclimatic zones are subdivided into subzones, which are themselves divided into variants.

Polygons are then delineated based on differences in bioterrain and ecological features. Bioterrain mapping identifies terrain features and landforms, while ecological mapping identifies site series (plant communities), site modifiers (e.g., aspect, slope) and structural stage. These bioterrain and ecological features are determined through digitized image or aerial photograph interpretation and verified by field sampling.

The following sections describe in further detail how these methods were applied to the CDFmm TEM project. As this project was carried out in a condensed time frame, most activities were concurrent, rather than in the order listed.

4.1 Background Research and Data Sources

In year one of the project, a mosaic of monochrome and colour aerial photographs of varying scales and years were acquired from ILMB for the majority of the project area. These photos were then prepared for interpretation. Preparation included boxing, north arrows and delineation of the study area boundary. In some areas there were gaps in the photo coverage and additional photos were ordered. In some areas where photos were not available or outdated, photos were acquired in Year 2. The majority of the photos were flown by the Province with the remainder flown by McElhanney Consulting Services Ltd. and Intergrated Mapping Technologies Inc. A full list of the aerial photographs and roll information is available in Appendix II.

Background materials on the geomorphology, vegetation ecology, land management, sensitive ecosystem inventory, rare element occurrences, Garry oak communities, aggregate resources, soils, and rare species were researched. Where permission was granted, numerous projects including sensitive ecosystem inventory and TEM that was previously carried out in portions of the CDFmm on private, Federal and Provincial Crown land were collected to provide additional information and data (BCMELP, 1999, BCMELP, 2001; Dunster & Booth, 2001; Madrone, 2002; Madrone, 2003; Madrone, 2005, Madrone 2008b).

Digital GIS datasets were provided by ILMB and Islands Trust. Access to Terrain Resource Inventory Mapping (TRIM) data for the entire project area, as well as orthophoto and satellite imagery, parks and protected areas, digital elevation models, hillshades, sensitive ecosystems inventory (SEI), and land tenure, was provided by ILMB.

The Islands Trust provided GIS datasets containing administrative boundaries, land tenure and prior Islands Trust ecosystem mapping. Madrone also obtained ecoregion, ecosection, and biogeoclimatic boundaries from the ILMB land and resources data warehouse.

4.2 Pre-typing Aerial Photographs

Photos were pre-typed for bioterrain (surficial geology material, texture, thickness, expression, processes, modifiers, and drainage) following the *Guidelines and Standards to Terrain Mapping in British Columbia* (RIC, 1996), the *Terrain Classification System for British Columbia* (Howes and Kenk, 1997) and the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RISC, 1998b). Bioterrain pre-typing was revised based on internal QA. Completed pre-typed photos of representative areas were sent to external quality assurance by Ms. D. Spaeth-Filatow, P. Geo., MoE, to ensure accuracy and consistency across the study area.

After adjustments were made to incorporate the QA, these sections were then pre-typed for ecosystem mapping, which consisted of subdividing bioterrain polygons where multiple discrete ecosystem types, aspects, and/or stages occurred, and adjusting the existing bioterrain polygons to correspond with the ecosystem polygons (RISC, 1998b). Pre-typed linework for SaltSpring Island was then sent to C. Cadrin and T. Lea, MoE, for QA.

4.3 Cascade Control

During year one of the project, all of the aerial photographs were cascade-controlled by Andrew Neale Digital Mapping. This procedure entails transferring geospatially referenced control points from high level TRIM photography into each typed photo. Control points situated close to the four corners of each typed photo are critical to ensure the accuracy of the monorestitution setup and transfer. The cascade control procedure followed the provincial standards (RISC, 2000, 2004).

The area covered by this project encompassed over 1400 air photos, requiring cascade control for approximately 700. Each section of the project area was cascade-controlled prior to pre-typing. In Year 2, new photos were received for the Saanich Peninsula and Thetis / Kuper Islands Trust Area and were subsequently cascade-controlled prior to pre-typing.

4.4 Monorestitution

Data capture of the pre-typed, cascade controlled aerial photographs was completed by Chartwell Consultants Ltd. following monorestitution guidelines (RISC, 2000, 2004).

In Year 1, Saltspring Island, Powell River, Texada Island, Lasqueti Island and Sechelt were monorestituted. In Year 2, the remainder of the study area was monorestituted.

Monorestitution following field work maximizes efficiency, after pre-typed line work was finalized through field verification and QA. This sequence minimizes the need for repeated digital editions and extensive cross-tracking of edits on photos and databases as polygons are adjusted. For this project, monorestitution was almost always completed prior to field work (excluding the Cowichan Valley and Saanich Peninsula) to provide field crews with maps to target field sampling based on polygon distribution and representation. This approach resulted in extensive post-field work and post-QA linework edits, which significantly added to the workflow for all project components.

4.5 Development of a Working Legend

Bioterrain attributes such as surficial material type and surface expression, soil drainage, soil depth, slope, aspect, and slope position were used to guide the development of an ecosystem working legend. Biogeoclimatic subzone profiles were created using the terrain features that typically correspond with the development of predictable ecosystem types. Preliminary field data and existing background information were integrated to develop a working legend prior to beginning field work (RISC, 1998b: Table 6.1). This legend was refined following ground truthing where modifications warranted, and ultimately integrated into a series of landscape profiles for the study area (See Figures 3 and 4 in Section 5.2)

4.6 Field Sampling

Field sampling methods followed provincial standards for TEM data collection (RISC, 1998a, 1998b). Sampling efforts were conducted by two teams, each led by an ecosystem and a bioterrain specialist. Polygons were sampled using three types of plots: full ecosystem plots with site, soil, vegetation and wildlife descriptions (FS882); ground inspection plots (FS212); and visual inspections (also recorded on FS212).

Spatial coordinates of each plot were recorded by a handheld GPS unit in addition to pin-pricks on the aerial photographs. A digital photograph was taken at each full and ground plot, as well as most of the visual plots.

Conservation evaluation forms (BCMOE, 2006) were filled out for all full and ground plots in the project area, except in protected and disturbed areas. Parameters include rare elements occurrences, disturbance sources, resilience, fragmentation, and presence of invasive species. These evaluations are used to prioritize areas for conservation efforts.

A stratified sampling strategy was designed to collect field data from as many types of ecosystems as possible throughout the study area. Full and ground plots were concentrated on sites likely to support zonal ecosystems, infrequently-occurring ecosystems, rare species, mature stands, and typical ecosystems representing all site series and positions on the edaphic grid mapped. Additional plots were included to confirm structural stages, site series, proposed new or non-correlated ecosystem types, and ecosystem types that were difficult to identify from the air photos (e.g., fluctuating water table sites and some disturbed sites).

Visual inspections were used to confirm site series, structural stages, identification of some disturbed and anthropogenic areas, and areas not accessible for more detailed plots because of access limitations. Disturbance features and riparian zones were noted, as well as other features of interest.

In order to clarify the boundary within transitional zone between the CDFmm and CWHxm subzones, elevational transects from high to low elevation were completed in accessible areas. Cool and warm aspects were assessed to identify the variability associated with topography in the study area. Pre-typed photos, draft maps, and plot data for areas where data potentially supported localized biogeoclimatic unit (i.e., zone, subzone, or variant) delineation adjustments were sent to the Regional Ecologist for approval of proposed changes.

4.6.1 Field Sampling – Year 1

Field work on Saltspring Island was conducted in January, March and April of 2007. Most sites were visited by vehicle, on foot, and by water taxi.

We aimed to sample 25% of polygons across Saltspring Island, with 50% polygon visitation rates in provincial parks and candidate areas identified by BC Parks at a ratio of 5:20:75 full:ground:visual sampling intensity. A total of 523 plots were assessed in the field: 25 full plots, 114 ground inspection plots, and 384 visual inspections. Sampling included public and private lands with landowner consent, supported by the Islands Trust.

4.6.2 Field Sampling – Year 2

Field work for the remainder of the study area was carried out between October 2007 and March 2008. For all areas sampled, most plots were visited by vehicle, on foot, or by water taxi. A draft field sampling plan was prepared in early September 2007. Following approval, Madrone field teams and provincial correlators completed plots on Maple Mountain and Mt. Richards in the Cowichan Valley on October 16 and 17, 2007. Field correlations ensured consistent field data collection for all field crews in accordance with the RISC (1998a) standards.

In early October 2007, a field crew of six Madrone staff completed 179 plots within Powell River, Texada Island and Savary Island. Provincial correlators Corey Erwin, Kim Everett and Sid Tsang conducted field work QA and reported on their findings to Madrone crews, who made the requisite adjustments to field sampling and data collection for subsequent plots.

Between October and December 2007, a field crew of two sampled 180 plots in the Cowichan Valley. This region contains the highest elevations in the study area. Results indicated a local revision of the CDFmm/CWHxm boundary was necessary. In early March 2008, Regional Ecologist Andy Mackinnon accompanied Madrone crews in the field and recommended that the CDFmm/CWHxm boundary should be moved from its present 150 m to 380 m.

A total of 62 plots were collected over four days on Denman and Hornby Islands in mid-December, 2007 by one crew of two. Field work assessing 76 plots across Sechelt and Lasqueti Island was conducted in mid-December, 2007. Sechelt field work was completed by one team of two; Lasqueti Island fieldwork was completed by local vegetation ecologist Doug Hopwood and one Madrone bioterrain team member.

A total of 215 plots were collected in the Bowser, Qualicum, Parksville, Nanaimo, and Ladysmith areas between November 2007 and February 2008. Kim Everett and Sid Tsang conducted field work QA in the Qualicum area.

The remainder of the Gulf Islands field work (Gabriola Island, Valdes Island, Thetis Island, and Galiano Island) was completed in early 2008, assessing 136 plots.

The Saanich Peninsula and Capital Regional District were sampled in February 2008. A total of 87 plots were collected in this area.

A total of 76 full plots, 399 ground inspection plots and 983 visual checks were completed by the Madrone team in 2007/8 (Table 2). Sampling included public and private lands (within the Islands Trust). Additional visual plot data were employed from existing projects (TEM, SEI, ecological assessments, and conservation evaluations) to fulfill the sampling intensity required to meet the project objectives while minimizing duplication of previous efforts. Plot data was entered into the provincial database VENUS 5.1 and checked for errors.

Table 2. Plot Summary: Sampling Intensity by General Location

Region	Full plots	Ground plots	Visual plots	Total plots	Conservation evaluation forms
Powell River	4	14	48	66	18
Texada Island	6	32	75	113	38
Sechelt and Lasqueti Island	4	25	47	76	17
Denman and Hornby Islands	4	16	42	62	20
Parksville and Qualicum	8	47	98	153	53
Gabriola Island	2	9	35	46	5
Valdes Island	1	1	9	11	2
Thetis Island	1	6	15	22	7
Nanaimo and Ladysmith	2	30	30	62	32
Cowichan Valley	8	55	117	180	58
Saltspring Island	25	114	384	523	0
Galiano Island	3	11	43	57	14
Saanich Peninsula and Greater Victoria	8	39	40	87	38
Totals	**76**	**399**	**983**	**1458**	**302**

4.7 Final Typing and Ecosystem Labelling

Following field work, preliminary bioterrain and ecosystem line work was adjusted. Ten percent of the photos from each section of the study area were then sent to Sid Tsang for final bioterrain mapping QA to ensure the mapping met the RISC standard.

Draft hard-copy maps were then created displaying final polygons. Each was assigned a unique number labeled within each polygon centroid. These maps were then used in conjunction with the aerial photographs to complete the ecosystem mapping. The ecosystem mappers reviewed the aerial photographs and applied ecosystem labels integrating all available data sources (e.g., field plots, background research, and bioterrain labels).

Each ecosystem label is coded using a standard format to describe the vegetation, site conditions, structural stage, stand composition, and disturbance. Ecosystems are assigned up to three ecosystem codes, each comprising a quantified proportion of the polygon area using deciles.

Ecosystems, with the exception of wetlands are coded using two upper case letters indicated in the the provincially correlated TEM code list[2], including sparsely vegetated, non-vegetated, and anthropogenic units. Wetlands are classified following the Wetland and Riparian Ecosystem Classification system (WREC) which is based on the BEC system (Mackenzie & Moran, 2004). They are assigned a four character code, and are considered a site series number in the database. The first two characters are letters (the first letter uppercase, and the second lower) while the second two characters are numbers. Where an ecosystem does not correspond to a designated unit, new codes were proposed to the Provincial correlators based on the field data collected.

Each ecosystem code has assumed (typical) site condition modifiers and may also have atypical site modifiers coded using individual lower case letters. The site series and/or site modifier is followed by the numerical structural stage designation (1 through 7). Structural stages describe the dominant seral stage for the ecosystem unit (RISC, 1998a).

[2] *http://www.env.gov.bc.ca/ecology/tem/list.html*

An optional structural stage modifier (a single lower case letter) further characterizes the structural stages. A stand composition modifier (single upper case letter) may follow the structural stage and/or structural stage modifier to differentiate forest stands based on proportions of coniferous and broadleaf canopy. For this project, the confierous modifier was assumed for all forested stands with a stand composition modifier applied when the situation was otherwise.

Disturbance type and subtypes where also mapped when apparent. Logging and land clearing represented the primary type of disturbance mapped in the study area.

Portions of the study area were submitted to Corey Erwin for the initial ecosystem mapping QA. Feedback was addressed by the ecologist that mapped the area and reviewed by the other mappers to ensure consistency throughout the study area. An internal QA process was established between Madrone ecosystem mappers, featuring continual communication, and detailed review of map work.

4.8 Database

As areas were completed and finalized, ecosystem and bioterrain map codes were entered into the standard Excel database (RISC, 2002). Once an area was complete, the database was imported into ArcGIS 9.2 and joined to the ecosystem polygons based on the unique polygon identifier. This preliminary join would highlight correspondence errors in the database.

The revised database had a one-to-one relationship between the spatial and non-spatial datasets. Mapsheet, ecosection and subzone fields were populated. The final database was then imported back into Excel and subjected to futher QA using the TEM Data Capture application (DC Tool). This tool highlights errors where there are non-standard ecosystems and bioterrain attributes. The final database was confirmed as error-free by the DC Tool utility, with the exception of non-standard or updated codes (e.g., wetlands) that the tool does not recognize.

4.9 Map Products

Following finalization of the northern half of the study area, a meeting between Madrone, ILMB and MoE was held in early March 2008 to ensure that the final maps would reflect the vision of the client. The client's highest priority was that the maps illustrated where Crown land intersected the forested ecosystems of the CDFmm and depicted the age classes (i.e., structural stages) of those forests. Mapped locations of Garry oak ecosystems, non-forested ecosystems, and wetland/riparian areas were also requested.

The study area was subdivided into 9 1:50,000 maps for ease of interpretation and application. The maps were created in ArcGIS 9.2 using a personal geodatabase as the platform for spatial data storage and management. A custom annotation file was created for the entire study area containing park names, cities and towns, unincorporated areas, major streams and rivers, major highways, and island names. The annotation overlays the following base data: parks and protected areas, Crown land ownership boundaries, major roads, and TRIM streams, rivers, and lakes.

A thematic layer was created that categorized the TEM data into eight classifications: old forest (structural stage 7), mature forest (structural stage 6), young forest (structural stage 5), immature forest (structural stage 3 – 4), Garry oak ecosystem (any Garry oak ecosystem type), non-forested (all non-forested ecosystem types), wetland/riparian (defined ecosystem types), and non-natural (any anthropogenic map unit). Non-forested ecosystems included rock outcrops, meadows, woodlands, coastal bluffs, beaches, and shorelines. Wetland ecosystems included marshes, fens, bogs, swamps and estuaries. Non-natural units included urban areas, agricultural areas, industrial sites, mine sites, roads, and golf courses.

Final thematic maps can be found in Appendix III.

4.10 Project Limitations

Project limitations included accessibility; project scheduling; historic and contemporary disturbance; minimum polygon size; and air photo coverage, year, and scale.

The air photo coverage provided for the project area varied in age, scale and flight direction. Most of the air photos for the entire project were at either 1:16,000 or 1:15,000, with small areas of overlapping flightlines of different scales. In the Cowichan Valley a significant portion of the map was derived from 1:10,000 scale air photos which resulted in a much smaller mean polygon size (9.5 ha) as compared to the rest of the study area (12.5 ha).

The airphotos used to map the study area spanned 25 years (1980 to 2005). A high percentage of the changes that have occurred in the CDFmm have taken place in the past 25 years, particularly due to urbanization but also due to logging. These changes are not accurately reflected in the mapping, thus creating inconsistency of mapping throughout the entire CDFmm, and in particular, of site disturbance, and the loss of ecosystems from urbanization. The use of both colour and black and white air photos (especially in the Cowichan Valley) may have resulted in some inconsistency in interpretation.

Access to private property was the primary limitation to sampling. Public land was inaccessible when surrounded by unroaded private lands. While every effort to sample consistently across the study area was made, not all ecosystem types could be directly observed.

In an effort to minimize this limitation, we based our mapping around these questionable areas on supporting information and background research.

The field sampling schedule (October through February, but including March and April in Year 1) greatly limited the effectiveness of the sampling with regard to complete species lists and general data collection accuracy. Field crews were rushed to complete a significant amount of sampling in an extremely short time frame during the winter months. Some of the data collected on Hornby Island and in the Nanaimo / Ladysmith area was completed in the snow; we suspect that the species lists collected in these plots are incomplete. In general, the winter sampling limited the efficacy of the ecological sampling, particularly with respect to annual indicator plants and classification of species guilds. In some sites, especially those dominated by herbaceous meadows and Garry Oak ecosystems, repeated sampling throughout the year results in a more comprehensive inventory of species composition since communities represented vary substantially throughout the growing season (Erickson and Meidinger, 2007).

The widespread (extensive) nature of disturbance and modification to the ecosystems throughout the study area was a critical factor affecting ecosystem classification and interpretation. Prevalence of exotic species, forest harvesting and regeneration of forest species that differ from those that would occur under natural succession and agricultural utilization altered the species and ecosystem dynamics of the study area.

To ensure sites were classified appropriately, topography, surficial geology, geomorphological history, soils, drainage, and (where available) local historical information was also evaluated where diagnostic plant communities differed from those expected at a site.

5.0 RESULTS AND DISCUSSION

Section 5.1 describes observed soil types and patterns across the landscape with respect to the regional terrain and geomorphology, and representative plant communities for various soil types. The results of the mapped ecosystems and dominant vegetation types are captured in Section 5.2. Section 5.3 contains bioterrain and vegetation descriptions for the ten geographic subregions in the study area. Finally, Section 5.4 summarizes the results integrated across the entire CDFmm study area.

5.1 Soil Landscapes

The following soil descriptions are based on background information summarized on the Ministry of Sustainable Resource Management's website describing the soil landscapes of B.C.[3], as well as observations made in the field.

Glaciation has produced a wide range of parent materials from which the majority of the soils of the study area have formed. Soil development in the area also occurs on modern sediments such as fluvial and marine deposits, and also from physical and chemical weathering of exposed bedrock.

The soil Orders identified in the project area include Brunisols, Podzols, Regosols, and to a lesser extent, Gleysols and Organics. The most common soil Great Groups in the area are Dystric Brunisols.

[3] *Ministry of Sustainable Resource Management Soils website: The soils landscape of British Columbia http://srmwww.gov.bc.ca/soils/landscape/part3.html. Accessed February 17, 2008*

Sombric Brunisols are the next most common. These soils typically occur in the drier, forested sites (i.e., site series CDFmm/01 to /04) supporting predominantly Douglas-fir, Garry oak, and arbutus. These sites may contain grand fir, which prefer slightly moister and richer sites. The most widespread parent materials were medium to coarse-textured till. Also occurring throughout the study area, but to a lesser extent are glaciomarine and glaciofluvial deposits. We also encountered exposed bedrock outcrops in many of our sample plots.

Humo-Ferric Podzols are also common in the project area. They occur predominantly in lower elevation inland valleys that support well established coniferous forests. These soils were also found in drier forested sites with moderately dense Douglas-fir and western hemlock. A moderately dense understory layer was found at most observed sites (which were dominated by younger forests). Podzolic soils are typically associated with glaciomarine and till deposits, and less frequently on glaciofluvial deposits.

Regosols occur where there has been little to no soil development overlying parent materials. Surficial materials associated with Regosols in the project area include fluvial and glaciofluvial deposits, thin colluvial deposits, and weathered bedrock. They occur on recent fluvial deposits such as along smaller streams and rivers, where the vegetation includes black cottonwood, red alder, and willow.

We also encountered Regosols on steep bedrock-controlled slopes. Some of these sites did not support forest vegetation.

Gleysols were rare in the area. They occur on very gently sloping to flat terrain, or low-lying moisture receiving areas associated with marine, glaciomarine or fluvial deposits, or saturated thick till deposits. These soils develop on the wetter ecological sites (i.e., site series CDFmm/06-09, and /12-/14). Typical vegetation includes red alder, black cottonwood, willows, skunk cabbage, and hydrpohytic sedges. However, Gleyed subgroups of Brunisols and Podzols were common.

Organic soils occur where the decay of organic residues is inhibited by a lack of oxygen caused by submersion or saturation (i.e., CDFmm/10 and /11). Organic soils were observed in the project area in wetlands and along forested areas adjacent to wetlands. Fibrisols were the most commonly observed organic Great Group, and typically consist of undecomposed sphagnum and forest litter.

Moderately decomposed organic soils (Mesisols) are less common, and were usually indicated by sedges, hardhack, mosses, willows, grasses, and reeds (i.e., fens). Mesisols are typically richer in nutrients because seepage inflows from adjacent mineral soils rather than from precipitation alone, as is the case with Fibrisols. Well-decomposed Humisols occur only rarely in the project area. Vegetation found on Fibrisols in the study area typically consists of shore pine with Labrador tea and sedges with hardhack.

5.2 Ecosystem Overview

There were a wide range of ecosystems represented throughout the CDFmm (Figures 3 and 4), and many are in disturbed states. This diversity of ecosystems consists of 14 forested site series (including three floodplain units and three fluctuating water table units), 17 wetland and estuary ecosystems, 19 non-forested ecosystems (including nine non-forested and ten sparsely-vegetated site series) and 14 anthropogenic units.

Forested ecosystems consist primarily of second-growth stands. Regenerating stands range from recent clearcuts to dense young stands and maturing forests. The past and current history of land clearing for agricultural practices has contributed to widespread invasive and weedy species colonizing many habitats, especially open sites. Urbanization and some industrialization have contributed to a high loss of ecosystems, particularly in the most southern portion of the study area.

The majority of the CDFmm was actively logged over the last 80 – 90 years, creating large areas of younger forest and alienated lands resulting from land use conversion. Substantial portions of the CDFmm are still dominated by forested ecosystems, consisting of a patchwork of different structural stages, but with negligible old-growth remaining (structural stage 7). In general, forest soils within the CDFmm are mesotrophic to rich (compared to forest soils in other biogeoclimatic zones), and support productive forest stands (Nuszdorfer *et al.*, 1990).

Mature forests of the CDFmm are dominated by the coastal variety of Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) throughout most of the regional landscape.

Tree species composition of forest stands varies considerably as a result of human disturbance, and also varies from that expected under natural succession regimes due to silviculture and disturbance. Mature and old growth forests are rare in the CDFmm. Less than 1% of the subzone remains in old forest condition as a result of logging and clearing of land for human settlement (BCMWLAP, 2004).

