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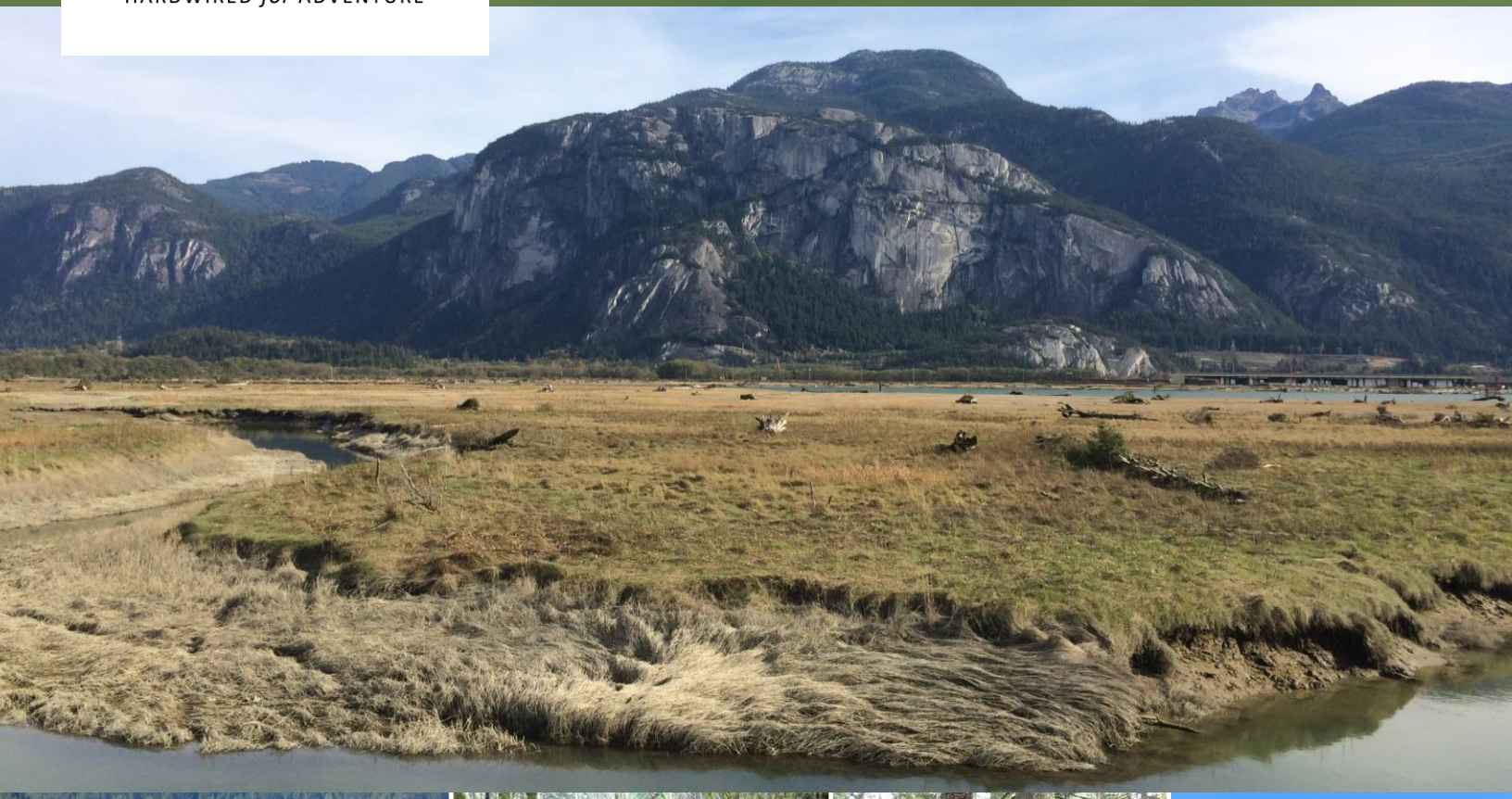
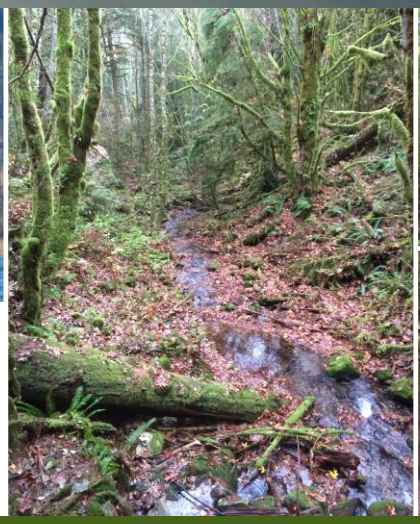
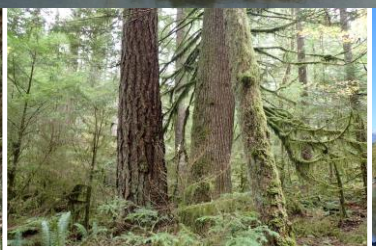
DISTRICT OF SQUAMISH
SENSITIVE ECOSYSTEMS INVENTORY (SEI) & ENVIRONMENTALLY SENSITIVE AREAS MAPPING







DURAND Ecological Ltd.