The understory vegetation in upland Douglas-fir forests is characterized by salal (*Gaultheria shallon*), sword fern (*Polystichum munitum*), Oregon-grape (*Mahonia* spp.) and feathermosses.

On drier sites and bedrock outcrops, Douglas-fir stands are joined by arbutus (*Arbutus menziesii*) and occasionally Garry oak (*Quercus garryana*). Baldhip rose (*Rosa gymnocarpa*), common snowberry (*Symphoricarpos albus*), oceanspray (*Holodiscus discolor*) and electrified cat's-tail moss (*Rhytidiadelphus triquetrus*) are frequent in the understory. Forests on lower slopes with moist to subhygric soils will typically contain western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), grand fir (*Abies grandis*), and bigleaf maple (*Acer macrophyllum*) in the canopy, with ladyfern (*Athyrium filix-femina*), spiny wood fern (*Dryopteris expansa*), salmonberry (*Rubus spectabilis*), Indian-plum (*Oemleria cerasiformis*), skunk cabbage (*Lysichiton americanum*), and leafy mosses in the understory.

A variety of other tree species thrive in the mild coastal climate of the CDFmm, adapted to a gradient of site moisture and nutrient regimes.

Less common trees include shore pine (*Pinus contorta* var. *contorta*), Sitka spruce (*Picea sitchensis*), Pacific yew (*Taxus brevifolia*), bitter cherry (*Prunus emarginata*), western flowering dogwood (*Cornus nuttallii*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), and rarely, trembling aspen (*Populus tremuloides*).

The disturbed character of many ecosystems presented challenges typical of the CDFmm when identifying and classifying sites in the field. The typical suite of characteristics – including indicator plants, species presence and distribution, and structural attributes – often differed considerably from what was expected in the undisturbed, mature to old seral stands used to develop the classifications (Green and Klinka 1994). This highlighted the importance of assessing soil and bioterrain characteristics, and evaluating site features that did not rely solely on vegetation, particularly mesoslope position, drainage, and disturbance history.

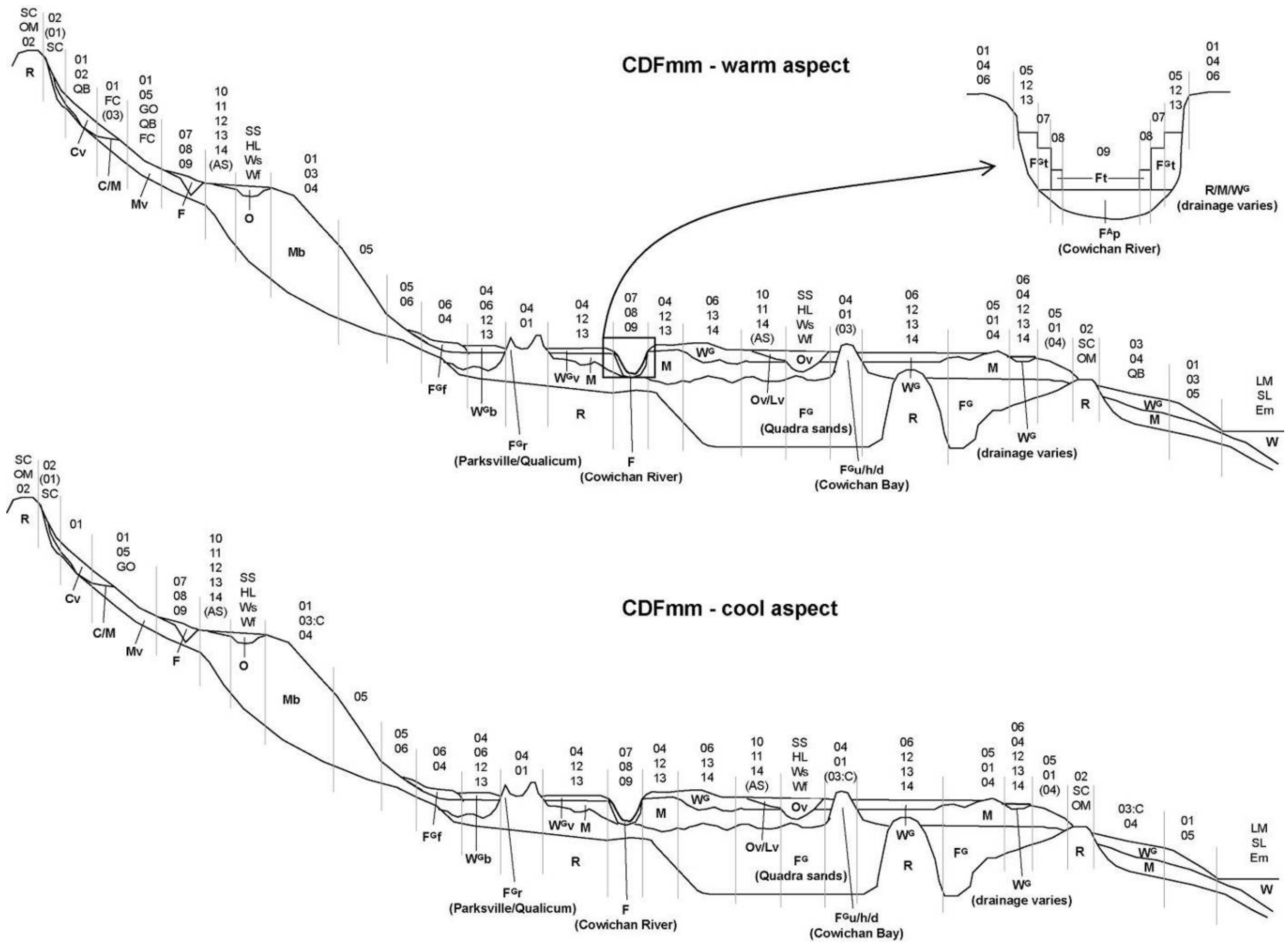

Figure 3. Landscape profile of CDFmm ecosystems in the project area.

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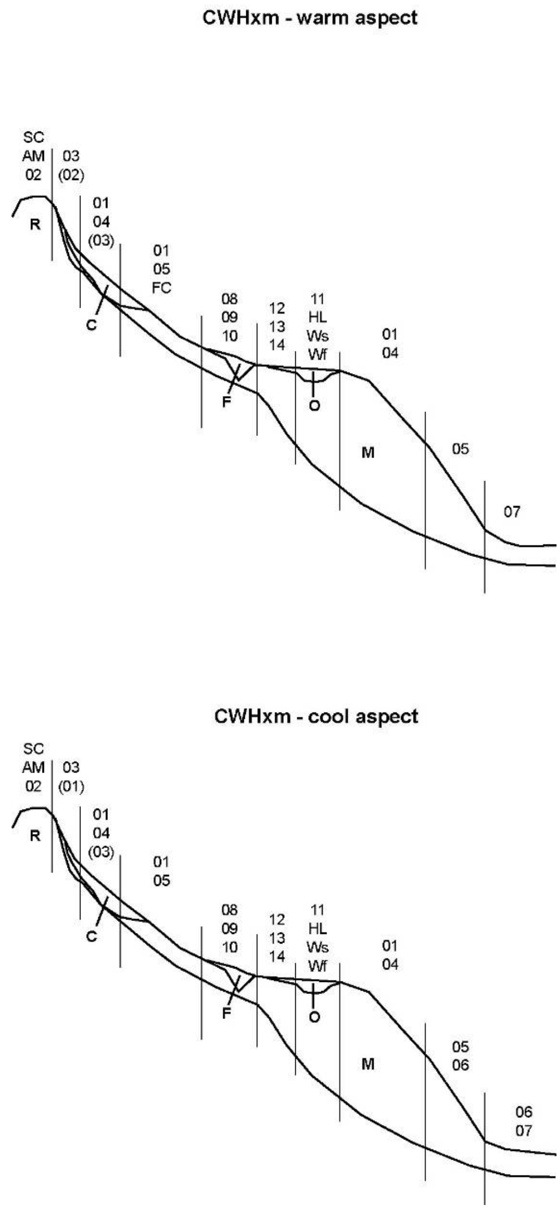

Figure 4. Landscape profile of CWHxm ecosystems in the project area.

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5.3 Subregional Location Descriptions

This section provides an overview of the each of the ten subregions in the study area based on the sequence of mapping from north to south. Table 3 outlines the major commuities and geographic location of each subregion. The following descriptions provide notes on special features with respect to their location, typical surficial material and soils as well as dominant vegetation and ecosystems.

Table 3. Geograhic Locations of Subregions Mapped in the Project Area

Map	Subregion	Major Communities and Islands
1, 2	Powell River	Powell River, Lund, Hernando Island, Savary Island, Harwood Island
2	North Texada Island	North Texada Island
3	Sunshine Coast, southern Texada Island, and Lasqueti Island	Northern Sechelt area, Thormanby Island, Southern Texada Island, Jedadiah Island, Lasqueti Island
4	Denman and Hornby Islands	Denman Island, Hornby Islands
4, 5	Parksville and Qualicum	Bowser, Fanny Bay, Qualicum, Parksville
5, 6, 7	Nanaimo, Ladysmith and Gabriola Island	Nanoose Bay, Nanaimo, Gabriola Island, Newcastle Island, Ladysmith
7, 8	Saltspring Island	Saltspring Island
7, 8	Galiano Island	Galiano Island
7, 8	Chemainus and Cowichan	Chemainus, Crofton, Valdes Island, Thetis Island, Reid Island, Kuper Island, Duncan, Cowichan Bay, Cobble Hill, Mill Bay, Maple Bay
8, 9	Saanich Peninsula and Greater Victoria	Saanich Peninsula, Greater Victoria

Powell River – Maps 1 and 2

Location

This subregion follows the lower elevations on the east side of the Strait of Georgia from Lund to Powell River, including Hernando, Savary, and Harwood Islands.

Bioterrain

Surficial materials within the Powell River subregion are predominantly thick, gravelly and diamictic sandy glaciomarine deposits found at elevations below 100 m asl. Above this, silty sandy diamictic till mantles were observed, grading into the glaciomarine deposits further downslope.

Gravelly, sandy glaciofluvial deposits are located in the southern area where several active and inactive gravel quarries were located. Hummocky and undulating bedrock outcrops are located throughout the area with thin soil overburden and well to very rapidly drained soils. Thin organics were found in small discrete wetland areas accompanied by imperfectly to poorly drained soils.

Glaciomarine materials support Orthic Humic Gleysols with moderately well to imperfectly drained soils on gentle to level ground, and Orthic Humo-Ferric Podzols with well drained soils on steeper gradients. Orthic Dystric Brusinsols and Orthic Humic Regosols were observed on rapidly-drained glaciofluvial sites. In general, the glaciomarine-derived soils are moderately well drained, and the till and glaciofluvial deposits are well drained.

Savary Island is comprised of the thick glaciofluvial Quadra Sands with numerous debris slides and slumps observed along steep, eroding cliffs. During the Holocene, wind action has created eolian deposits in the form of dunes in the central and eastern portions of the island.

Vegetation and Ecosystems

The mainland portion of this subregion, including the land surrounding the City of Powell River, has been intensively logged and developed, with the remaining young forests dominated by Douglas-fir, often consisting of planted stands. Similarly, residential and industrial development on the adjacent islands has reduced the distribution of mature forests.

Several rare plants and vegetation communities were found on the shoreline dune ecosystems of Savary Island, including the provincially red-listed plant contorted-pod evening-primrose (*Camissonia contorta*) and the red-listed vegetation community dominated by large-headed sedge (*Carex macrocephala*). The steep sand dunes and cliffs support the Dunegrass–Beach pea site association and exposed soil map units, unless plot data showed otherwise. Douglas-fir is the most common tree species on these sites, with pockets of arbutus. The well-drained soils provide optimal conditions for shore pine on Savary Island. No Garry oak vegetation communities exist in this subregion of the project area.

The CDFmm/CWHxm transition was apparent in the field assessment plots around Lund and Savary Island where western hemlock was found scattered throughout.

North Texada Island – Map 2

Location

The CDFmm occurs along the northwest portion and western edges of Texada Island up to 150 m elevation.

Bioterrain

In this subregion, glaciomarine sediments were expected to occur up to approximately 100 m elevation; however, thick sandy glaciofluvial sediments, and thin diamictic sandy till mantles were found. Well drained glaciofluvial deposits are common throughout the area on gentle slopes and following local depressions. Glaciofluvial deposits give way to morainal and colluvial deposits, as well as bedrock bluffs and hummocks on steeper slopes. The tills tend to be in the form of well drained veneers to thin veneers; however, thicker deposits with moderately well drained soils occur in local depressions.

In the north along the west coast, a complex of thin deposits till and decomposed bedrock were common. Bedrock exposures are common on Texada Island, with numerous exposures of granitic rock. There are also numerous limestone quarries. Thin colluvial deposits are common along the bases of steep slopes. Other colluvial deposits occur along the west central island slopes along the shoreline where slumping was observed in oversteepened glaciofluvial slopes.

Thin, gravelly sandy glaciomarine and marine deposits are less common, occurring only in the Gillies Bay area and along low-lying shorelines. These areas are fine-textured and moderately–well drained. Organic deposits were mapped around small wetlands throughout the area, and were predominatly with fibric to mesic veneers.

Dystric and Eutric Brunisols are the most common soils on the island and they develop on both till and glaciofluvial deposits. Orthic Humo-Ferric Podzols were observed in till veneers, and an Orthic Humic Regosol was observed on a fluvial plain.

Vegetation and Ecosystems

Douglas-fir forests dominate Texada Island; however, most areas have been extensively logged. Recent clearcuts and blocks re-planted within the last five years are common.

The abundant deer populations on Texada heavily browse Douglas-fir and select understorey shrubs, modifying ecological sussession in the area. Limestone quarries occupy large areas in the northern part of Texada.

The Douglas-fir forests on northern Texada Island are predominately zonal ecosystems (Douglas-fir−Salal). The island contains a relatively high percentage of slightly wetter forests (Western redcedar−Douglas-fir−Oregon beaked moss), higher than the other subregions mapped in the CDFmm. These forests occur on flat or very gentle slopes (less than 5%), where compact marine sediments impede water drainage. Several moist, rich sites (Western redcedar−Skunk cabbage) containing Sitka Spruce, western redcedar and red alder occur on organic veneers. The wetter richer ecosystems (Western redcedar–Grand fir–Foamflower) were generally found alongside drainages between wetlands and from wetlands to the ocean. Rare fern species are known to occur on Texada within this ecosystem types.

Numerous wetlands are located on northern Texada Island and differ in ecosystem type according to drainage patterns. The dominant wetland types include fens and swamps (Sitka sedge−peat moss fen, Pink spirea−Sitka sedge swamp, Sitka willow−Pacific willow−Skunk cabbage swamp) which were dominated by sedges, hardhack and willows and red alder, respectively. Rare plants are associated with these wetland plant communities.

Rocky shoreline bluffs exist along the coast of north Texada Island containing a diverse vegetation assemblage in sharp contrast to the Douglas-fir forest ecosystems inland on deeper soils. The shoreline vegetation communities develop on bedrock and very shallow soils and are composed of several tree, shrub, herb, lichen and moss species that are well adapted to salt spray. A mixture of shore pine, Douglas-fir, Rocky Mountain juniper, common juniper, Nootka rose, and evergreen huckleberry occupy the tree and shrub layers. Life forms range from mature trees to stunted, windswept shrubs. An assortment of forbs, grasses, and sedges can occur in the herb layer, including entire-leaved gumweed and sea plantain. Several open water polygons complexed with sedge wetlands occur on northern Texada Island, supporting rare plant species and vegetation communities.

Sunshine Coast, Lasqueti Island and Southern Texada Island – Map 3

Location

The Sunshine Coast portion of the study area includes Sechelt and extends from Secret Cove to south of Smuggler Cove Marine Provincial Park. Lasqueti Island is located off the east coast of Vancouver Island between Parksville and southern Texada Island. This subregion also includes North and South Thormanby Islands between the Sunshine Coast and Texada Island.

Bioterrain

The Sechelt study area is draped by thick silty, sandy glaciomarine deposits on lower and middle slopes, and to a lesser extent gravelly, sandy glaciofluvial deposits along the lower slopes of the southern part of the subregion where glacial rivers flowed into the ocean. Thinner glaciomarine deposits change to well drained diamictic, sandy till veneers along the middle and upper slopes. Undulating and hummocky bedrock outcrops are distributed throughout the area, but predominantly on the middle and upper slopes, as well as along the shoreline. There are several organic deposits in the area that are associated with small lakes and active floodplains.

North Thormanby Island consists of thick, well drained glaciofluvial deposits (likely Quadra Sands) overlying a thin till veneer. Several slumps and small slides have occurred along the steep, high sandy bluffs adjacent to the shoreline. South Thormanby Island is dominated by a moderately well to well-drained silty sandy glaciomarine mantle. Thin, discontinuous till veneers and thin weathered bedrock veneers are typical on the higher-elevation bedrock outcrops found along the northern and eastern areas of this island.

Lasqueti and the smaller adjacent islands have undulating terrain with a few high elevations that were not inundated by marine and glaciomarine sediments. The majority of the low-lying land is covered by thick, sandy glaciomarine deposits with well to imperfectly drained soils. There are several hummocky bedrock exposures where rubbly, sandy colluvial deposits overlie these glaciomarine sediments. Diamictic sandy till mantles are present from 100 m to more than 150 m, and typically have well to moderately well-drained soils. There are a few areas with glaciofluvial deposits: along ancient river valleys on Lasqueti, and isolated areas along the smaller islands where Quadra Sands likely deposited.

Southern Texada Island is composed of a well-drained sandy gravelly glaciofluvial veneer and blanket, grading to well to moderately well-drained diamictic sandy till veneer along upper slopes.

Soils associated with these areas are Dystric Brunisols and and Orthic Humo-Ferric and Humic Podzols. Brunisols are assocated with the glaciomarine and colluvial deposits, while Podzols are found in the till and glaciofluvial sediments.

Vegetation and Ecosystems

Lasqueti Island contains diverse wetland ecosystem types. These wetlands are generally surrounded by wet, rich forest ecosystems (Western redcedar–Skunk cabbage) or the drier rich ecosystem (Western redcedar–Grand fir–Foamflower). The forests of Lasqueti Island were varied, but notably were not dominated by the zonal Douglas-fir−Salal type. They were unique within the CDFmm in that dry Douglas-fir–Shore pine–Arbutus forests were abundant, complexed with moss covered rock outcrops (Wallace's selaginella–Cladina community), in many places grading into dry, rich Douglas-fir–Grand-fir–Oregon-grape forests. Several larger polygons containing older forests on private land were mapped.

On the Sunshine Coast mainland, ecosystems consisted primarily of zonal Douglas-fir−Salal forests transitioning on rocky areas with shallow soils to dry Douglas-fir–Shore pine–Arbutus forests. Wetter, richer ecosystems are localized along streams and creeks (typically Western redcedar–Grand fir–Foamflower). On the wet (subhydric to hydric and fluctuating water table) sites, ecosystems ranged from fluctuating water tables (Western redcedar–Indian-plum and Western redcedar–Slough sedge) to the richer, slightly drier (subhygric) ecosystems (Western redcedar–Grand fir–Foamflower).

North Thormanby and South Thormanby support different forested ecosystem types. North Thormanby is relatively flat, and forests are generally richer zonal (Douglas-fir−Salal) mature forests, with some pockets of wetter forests (Western redcedar–Grand fir–Foamflower). Steep slopes and cliffs with seepage are abundant around the island.

South Thormanby forests are dominated by a mix of Douglas-fir–Shore pine–Arbutus forests, moss covered rock outcrops, and Douglas-fir−Salal forest. Some portions of the island contain moist pockets with fluctuating water tables characterized by Western redcedar–Vanilla-leaf and Western redcedar–Indian-plum associations. Several streams and small drainages contain the richer forested ecosystems.

Denman and Hornby Islands – Map 4

Location

Denman Island and Hornby Islands are just east of the east coast of Vancouver Island adjacent to Deep Bay. This subregion also covers the communities of Fanny Bay and Bowser.

Bioterrain

On both islands, surficial materials consist of predominantly glaciomarine sediments of variable thickness. These deposits extend from the shoreline to the island centres, and range from well to poorly drained. Morainal deposits occur in the central portion of the islands on hill tops above 100 m asl. Steep, exposed bedrock bluffs occur on the western sides of the islands. Both islands are comprised of Nanaimo Group sedimentary rock which consists of sandstone, conglomerate, and mudstone. Organic soils are scattered throughout the area in local depressions and on gentle terrain. These materials vary in thickness from veneers to blankets and are poorly to very poorly drained. Orthic Dystric Brunisols were found in all full plots associated with glaciomarine deposits.

Vegetation and Ecosystems

Mesic zonal Douglas-fir forests dominated Hornby Island; with small areas of the wetter richer ecosystem (Western redcedar−Grand fir−Foamflower). Several Garry oak ecosystems (Garry oak−Brome/mixed grasses) occurred throughout Hornby Island, including the southern tip, in the Heron Rocks area. Associated with the Garry oak ecosystems were native grasses and wildflowers. Native grasslands are extensive along the ocean edge of Helliwell Park and were classified and mapped as Fescue-Camas ecosystems. These sites have very shallow soils over bedrock and are very sensitive. A small trembling aspen stand was also identified at Heron Rocks (Trembling aspen−Slough sedge). Cultivated fields were common throughout the landscape, as well as rural areas where houses, small fields and trees were conspicuous features.

The ecosystems of Denman are similar to Hornby Island. A notable feature of Denman Island is the large recently harvested area in the northeastern portion of the island, which covers approximately one third of the island. The remainder of Denman Island consisted of cultivated fields and rural areas. Mesic zonal forests (Douglas-fir–Salal) were the dominant forest type, with drier forests on thin soils (Douglas-fir−Shore Pine−Arbutus) above the coastline. Fluctuating water table ecosystems (Western redcedar−Vanilla-leaf, Western redcedar−Indian-plum) occurred on level areas on compacted glaciomarine deposits, while the richer ecosystems, (Western redcedar−Grand fir−Foamflower), occurred along streams and between wetlands. Several large and numerous shrub dominated wetlands (Pink spirea−Sitka sedge swamp, Sitka willow−Pacific willow−Skunk cabbage swamp) were found on Denman Island.

Parksville and Qualicum – Maps 4 and 5

Location

The Parksville and Qualicum mapping area extends from several kilometres north of Bowser south to Nanoose, from the ocean to 150 m in elevation.

Bioterrain

The Parksville and Qualicum areas are generally flat, with some undulating terrain along the western boundary. Gravelly sandy marine and glaciomarine deposits of varying thickness dominate the terrain below 110 m asl, and are well to imperfectly drained.

Gravelly sandy glaciofluvial sediments are mapped further inland and along river systems, grading to glaciomarine sediments towards the coast. Drainage in these subregions varies from well to imperfect. The Englishman and Qualicum Rivers have produced thick fluvial deposits along the perimeters of their respective valleys, and there is evidence of similar deposits along their post-glacial floodplains.

Diamictic, sandy morainal deposits are less common, occurring predominantly along the western margins of the study area, on steeper slopes, and in steep cutbanks of creek channels where underlying sediments are exposed. Bedock outcrops are uncommon, and occur as scattered hummocks throughout the area.

Duric Dystric Brunisols with strongly cemented horizons were found in the thick glaciofluvial and till deposits, with Gleyed Dystric Brunisols found in a marine fan deposit. Orthic Humo-Ferric Podzols were observed on glently sloping and undulating glaciofluvial and glaciomarine deposits. Orthic Humic Regosols occurred in shallow weathered bedrock deposits, as well as with fine textured thick glaciomarine deposits. We also encountered Orthic Humic Gleysols developed where organic veneers overlay fine textured thick glaciomarine deposits.

Vegetation and Ecosystems

This area is generally flat with landforms dominated by glaciomarine and glaciofluvial deposits. These deposits in many places contained compacted horizons, which restricted percolation and created seasonally fluctuating water tables. Fluctuating water table ecosystems were widespread. The wettest type (Western redcedar–Slough sedge) was most frequent adjacent to wetlands, while the most common type mapped was Western redcedar–Indian-plum. On slopes steeper than 5%, drainage was free and forests graded into Douglas-fir–Grand fir–Oregon-grape or Douglas-fir–Salal ecosystem types, depending on nutrient availability. Typical species on these fluctuating water tables were Sitka spruce, western redcedar, and Douglas-fir. Skunk cabbage and lady fern dominated the understory, which developed over a thick layer of peat, corresponding most closely to the Western redcedar–Indian-plum association. These rich sites were mapped in the Bowser area. The rich moist ecosystem type Western redcedar–Grand fir–Foamflower was consistently found in riparian areas with deep soils.

Where the duric horizon was absent, the sandy glaciofluvial soils supported nutrient-poor forests of slow growing, occasionally stunted Douglas-fir and shore pine with understory indicators of low nutrient status, reflecting their subxeric, poor site conditions. This combination corresponsed to site series CDFmm/01 (Douglas-fir–Salal; Green and Klinka, 1994), but were typically drier and more nutrient-poor, transitional to site series CDFmm/02 (Douglas-fir–Shore Pine–Arbutus). These forests were extensive in the Parksville and Qualicum areas.

In this subregion, there were few areas of contiguous mature and older forests. Rathtrevor Park and Englishman River Estuary contained the oldest forests in the area. Other mature and older forests were being harvested during field assessments.

Nanaimo, Ladysmith and Gabriola Island – Maps 5, 6, and 7

Location

The Nanaimo subregion extends from Nanoose south through the City of Nanaimo to the Town of Ladysmith, from sea level to 150 m asl.

Bioterrain

The Nanaimo area generally transitions from flat to gently sloping beach deposits along the eastern coastline, to undulating terrain and rolling hills to the west. Slope steepness and the presence of scattered bedrock controlled slopes increases from the west of Highway 19 to the 150 m contour line that serves as the western boundary.

Below 110 m a.s.l, marine and glaciomarine deposits of varying thickness dominate the terrain paralleling the coastline, and particularly east of Highway 19. Pockets of hummocky to undulating bedrock slopes with thin soil veneers of coarse mixed fragments are scattered throughout this coastal lowlands. Coarse-textured glaciofluvial deposits and ablation tills are common (but in places there was uncertainty as to the origin of these deposits; some could have been glaciomarine). Surficial materials to the west of Highway 19 are till blankets and veneers on steeper terrain, deep glaciofluvial materials in valley bottoms and fan deposits where streams leave confined gully systems. Colluvium is rare, as are the steep bedrock slopes. The bedrock observed consisted primarily of sedimentary rocks of the Nanaimo Group.

The sediments in the Nanaimo area and the soils they support are typically coarse, gravelly-sandy, and well-drained; however, drainage can vary greatly depending on slope position and depth to the impermeable horizon. Soils are typically poorly developed Orthic Dystric Brunisols and Regosols. Humo-Ferric Podzols are primarily associated with well-established forests. We encountered isolated areas of imperfectly to poorly drained soils (Gleysols) in depressions and where perched water tables are formed over less permeable underlying sediments. Organic soils are rarely found in these sites.

On Gabriola Island, glaciomarine sediments are the dominant surficial material. These deposits range from gravelly sandy to sandy gravelly in texture, with drainage ranging from rapidly to well-drained. Morainal deposits occur only in the higher elevations at the centre of the island.

Soils tend to be thin near the coast, especially in the northern portion of the island where surficial materials are dominated by well to moderately-well drained veneers to thin veneers of weathered bedrock and glaciomarine sediments, with some sedimentary bedrock exposures. Steep slopes of bedrock and colluvium occur sporadically along the northeast and southwest sides of the island. Bedrock on Gabriola Island consists of Nanaimo Group sedimentary sandstone, conglomerate, and mudstone.

Vegetation and Ecosystems

The few non-fragmented and undisturbed ecosystems that occur throughout the subregion are primarily on Crown land. Many small younger zonal forest patches (structural stage 5) occur throughout the rural areas, in parks, and on Provincial and Federal Crown land. Drier forests complexed with well to rapidly drained moss-covered rock outcrops (Wallace's selaginella− Cladina communities) are common on the elevated sites where soils are shallow.

Garry oak sites are scattered in the Nanaimo area, and are generally associated with moss and herb-covered rock outcrops. Garry oak sites located in the Linley Valley−Departure Bay area exist on the margin of current residential and commercial development. More extensive Garry oak sites are mapped in the Nanoose area, particularly on the Department of National Defense lands. Scattered pockets occur on Provincial Crown land and some on private lands.

Several large herbaceous–moss communities containing rare plant species were mapped around Harewood Plains, Cable Bay, and the Linley Valley in Nanaimo. The Linley Valley has a wide range of mature forested ecosystems with high wildlife value, including riparian, zonal, Garry oak and dry forests. The Nanaimo River estuary is also a significant contiguous natural area, although highly disturbed. The previously undescribed map unit Nootka rose–Pacific crab apple was mapped along the river. A high percentage of the Nanaimo area has been mapped as urban and rural.

Saltspring Island – Maps 7 and 8

This area has been mapped in detail during Year 1 and has been described in Madrone (2008a).

Galiano Island – Maps 7 and 8

Location

Galiano Island is located east of Saltspring Island between Vancouver Island and the Fraser Valley and northwestern Washington State.

Bioterrain

Galiano Island consists of long narrow bedrock ridges and steep bluffs overlooking small valleys and shorelines (i.e., Lovers' Leap Viewpoint, Montague Harbour area, and Bluffs Park). Mount Sutil (323 m) and Mount Galiano (341 m) are the highest points on the island. There several other steep bedrock-exposed slopes aligned northwest to southeast. North-south passes across the island are limited to the area between Pebble Beach and Retreat Cove and the eastern tip of the island. Surface water drainage is controlled by the ridges, with predominantly seasonal streams flowing perpendicularly from the ridges to the beaches.

The steep, well to rapidly drained bedrock ridges and colluvial veneer complexes lead to interior lowlands with small valleys. Hummocky terrain in the lowland areas consists of well to moderately well drained, silty sandy tills, and pockets of gravelly sandy glaciofluvial blankets (observed to the east of Laughlin Lake only). In valleys, and on uniform slopes at and below 100 m, are finer textured glaciomarine and marine deposits that lead to beaches surrounding the island. Drainage in these small valleys and on the low gradient slopes leading to the shoreline ranged from well to imperfectly drained depending on the proportion of silts and clays. Soils encountered in both the till, marine and glaciomarine environments ranged from Orthic to Gleyed Dystric Brunisols. In some valley depressions, a few small wetlands and lakes have formed, with associated organic deposits typically developing moderately well decomposed soils.

Vegetation and Ecosystems

Galiano Island is the driest of the Gulf Islands characterized by long narrow ridges of sandstone which run the full length of the island. Stands of dry Douglas-fir – arbutus forests (Douglas-fir–Shore Pine–Arbutus) complexed with mesic zonal Douglas-fir forests (Douglas-fir–Salal) grow along these ridges. A mosaic of Garry oak ecosystems (Garry oak–Brome/mixed grasses) interspersed with grass (Fescue–Camas) and moss dominated ecosystems (Cladina–Wallace's selaginella) occur along south facing slopes.

Along the base and between these ridges is a combination of rich, moist and productive forests of wester redcedar and bigleaf maple (Western redcedar–Grand fir–Foamflower) mixed with zonal Douglas-fir forests (Douglas-fir–Salal). Where the underlying drainage is poor shrub and herb-dominated wetlands are present. Relative to the other Gulf Islands, Galiano Island has more mature and older forest (greater that 140 year old) and fewer cultivated fields.

Chemainus and Cowichan – Maps 7 and 8

Location

This subregion includes Chemainus, the Cowichan Valley, Valdez Island, Thetis Island, and Kuper Island. The western boundary extends up to 150 m.

Bioterrain

In the Cowichan Valley, glaciomarine sediments of variable thickness are the dominant sediments of the flat to undulating slopes below 100 m. These occur mainly south of the Cowichan River, especially on the south shores of Cowichan Bay. These marine sediments are easily seen in the scarp faces in the community of Cowichan Bay extending south to Mill Bay. Soil textures in our plots were typically silty to clayey silt. Drainage was typically moderate to imperfect.

Extensive deposits of sandy gravelly glaciofluvial materials also occur throughout the area. Soils that have developed on these materials are typically well drained and give rise to Orthic Dystric Brunisols (Jungen, 1985) on gentle slopes with well drained to moderately well drained soils.

Fluvial deposits are more common towards the estuaries of both the Cowichan and Chemainus Rivers. Smaller fluvial deposits occur in thin bands along the main creeks in the study area such as Stocking, Porter, Bonsall, and Hollings Creeks. Soils active fluvial environments along Hollings Creek are typically classified as a moderately well-drained Cumulic Humic Regosol.

Till is common above 100 m in this subregion. Most of the higher topography occurs north of the Cowichan River and includes the slopes of Mount Tzouhalem (497 m), Maple Mountain (525 m), Mt. Richards (353 m), Stoney Hill (200 m), and Grouse Hill (191 m).

These upper slopes are typically covered with moderately to rapidly drained sandy diamictic veneers and blankets of till. Orthic Dystric Brunisols are common (Jungen, 1985). Three full plots were completed in till-derived polygons. All were on gentle to moderately steep slopes that were well drained. Two were classified as Orthic Dystric Brunisols and the third was classified as Orthic Sombric Brunisol. Colluvial deposits and bedrock outcrops also occur on these slopes.

Organic deposits are rare in this area. The largest area of organic soil occurs along Richards Creek north of Somenos Lake, and another pocket occurs west of Dougan's Lake. These large areas of organic soils are used for agriculture; consequently no full plot data was collected in these areas. Soils data in an organic deposit were collected in a pocket of humic organic material towards Shawnigan Lake on Crown land at the end of Owl Road. This area of very poorly drained organic material was classifed as a Typic Humisol.

Vegetation and Ecosystems

The Cowichan Valley is a developed rural landscape, characterized by a mosaic of cultivated fields, forests and residential areas. Urban centres occur along the main highway corridor. There are extensive shoreline and coastal bluffs, most of which have been modified for residential housing. In the Cowichan Valley, most sampling was conducted on Cowichan Valley Regional Parks (CVRD) land, District of North Cowichan municipal forests, and Crown land. The majority of the landscape in the Cowichan Valley contains second-growth forest.

Zonal forest types (Douglas-fir–Salal) are very diverse in this area, and can be found on moderately dry (SMR 2) to submesic to mesic (SMR 4) site conditions. Mesic zonal sites occur on deep, medium textured soil, gentle slopes, and are dominated by salal in the understory. Douglas-fir dominates the canopy with admixtures of western redcedar, bigleaf maple, and grand fir. Submesic zonal sites tend to occur on shallow and/or coarse soils, steep slopes, warm aspects, and upper to crest mesoslope positions. Drier sites support less salal which is replaced by tall Oregon-grape. In submesic to subxeric Douglas-fir–Salal forests, arbutus becomes more common in the canopy, with less western redcedar, grand fir, and bigleaf maple.

Ecosystems that tend to develop on drier sites, such as the Douglas-fir–Shore Pine–Arbutus forest, typically occur in a mosaic with the non-forested Wallace's selaginella–Cladina community; this combination was quite common in the area. Both ecosystem types occurred on very shallow (often <10 cm) soils (i.e., Orthic Regosols to Non-soil) and warm aspects, occasionally occurring on cool aspects. The Douglas-fir–Oniongrass forest type was much less common, and almost always developed on warm aspect, upper slopes.

The Western redcedar–Grand fir–Foamflower association was also very common in this subregion in draws, adjacent to creeks or in moisture-receiving lower slopes. This forest type is distinguished from the Douglas-fir–Salal forest type predominantly by abundant bigleaf maple, with varying amounts of grand fir, western redcedar, and red alder, with Douglas-fir less frequent and salal only a minor understorey component. The understory is very lush in structural stages that contain canopy gaps, with rich site indicator species such as foamflower and vanilla-leaf.

Garry oak ecosystems are present but limited in extent and distribution. Most were found on dry rocky outcrops such as those found on Cobble Hill, Mt. Tzouhalem, and Maple Mountain. Scattered large Garry oak trees occur around the east side of Somenos Lake throughout residential developments, and scattered groves can be found in cultivated fields. Historically these ecosystems were mapped over a much broader range of sites than their current distribution (Lea, 2006).

The Douglas-fir– Grand fir –Oregon grape forest type is most often restricted to side slopes of creek draws, occurring both on till and glaciomarine substrates. This forest type occurred in various site conditions, but was relatively limited in this area. These forests have a constant presence of Douglas-fir, western redcedar, and sword fern.

Active floodplain ecosystems most often occur along main river corridors such as those of the Cowichan, Chemainus and Koksilah Rivers, but can occur to a lesser extent along some of the smaller tributaries. Quite often these riparian forests are mature or old forests, older than surrounding forests.

Extensive stands of grand fir, western redcedar and bigleaf maple characterize high-bench floodplain sites while stands of black cottonwood occur on mid-bench sites. Low-bench floodplain sites are shrub dominated by willow species and red alder. All have high wildlife value.

Ecosystems characteristic of fluctuating water tables, particularly the Western redcedar–Indian-plum were very common, while the wetter analogue Western redcedar–Slough sedge was restricted to wetland margins.

Extensive wetland complexes occur around Somenos Lake, as well as smaller scattered wetlands throughout the Cowichan Valley. The most frequent wetlands are the shrub swamp types: the Spirea–Sitka sedge and the Sitka willow–Pacific willow–Skunk cabbage associations. Cattail marshes were typically associated with lakes, ponds, and the margins around shallow open water. The estuary at Cowichan Bay was characterized by the Nootka rose–Pacific crab apple shrub-dominated ecosystem in complex with estuary meadows and marshes.

Saanich Peninsula and Greater Victoria (CRD) – Maps 8 and 9

Location

The CDFmm encompasses the entire Saanich Peninsula and Greater Victoria. This subregion is characterized by an urban landscape with developed shorelines and coastal bluffs.

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The Saanich/Victoria subregion can be roughly divided into four physiographic sections based on surficial materials and surface shape (Stanley-Jones and Benson, 1973).

The largest section in the Saanich/Victoria map area is the mountainous Highlands and Goldstream section in the west area along Finlayson Arm. The topography is moderately rugged, including Mount Finlayson (416 m) and Mount Work (446 m). Surficial materials in this area are typically well to moderately well-drained sandy diamictic till veneers. Outcrops of bedrock are common on high peaks and steep slopes, and the bedrock is hummocky to undulating.

The hummocky nature of the bedrock gives rise to small pockets of wetter soils in the lower areas. Colluvial deposits were observed along the steep slopes of along Finlayson Arm.

The second largest section is comprised of nearly level to gently rolling glaciomarine deposits that are characteristic of the Saanich Peninsula up to approximately 100 m. Plot data gathered in this area showed parent material that was typically silty glaciomarine with moderate to imperfect drainage. Horth Hill (136 m), Mount Newton (302 m), and Bear Hill (220 m) all rise above the rolling countryside on the peninsula and have well-driained sandy till veneers. Bedrock outcrops were also common. Due to the competent nature of the bedrock, colluvial deposits were uncommon. Glaciomarine materials are also found on the southwest side of the study area in Metchosin below 100 m (e.g., at Witty's Lagoon).

The third section is an extensive deposit of glaciofluvial sediments in the vicinity of Langford and Colwood. These deposits can be easily observed at the large gravel pit operations on Metchosin Road south of Esquimalt Lagoon. Soils in this area are sandy gravelly in texture and typically well to moderately well drained.

The fourth section is the Greater Victoria area. Much of this area was mapped as anthropogenic, indicating surficial materials have been significantly altered by excavation and pavement.

Vegetation and Ecosystems

Several provincial and regional parks, such as Mt. Douglas, Mill Hill, and Mt. Tolmie have excellent examples of Douglas-fir forests below Garry oak ecosystems.

These sites display clear vegetation zonation with elevation: Douglas-fir-Salal on deep, medium textured soil and gentle slopes; Douglas-fir–Shore pine–Arbutus forests on shallow, coarse soils and warm aspects; and Garry oak–Brome/mixed grasses woodlands on upper to crest slope positions. In general, the parks around Victoria and Saanich Peninsula represent fragmented islands of forested and non-forested ecosystems intersected by development and transportation corridors. Many of the remnant patches of forest tend to occur on sites with shallow soils and on rocky outcrops (e.g., Mt. Douglas and Mt. Tolmie). Douglas-fir-Salal forests in the subregion tend to occur on shallow soils with submesic to subxeric moisture regimes.

Most of the extant forests are second-growth (structural stages 5 and 6), with patches of older forest in John Dean Park.

The Western redcedar–Grand fir–Foamflower site series in this area was typically restricted to the bases of draws, riparian areas, and moisture-receiving lower slopes. These forest types often had a substantial hardwood component comprised of bigleaf maple and red alder, with varying amounts of grand fir and western redcedar. The understory was variable, but could support very dense vegetation featuring indicator species typical of richer sites.

Sites with fluctuating water tables occur throughout the Saanich Peninsula. The Western redcedar–Indian-plum ecosystem type was by far the most abundant, occurring frequently on level sites and particularly through channels of cultivated fields in sites with deep glaciomarine sediments. The wetter sites supporting the Western redcedar–Slough sedge ecosystem were less abundant, typically adjacent to small wetlands. The Western redcedar–Vanilla-leaf fluctuating water table ecosystem type was uncommon in this subregion.

Garry oak ecosystems are far more abundant in the Saanich Peninsula than in other areas. Two main Garry oak units occur: those developed on rocky outcrops and those on deep soils with a parkland character. The former was mapped as QB with a shallow soil modifier; the latter was mapped as QB with no shallow soil modifer. The rocky outcrop Garry oak units were most abundant near Victoria proper, represented on Mt. Douglas, Mt. Tolmie, and in Saanich and adjacent areas around the Highlands, Mt. Work, Gowlland Tod Provincial Park, and around Prospect and Elk Lakes.

The parkland Garry oak unit was most commonly found interspersed through the cultivated fields of Central and North Saanich where rich soils have developed from deep glaciomarine deposits to support large, robust Garry oak trees, in sharp contrast with the stunted Garry oak trees found on rocky outcrops.

The estuaries of Goldstream, McKenzie Bight, Witty's Lagoon and Island View Beach were a complex of the Nootka rose–Pacific crab apple shrub ecosystem and estuary marsh and meadows. Non-forested wetlands are uncommon in this area, and, where present, consist of shrub-dominated wetlands such as the Sitka willow–Pacific willow–Skunk cabbage swamp type. This unit occurs around Swan Lake and Blenkinskop Lake, among others, usually in a complex with marsh ecosystems such as the Cattail marsh.

5.4 Ecosystem Representation and Condition in the Study Area

A total of 17,621 ecosystem polygons were delineated in the CDFmm project area (212,660 ha), with an average polygon size of 11.6 hectares (ranging from 0.20 to 7,093 ha). The vast majority of mapped polygons (17,188 or 98%) were in the CDFmm subzone; the remaining polygons are in the CWHxm subzone. A list of the TEM units mapped in the project area is provided in the expanded legend in Appendix V. The legend includes site descriptions, assumed modifiers, site characteristics, photographs and plot reference numbers of each ecosystem unit mapped in the study area.

The project area does not include the Gulf Islands National Park Reserve (GINPR, established in 2003), which features nearly 3,500 ha of diverse ecosystems on primarily sandstone-derived, well-drained, drier landforms that are strongly influenced by ocean spray at lower elevations. Incorporating ecosystem information from the mapping completed in the GINPR would yield a more accurate representation of ecosystem distribution and status across the entire CDFmm. However, the defined scope for this project is restricted to interpretation and discussion of the previously defined project area.

5.4.1 Site Series and Ecosystem Units

The following results illustrate the ecosystems mapped in the CDFmm, including forested, non-forested, sparsely-vegetated, wetland and anthropogenic units. Tables 4 – 10 list the various ecosystem units mapped, the total area of each unit, and the percentage of the total project area.

In the CDFmm, 14 forested site series (including three floodplain units and three fluctuating water table units) comprised 61% (127,411 ha) of the study area. Natural non-forested ecosystems (including nine non-forested and ten sparsely-vegetated site series) made up 4% (9,888 ha) of the CDFmm. Lastly, 17 wetland and estuary ecosystems and 14 anthropogenic units were mapped totaling 2% (3,394 ha) and 33% (69,048 ha), respectively (Figure 5).

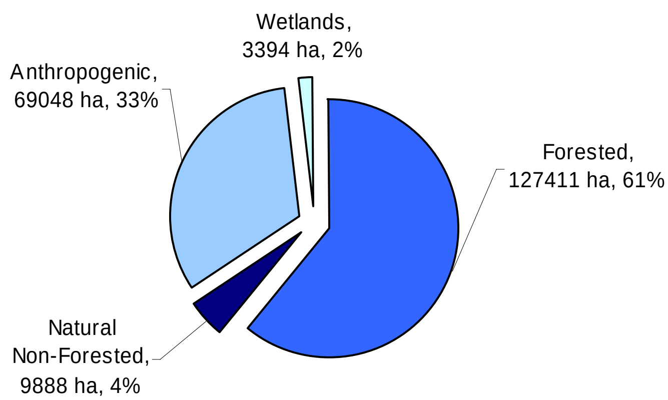

Figure 5. Distribution of ecosystem categories in the CDFmm by area and percentage.

The most common forested ecosystems within the CDFmm study area were the zonal Douglas-fir–Salal, the richer/wetter Western redcedar–Grand fir–Foamflower forest type, and the drier Douglas-fir–Shore Pine–Arbutus forest type comprising 37%, 7%, and 5% of the study area, respectively. Forested fluctuating water table sites (Western redcedar–Vanilla-leaf, Western redcedar–Indian-plum, Western redcedar–Slough sedge) were also fairly common collectively, representing 6% or almost 12,500 ha. Douglas-fir–Oniongrass, Shore pine–Sphagnum, Western redcedar–Skunk cabbage, and the forested floodplain ecosytems were the least common in the CDFmm study area (Table 4 and Figure 6).

Table 4. Ecosystems Mapped in the CDFmm Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Forested site series				
DS	01	Douglas-fir–Salal	77063	36.9
DA	02	Douglas-fir–Shore Pine–Arbutus	11044	5.29
DO	03	Douglas-fir–Oniongrass	1083	0.52
DG	04	Douglas-fir–Grand fir–Oregon-grape	3794	1.82
RK	05	Western redcedar–Douglas-fir–Oregon beaked moss	3935	1.89
RF	06	Western redcedar–Grand fir–Foamflower	15399	7.38
LS	10	Shore pine–Sphagnum	154	0.07
RC/Ws53	11	Western redcedar–Skunk cabbage	925	0.44
Forested floodplain site series				
RS	07	Western redcedar–Snowberry high bench floodplain	396	0.19
CD/Fm50	08	Black cottonwood–Red-osier dogwood medium bench floodplain	224	0.11
CW	09	Black cottonwood–Willow low bench floodplain	38	0.02
Forested fluctuating water table site series				
RV	12	Western redcedar–Vanilla-leaf	3107	1.49
RP	13	Western redcedar–Indian-plum	7956	3.64
CS	14	Western redcedar–Slough sedge	1426	0.68
Total Forested			127411	61

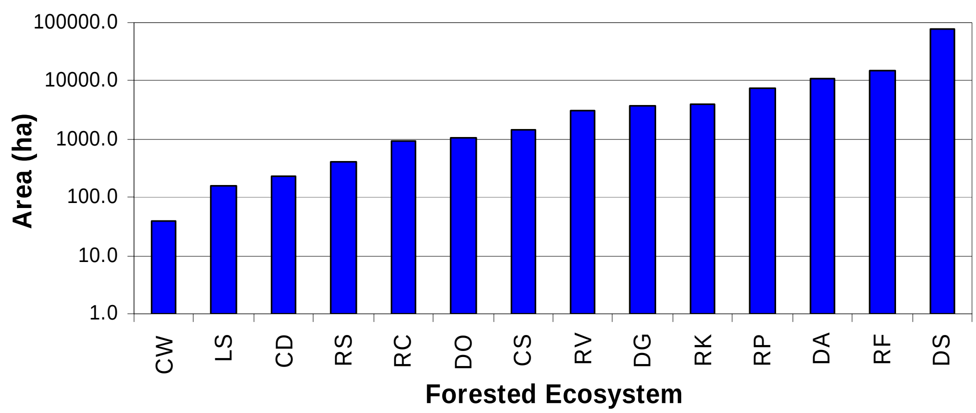

Figure 6. Distribution of forested ecosystem units in the CDFmm by area, including floodplain and fluctuating water table site series: note log area scale.

Natural non-forested ecosystems, including non-forested and sparsely vegetated ecosystems, represented 4% of the CDFmm study area, but, incorporating data from the Gulf Islands National Park Reserve would likely increase the coverage of these ecosystem types.

Typically the majority of these ecosystems were rare throughout the CDFmm. The most common ecosystems were Cladina–Wallace's selaginella which occurred over approximately 1.4% of the study area and were generally associated with rock outcrops. Garry oak ecosystems (Garry oak–Oceanspray, Garry oak–Moss, Garry oak–Brome/mixed grasses) only comprised about 0.5% within the CDFmm (Table 5 and Figure 7).

Table 5. Natural Non-Forested (Non-Forested and Sparsely Vegetated) Ecosystems Mapped in the CDFmm Project Area

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Non-forested ecosystems				
AS	00	Trembling aspen-Slough sedge	12	0.006
FC	00	Fescue-Camas	381	0.18
GO	00	Garry oak-Oceanspray	4	0.002
LM	00	Dunegrass-Beach pea	127	0.06
OM	00	Garry oak-Moss	26	0.01
OR	00	Oceanspray-Rose	5	0.002
RA	00	Nootka rose-Pacific crab apple	978	0.47
QB	00	Garry oak-Brome/mixed grasses	81	0.04
SC	00	Cladina-Wallace's selaginella	2866	1.37
Sparsely vegetated units				
BE		Beach	526	0.25
CL		Cliff	132	0.06
GB		Gravel bar	137	0.07
LA		Lake	1911	0.92
MU		Mudflat	68	0.03
OW		Open water	552	0.27
PD		Pond	145	0.07
RI		River	312	0.15
RO		Rock outcrop	1623	0.78
TA		Talus	3	0.001
Total Natural Non-forested			9888	4

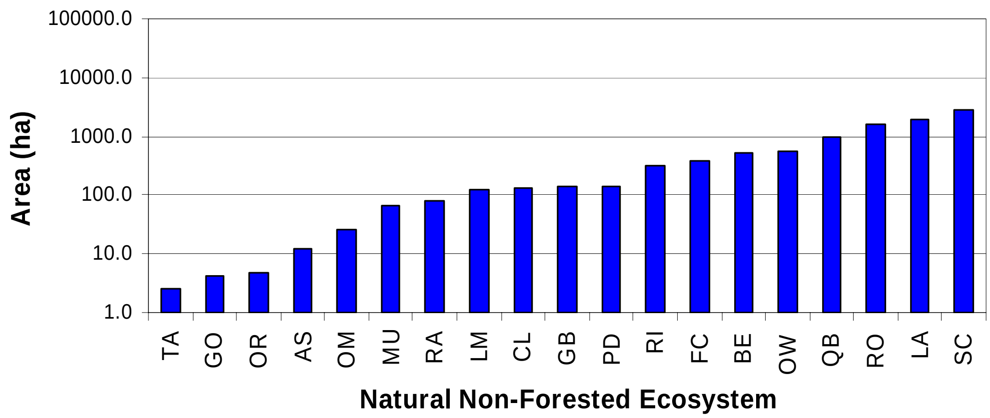

Figure 7. Distribution of natural non-forested ecosystem units in the CDFmm by area, including non-forested and sparsely vegetated ecosystems: note log area scale.

Wetland and estuary ecosystems, including bogs, fens, marshes, and swamps, represented only 2% of the CDFmm study area. The most common ecosystems are Pink spirea–Sitka sedge swamp, Sitka willow–Pacific willow–Skunk cabbage swamp and Cattail marsh, which comprised 0.6%, 0.4%, and 0.2% of the study area, respectively (Table 6 and Figure 8).

Table 6. Wetland and Estuary Ecosystems Mapped in the CDFmm Project Area

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Wetland and estuary ecosystems				
Ed01	00	Tufted hairgrass-Meadow barley estuarine meadow	134	0.06
Ed03	00	Arctic rush-Alaska plantain estuarine meadow	21	0.01
Em01	00	Widgeon-grass tidal flat	34	0.02
Em02	00	Glasswort-Sea-milkwort estuarine marsh	131	0.06
Em03	00	Seashore saltgrass	50	0.02
Em05	00	Lyngbye's sedge estuarine marsh	232	0.11
Wb50	00	Labrador tea-Bog-laurel-Peat-moss bog	6	0.003
Wf51	00	Sitka sedge-Peat-moss fen	135	0.07
Wf52	00	Sweet gale-Sitka sedge fen	30	0.01
Wf53	00	Slender sedge-White beak-rush fen	13	0.006
Wm05	00	Cattail marsh	347	0.17
Wm06	00	Great bulrush marsh	1	0.001
Wm50	00	Sitka sedge-Hemlock-parsely marsh	74	0.04
Wm51	00	Three-way sedge marsh	22	0.01
Ws50	00	Pink spirea-Sitka sedge swamp	1258	0.60
Ws51	00	Sitka willow-Pacific willow-Skunk cabbage swamp	892	0.42
Ws52	00	Red alder-Skunk cabbage swamp	11	0.01
Total wetlands and estuaries			3394	2

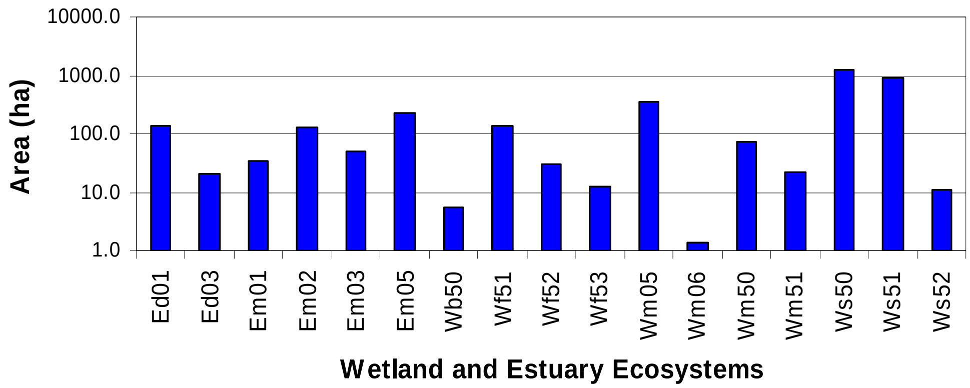

Figure 8. Distribution of wetland and estuary ecosystem units in the CDFmm by area: note log area scale.

Anthropogenic units represented a disproportionately large 33% of the CDFmm study area. Ecosystems converted primarily to rural residential land use covered approximately 9.5% of the CDFmm study area while urban areas accounted for about 9.4%. These areas were common throughout the entire CDFmm but were most prevelant near or adjacent to the major city centres, such as Victoria, and Nananimo. Fields, including those in use for cultivation and grazing, or fallow fields, covered approximately 10.7% (Table 7 and Figure 9).

Table 7. Anthropogenic Units Mapped in the CDFmm Project Area

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Anthropogenic units				
CF		Cultivated field	22348	10.7
CO		Cultivated orchard	176	0.08
CV		Cultivated vineyard	74	0.04
ES		Exposed soil	538	0.26
GC		Golf course	1266	0.61
GP		Gravel pit	903	0.43
IN		Industrial	1555	0.75
MI		Mine	675	0.32
RE		Reservoir	41	0.02
RN		Railway surface	33	0.02
RZ		Road surface	1708	0.82
RW		Rural	19857	9.52
TZ		Mine tailings	180	0.09
UR		Urban	19696	9.44
Total anthropogenic			69048	33

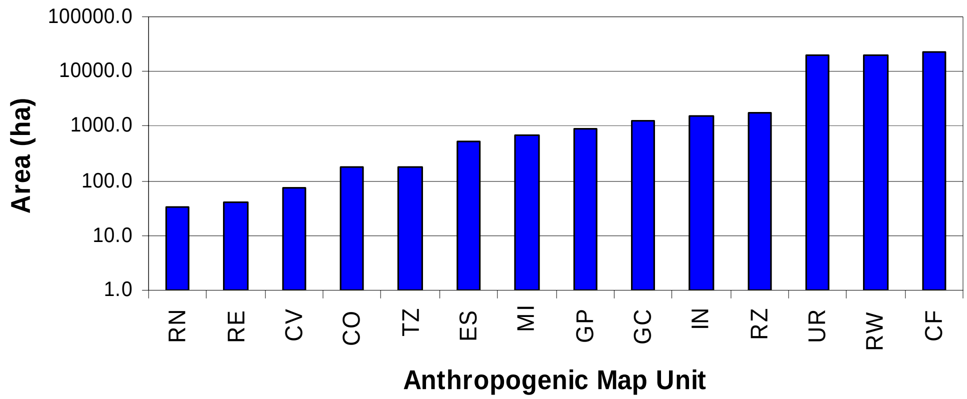

Figure 9. Distribution of anthropogenic map units in the CDFmm by area: note log area scale.

The CWHxm accounted for 2% of the project study area. In the CWHxm, 13 forested site series (including two floodplain units and three fluctuating water table units) comprised 91% (3,757 ha) of the mapped area. Natural non-forested ecosystems, including four non-forested, four sparsely-vegetated and four wetland ecosystems, made up 4% (174 ha). A total of four anthropogenic unit types were mapped over 5% (210 ha) of the CWHxm within the study area (Figure 10).

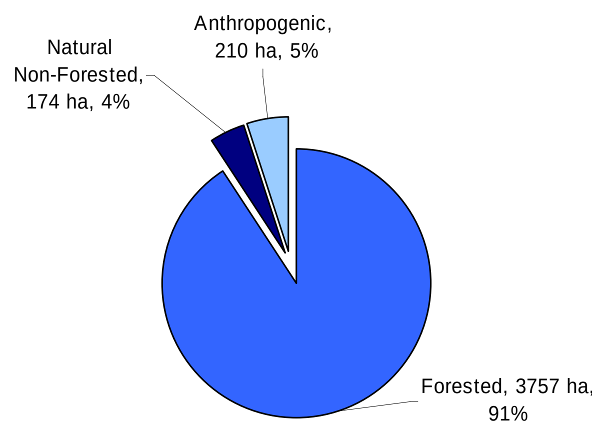

Figure 10. Distribution of ecosystem categories in the CWHxm by area and percentage.

The most common forested ecosystems mapped within the CWHxm study area were the zonal mesic Western hemlock–Douglas-fir–Oregon beaked moss, the slightly drier Douglas-fir/Western hemlock–Salal, and the richer mesic Western hemlock/western redcedar–Deer fern associations, which comprised 45%, 16%, and 8% of the CWHxm study area, respectively. Forested fluctuating water table sites and the forested floodplain ecosytems were rare within the study area (Table 8 and Figure 11).

Table 8. Forested Ecosystems Mapped in the CWHxm Project Area

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Forested site series				
HK	01	Western hemlock–Douglas-fir–Oregon beaked moss	1880	45.4
DC	02	Douglas-fir–Shore pine–Cladina	195	4.69
DS	03	Douglas-fir–Western hemlock–Salal	680	16.4
DF	04	Douglas-fir–Sword fern	215	5.18
RS	05	Western redcedar–Sword fern	266	6.42
HD	06	Western hemlock–Western redcedar–Deer fern	324	7.82
RF	07	Western redcedar–Foamflower	121	2.92
RC (Ws53)	12	Western redcedar–Sitka spruce–Skunk cabbage	12	0.28
Forested floodplain site series				
SS	08	Sitka spruce–Salmonberry high bench floodplain	1	0.02
CW (Fl50)	10	Black cottonwood–Willow low bench floodplain	1	0.02
Forested fluctuating water table site series				
RB	13	Western redcedar–Salmonberry	33	0.79
RT	14	Western redcedar–Black twinberry	28	0.67
CS	15	Western redcedar–Slough sedge	4	0.10
Total Forested			3757	91

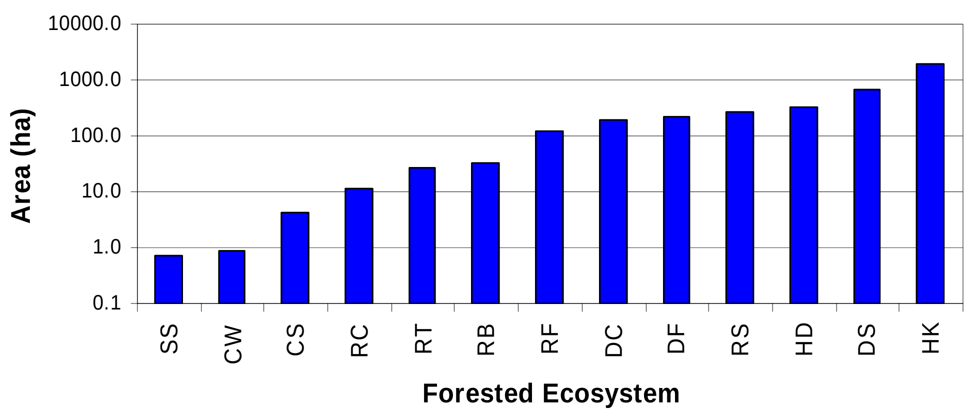

Figure 11. Distribution of forested ecosystem units mapped in the CWHxm by area, including floodplain and fluctuating water table site series: note log area scale.

Natural non-forested ecosystems, including non-forested, sparsely vegetated, and wetland ecosystems, represented 4% of the CWHxm study area mapped. The most common ecosystem was the Arbutus−Hairy manzanita which occurred on 1.3% of the study area (53 ha). Wetland ecosystems collectively accounted for approximately 0.5% of the CWHxm (Table 9 and Figure 12).

Table 9. Natural Non-Forested (Non-Forested, Sparsely Vegetated, and Wetland) Ecosystems Mapped in the CWHxm Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Non-forested ecosystems				
AM	00	Arbutus−Hairy manzanita	53	1.29
FC	00	Fescue−Camas	5	0.12
QB	00	Garry oak−Brome/mixed grasses	1	0.02
SC	00	Cladina−Wallace's selaginella	29	0.70
Sparsely vegetated units				
CL		Cliff	22	0.52
LA		Lake	30	0.74
OW		Open water	1	0.01
RO		Rock outcrop	11	0.28
Wetland ecosystems				
Wb50	00	Labrador tea−Bog-laurel−Peat-moss bog	1	0.02
Wf53	00	Slender sedge−White beak-rush fen	14	0.33
Ws50	00	Pink spirea−Sitka sedge swamp	6	0.14
Ws51	00	Sitka willow - Pacific willow−Skunk cabbage swamp	2	0.05
Total natural aon-forested			174	4

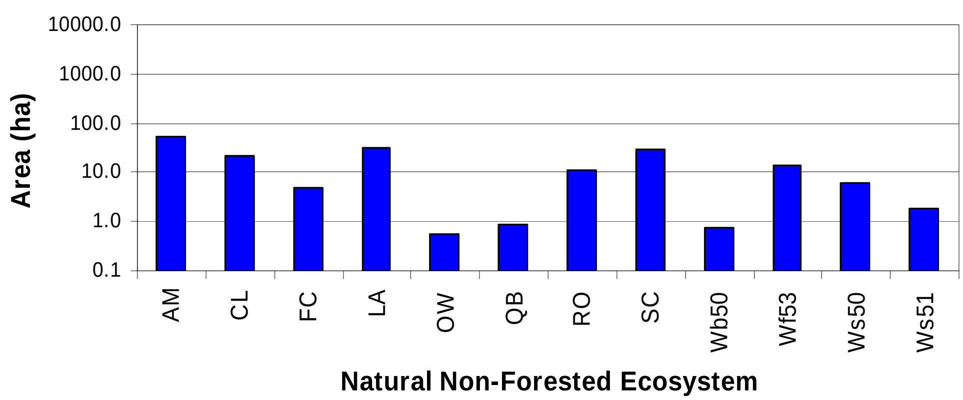

Figure 12. Distribution of natural non-forested ecosystem units mapped in the CWHxm by area, including non-forested, sparsely vegetated, and wetland ecosystems: note log area scale.

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Anthropogenic units represented 5% of the CWHxm study area mapped with rural residential land use and cultivated fields comprising 3.07% and 1.57%, respectively (Table 10 and Figure 13).

Table 10. Anthropogenic Units Mapped in the CWHxm Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Anthropogenic units				
CF		Cultivated field	65	1.57
ES		Exposed soil	18	0.43
RW		Rural	127	3.07
RZ		Road surface	1	0.02
Total anthropogenic			210	5

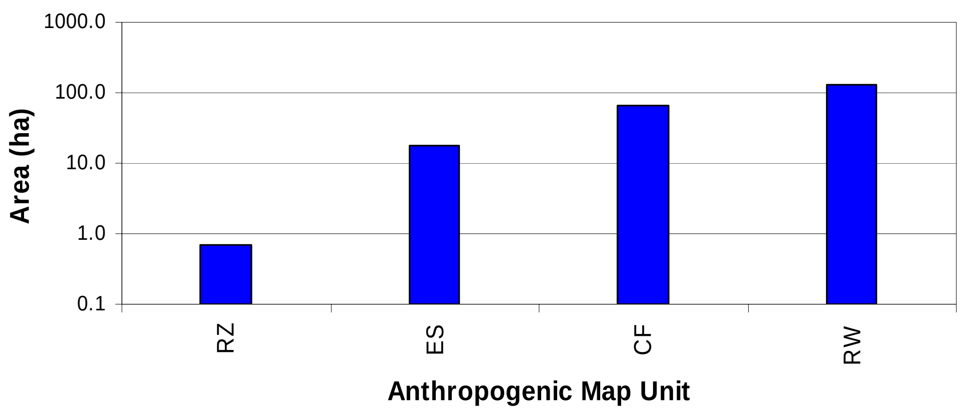

Figure 13. Distribution of anthropogenic map units mapped in the CWHxm by area: note log area scale.

Ecosystem accounts for each map unit are provided in the expanded legend (Appendix VI). Each unit includes a description of the site, soil and terrain characteristics observed in each ecosystem, and a representative photo.

5.4.2 Structural Stage

Young forests (structural stage 5) are the most common structural stages in the CDFmm study area, representing 45% of the landscape (Figure 14). Young forests typically range from 40 – 80 years old in this area, with self-thinning evident, producing a forest canopy which is beginning to differente into distinct layers.

These forests reflect logging or another disturbance that has occurred over the past 40 – 80 years (forest harvesting being the most common in the project area). In the CWHxm within the study area, young forests and immature forests (structural stage 4 and 5) were the most typical at 41% and 37%, respectively (Figure 15).

There was extremely little old growth, (structural stage 7) mapped in the CDFmm zone. Only 610 ha of old forest were mapped on Lasqueti Island and small pockets scattered on southern Vancouver Island. Immature forest (sturctual stage 4) and mature forest (structural stage 6) represented 12% and 13% of the CDFmm study area, respectively. Lastly, structural stages 1 – 3 combined occurred over 30% of the landscape representing logged or otherwise disturbed forests, natural non-forested ecosystems (non-forested, sparsely vegetated, wetland), and a small percentage of anthropogenic areas (Figure 14).

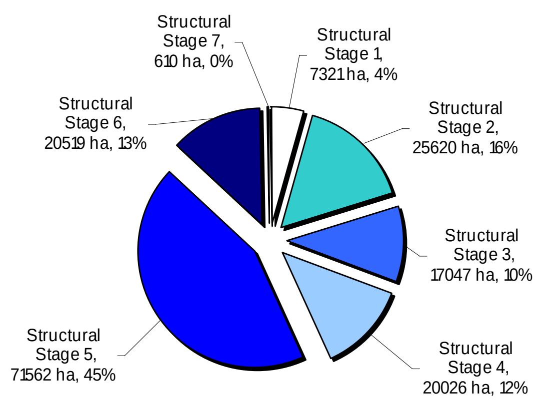

Figure 14. Distribution of structural stages in the CDFmm by area and percentage.

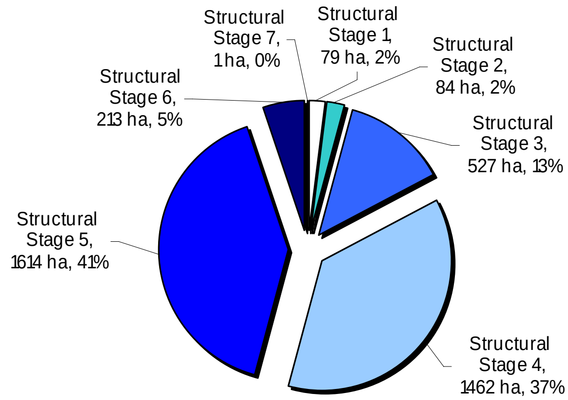

Figure 15. Distribution of structural stages in the CWHxm by area and percentage.

5.4.3 Disturbance

The CDFmm subzone covers a diverse range of landforms, land uses, ecosystems, and infrastructure. Historic and modern settlement and resource extraction have displaced many naturally occurring ecosystems across the region, limiting their distribution.

Disturbance is extensive across the east side of Vancouver Island, especially near the major centres (e.g., Greater Victoria and Nanaimo), and to a lesser extent, on the Gulf Islands, and Sunshine Coast. Disturbances consisted primarily of urban and rural residential development, followed by logging and agriculture.

Larger protected areas on eastern Vancouver Island Island such as East Sooke Park and Thetis Lake Park harbour substantial representative areas of CDFmm forests, but are still impacted to varying degrees by disturbance and invasive species. All of the Gulf Islands have had more or less intensive human disturbance, while some retain a variety of remant CDFmm ecosystems.

Intensive agriculture is relatively common, especially in glaciomarine and glaciolacustrine deposits. These rich, gently undulating to flat sites support productive crop growth and forage. Wetland modification through drainage, excavation, and vegetation change also impacts on ecosystem representation and ecological integrity.

Seasonally flooded fields are recognized and mapped as sensitive ecosystems through the Sensitive Ecosystem Inventory (SEI) program due to their high habitat value (Ward *et al*. 1998); however the CDFmm TEM mapping project includes these areas as cultivated fields.

Cultivated fields are widely distributed throughout the CDFmm, from the Saanich Peninsula to the Cowichan Valley and Salt Spring Island. Cultivated fields predominantly occur on deep glaciomarine deposits and are heavily used for haying, grazing, and agriculture. Some small-scale orchards and vineyards have been established on gently to moderately sloping well-drained terrain. Between major urban centers and intermixed with cultivated fields, rural residential development is predominant.

Rural residential and cultivated field modification involves land conversion or alienation such that natural processes and functions are hampered or modified to the extent that native plant communities are not supported.

This does not negate their potential function, should they be restored or set aside for reclamation. Seasonally flooded fields, hedgerows, ditches, and windbreaks also provide habitat for a variety of wildlife species, serving to maintain some degree of landscape habitat connectivity and support forage species, shelter, roosting sites, nest locations, and prey populations.

Forest harvesting has been occurring in the region for more than 100 years. The dominant silvicultural system is clearcutting with and without reserves, with lesser amounts of single-tree and group selection systems. Intensive agriculture and hobby farms are relatively common and widespread, especially in glaciomarine and glaciolacustrine deposits. Glaciofluvial sites and some gentler till deposits support orchards and vineyards. The entire area has been subject to varying degrees of wetland diking, drainage, and excavation.

Another modern threat to CDF forests is fire suppression. The characteristic Garry oak ecosystems represent a disturbance driven, fire-dependent disclimax type and has had widespread declines concurrent with fire suppression (MacDougall and Turkington 2004; MacDougall et al. 2004).

Fire frequency is suspected to have historically fluctuated based on cultural practices (McDougall and Turkington 2004; McCoy et al. 2006). The Garry Oak Ecosystems Restoration Team (GOERT) has collected a wide range of contemporary and historical baseline data to provide context regarding the extent, condition, composition, and resilience of these ecosystems, including their responses to restoration treatments.

Within the CDFmm study area, 40% of the landscape was determined to be disturbed by anthropogenic factors, such as urbanization and farming, as well as logging, fires and biotic effects, such as grazing (Figure 16). Similar findings occurred in the CWHxm study area with anthropogenic disturbances and logging making up 42% of the landscape (Figure 17). These values, however, likely drastically underestimate the actual amount of disturbance, especially within the CDFmm, as the air photos used for mapping the majority of the study area were out-dated, going back as far as 1980. Based on field observations, many areas within the CDFmm were recently disturbed and therefore not reflected on the air photos. The area from Deep Bay to Cowichan, which includes Qualicum, Parksville, Nanaimo, Ladysmith, and Duncan have air photos ranging in age from 1980 to 1998 (Appendix II).

Other than Victoria and Saanich, these areas have likely been the most altered in the past 10 to 20 years and contain substantially more disturbed areas (urbanized, agricultural and logged) than accounted for in this study.

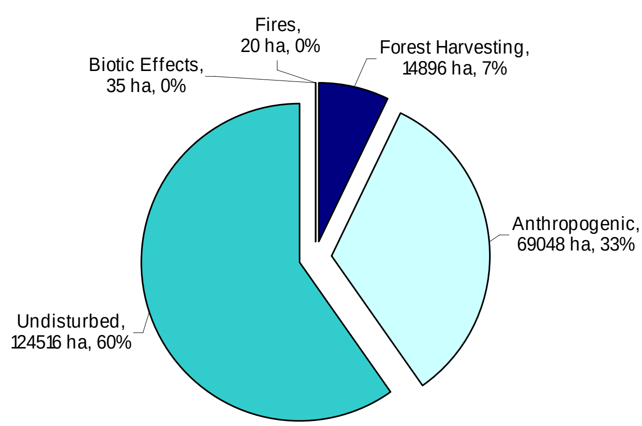

Figure 16. Distribution of disturbance types in the CDFmm by area and percentage.

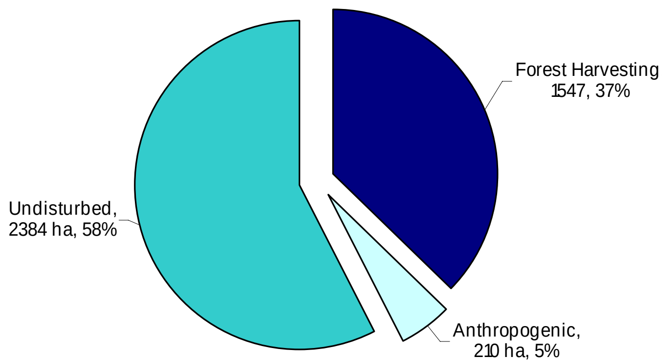

Figure 17. Distribution of disturbance types in the CWHxm by area and percentage.

5.4.4 Invasive species

Exotic and indigenous invasive plants displace native and endemic species, particularly those with narrow ecological niches and slow growth and recruitment. Transportation corridors and recreational areas, agricultural, residential, and disturbed sites all increase the presence and abundance of weedy invasive species which tend to flourish in pioneer habitats.

The past century has seen the gradual introduction of many exotic species into the CDFmm, many of which have become naturalized. The number and abundance of these species has been dramatically increasing over the past several decades, driving a concerted effort by local, regional, and provincial agencies and non-profit groups to gather data and develop control and eradication strategies.

The most prevalent exotic species in the study area are: Scotch broom, English ivy, foxglove, Daphne-laurel, agronomic grasses, gorse, English hawthorn, English oak species, holly, and Himalayan blackberry. There are many others that are localized to particular habitats, such as rush skeletonweed, thistles, giant cow-parsnip, white poplar, knotweed species, knapweed species, carpet burweed, yellow-flag iris, Eurasian milfoil, purple loosestrife, and spartina cordgrass. Typical strategies of successful invasive and weedy species include the ability to colonize mineral seedbeds, rapid early growth, prolific reproduction, robust seed banks, vegetative spread, apomixes and/or self-fertilization, and dense monotypic growth habits.

These characteristics modify existing microsites in such a way that native species are out-shaded, displaced spatially, unable to access sufficient moisture and nutrients, or restricted in reproductive capacity.

Displacement of rare indigenous species by exotic and indigenous invasive plants has also contributed substantially to the decline of Garry oak ecosystems (MacDougall and Turkington 2004) and ecosystems of the CDFmm in general. Introduced and feral domestic livestock serve as vectors for many weedy species. Other invasives have been deliberately introduced as ornamentals, or forage crops. Site disturbance that exposes mineral seedbeds hastens colonization by weedy invasive species. Scotch broom, many common agronomic grasses, gorse, English hawthorn and oak, holly, and a wide range of other life forms aggressively colonize nearly all sites in the CDFmm. Their adaptations to disturbance, including rapid growth, prolific reproduction, robust seed banks, vegetative spread, and dense monotypic growth habits, tend to render sites unsuitable for many native species, particularly those that require specialized microhabitats.

Wetland ecosystems (including ponds, marshes, lakes, streams, estuaries, and fens) have experienced similar invasive species which have caused changes in ecological representation and condition. Purple loosestrife, Eurasian milfoil, yellow flag iris, cordgrass species, and many other escaped cultivated plants have altered the hydrological regime, decreased habitat diversity, and displaced native aquatic and estuarine plants.

Many particularly insidious weeds affecting wetlands originated via escapes from cultivation. These habitat types are increasingly less frequent throughout the CDFmm and their sensitivity to ecological disturbance makes them particularly vulnerable to degradation (MacDougall et al. 2006).

5.4.5 Rare Elements

Forestry and intense development pressure has resulted in fragmentation and permanent loss of habitat. The British Columbia Conservation Data Centre (CDC) has listed 35 ecological communities in the CDFmm, representing all ecosystems within this zone and subzone, as provincially at risk (red-or blue-listed) (CDC 2008: see Appendix I). Most of these ecosystems are described as "imperiled" (S2) or "critically imperiled" (S1).

The vegetation of the CDFmm includes ecosystems and species that are considered rare due to their limited occurrences and restricted range. Most of these are at the northern limits of their distribution and include species that occupy seaside, aquatic, rock outcrop, and forested habitats. A few species of animals, plants, and mosses are entirely restricted or endemic to the CDFmm zone, such as Macoun's meadowfoam. Endemic species and unique assemblages of ecosystems provide genetic-, species-, and landscape-level components that are important for maintaining biodiversity. Due to its restricted distribution and the aforementioned impacts, many plant and wildlife species found in the CDFmm are listed federally under Schedules of the *Species at Risk Act*, and others are on the provincial Red and Blue lists due to their rarity and/or special concern. These species may also be afforded additional protection under legislation such as the *Forest and Range Practices Act* (FRPA) and associated regulations. The CDC lists 63 plants and animals (including six unique populations of stickleback and six owl species/subspecies) whose habitat overlaps or falls completely within the CDFmm [March 2008]. Animal species include invertebrates, insects, fish, insectivorous mammals, raptors, and bats. Plant species include a range of taxa, although many are annual flowering plants (CDC 2008).

Provincially, the CDC also lists 218 plants and animals as either blue-or red-listed in the CDFmm; including 127 vascular plant species, three non-vascular plants, 53 vertebrate animals, and 35 invertebrate animals. Of these, 101 plants and animals are blue-listed and 117 are red-listed.

Federally, the Committee on the Status of Endangered Species in Canada (COSEWIC) ranks 78 plants and animals with conservation status, 45 of these being endangered, denoting species facing imminent extirpation or extinction. And lastly, the *Species at Risk Act* (SARA) lists 68 of these plants and animals on their Schedule 1, which classifies wildlife species at risk as being either extirpated, endangered, threatened, or special concern. Table 11 outlines the number of species of plants and animals listed under provincial and federal jurisdictions in the CDFmm.

Table 11 Conservation Status of Plants and Animals Listed in the CDFmm

Rare Species Category	Vascular Plants	Non-vascular Plants	Vertebrate Animals	Non-vertebrate Animals
Number of Listed Individuals	127	3	53	35
Jurisdiction	**Conservation Status**		**Number of Listed Individuals**	
Provincial Rank	Blue-listed		101	
	Red-listed		117	
Federal Rank	COSEWIC (Endangered)		78 (45)	
	SARA Schedule 1		68	

The rank and status of species and ecosystems are based on several factors, and screened by committees of experts: rarity/abundance based on inventory data, connectivity based on spatial distribution, changes in abundance or distribution (e.g., fragmentation), areas with protected status, and external factors influencing the species or ecosystem (e.g., exotic pests or diseases, pending land use changes, etc.).

The CDFmm is home to a rich diversity and abundance of native species and habitats. Programs within the Ministry of Environment endeavour to conserve biodiversity, provide a variety of opportunities for the use and enjoyment of wildlife in B.C., and maintain a balance between the needs of wildlife and the needs of the people. The Species at Risk Coordination Office of the Integrated Land Management Bureau and the Ministry of the Environment are developing a provincial strategy for the conservation and recovery of species at risk in the province. The intention of the conservation framework will foster proactive, priority-driven conservation approaches, based on reliable science, which will lead to better outcomes for species at risk (ILMB, 2007)

6.0 RECOMMENDATIONS

The results of the project are limited by the fact that the mapping product that accompanies this report does not reflect an accurate measure of the urbanized, agricultural and logged area that has replaced mature and old forest since the date of many of the photos. To realize the full capacity of this project, and to fulfill the objectives and intent, we make the following recommendations.

- Conduct an analysis of the "depletion layer" using the TEM product provided. The TEM product can be updated by identifying the areas that are now logged using satellite imagery and updating those polygon labels to more accurately map the extent and impacts to ecosystems at risk.

- Update identified sensitive ecosystem inventory and quantify alterations to identified SEI polygons since the last SEI update (AXYS, 2005) where appropriate at this scale.

- Almagamate the TEM completed for the Gulf Islands National Park Reserve with this project.

- Conduct TEM on the CWHxm subzone, which also contains similar ecosystems and species that are listed provincially.

- Complete TEM for Vancouver Island. Many areas have already been mapped and this information can be integrated, gaps identified, and an integrated map of the entire Island can be used to provide detailed information for land use planning. Further, existing mapping could be updated fairly efficiently using satellite imagery where structural stages have changed.

7.0 CONCLUSION

The data collected and maps produced from this report represent a rich resource that can be used for many applications. One such application is as baseline inventory for a landscape management strategy across the CDFmm.

Data collected in this project was supported by a total of 1458 plots, as well as 331 background plots, resulting in 1234 field checked polygons which provided ecosystem information on geology, soils, site charcteristics and vegetation for final ecosystem mapping. Level-five survey intensity was accomplished with 9% polygon inspection (including background plot data). The extensive background research, wide sampling framework, and rigorous internal and external quality assurance in place provide a high degree of confidence in the interpolations made during photo interpretation.

Mapping revealed that although the project area contains a diverse range of forested and non-forested ecosystems, including wetlands, and herbaceous meadows, most of them have been impacted by disturbance over the past century. A large proportion of the land area has been alienated by conversion to urban, rural, agricultural, and industrial use. Forest harvesting, mining, and associated activities have further restricted succession of ecosystems, maintaining a disproportionately high part of the landscape in early seral stages. Negligible mature and old forest remains within the CDFmm.

While some of these patterns are certainly associated with land tenure, an integrated framework for land use, such as the existing Vancouver Island Land Use Plan, can be used to guide priorities for regional outcomes. Considering the CDFmm as a single, integrated system may aid planners to better evaluate the potential impacts of resource and land use decisions across jurisdictions with respect to this restricted and high-value ecological zone.

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APPENDIX I

Red- and Blue-listed Ecosystems and Species in the CDFmm

Appendix I. Red- and Blue-listed Ecosystems and Species in the CDFmm

Red- and blue-listed ecosystems in the CDFmm

Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit
Abies grandis / Mahonia nervosa	grand fir / dull Oregon-grape	G1	S1	Red	CDFmm/04
Abies grandis / Tiarella trifoliata	grand fir / three-leaved foamflower	G1	S1	Red	CDFmm/06
Alnus rubra / Carex obnupta [*Populus balsamifera* ssp. *trichocarpa*]	red alder / slough sedge [black cottonwood]	G1	S1	Red	CDFmm/14
Festuca idahoensis ssp. roemeri - Koeleria macrantha	Roemer's fescue - junegrass	G1	S1	Red	CDFmm/00; CWHxm1/00
Pseudotsuga menziesii / Melica subulata	Douglas-fir / Alaska oniongrass	G1	S1	Red	CDFmm/03
Quercus garryana - Arbutus menziesii	Garry oak - arbutus	G1	S1	Red	CDFmm/00
Quercus garryana / Bromus carinatus	Garry oak / California brome	G1	S1	Red	CDFmm/00
Quercus garryana / Holodiscus discolor	Garry oak / oceanspray	G1	S1	Red	CDFmm/00
Thuja plicata / Achlys triphylla	western redcedar / vanilla leaf	G1	S1	Red	CDFmm/12
Thuja plicata / Oemleria cerasiformis	western redcedar / Indian-plum	G1	S1	Red	CDFmm/13
Carex macrocephala Herbaceous Vegetation	large-headed sedge Herbaceous Vegetation	G1G2	S1S2	Red	CDFmm/00; CWHvh1/00; CWHwh1
Populus tremuloides / Malus fusca / Carex obnupta	trembling aspen / Pacific crab apple / slough sedge	G1G2	S1S2	Red	CDFmm/00
Arbutus menziesii / Arctostaphylos columbiana	arbutus / hairy manzanita	G2	S2	Red	CDFmm/00; CWHxm1/00
Carex lasiocarpa - Rhynchospora alba	slender sedge - white beak-rush	G2	S2	Red	CDFmm/Wf53; CWHmm1/Wf53; CWHmm2/Wf53; CWHxm1/Wf53; CWHxm2/Wf53
Myosurus minimus - Montia spp. - *Limnanthes macounii*	tiny mousetail - montias - Macoun's meadow-foam	G2	S1	Red	CDFmm/00
Pseudotsuga menziesii / Mahonia nervosa	Douglas-fir / dull Oregon-grape	G2	S2	Red	CDFmm/01
Salix sitchensis - Salix lucida ssp. lasiandra / Lysichiton americanus	Sitka willow - Pacific willow / skunk cabbage	G2	S2	Red	CDFmm/Ws51; CWH/Ws51; ICH/Ws51

Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit
Deschampsia cespitosa ssp. beringensis - Aster subspicatus	tufted hairgrass - Douglas' aster	G3	S3	Blue	CDFmm/Ed02; CWH/Ed02
Deschampsia cespitosa ssp. *beringensis - Hordeum brachyantherum*	tufted hairgrass - meadow barley	G3	S3	Blue	CDFmm/Ed01
Menyanthes trifoliata - Carex lasiocarpa	buckbean - slender sedge	G3	S3	Blue	CDFmm/Wf06; CWHws1/Wf06; ICHwk1/Wf06; IDFdk2/Wf06; SBSdk/Wf06
Myrica gale / Carex sitchensis	sweet gale / Sitka sedge	G3	S2	Red	CDFmm/Wf52; CWHmm1/Wf52; CWHmm2/Wf52; CWHvh2/Wf52; CWHwm/Wf52; CWHxm1/Wf52; CWHxm2/Wf52
Salicornia virginiana - Glaux maritima	American glasswort - sea-milkwort	G3G4	S2	Red	CDFmm/Em02; CWH/Em02
Typha latifolia Marsh	common cattail Marsh	G5	S3	Blue	BGxh1/Wm05; BGxh2/Wm05; BGxw1/Wm05; CDFmm/Wm05; CWHdm/Wm05; CWHxm1/Wm05; CWHxm2/Wm05; IDFdk3/Wm05; IDFdm2/Wm05; PPxh1/Wm05
Distichlis spicata var. spicata Herbaceous Vegetation	seashore saltgrass Herbaceous Vegetation	G5	S1S2	Red	CDFmm/Em03
Alnus rubra / Lysichiton americanus	red alder / skunk cabbage	GNR	S2S3	Blue	CDFmm/11
Carex lyngbyei Herbaceous Vegetation	Lyngbye's sedge herbaceous vegetation	GNR	S3	Blue	CDFmm/Em05
Eleocharis palustris Herbaceous Vegetation	common spike-rush	GNR	S3	Blue	BGxw2/Wm04; CDFmm/Wm04; ESSFdv d/Wm04; ESSFdv/Wm04; IDFxm/Wm04; SBSdk/Wm04; SBSmk2/Wm04
Artemisia campestris - Festuca rubra / Racomitrium canescens	northern wormwood - red fescue / grey rock-moss	GNR	S1	Red	CDFmm/n/a
Dulichium arundinaceum Herbaceous Vegetation	three-way sedge	GNR	S2	Red	CDFmm/Wm51; CWHmm1/Wm51; CWHxm2/Wm51; ICHwk1/Wm51
Juncus arcticus - Plantago macrocarpa	arctic rush - Alaska plantain	GNR	S1	Red	CDFmm/Ed03; CWH/Ed03
Pinus contorta / Sphagnum spp. CDFmm	lodgepole pine / peat-mosses CDFmm	GNR	S1	Red	CDFmm/10
Pseudotsuga menziesii - Arbutus menziesii	Douglas-fir - arbutus	GNR	S2	Red	CDFmm/02
Ruppia maritima Herbaceous Vegetation	beaked ditch-grass Herbaceous Vegetation	GNR	S2	Red	CDFmm/Em01; CWH/Em01
Thuja plicata - Pseudotsuga menziesii / Eurhynchium oreganum	western redcedar - Douglas-fir / Oregon beaked-moss	GNR	S1	Red	CDFmm/05

Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit
Thuja plicata / Symphoricarpos albus	western redcedar / common snowberry	GNR	S1	Red	CDFmm/07

Search Criteria

Ecological Communities
AND BC Conservation Status:Red (Extirpated, Endangered, or Threatened) OR Blue (Special Concern)
AND MOE Regions:1- Vancouver Island,2- Lower Mainland
AND BGC Zone, Subzone, Variant, Phase:CDFmm
Sort Order:Scientific Name Ascending
Accessed May 31 2008

Red- and blue-listed species in the CDFmm

Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit	Habitat Type
Fish						
Acipenser medirostris	Green Sturgeon	G3	S1N	Red	CDF; CWH	Estuarine; Marine; Riverine
Acipenser transmontanus pop. 4	White Sturgeon (Lower Fraser River population)	G4T2Q	S2	Red	CDF; CWH; IDF	Estuarine; Lacustrine; Marine; Riverine
Oncorhynchus clarkii clarkii	Cutthroat Trout, *clarkii* subspecies	G4T4	S3S4	Blue	BWBS; CDF; CWH; ICH; SBS	Estuarine; Lacustrine; Marine; Riverine
Salvelinus malma	Dolly Varden	G5	S3S4	Blue	BWBS; CDF; CWH; ESSF; ICH; MH; SBS	Estuarine; Lacustrine; Marine; Riverine
Gasterosteus sp. 16	Vananda Creek Limnetic Stickleback	G1	S1	Red	CDF	Lacustrine
Gasterosteus sp. 17	Vananda Creek Benthic Stickleback	G1	S1	Red	CDF	Lacustrine
Gasterosteus sp. 2	Enos Lake Limnetic Stickleback	G1	S1	Red	CDF	Lacustrine
Gasterosteus sp. 3	Enos Lake Benthic Stickleback	G1	S1	Red	CDF	Lacustrine
Gasterosteus sp. 4	Paxton Lake Limnetic Stickleback	G1	S1	Red	CDF	Lacustrine
Gasterosteus sp. 5	Paxton Lake Benthic Stickleback	G1	S1	Red	CDF	Lacustrine
Amphibiams						
Rana aurora	Red-legged Frog	G4	S3S4	Blue	CDF; CWH	Lacustrine; Palustrine; Riverine; Terrestrial

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Rana pipiens	Northern Leopard Frog	G5	S1	Red	CDF; ICH; IDF; PP	Lacustrine; Palustrine; Riverine; Terrestrial
Reptiles						
Chrysemys picta pop. 1	Western Painted Turtle - Pacific Coast Population	G5TNR	S2	Red	CDF; CWH; MH	Lacustrine; Palustrine; Riverine
Contia tenuis	Sharp-tailed Snake	G5	S1	Red	CDF	Subterranean; Terrestrial
Pituophis catenifer catenifer	Gopher Snake, *catenifer* subspecies	G5T5	SX	Red	CDF; CWH	Palustrine; Terrestrial
Birds: Anseriformes						
Branta canadensis occidentalis	Canada Goose, *occidentalis* subspecies	G5T2T3	S1N	Blue	CDF; CWH	Lacustrine; Palustrine; Terrestrial
Birds: Pelecaniformes						
Phalacrocorax auritus	Double-crested Cormorant	G5	S3B	Blue	CDF; CWH; ICH; SBPS	Estuarine; Lacustrine; Marine; Palustrine; Riverine; Terrestrial
Phalacrocorax pelagicus pelagicus	Pelagic Cormorant, *pelagicus* subspecies	G5TU	S2B	Red	CDF; CWH	Estuarine; Marine; Terrestrial
Phalacrocorax penicillatus	Brandt's Cormorant	G5	S1B,S4N	Red	CDF; CWH	Estuarine; Marine
Birds: Ciconiiformes						
Ardea herodias fannini	Great Blue Heron, *fannini* subspecies	G5T4	S3B,S4N	Blue	CDF; CWH	Estuarine; Lacustrine; Palustrine; Riverine; Terrestrial
Botaurus lentiginosus	American Bittern	G4	S3B	Blue	BG; BWBS; CDF; CWH; ICH; IDF; PP; SBPS; SBS	Estuarine; Palustrine
Butorides virescens	Green Heron	G5	S3S4B	Blue	CDF; CWH	Estuarine; Lacustrine; Palustrine; Riverine
Birds: Faconiformes						
Accipiter gentilis laingi	Northern Goshawk, *laingi* subspecies	G5T2	S2B	Red	CDF; CWH; MH	Terrestrial
Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	G4T4	S2B	Red	BG; BWBS; CDF; CWH; IDF; MS; PP; SBS	Estuarine; Terrestrial
Falco peregrinus pealei	Peregrine Falcon, *pealei* subspecies	G4T3	S3B	Blue	CDF; CWH	Estuarine; Lacustrine; Marine; Riverine; Terrestrial

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Birds: Charadriiformes						
Hydroprogne caspia	Caspian Tern	G5	S3B	Blue	CDF; CWH; IDF; SBS	Estuarine; Lacustrine; Marine; Palustrine; Riverine; Terrestrial
Brachyramphus marmoratus	Marbled Murrelet	G3G4	S2B,S4N	Red	CDF; CWH; MH	Estuarine; Lacustrine; Marine; Terrestrial
Fratercula cirrhata	Tufted Puffin	G5	S3B,S4N	Blue	CDF; CWH	Marine; Terrestrial
Birds: Colombiformes						
Patagioenas fasciata	Band-tailed Pigeon	G4	S3S4B	Blue	CDF; CWH; ICH	Palustrine; Terrestrial
Birds: Cuculiformes						
Coccyzus americanus	Yellow-billed cuckoo	G5	SXB	Red	CDF; CWH	Estuarine; Palustrine; Terrestrial
Birds: Strigiformes						
Tyto alba	Barn Owl	G5	S3	Blue	BG; CDF; CWH	Palustrine; Terrestrial
Asio flammeus	Short-eared Owl	G5	S3B,S2N	Blue	BG; BWBS; CDF; CWH; ICH; IDF; PP; SBPS; SBS; SWB	Estuarine; Palustrine; Terrestrial
Athene cunicularia	Burrowing Owl	G4	S1B	Red	BG; CDF; CWH; IDF; PP	Terrestrial
Glaucidium gnoma swarthi	Northern Pygmy-Owl, *swarthi* subspecies	G5T3Q	S3	Blue	CDF; CWH; MH	Terrestrial
Megascops kennicottii kennicottii	Western Screech-Owl, *kennicottii* subspecies	G5T4	S3	Blue	CDF; CWH; IDF	Palustrine; Terrestrial
Birds: Piciformes						
Melanerpes lewis	Lewis's Woodpecker	G4	S2B	Red	BG; CDF; CWH; ICH; IDF; PP	Palustrine; Terrestrial
Melanerpes lewis pop. 1	Lewis's Woodpecker (Georgia Depression population)	G5TXQ	SXB	Red	CDF; CWH	Palustrine; Terrestrial
Birds: Passeriformes						
Eremophila alpestris strigata	Horned Lark, *strigata* subspecies	G5T2	SX	Red	CDF; CWH	Terrestrial
Hirundo rustica	Barn Swallow	G5	S3S4B	Blue	BAFA; BG; BWBS; CDF; CWH; ESSF; ICH; IDF; IMA; MH; MS; PP; SBPS; SWB	Estuarine; Lacustrine; Palustrine; Riverine; Terrestrial

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Progne subis	Purple Martin	G5	S2S3B	Blue	CDF; CWH; ICH	Estuarine; Lacustrine; Palustrine; Terrestrial
Sialia mexicana pop. 1	Western Bluebird (Georgia Depression population)	G5TNRQ	SHB	Red	CDF; CWH	Palustrine; Terrestrial
Pooecetes gramineus affinis	Vesper Sparrow, *affinis* subspecies	G5T3	S1B	Red	CDF	Terrestrial
Sturnella neglecta pop. 1	Western Meadowlark (Georgia Depression population)	G5TNRQ	SXB	Red	CDF; CWH	Terrestrial
Mammals						
Aplodontia rufa rufa	Mountain Beaver, *rufa* subspecies	G5T4?	S3	Blue	CDF; CWH; MH	Terrestrial
Myodes gapperi occidentalis	Southern Red-backed Vole, *occidentalis* subspecies	G5T5	S1	Red	CDF; CWH	Palustrine; Terrestrial
Lepus americanus washingtonii	Snowshoe Hare, *washingtonii* subspecies	G5T3T5	S1	Red	CDF; CWH	Palustrine; Terrestrial
Sorex palustris brooksi	American Water Shrew, *brooksi* subspecies	G5T2	S2	Red	CDF; CWH	Lacustrine; Palustrine; Riverine
Sorex rohweri	Olympic Shrew	G4G5	S1	Red	CDF	Terrestrial
Sorex trowbridgii	Trowbridge's Shrew	G5	S3S4	Blue	CDF; CWH	Palustrine; Terrestrial
Corynorhinus townsendii	Townsend's Big-eared Bat	G4	S3	Blue	BG; CDF; CWH; ICH; IDF; PP	Palustrine; Subterranean; Terrestrial
Martes pennanti	Fisher	G5	S2S3	Blue	BAFA; BWBS; CDF; CMA; CWH; ESSF; ICH; IDF; IMA; MH; MS; PP; SBPS; SBS; SWB	Palustrine; Terrestrial
Mustela erminea anguinae	Ermine, *anguinae* subspecies	G5T3	S3	Blue	CDF; CWH; MH	Palustrine; Terrestrial
Marine Mammals						
Eumetopias jubatus	Steller Sea Lion	G3	S2S3B,S3N	Blue	CDF; CWH; MH	Estuarine; Marine
Insects						
Erythemis collocata	Western Pondhawk	G5	S3	Blue	BG; CDF; CWH; ESSF; PP	Lacustrine

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Sympetrum vicinum	Autumn Meadowhawk	G5	S3S4	Blue	CDF; CWH	Lacustrine; Riverine
Tramea lacerata	Black Saddlebags	G5	S1	Red	CDF	
Omus audouini	Audouin's Night-stalking Tiger Beetle	G5	S1	Red	CDF; CWH	
Epargyreus clarus	Silver-spotted Skipper	G5	S3	Blue	CDF; CWH; ESSF; ICH; MH; MS; PP	Terrestrial
Epargyreus clarus clarus	Silver-spotted Skipper, *clarus* subspecies	G5T5	S3	Red	CDF; CWH	Terrestrial
Erynnis propertius	Propertius Duskywing	G5	S2S3	Blue	CDF; CWH	Terrestrial
Euphyes vestris	Dun Skipper	G5	S3	Blue	CDF; CWH; IDF	Palustrine; Terrestrial
Parnassius smintheus olympiannus	Rocky Mountain Parnassian, *olympiannus* subspecies	G5T4	S2S3	Blue	CDF; CWH	
Euchloe ausonides insulanus	Large Marble, *insulanus* subspecies	G5T1	SX	Red	CDF	Terrestrial
Callophrys eryphon sheltonensis	Western Pine Elfin, *sheltonensis* subspecies	G5TNR	S3	Blue	CDF; CWH	
Callophrys mossii mossii	Moss' Elfin, *mossii* subspecies	G4T4	S2S3	Blue	CDF; CWH	Terrestrial
Plebejus saepiolus insulanus	Greenish Blue, *insulanus* subspecies	G5TH	SH	Red	CDF; CWH	Terrestrial
Cercyonis pegala incana	Common Wood-nymph, *incana* subspecies	G5T4T5	S2	Red	CDF	Terrestrial
Coenonympha tullia insulana	Common Ringlet, *insulana* subspecies	G5T3T4	S1	Red	CDF; CWH	Terrestrial
Danaus plexippus	Monarch	G5	S3B	Blue	CDF; CWH; IDF; PP	Palustrine; Terrestrial
Euphydryas editha taylori	Edith's Checkerspot, *taylori* subspecies	G5T1	S1	Red	CDF	Terrestrial
Copablepharon fuscum	Sand-verbena Moth	G1G2	S1	Red	CDF	
Molluscs						
Haliotis kamtschatkana	Northern Abalone	G3G4	S2	Red	CDF; CWH	Marine
Fossaria vancouverensis		GHQ	SH	Red	CDF	Lacustrine

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Physella heterostropha	Pewter Physa	G5Q	S1S3	Red	CDF	Lacustrine
Physella integra	Ashy Physa	G5	S1S3	Red	CDF	Lacustrine; Riverine
Promenetus umbilicatellus	Umbilicate Sprite	G4	S3S4	Blue	BG; CDF; IDF; PP	Riverine
Carychium occidentale	Western Thorn	G3G4	S2S3	Blue	CDF; CWH	Terrestrial
Nearctula sp. 1	Threaded Vertigo	G3G5	S2	Red	CDF; CWH	Terrestrial
Vertigo andrusiana	Pacific Vertigo	G2G3	S2	Red	CDF	Terrestrial
Hemphillia dromedarius	Dromedary Jumping-slug	G3G4	S2	Red	CDF; CWH	Terrestrial
Hemphillia glandulosa	Warty Jumping-slug	G3G4	S2S3	Blue	CDF; CWH	Palustrine; Terrestrial
Prophysaon coeruleum	Blue-grey Taildropper	G3G4	S1	Red	CDF; CWH	Terrestrial
Prophysaon vanattae	Scarletback Taildropper	G4	S3S4	Blue	CDF; CWH; MH	Terrestrial
Pristiloma johnsoni	Broadwhorl Tightcoil	G2G3	S2S3	Blue	CDF; CWH; MH	Terrestrial
Zonitoides nitidus	Black Gloss	G5	S3S4	Blue	CDF; CWH; IDF; PP	Palustrine
Allogona townsendiana	Oregon Forestsnail	G3G4	S1S2	Red	CDF; CWH	Terrestrial
Cryptomastix devia	Puget Oregonian	G3	SX	Red	CDF; CWH	Palustrine; Terrestrial
Monadenia fidelis	Pacific Sideband	G4G5	S3S4	Blue	CDF; CWH	Terrestrial
Ferns and allies						
Botrychium simplex	least moonwort	G5	S2S3	Blue	BWBSmw; CDFmm; CWHds; CWHxm; ICHmw; IDFxh; MSdk; SBPSxc	Palustrine; Riverine; Terrestrial
Dryopteris arguta	coastal wood fern	G5	S2S3	Blue	CDFmm	Palustrine; Terrestrial
Isoetes nuttallii	Nuttall's quillwort	G4?	S3	Blue	CDFmm; CWHxm	Palustrine; Riverine; Terrestrial
Ophioglossum pusillum	northern adder's-tongue	G5	S2S3	Blue	CDFmm; CWHvm; CWHxm; ICHmw; IDFxh	Lacustrine; Palustrine; Riverine; Terrestrial
Woodwardia fimbriata	giant chain fern	G5	S3	Blue	CDFmm; CWHxm	Palustrine; Riverine; Terrestrial
Dicotyledons						
Abronia latifolia	yellow sand-verbena	G5	S3	Blue	CDFmm; CWHvh; CWHxm	Terrestrial
Anagallis minima	chaffweed	G5	S2S3	Blue	CDFmm; CWHxm	Estuarine; Palustrine; Terrestrial
Aster curtus	white-top aster	G3	S3	Blue	CDFmm; CWHxm	Terrestrial
Aster radulinus	rough-leaved aster	G4G5	S1	Red	CDFmm; CWHxm	Terrestrial

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Balsamorhiza deltoidea	deltoid balsamroot	G5	S1	Red	CDFmm; CWHxm	Terrestrial
Bidens amplissima	Vancouver Island beggarticks	G3	S3	Blue	CDFmm; CWHdm; CWHxm	Palustrine
Callitriche heterophylla ssp. *heterophylla*	two-edged water-starwort	G5T5	S2S3	Blue	CDFmm; CWHvm; CWHxm	Estuarine; Lacustrine; Palustrine
Callitriche longipedunculata	long-stalked water-starwort	G2G3	S1	Red	CDFmm	Palustrine; Terrestrial
Caltha palustris var. *palustris*	yellow marsh-marigold	G5T5	S2S3	Blue	CDFmm; CWHvm; CWHwm; CWHws	Estuarine; Palustrine
Camissonia contorta	contorted-pod evening-primrose	G5	S1	Red	CDFmm	Terrestrial
Cardamine parviflora var. *arenicola*	small-flowered bitter-cress	G5T5	S1	Red	CDFmm; CWHdm	Terrestrial
Castilleja levisecta	golden paintbrush	G1	S1	Red	CDFmm	Terrestrial
Castilleja victoriae	Victoria owl-clover	G1	S1	Red	CDFmm	Palustrine
Centaurium muehlenbergii	Muhlenberg's centaury	G5?	S1	Red	CDFmm; CWHdm	Palustrine
Ceratophyllum echinatum	spring hornwort	G4?	S3	Blue	CDFmm; CWHds; CWHxm	Lacustrine; Palustrine; Riverine
Chamaesyce serpyllifolia ssp. *serpyllifolia*	thyme-leaved spurge	G5T5	S2S3	Blue	BGxh; BGxw; CDFmm; CWHxm; IDFxh	Lacustrine; Palustrine; Terrestrial
Clarkia amoena var. *caurina*	farewell-to-spring	G5T5?	S3	Blue	CDFmm; CWHxm	Terrestrial
Clarkia amoena var. *lindleyi*	farewell-to-spring	G5T5	S3	Blue	CDFmm; CWHxm	Terrestrial
Clarkia purpurea ssp. *quadrivulnera*	small-flowered godetia	G5T5	S1	Red	CDFmm; CWHxm	
Claytonia washingtoniana	Washington springbeauty	G2G4	S2	Red	CDFmm; CWHdm; CWHxm; IDFww	Riverine; Terrestrial
Crassula aquatica	pigmyweed	G5	S3	Blue	CDFmm; CWHds; ICHxw; IDFxh	Estuarine; Lacustrine; Palustrine
Crassula connata var. *connata*	erect pygmyweed	G5TNR	S2	Red	CDFmm	Palustrine; Riverine; Terrestrial
Cuscuta campestris	field dodder	G5	S2S3	Blue	BGxh; CDFmm; CWHdm; CWHxm; IDFxh	

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Elatine rubella	three-flowered waterwort	G5	S2S3	Blue	BGxh; CDFmm; CWHdm; CWHxm; IDFxh	Estuarine; Lacustrine; Palustrine
Epilobium ciliatum ssp. *watsonii*	purple-leaved willowherb	G5T3T5	S2S3	Blue	CDFmm; CWHvh; CWHvm; CWHwh; CWHxm; ICHmw; IDFxm; SBSdh	Estuarine; Palustrine; Terrestrial
Epilobium densiflorum	dense spike-primrose	G5	S1	Red	CDFmm	Palustrine; Terrestrial
Epilobium halleanum	Hall's willowherb	G5	S2S3	Blue	BGxh; BGxw; CDFmm; ESSFdcp; ICHdw; ICHwk; SBSwk; SWBun	Lacustrine; Palustrine; Riverine; Terrestrial
Epilobium torreyi	brook spike-primrose	G5	SX	Red	CDFmm	Palustrine; Terrestrial
Eupatorium maculatum ssp. *bruneri*	Joe-pye weed	G5T4T5Q	S1	Red	CDFmm; ICHmw	
Fraxinus latifolia	Oregon ash	G5	S1	Red	CDFmm; CWHxm	Estuarine; Palustrine
Githopsis specularioides	common bluecup	G5	S2S3	Blue	CDFmm; CWHmm; CWHxm; MHmm	Palustrine; Riverine; Terrestrial
Grindelia hirsutula var. *hirsutula*	hairy gumweed	G5T3T4	S1	Red	CDFmm	Terrestrial
Helenium autumnale var. *grandiflorum*	mountain sneezeweed	G5T3T5	S2S3	Blue	BGxh; CDFmm; CWHdm; CWHxm; ICHmw; ICHxw; PPdh	Estuarine; Lacustrine; Palustrine; Terrestrial
Heterocodon rariflorum	heterocodon	G5	S3	Blue	CDFmm; CWHds; CWHxm; ICHdw; IDFdm; IDFxh; PPdh	Palustrine; Riverine; Terrestrial
Hippuris tetraphylla	four-leaved mare's-tail	G5	S2S3	Blue	CDFmm; CWHds; CWHms	Estuarine; Palustrine
Hutchinsia procumbens	hutchinsia	G5	S1	Red	BGxh; BGxw; CDFmm; CWHxm; IDFxh	Lacustrine; Palustrine; Riverine; Terrestrial
Hydrocotyle ranunculoides	floating water pennywort	G5	SH	Red	CDFmm	Palustrine

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Hydrophyllum tenuipes	Pacific waterleaf	G4G5	S2	Red	CDFmm; CWHdm; CWHxm	Palustrine; Terrestrial
Idahoa scapigera	scalepod	G5	S2	Red	CDFmm; CWHxm; ICHxw; IDFww; PPxh	Palustrine; Riverine
Jaumea carnosa	fleshy jaumea	G4G5	S2S3	Blue	CDFmm; CWHvh; CWHvm; CWHxm	Estuarine
Lepidium oxycarpum	sharp-pod peppergrass	G4	SX	Red	CDFmm	
Limnanthes macounii	Macoun's meadow-foam	G2	S2	Red	CDFmm; CWHxm	Palustrine; Terrestrial
Linaria canadensis var. *texana*	blue toadflax	G5T4T5	S3	Blue	CDFmm	
Lomatium dissectum var. *dissectum*	fern-leaved desert-parsley	G4T4	S1	Red	CDFmm	Terrestrial
Lomatium grayi	Gray's desert-parsley	G5	S1	Red	CDFmm; CWHxm	Terrestrial
Lotus formosissimus	seaside birds-foot trefoil	G4	S1	Red	CDFmm	Terrestrial
Lotus pinnatus	bog bird's-foot trefoil	G4G5	S1	Red	CDFmm; CWHmm	Palustrine; Riverine; Terrestrial
Lotus unifoliolatus var. *unifoliolatus*	Spanish-clover	G5T5	S3	Blue	CDFmm; CWHxm	Terrestrial
Lupinus densiflorus var. *densiflorus*	dense-flowered lupine	G5T4	S1	Red	CDFmm	Riverine; Terrestrial
Lupinus lepidus	prairie lupine	G5	S1	Red	CDFmm; CWHmm; CWHxm	Terrestrial
Lupinus oreganus var. *kincaidii*	Kincaid's lupine	G5T2	SX	Red	CDFmm	Terrestrial
Lupinus rivularis	streambank lupine	G2G4	S1	Red	CDFmm; CWHdm; CWHxm	
Marah oreganus	manroot	G5	S1	Red	CDFmm; CWHxm	Terrestrial
Meconella oregana	white meconella	G2G3	S1	Red	CDFmm; CWHxm	Palustrine; Terrestrial
Megalodonta beckii var. *beckii*	water marigold	G4G5T4T5	S3	Blue	CDFmm; ICHdw; ICHmw; ICHxw; IDFdm; IDFun; SBSmk	Lacustrine; Palustrine; Riverine
Microseris bigelovii	coast microseris	G4	S1	Red	CDFmm	Palustrine; Terrestrial
Microseris lindleyi	Lindley's microseris	G5	S1	Red	CDFmm	Terrestrial
Minuartia pusilla	dwarf sandwort	G5	S1	Red	CDFmm	Terrestrial

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Myriophyllum quitense	waterwort water-milfoil	G4?	S2S3	Blue	CDFmm; CWHvh; CWHwh; CWHxm	Lacustrine; Palustrine; Riverine
Myriophyllum ussuriense	Ussurian water-milfoil	G3	S3	Blue	CDFmm; CWHdm; CWHvh; ICHdw; IDFmw	Estuarine; Lacustrine; Palustrine; Riverine
Navarretia intertexta	needle-leaved navarretia	G5	S2	Red	CDFmm; CWHxm; ICHmk; IDFxh	Palustrine; Riverine; Terrestrial
Orobanche pinorum	pine broomrape	G4	S1	Red	CDFmm; CWHmm; CWHxm	Terrestrial
Orthocarpus bracteosus	rosy owl-clover	G3?	S1	Red	CDFmm	Palustrine; Terrestrial
Plagiobothrys figuratus ssp. *figuratus*	fragrant popcornflower	G4T4	S1	Red	CDFmm	Palustrine
Plagiobothrys tenellus	slender popcornflower	G4G5	S2	Red	CDFmm	Terrestrial
Polygonum hydropiperoides	water-pepper	G5	S2S3	Blue	CDFmm; CWHdm; CWHds; CWHxm	Lacustrine; Palustrine
Potentilla gracilis var. *gracilis*	graceful cinquefoil	G5T5	S2S3	Blue	CDFmm	
Psilocarphus elatior	tall woolly-heads	G4Q	S1	Red	CDFmm; CWHvh	Palustrine; Terrestrial
Psilocarphus tenellus var. *tenellus*	slender woolly-heads	G4T4	S3	Blue	CDFmm; CWHxm	Palustrine; Terrestrial
Ranunculus alismifolius var. *alismifolius*	water-plantain buttercup	G5T5	S1	Red	CDFmm	Palustrine; Terrestrial
Ranunculus californicus	California buttercup	G5	S1	Red	CDFmm	Terrestrial
Ranunculus lobbii	Lobb's water-buttercup	G4	SH	Red	CDFmm	Lacustrine; Palustrine
Rubus lasiococcus	dwarf bramble	G5	S2S3	Blue	CDFmm; CWHds; CWHmm; CWHxm; ESSFmw; MHmm	Terrestrial
Rubus nivalis	snow bramble	G4?	S2	Red	CDFmm; CWHmm; CWHvh; CWHvm; CWHxm; ICHmw; MHmm	Terrestrial
Rupertia physodes	California-tea	G4	S3	Blue	CDFmm; CWHmm; CWHxm; MHmm	Terrestrial

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Salix lemmonii	Lemmon's willow	G5	S1	Red	CDFmm	Lacustrine; Palustrine
Salix sessilifolia	soft-leaved willow	G4	S2S3	Blue	CDFmm; CWHdm; CWHds; CWHvm; CWHxm	Estuarine; Lacustrine; Palustrine; Terrestrial
Sanicula arctopoides	snake-root sanicle	G5	S1	Red	CDFmm	
Sanicula bipinnatifida	purple sanicle	G5	S2	Red	CDFmm; CWHxm	Terrestrial
Senecio macounii	Macoun's groundsel	G5	S3	Blue	CDFmm; CWHmm; CWHxm	Estuarine; Terrestrial
Sidalcea hendersonii	Henderson's checker-mallow	G3	S3	Blue	CDFmm; CWHxm	Estuarine; Palustrine
Silene scouleri ssp. grandis	Scouler's catchfly	G5TNR	S1	Red	CDFmm	Terrestrial
Thysanocarpus curvipes	sand lacepod	G4G5	S3	Blue	CDFmm	
Tonella tenella	small-flowered tonella	G5	S1	Red	CDFmm	Terrestrial
Toxicodendron diversilobum	poison oak	G5	S2S3	Blue	CDFmm; CWHdm; CWHxm	Terrestrial
Trifolium cyathiferum	cup clover	G4	S1	Red	BGxh; CDFmm; CWHmm; CWHxm; ICHdw; ICHmw; IDFdm; IDFxh; PPdh	Palustrine; Riverine; Terrestrial
Trifolium depauperatum var. *depauperatum*	poverty clover	G5T5?	S3	Blue	CDFmm; CWHxm	Palustrine; Riverine; Terrestrial
Trifolium dichotomum	Macrae's clover	G4?	S2S3	Blue	CDFmm; CWHxm	Terrestrial
Triphysaria versicolor ssp. *versicolor*	bearded owl-clover	G5T5	S1	Red	CDFmm	Palustrine; Terrestrial
Utricularia ochroleuca	ochroleucous bladderwort	G4?	S2S3	Blue	BWBSdk; CDFmm; ESSFmv; ICHmw	Lacustrine; Palustrine
Viola howellii	Howell's violet	G4	S2S3	Blue	CDFmm; CWHmm; CWHxm; MHmm	Palustrine; Riverine; Terrestrial
Viola praemorsa ssp. *praemorsa*	yellow montane violet	G5T3T5	S2	Red	CDFmm; CWHxm	Terrestrial
Yabea microcarpa	California hedge-parsley	G5?	S2	Red	CDFmm; CWHxm	Terrestrial
Monocotyledons						

Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit	Habitat Type
Agrostis pallens	dune bentgrass	G4G5	S3	Blue	CDFmm; CWHds; CWHmm; CWHvh; CWHvm; CWHxm	Palustrine; Terrestrial
Allium amplectens	slimleaf onion	G4	S3	Blue	CDFmm; CWHxm	Terrestrial
Allium crenulatum	Olympic onion	G4	S2	Red	CDFmm; CMA; CWHxm; MHmm	Terrestrial
Allium geyeri var. *tenerum*	Geyer's onion	G4G5T3T5	S2S3	Blue	BGxw; CDFmm; CWHxm; ESSFxc; IDFdk; IDFmw; IDFww; IDFxm; MSdm	Estuarine; Palustrine; Terrestrial
Alopecurus carolinianus	Carolina meadow-foxtail	G5	S2	Red	CDFmm; CWHdm; CWHds; IDFxh	Palustrine; Terrestrial
Bulbostylis capillaris	densetuft hairsedge	G5	S1	Red	CDFmm	
Carex feta	green-sheathed sedge	G5	S2	Red	CDFmm; CWHxm	Palustrine; Riverine; Terrestrial
Carex interrupta	green-fruited sedge	G4	S2	Red	CDFmm; CWHdm	Lacustrine; Palustrine; Terrestrial
Carex scoparia	pointed broom sedge	G5	S2S3	Blue	BWBSmw; CDFmm; CWHdm; CWHvh; CWHxm; ICHdw; ICHwk; ICHxw; SBSvk	Lacustrine; Palustrine; Terrestrial
Carex tumulicola	foothill sedge	G4	S2	Red	CDFmm	Palustrine; Terrestrial
Cephalanthera austiniae	phantom orchid	G4	S2	Red	CDFmm; CWHdm; CWHxm	Terrestrial
Cyperus squarrosus	awned cyperus	G5	S3	Blue	BGxh; CDFmm; CWHxm; IDFmw; IDFxh; PPxh	Lacustrine; Palustrine; Riverine; Terrestrial
Eleocharis parvula	small spike-rush	G5	S2S3	Blue	CDFmm; CWHvm; CWHwh; CWHxm	Estuarine; Lacustrine; Palustrine
Eleocharis rostellata	beaked spike-rush	G5	S2S3	Blue	CDFmm; CWHdm; CWHxm; ICHmw; IDFdm; IDFmw; MSdm; MSxk	Estuarine; Lacustrine; Palustrine; Riverine; Terrestrial

Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit	Habitat Type
Glyceria leptostachya	slender-spiked mannagrass	G3	S2S3	Blue	CDFmm; CWHdm; CWHwh; CWHxm	Estuarine; Lacustrine; Palustrine; Terrestrial
Juncus kelloggii	Kellogg's rush	G3?	S1	Red	CDFmm	Palustrine
Juncus occidentalis	western rush	G5	S2S3	Blue	CDFmm	
Juncus oxymeris	pointed rush	G5	S2S3	Blue	CDFmm; CWHdm; CWHxm	Estuarine; Palustrine; Terrestrial
Leymus triticoides	creeping wildrye	G4G5	S1	Red	CDFmm	Terrestrial
Lilaea scilloides	flowering quillwort	G5?	S2S3	Blue	CDFmm; CWHdm; CWHvm; CWHxm	Estuarine; Palustrine
Malaxis brachypoda	white adder's-mouth orchid	G4Q	S2S3	Blue	BWBSdk; BWBSmw; CDFmm; CWHdm; CWHvm; CWHwh; CWHws; CWHxm; SBSvk	Estuarine; Lacustrine; Palustrine; Riverine; Terrestrial
Melica harfordii	Harford's melic	G5	S2S3	Blue	CDFmm	
Piperia candida	white-lip rein orchid	G3G4	S2	Red	CDFmm; CWHvh	Terrestrial
Pleuropogon refractus	nodding semaphoregrass	G4	S3	Blue	CDFmm; CWHdm; CWHms; CWHvh; CWHvm; CWHxm; MHmm	Palustrine; Terrestrial
Potamogeton oakesianus	Oakes' pondweed	G4	S2S3	Blue	CDFmm; CWHvm; ICHmw	Lacustrine
Schoenoplectus americanus	Olney's bulrush	G5	S1	Red	CDFmm; CWHds	Lacustrine; Palustrine; Riverine; Terrestrial
Triglochin concinna	graceful arrow-grass	G5	S2	Red	CDFmm; CWHvh; CWHwh	Estuarine
Triteleia howellii	Howell's triteleia	G3G4	S1	Red	CDFmm	Terrestrial
Wolffia columbiana	Columbian water-meal	G5	S1	Red	CDFmm	Lacustrine
Bryophytes						
Bartramia stricta	apple moss	GU	S1	Red	CDFmm	Terrestrial
Entosthodon fascicularis	banded cord-moss	G4G5	S2S3	Blue	CDFmm; CWHxm; ICHdm; IDFdw	Palustrine; Riverine; Terrestrial
Syntrichia laevipila	twisted oak moss	GNR	S2S3	Blue	CDFmm	

Search Criteria

Species Group:Plants & Animals
AND BC Conservation Status:Red (Extirpated, Endangered, or Threatened) OR Blue (Special Concern)
AND BGC Zone:CDF
Sort Order:Phylogenetic Ascending
Accessed May 31 2008

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APPENDIX II

Air Photos Used for the Project

Appendix II. Air Photos Used for the Project

General Area	Flightline	Roll Number	Start Frame	End Frame	Total Photos	Flown	Scale	Source
Saltspring Island	SS-1	RC29	205	206	2	2005	1:16,500	McElhanney
Saltspring Island	SS-2	RC29	195	198	4	2005	1:16,500	McElhanney
Saltspring Island	SS-3	RC29	190	194	5	2005	1:16,500	McElhanney
Saltspring Island	SS-4	RC29	173	178	6	2005	1:16,500	McElhanney
Saltspring Island	SS-5	RC29	166	172	7	2005	1:16,500	McElhanney
Saltspring Island	SS-6	RC29	140	147	8	2005	1:16,500	McElhanney
Saltspring Island	SS-7	RC30	6	14	9	2005	1:16,500	McElhanney
Saltspring Island	SS-8	RC30	15	24	10	2005	1:16,500	McElhanney
Saltspring Island	SS-9	RC30	25	33	9	2005	1:16,500	McElhanney
Saltspring Island	SS-10	RC30	34	44	11	2005	1:16,500	McElhanney
Saltspring Island	SS-11	RC30	45	56	12	2005	1:16,500	McElhanney
Saltspring Island	SS-12	RC30	58	67	10	2005	1:16,500	McElhanney
Saltspring Island	SS-13	RC30	68	74	7	2005	1:16,500	McElhanney
Texada Island	TI-1	30BCC03037	208	216	9	2003	1:15000	ILMB
Texada Island	TI-2	30BCC03038	12	22	11	2003	1:15000	ILMB
Texada Island	TI-3	30BCC03038	24	32	9	2003	1:15000	ILMB
Texada Island	TI-4	30BCC03038	45	51	7	2003	1:15000	ILMB
Texada Island	TI-5	30BCC03038	52	58	7	2003	1:15000	ILMB
Texada Island	TI-6	30BCC03038	70	76	7	2003	1:15000	ILMB
Texada Island	TI-7	30BCC03038	77	81	5	2003	1:15000	ILMB
Texada Island	TI-8	30BCC03038	97	101	5	2003	1:15000	ILMB
Texada Island	TI-9	30BCC03038	104	108	5	2003	1:15000	ILMB
Texada Island	TI-10	30BCC03038	120	125	6	2003	1:15000	ILMB
Texada Island	TI-11	30BCC03038	134	139	6	2003	1:15000	ILMB
Texada Island	TI-12	30BCC03038	142	157	16	2003	1:15000	ILMB

Appendix II. Air Photos Used for the Project (continued)

General Area	Flightline	Roll Number	Start Frame	End Frame	Total Photos	Flown	Scale	Source
Texada Island	TI-13	30BCC03038	160	175	16	2003	1:15000	ILMB
Texada Island	TI-14	30BCC03038	176	189	14	2003	1:15000	ILMB
Texada Island	TI-15	30BCC03038	190	200	11	2003	1:15000	ILMB
Sunshine Coast	SC-1	30BCC03039	167	171	5	2003	1:15000	ILMB
Sunshine Coast	SC-2	30BCC03039	92	100	9	2003	1:15000	ILMB
Sunshine Coast	SC-3	30BCC03039	83	91	9	2003	1:15000	ILMB
Sunshine Coast	SC-4	30BCC03039	1	11	11	2003	1:15000	ILMB
Powell River	PR-1	30BCC03036	154	158	5	2003	1:15000	ILMB
Powell River	PR-2	30BCC03036	185	197	13	2003	1:15000	ILMB
Powell River	PR-3	30BCC03036	199	211	13	2003	1:15000	ILMB
Powell River	PR-4	30BCC03037	8	19	12	2003	1:15000	ILMB
Powell River	PR-5	30BCC03037	31	36	6	2003	1:15000	ILMB
Powell River	PR-6	30BCC03037	53	58	6	2003	1:15000	ILMB
Powell River	PR-7	30BCC03037	61	68	8	2003	1:15000	ILMB
Powell River	PR-8	30BCC03037	88	99	12	2003	1:15000	ILMB
Powell River	PR-9	30BCC03037	100	112	13	2003	1:15000	ILMB
Powell River	PR-10	30BCC03037	141	147	7	2003	1:15000	ILMB
Powell River	PR-11	30BCC03037	154	166	13	2003	1:15000	ILMB
Powell River	PR-12	30BCC03037	194	207	14	2003	1:15000	ILMB
Galiano Island	GI-1	RC29	202	204	3	2005	1:16,500	ILMB
Galiano Island	GI-2	RC29	199	201	3	2005	1:16,500	ILMB
Galiano Island	GI-3	RC29	185	189	5	2005	1:16,500	ILMB
Galiano Island	GI-4	RC29	179	184	6	2005	1:16,500	ILMB
Galiano Island	GI-5	RC29	157	165	9	2005	1:16,500	ILMB
Galiano Island	GI-6	RC29	148	153	6	2005	1:16,500	ILMB
Galiano Island	GI-7	RC29	134	139	6	2005	1:16,500	ILMB

Appendix II. Air Photos Used for the Project (continued)

General Area	Flightline	Roll Number	Start Frame	End Frame	Total Photos	Flown	Scale	Source
Denman Island	DI-1	354c 8	1	4	4	2001	1:20000	McElhanney
Denman Island	DI-2	354c 9	1	5	5	2001	1:20000	McElhanney
Denman Island	DI-3	354c 10	1	11	11	2001	1:20000	McElhanney
Denman Island	DI-4	354c 11	1	13	13	2001	1:20000	McElhanney
Denman Island	DI-5	354c 12	1	9	9	2001	1:20000	McElhanney
Northeast Van Isl	VI-6 #2	30BCC98008	117	119	3	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #3	30BCC98008	130	142	13	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #3	30BCC98037	91	93	3	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #4	30BCC98037	82	83	2	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #4	30BCC98008	11	29	19	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #5	30BCC98037	45	68	24	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #6	30BCC98037	112	128	17	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #7	30BCC98038	1	15	15	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #8	30BCC98038	91	99	9	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #8	30BCC98055	130	133	4	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #9	30BCC98038	100	115	16	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #10	30BCC98037	22	33	12	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #10	30BCC98038	154	158	5	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #10	30BCC98038	174	184	11	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #11	30BCC98037	13	21	9	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #11	30BCC98037	129	158	30	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #12	30BCC98036	134	157	24	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #12	30BCC98038	188	199	12	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #13	30BCC98036	107	133	27	1998	1:15000	ILMB
Northeast Van Isl	VI-6 #14	30BCC98036	87	106	20	1998	1:15000	ILMB

Appendix II. Air Photos Used for the Project (continued)

General Area	Flightline	Roll Number	Start Frame	End Frame	Total Photos	Flown	Scale	Source
Northeast Van Isl	VI-6 #15	30BCC98036	81	86	6	1998	1:15000	ILMB
Duncan/Cowichan	VI-4 #2	15BCB92131	80	95	16	1992	1:10000	ILMB
Duncan/Cowichan	VI-4 #3	15BCB92131	185	215	31	1992	1:10000	ILMB
Duncan/Cowichan	VI-4 #4	15BCB92133	165	201	37	1992	1:10000	ILMB
Duncan/Cowichan	VI-4 #5	15BCB92133	68	110	43	1992	1:10000	ILMB
Duncan/Cowichan	VI-4 #6	15BCB92132	30	83	54	1992	1:10000	ILMB
Duncan/Cowichan	VI-4 #7	15BCB92130	209	257	49	1992	1:10000	ILMB
Duncan/Cowichan	VI-4 #8	15BCB92132	84	125	42	1992	1:10000	ILMB
Duncan/Cowichan	VI-6 #7	30BCC98036	61	74	14	1998	1:15000	ILMB
Duncan/Cowichan	VI-6 #9	30BCC98038	149	153	5	1998	1:15000	ILMB
Duncan/Cowichan	VI-6 #10	30BCC98037	34	44	11	1998	1:15000	ILMB
Duncan/Cowichan	VI-6 #11	30BCC98037	1	12	12	1998	1:15000	ILMB
West Cowichan	VI-5 #2	30BCC98034	172	182	11	1998	1:15000	ILMB
West Cowichan	VI-5 #2	30BCC98034	152	158	7	1998	1:15000	ILMB
West Cowichan	VI-5 #3	30BCC98036	13	29	17	1998	1:15000	ILMB
West Cowichan	VI-5 #3	30BCC98055	155	162	8	1998	1:15000	ILMB
West Cowichan	VI-5 #4	30BCC98036	30	48	19	1998	1:15000	ILMB
Ladysmith	LS-1	15BCB86007	89	95	7	1980	1:20000	ILMB
Ladysmith	LS-2	15BCB86007	99	104	6	1980	1:20000	ILMB
Ladysmith	LS-3	15BCB86007	139	146	8	1980	1:20000	ILMB
Bamberton	BM-1	15BCB92140	215	220	6	1992	1:10000	ILMB
Bamberton	BM-2	15BCB92140	113	118	6	1992	1:10000	ILMB
Cowichan Bay	CB-1	15BCB93096	18	31	14	1992	1:10000	ILMB
Cowichan Bay	CB-2	15BCB93096	50	62	13	1992	1:10000	ILMB
Cowichan Bay	CB-3	15BCB93096	82	89	8	1992	1:10000	ILMB

Appendix II. Air Photos Used for the Project (continued)

General Area	Flightline	Roll Number	Start Frame	End Frame	Total Photos	Flown	Scale	Source
Gabriola, Thetis, Valdes, Kuper	GI-1	RC06	397	401	5	2007	1:16500	ILMB
Gabriola, Thetis, Valdes, Kuper	GI-2	RC06	390	396	7	2007	1:16500	ILMB
Gabriola, Thetis, Valdes, Kuper	GI-3	RC06	358	364	7	2007	1:16500	ILMB
Gabriola, Thetis, Valdes, Kuper	GI-4	RC06	351	357	7	2007	1:16500	ILMB
Gabriola, Thetis, Valdes, Kuper	GI-5	RC06	280	295	16	2007	1:16500	ILMB
Gabriola, Thetis, Valdes, Kuper	GI-6	RC06	262	279	18	2007	1:16500	ILMB
Gabriola, Thetis, Valdes, Kuper	GI-7	RC06	210	222	13	2007	1:16500	ILMB
Gabriola, Thetis, Valdes, Kuper	GI-8	RC06	203	209	7	2007	1:16500	ILMB
Saanich Peninsula/CRD	Saanich1	RC04	6	14	9	2007	1:20000	ILMB
Saanich Peninsula/CRD	Saanich2	RC04	15	23	9	2007	1:20000	ILMB
Saanich Peninsula/CRD	Saanich2	RC13	173	181	9	2005	1:8500	ILMB
Saanich Peninsula/CRD	Saanich2	RC13	3	7	5	2005	1:16500	ILMB
Saanich Peninsula/CRD	Saanich3	RC04	24	36	13	2007	1:20000	ILMB
Saanich Peninsula/CRD	Saanich3	RC13	162	168	7	2005	1:16500	ILMB
Saanich Peninsula/CRD	Saanich4	RC04	37	56	20	2007	1:20000	ILMB
Saanich Peninsula/CRD	Saanich5	RC04	57	75	19	2007	1:20000	ILMB
Saanich Peninsula/CRD	Saanich6	RC04	76	97	22	2007	1:20000	ILMB
Saanich Peninsula/CRD	Saanich7	RC04	98	106	9	2007	1:20000	ILMB
Saanich Peninsula/CRD	Saanich8	RC04	107	114	8	2007	1:20000	ILMB
Saanich Peninsula/CRD	Saanich9	RC04	115	115	1	2007	1:20000	ILMB

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APPENDIX IV

TEM Map Legend

TERRESTRIAL ECOSYSTEM MAPPING OF THE CDFMM SUBZONE

Map sheets: 92B/023, 032, 033, 034, 043, 044, 053, 054, 062, 063, 064, 071, 072, 073, 074, 081, 082, 083, 084, 091, 092, 093, 094, 92F/020, 028, 029, 030, 037, 038, 039, 040, 047, 048, 049, 050, 056, 057, 058, 059, 060, 066, 067, 068, 069, 077, 078, 087, 088, 096, 097, 098, 92G/001, 002, 003, 011, 012, 021, 041, 051

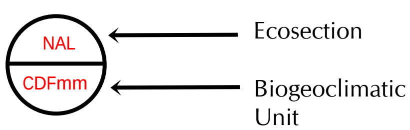
Scale 1: 20,000
June 2008

INTRODUCTION

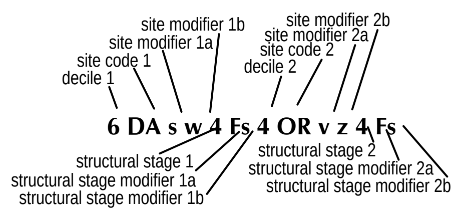
This project synthesizes results of bioterrain and terrestrial ecosystem mapping of the CDFmm biogeoclimatic subzone. The CDFmm occurs in south eastern BC, covering ecosystems along the eastern coastline of Vancouver Island, the southern Gulf Islands, parts of the Sunshine Coast and a portion of the Fraser Valley. On Vancouver Island, Deep Bay marks the northern extent of the CDFmm; Metchosin marks the southern boundary. From Deep Bay moving south, the subzone extends along the Strait of Georgia from sea level to an approximate elevation of 150m above sea level (asl) and includes the major centres of Nanaimo, Duncan and Victoria. The CDFmm covers or partially covers all of the Gulf Islands south of Cortes Island; including: Texada, Hornby, Denman, Lasqueti, Gabriola Galiano, Thetis, Kuper, Saltspring, North Pender, South Pender, Mayne, Saturna, Sidney and several smaller islets in between. Across the Strait of Georgia, the CDFmm covers portions of Lund, Powell River, Sechelt and the Fraser Valley for a total area of approximately 252,000 hectares.

Digital maps will aid interpretation for resource management and land use planning; identified wildlife habitat capability and suitability; and to collate a comprehensive baseline data set of attributes of interest for the CDFmm. A seamless database of polygon attributes and the associated bioterrain and ecosystem data, as well as other features and parameters of interest accompanies this legend. Mapping was completed following the methods outlined in Standard for Terrestrial Ecosystem Mapping in British Columbia1. Field work was completed in 2007 and 2008 at a modified survey intensity level 5.

ECOSECTION & BIOGEOCLIMATIC UNITS



ECOSYSTEM UNIT LABEL



MAP SYMBOLS

Ecosection — - - - - - -

Biogeoclimatic Unit ———

Ecosystem Unit ———

Study Area Boundary ———

Plot Location •

Ecosections
SGI: Southern Gulf Islands
SGO: Strait of Georgia
NAL: Nanaimo Lowland
GEL: Georgia Lowland

Biogeoclimatic Units:
CDFmm: Coastal Douglas-Fir zone, moist maritime subzone
CWHxm1: Coastal Western Hemlock zone, very dry maritime subzone, eastern variant
CWHxm2: Coastal Western Hemlock zone, very dry maritime subzone, western variant

ECOSYSTEM UNITS

CDFmm

Site Code	Description	Site Series	Assumed Modifiers	Soil Moisture Regime	Mapped Modifiers
AS	Trembling aspen - Slough sedge	00	j, m	subhygric - subhydric	s
CD	Act - Red-osier dogwood	08	a, d, j, m	subhygric - hygric	n, s, t
CS	Cw - Slough sedge	14	d, j, m	subhydric	c, n, p, s, t, w
CW	Act - Willow	09	a, c, d, j	subhygric - hygric	

ECOSYSTEM UNITS					
CDFmm (continued)					
Site Code	**Description**	**Site Series**	**Assumed Modifiers**	**Soil Moisture Regime**	**Mapped Modifiers**
DA	FdPl - Arbutus	02	j, d, m, r	xeric	c, h, k, q, s, v, w, x, z
DG	FdBg - Oregon grape	04	d, j, m	subxeric - mesic	c, f, g, h, k, q, r, s, t, v, w, x, z
DO	Fd - Oniongrass	03	d, m, r	xeric	h, k, s, v, w, x
DS	Fd - Salal	01	d, j, m	subxeric - mesic	c, f, g, h, k, n, q, r, s, t, v, w, x, z
FC	Fescue - Camas	00	j, m, s	subxeric	c, d, h, k, n, v, w
GO	Garry Oak - Ocean Spray	00	j, m, r	xeric - submesic	s, v, w, z
LM	Dunegrass - Beach pea	00	j, m, v	subxeric - submesic	c, w
LS	Pl - Sphagnum	10	d, j, p	subhydric	
OM	Garry Oak - Moss	00	j, v	xeric	k, v, w
OR	Oceanspray - Rose	00	m, s	mesic	w
QB	Garry Oak - Brome/mixed grasses	00	j, m, r	xeric - submesic	h, k, s, v, w, z
RA	Nootka Rose - Pacific Crab Apple	00		subhydric	
RC	Cw - Skunk cabbage	11	d, j, m	subhydric	c, f, n, p, s, t
RF	CwBg - Foamflower	06	d, j, m	subhygric - hygric	a, c, f, g, h, k, n, p, q, s, t, v, w, z
RK	CwFd - Kindbergia	05	d, j, m	subhygric - hygric	c, g, h, k, n, r, s, t, v, w, x, y, z
RP	Cw - Indian-plum	13	d, j, m	hygric	c, h, k, n, p, s, t, w
RS	Cw - Snowberry	07	a, d, j, m	subhygric - hygric	g, k, s, t, w
RV	Cw - Vanilla-leaf	12	d, j, m	subhygric	c, h, n, p, s, v
SC	Cladina - Wallace's selaginella	00	j, m, r, v	subxeric	h, k, q, s, w, z
Ed01	Tufted hairgrass - Meadow barley	Ed01		subhydric - hydric	
Ed03	Arctic rush - Alaska plantain	Ed03		subhydric - hydric	
Em01	Widgeon-grass	Em01		hydric	
Em02	Glasswort - Sea milkwort	Em02		subhydric - hydric	
Em03	Seashore saltgrass	Em03		subhydric - hydric	
Em05	Lyngbye's sedge	Em05		subhydric - hydric	
Wb50	Labrador tea - Bog-laurel - Peat-moss	Wb50		subhydric	
Wf51	Sitka sedge - Peat-moss	Wf51		subhydric	p
Wf52	Sweet gale - Sitka sedge	Wf52		subhydric	p
Wf53	Slender sedge - White beak-rush	Wf53		subhydric - hydric	d, s
Wm05	Cattail	Wm05		hydric	p
Wm06	Great bulrush	Wm06		hydric	
Wm50	Sitka sedge - Hemlock -parsley	Wm50		subhydric - hydric	
Wm51	Three-way sedge	Wm51		hydric	
Ws50	Hardhack (pink spirea) - Sitka sedge	Ws50		subhydric - hydric	p, s
Ws51	Sitka willow - Pacific willow -Skunk cabbage	Ws51		subhydric - hydric	p
Ws52	Red alder - Skunk cabbage	Ws52		subhydric - hydric	

CWHxm					
Site Code	**Description**	**Site Series**	**Assumed Modifiers**	**Soil Moisture Regime**	**Mapped Modifiers**
AM	Arbutus-Hairy manzanita	00	j, r, s	xeric	v, w, z
CS	Cw-Slough sedge	15	d, j, m	subhydric	
CW	Act-Willow (Fl50-Sitka willow-False lily-of-the-valley)	10	a, c, d, j	subhygric - hygric	
DC	FdPl-Cladina	02	j, m, r, s	very xeric	h, k, s, v, w, z
DF	Fd-Sword fern	04	d, j, m	xeric - subxeric	h, k, q, s, v, w, z
DS	FdHw-Salal	03	d, m, w	xeric - subxeric	h, j, k, q, r, s, v, x, y, z
FC	Fescue-Common camas	00	j, r, s	xeric	
HD	HwCw-Deer fern	06	d, j, m	subhygric - hygric	h, k, s, v, w
HK	HwFd-Kindbergia	01	d, j, m	submesic - mesic	h, k, q, r, s, v, w, x, z
QB	Garry Oak - Brome/mixed grasses	00	j, m, r	xeric - submesic	
RB	Cw-Salmonberry	13	d, j, m	subhygric	h, k, s, v
RC	CwSs-Skunk cabbage (Ws53-Cw-Sword fern-Skunk cabbage)	12	d, j, m	subhydric	p, s
RF	Cw-Foamflower	07	d, j, m	subhygric - hygric	h, k, s, w
RS	Cw-Sword fern	05	d, m	submesic - mesic	h, j, k, q, s, v, w, x
RT	Cw-Black twinberry	14	d, j, m	hygric	s
SC	Cladina - Wallace's selaginella	00	j, m, r, v	subxeric	
SS	Ss-Salmonberry	08	a, d, j, m	subhygric - hygric	
Wb50	Labrador tea - Bog-laurel -Peat-moss	Wb50		subhydric	
Wf53	Slender sedge - White beak-rush	Wf53		subhydric - hydric	
Ws50	Hardhack (pink spirea) - Sitka sedge	Ws50		subhydric - hydric	
Ws51	Sitka willow-Pacific willow-Skunk cabbage	Ws51		subhydric - hydric	

Non-Vegetated / Sparsely Vegetated / Anthropogenic	
Site Code	**Description**
BE	Beach
CF	Cultivated Field
CL	Cliff
CO	Cultivated Orchard
CV	Cultivated Vineyard
DM	Dam
ES	Exposed Soil
GB	Gravel Bar
GC	Golf Course
GP	Gravel Pit
IN	Industrial
LA	Lake
MI	Mine
MU	Mudflat Sediment
OW	Shallow Open Water
PD	Pond
RE	Reservoir
RI	River
RN	Railway Surface
RO	Rock Outcrop
RZ	Road Surface
RW	Rural
TA	Talus
TZ	Mine Tailings
UR	Urban/ Suburban

SITE MODIFIERS	
Code	**Topography**
a	active floodplain[1]: level or very gently sloping area bordering a river that has been formed by river erosion and deposition, with evidence of active sedimentation and deposition
g	gullying[1]: occurs within a gully, or with gullying throughout the delineated area
h	hummocky[1] terrain: indicated by the terrain surface expression
j	gentle slope: < 35% in the CWH and CDF zones
k	cool aspect: occurs on aspects 285°–135°, on moderately steep slopes (35%–100% in the CWH and CDF)
n	fan[1]: occurs on a fluvial fan or on a colluvial fan or cone
q	very steep cool aspect–very steep slopes (< 100%) with aspects 285°–135°
r	ridge[1]: occurs throughout an area of ridged terrain, or on a ridge crest
t	terrace[1]: occurs on a fluvial, glaciofluvial, lacustrine, or rock cut terrace
w	warm aspect: 135°–285°, on moderately steep slopes (35%–100% slope in the CWH and CDF zones)
z	very steep warm aspect –slopes > 100% on aspects 135°–285°
Code	**Soil**
x	drier than typical
y	moister than typical
c	coarse-textured soils[2]: sand and loamy sand, and sandy loam, loam, and sandy clay loam with > 70% coarse fragment volume
d	deep soil: >100 cm to bedrock
f	fine-textured soils[2]: silt and silt loam with < 20% coarse fragment volume; and clay, silty clay, silty clay loam, clay loam, sandy clay, and heavy clay with < 35% coarse fragment volume
p	peaty: on deep organics or a peaty surface (15–60 cm)[3] over mineral materials
s	shallow soils: 20–100 cm to bedrock
v	very shallow soils: < 20 cm to bedrock

STRUCTURAL STAGE	
Code	**Structural Stage[1]**
1	**Sparse (1a)** bare rock or ground / **bryoid (1b)** bryophytes and lichens dominant, may reflect recent disturbance
2	**Herb** some invading or residual shrubs and trees may be present, may reflect recent disturbance **Forb-dominated (2a) / Graminoid-dominated (2b) / Aquatic (2c) / Dwarf shrub (2d)**
3	**Shrub** Early successional stage or maintained by environmental conditions or disturbance **Low shrub (3a)** < 2 m tall / **Tall shrub (3a)** 2–10 m tall
4	**Pole/Sapling** Trees > 10 m tall, often densely stocked, no vertical canopy structure, typically < 40 years since disturbance
5	**Young Forest** Self-thinning and canopy differentiation initiated, typically 40–80 years since disturbance
6	**Mature Forest** Mature tree canopy, typically 80–250 years since disturbance
7	**Old Forest** Structurally complex stands comprised mainly of shade-tolerant and regenerating tree species; snags and coarse woody debris and patchy understories, typically > 250 years since disturbance.

DISTURBANCE MODIFIERS			
B	Biotic Disturbances	F	Fire disturbances
b	▪ Beaver tree cutting	c	▪ overstorey crown fire
d	▪ Domestic grazing/browsing	g	▪ light surface (ground) fire
w	▪ Wildlife grazing/browsing	r	▪ repeated light surface fires
k	▪ Insects	s	▪ severe surface fire
ki	⇨ Insect kill	i	▪ repeated severe surface fires
in	⇨ Infestation	l	▪ slash burning
p	▪ Disease	bb	⇨ broadcast burn
v	▪ Aggressive vegetation	pb	⇨ piled and burned
		wb	⇨ burned windrows
L	Forest Harvesting	L	Forest Harvesting
a	▪ patch cut system	e	▪ selection system
wr	⇨ with reserves	gr	⇨ group selection
c	▪ clearcut system	si	⇨ single tree
wr	⇨ with reserves (patch retention)	st	⇨ strip
d	▪ seed tree system	l	▪ land clearing
un	⇨ uniform	s	▪ Shelterwood system
gr	⇨ grouped	un	⇨ Uniform
		gr	⇨ Group
		st	⇨ Strip
		ir	⇨ Irregular

DATA SOURCES

This mapping project is based on a mix of monochrome and colour stereo aerial photography provided by the ILMB and the Islands Trust Fund. Airphotos ranged in scale from 1:8500 to 1:25000; photo age ranged from 1980 to 2007. Base map data is from Terrain Resource Inventory Mapping (TRIM) and provided by the Integrated Land Management Bureau (ILMB). A total of 9% polygon inspection was achieved. 78 full plots, 399 ground inspections and 985 visual checks were completed.

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APPENDIX V

Terrain Legend

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Appendix V. Terrain Legend

MINERAL SOIL TEXTURE

c	clay (<0.002 mm)	**g**	gravel (256-2 mm)
z	silt (0.062-0.002 mm)	**d**	diamict (mixed fragments)
s	sand (2-0.062 mm)		

SURFICIAL MATERIALS

C - colluvium	**F**^{G} - glaciofluvial	**O** - organic
D - weathered bedrock	**L** - lacustrine	**R** - bedrock
E - eolian	**L**^{G} - glaciolacustrine	**W** - marine
F - fluvial	**M** - morainal	**W**^{A} – active marine
F^{A} - active fluvial	**N** - not mapped	**W**^{G} - glaciomarine

SURFACE EXPRESSION

Simple (unidirectional) slopes	**Material thickness**
p plain, less than 5%	**b** blanket (greater than 1m)
j gentle slope(s), 6-27%	**v** veneer (less than 1 m)
a moderate slope(s), 28-49%	**w** variable thickness, (0-3m)
k moderately steep slope(s), 50-70%	**x** thin veneer (2-20cm)
s steep slopes(s), >70%	
Complex slopes	**Shape**
m rolling	**c** cone (slope greater than 27%)
u undulating	**f** fan (slope less than 27%)
h hummocky	**t** terrace
r ridged	**d** depression

GEOMORPHOLOGICAL PROCESS

Code	Definition	Code	Definition
E	channeled by meltwater	**R**	rapid mass movement
F	slow mass movement	**V**	gully erosion
H	kettled	**W**	washing

Mass Movement Subclasses (used with process F and/or R)

Code	Definition
"	initiation zone
b	descent of masses of bedrock by falling, bouncing & rolling
f	decent of a mass of surficial material by falling, bouncing & rolling
r	descent of masses of disintegrating bedrock by sliding
s	debris slide
u	slump of surficial material along a slip plane that is concave upward or planar.
x	combined slump (upper part) and earthflow (lower part)

SOIL DRAINAGE

Code	Definition	Code	Definition	Drainage separation	Definition
i	imperfectly drained	**r**	rapidly drained	**,**	no intermediate classes
m	moderately well drained	**w**	well drained	**-**	all intermediate classes
p	poorly drained	**x**	very rapidly drained		

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APPENDIX VI

Expanded TEM Legend

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APPENDIX VII

Vascular and Non-Vascular Plant Species Observed During Field Assessments in the CDFmm Study Area

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Appendix VII. Vascular and Non-Vascular Plant Species Observed During Field Assessments in the Study Area

Abies amabilis	amabilis fir
Abies grandis	grand fir
Acer macrophyllum	bigleaf maple
Achillea millefolium	yarrow
Achlys triphylla	vanilla-leaf
Adenocaulon bicolor	pathfinder
Agoseris grandiflora	large-flowered agoseris
Agrostis scabra	hair bentgrass
Agrostis sp.	bentgrass
Agrostis stolonifera	creeping bentgrass
Aira caryophyllea	silver hairgrass
Aira praecox	early hairgrass
Allium amplectens	slimleaf onion
Allium cernuum	nodding onion
Alnus rubra	red alder
Amelanchier alnifolia	saskatoon berry
Anthoxanthum odoratum	sweet vernalgrass
Aphanes arvensis	field aphanes
Arabis hirsuta	hoary rock-cress
Arbutus menziesii	arbutus
Arctostaphylos columbiana	*hairy manzanita*
Arctostaphylos uva-ursi	kinnikinnick
Asarum caudatum	wild ginger
Asplenium trichomanes	common spleenwort
Aster sp.	Aster sp.
Athyrium filix-femina	lady fern
Atriplex sp.	Orache
Bellis perenis	English daisy
Blechnum spicant	deer fern
Brachythecium frigidum	golden short-capsuled moss
Bromus carinatus	California brome
Bromus hordeaceus	soft brome
Bromus vulgaris	Columbia brome
Bryum sp.	Bryum sp.
Calamagrostis canadensis	bluejoint reedgrass
Callitriche sp.	water starwort
Calypso bulbosa	fairy-slipper
Camassia leichtlinii	great camas
Camassia quamash	common camas
Campanula rotundifolia	common harebell
Cardamine occidentalis	western bitter-cress
Cardamine oligosperma	little western bitter-cress
Carex aquatilis	water sedge
Carex deweyana	Dewey's sedge
Carex lasiocarpa	slender sedge
Carex obnupta	slough sedge
Carex sitchensis	Sitka sedge
Castilleja hispida	harsh paintbrush

Cerastium arvense	field chickweed
Cerastium vulgatum	mouse-ear chickweed
Chimaphila umbellatum	prince's pine
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
Cladina mitis	lesser green reindeer lichen
Cladina portentosa	coastal reindeer lichen
Cladina rangiferina	grey reindeer lichen
Cladonia chlorophaea	peppered pixie-cup
Claytonia perfoliata	miner's lettuce
Claytonia sibirica	Siberian spring beauty
Claytonia spathulata	pale montia
Collinsia parviflora	small-flowered blue-eyed Mary
Cornus nuttallii	western flowering dogwood
Crataegus douglasii	black hawthorn
Crepis tectorum	annual hawksbeard
Cytusus scopulorum	Scotch broom
Dactylis glomerata	orchardgrass
Daphne laureola	spurge-laurel
Dicranum fuscescens	curly heron's-bill moss
Dicranum scoparium	broom moss
Dicranum sp.	heron's bill moss
Digitalis purpurea	common foxglove
Distichlis sp.	saltgrass
Dryopteris expansa	spiny wood fern
Elymus glaucus	blue wildrye
Epilobium angustifolium	fireweed
Epilobium ciliolatum	purple-leaved willowherb
Epilobium sp.	willowherb
Equisetum arvense	common horsetail
Equisetum hyemale	scouring-rush
Equisetum pretense	meadow horsetail
Equisetum sylvaticum	wood horsetail
Erythronium oreganum	white fawn lily
Eurhynchium oreganum	Oregon beaked moss
Eurhynchium praelonga	Oregon slender moss
Festuca occidentalis	western fescue
Festuca rubra	red fescue
Festuca sp.	fescue
Festuca subulata	bearded fescue
Fragaria chiloensis	beach strawberry
Fragaria sp.	strawberry
Fragaria vesca	wood starwberry
Fragaria virginiana	wild strawberry
Fritillaria lanceolata	chocolate lily
Galium aparine	cleavers
Galium palustre	marsh bedstraw
Galium trifidum	small bedstraw
Galium triflorum	sweet-scented bedstraw
Gaultheria shallon	salal
Gentiana sp.	gentian

Geranium bicknellii	Bicknell's geranium
Geum macrophyllum	big-leaved avens
Gnaphalium microcephalum	slender cudweed
Gnaphalium sp.	cudweed
Goodyera oblongifolia	rattlesnake-plantain
Geranium molle	dove-foot geranium
Gratiola ebracteata	bractless hedge-hyssop
Grindelia integrifolia	entire-leaved gumweed
Heracleum maximum	cow-parsnip
Heuchera micrantha	small-flowered alumroot
Hieracium albiflorum	white-flowered hawkweed
Holcus lanatus	common velvet-grass
Holodiscus discolor	oceanspray
Hylocomium splendens	step moss
Hypericum sp.	St.John’s wort
Hypochaeris glabra	smooth cat’s ear
Hypocaoeris radicata	hairy cat's-ear
Ilex aquifolium	English holly
Juncus articulatus	jointed rush
Juncus balticus	Baltic rush
Juncus covillei	Coville’s rush
Juncus effuses	common rush
Juncus sp.	rush
Juniperus communis	common juniper
Juniperus scopulorum	Rocky Mountain juniper
Kindbergia oregano	Oregon beaked moss
Koeleria macrantha	junegrass
Lactuca muralis	wall lettuce
Leucolepis acanthoneuron	palm tree moss
Lilaeopsis occidentalis	western lilaeopsis
Lilium columbianum	Columbia lily
Linnaea borealis	twinflower
Listera caurina	northwestern twayblade
Lithophragma parviflora	woodland star
Lonicera ciliosa	western trumpet honeysuckle
Lonicera hispidula	hairy honeysuckle
Lonicera sp.	honeysuckle
Lotus micranthus	small-flowered birds-foot trefoil
Luzula multiflora	many-flowered woodrush
Luzula parviflora	small-flowered woodrush
Lycopus uniflorus	northern water-horehound
Lysichiton americanus	skunk cabbage
Madia sp.	tarweed
Mahonia aquifolium	tall Oregon-grape
Mahonia nervosa	dull Oregon-grape
Maianthemum stellatum	star-flowered false Solomon’s-seal
Malus fusca	Pacific crab apple
Melica subulata	Alaska onion-grass
Mentha arvensis	field mint
Mimulus alsinoides	chickweed monkeyflower
Mimulus guttatus	common monkeyflower

Moehringia macrophylla	big-leaved sandwort
Monotropa uniflora	Indian pipe
Montia parvifolia	small-leaved montia
Myosotis laxa	small-flowered forget-me-not
Nemophila parviflora	small-flowered nemophila
Nuphar lutea	yellow pond-lily
Oenanthe sarmentosa	Pacific water-parsley
Oplopanax horridus	devil's club
Opuntia fragilis	prickly-pear cactus
Orthocarpus pusillus	tiny owl-clover
Osmorhiza chilensis	sweet cicely
Pachystima myrsinites	false-box
Panicum occidentale	western witchgrass
Peltigera sp.	pelt lichen
Pentagramma triangularis	golden-back fern
Petasites frigidus	palmate coltsfoot
Philonotis Fontana	spring moss
Physocarpus capitatus	Pacific ninebark
Picea sitchensis	Sitka spruce
Pinus monticola	western white pine
Pinus contorta var. *contorta*	shore pine
Plagiomnium insigne	coastal leafy moss
Plagiomnium sp.	leafy moss
Plagiothecium undulatum	flat-moss
Plantago elongata	dwarf plantain
Plantago lanceolata	ribwort plantain
Plantago major	common plantain
Plantago maritima	seashore plantain
Platanthera orbiculata	large round-leaved rein orchid
Platanthera unalascensis	Alaska rein orchid
Plectritis congesta	sea blush
Pleurozium schreberi	red-stemmed feathermoss
Poa annua	annual bluegrass
Poa compressa	Canada bluegrass
Poa pratensis	Kentucky bluegrass
Polypodium glycyrrhiza	licorice fern
Polystichum munitum	sword fern
Polytrichum juniperinum	juniper haircap moss
Polytrichum piliferum	awned haircap moss
Polytrichum sp.	haircap moss
Polytrichum strictum	bog haircap moss
Populus tremuloides	trembling aspen
Potentilla anserina ssp. *pacifica*	Pacific silverweed
Prunella vulgaris	self-heal
Prunus emarginata	bitter cherry
Pseudotsuga menziesii	Douglas-fir
Pteridium aquilinum	bracken fern
Racomitrium canescens	grey rock moss
Racomitrium lanuginosum	hoary rock moss
Ranunculus acris	meadow spearwort
Ranunculus repens	creeping buttercup

Ranunculus sp.	buttercup
Ranunculus uncinatus	small-flowered buttercup
Rhamnus purshiana	cascara
Rhizomnium sp.	leafy moss
Rhytidiadelphus loreus	lanky moss
Rhytidiadelphus triquetrus	electrified cat's-tail moss
Ribes lacustre	black gooseberry
Ribes sanguineum	red flowering currant
Rosa gymnocarpa	baldhip rose
Rosa nutkana	Nootka rose
Rubus laciniatus	evergreen blackberry
Rubus parviflorus	thimbleberry
Rubus discolor	Himalayan blackberry
Rubus pedatus	five-leaved bramble
Rubus spectabilis	salmonberry
Rubus ursinus	trailing blackberry
Rumex acetosella	sheep sorrel
Rumex obtusifolius	dock
Sagina procumbens	procumbent pearlwort
Salix lucida	Pacific willow
Salix sitchensis	Sitka willow
Salix sp.	willow
Sambucus racemosa	red elderberry
Sanguisorba canadensis	Sitka burnet
Sanicula crassicaulis	Pacific sanicle
Satureja douglasii	yerba buena
Saxifraga ferruginea	Alaska saxifrage
Scapania bolanderi	yellow-ladle liverwort
Schoenoplectus acutus	hard-stemmed bulrush
Sedum oreganum	Oregon stonecrop
Sedum spathulifolium	broad-leaved stonecrop
Selaginella wallacei	Wallace's selaginella
Senecio sylvaticus	wood groundsel
Sherardia arvensis	spurwort
Sonchus arvensis	field sowthistle
Sonchus asper	prickly sow-thistle
Sphagnum girgensohnii	common green peat-moss
Sphagnum sp.	peat-moss
Spiraea douglasii	hardhack
Stellaria crispa	crisp starwort
Stellaria media	chickweed
Stellaria sp.	starwort
Symphoricarpos albus	common snowberry
Symphoricarpos hesperius	trailing snowberry
Taraxacum officinale	common dandelion
Taxus brevifolia	western yew
Tellima grandiflora	fringe-cup
Thuja plicata	western redcedar
Tiarella trifoliata	three-leaved foamflower
Timmia austraica	false-polytrichum
Tolmiea menziesii	piggy-back plant

Trientalis latifolia	broad-leaved starflower
Trifolium microcephalum	woolly clover
Trifolium oliganthum	few-flowered clover
Trifolium repens	white clover
Trifolium variegatum	white-tip clover
Tsuga heterophylla	western hemlock
Typha latifolia	cat-tail
Ulex europaeus	gorse
Urtica dioica	stinging nettle
Vaccinium ovalifolium	oval-leaved blueberry
Vaccinium ovatum	evergreen huckleberry
Vaccinium parvifolium	red huckleberry
Veronica arvensis	wall speedwell
Veronica officinalis	common speedwell
Viburnum edule	highbush-cranberry
Vicia americana	American vetch
Vicia gigantean	giant vetch
Vicia sp.	vetch
Xanthoparmelia cumberlandia	questionable rockfrog
Zygadenus venenosus	death camas