PHASE 2 - ENVIRONMENTALLY SENSITIVE AREAS MAPPING

ECOSCAPE Environmental Consultants Ltd.

Prepared For: District of Squamish

Prepared By:
Durand Ecological Ltd.
In Partnership with:
Ecoscape Environmental Consultants Ltd.

January, 2016

DISTRICT OF SQUAMISH
SENSITIVE ECOSYSTEM INVENTORY (SEI) & ENVIRONMENTALLY SENSITIVE AREAS MAPPING

Prepared For:

DISTRICT OF SQUAMISH
Municipal Hall, Engineering
37955 Second Ave
Squamish, BC V8B 0A3

ATTENTION TO: Caroline Ashekian, MSc, R.P.Bio. | Environmental Coordinator

Prepared By:

Ryan Durand, R.P.Bio. (DURAND ECOLOGICAL LTD.)

IN PARTNERSHIP WITH:

ECOSCAPE ENVIRONMENTAL CONSULTANTS LTD.
102 - 450 Neave Court
Kelowna, BC
V1V 2M2

DURAND Ecologial Ltd.

ECOSCAPE Environmental Consultants Ltd.

January, 2016

Ecoscape File No.15-1584

EXECUTIVE SUMMARY

The District of Squamish (DOS) identified sensitive habitat mapping as a strategic priority for the anticipated 2016 Official Community Plan update. In September, 2015 Ecoscape Environmental Consultants Ltd., in partnership with Durand Ecological Ltd. and Polar Geoscience Ltd., were retained to complete Environmentally Sensitive Areas (ESA) mapping of the DOS. This report contains the results of the ESA Mapping of the DOS, which included Sensitive Ecosystems Inventory (SEI) mapping modelled from Terrestrial Ecosystem Mapping (TEM). The results of the 2015 TEM is contained in a separate report.

The study area for this project was 10,317 hectares and encompassed the majority of the DOS. It included three Coastal Western Hemlock (CWH) biogeoclimatic subzones: dry maritime, dry submaritime, and very wet maritime (which is further divided into two variants). A total of 454 sample plots were completed for the project, representing 24% of the total mapped polygons, and 40% of the polygons that were primarily classified by a vegetated ecosystem (i.e. excluding polygons mapped ocean, gravel pit, road, urban, etc.).

The results of the study indicated that 42% of the study area contained a Sensitive Ecosystem, with Riparian and Ocean comprising 27%. Other Important Ecosystems were mapped on 30% of the study area, while 28% was considered to be Not Sensitive. The SEI mapping was then converted to a simplified ESA map with ranks of High, Medium and Low. As the ESA used a numeric system that allowed for the recognition of SEs that only occurred as a small portion of an SEI polygon, the results were slightly different that the SEI totals. 47% of the study area was considered to have high environmental sensitivity, while 25% was mapped as medium, and 27% as low.

ACKNOWLEDGEMENTS

This project was coordinated by Caroline Ashekian (Environmental Coordinator) and Dan Griffin (GIS Manager) from the District of Squamish. Kyle Hawes (Ecoscape Environmental Consultants Ltd.) managed the project and GIS support was provided by Robert Wagner (Ecoscape Environmental Consultants Ltd.). Much of the report is based on bioterrain mapping completed by Polly Unnila (Polar Geoscience). Imagery and PurVIEW models were created by McElhenney and 4DGIS.

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1.0 INTRODUCTION

The District of Squamish (DOS) identified sensitive habitat mapping as a strategic priority for the anticipated 2016 Official Community Plan update. In order to complete the mapping, the DOS identified the following priorities:

- Conducting a gap analysis to identify a plan to complete Terrestrial Ecosystem Mapping (TEM), Sensitive Ecosystem Inventory Mapping (SEI), wetland inventories and mapping, and ecological assessments in general for the District;
- Determining a rating system for inventoried features to help prioritize protection;
- Developing a rating system for aquatic habitat to guide policy, bylaws and zoning; and
- Creating protection measures and guidelines to align existing zoning with environmentally sensitive habitat.

The gap analysis was completed in the spring of 2015 (Hawes and Durand). In September, 2015 Ecoscape Environmental Consultants Ltd., in partnership with Durand Ecological Ltd. and Polar Geoscience Ltd., were retained to complete Environmentally Sensitive Areas (ESA) mapping of the DOS. The project will provide ecological baseline data for the District, in order to establish an inventory of environmental features and their locations. The project includes:

- new Terrestrial Ecosystem Mapping of most of the DOS;
- detailed wetland, estuary and marine shoreline mapping;
- Sensitive Ecosystem Inventory Mapping; and
- modelling of Ecosystem Sensitivity Ratings (ESR) to develop an Environmentally Sensitive Areas (ESA) map.

This report contains the results of the SEI and ESA mapping.

2.0 STUDY AREA

The DOS is located in the Sea-to-Sky corridor midway between Vancouver and Whistler. It is situated at the north end of Howe Sound and the mouth of the Squamish River in addition to the confluence of four other rivers – the Mamquam, Cheakamus, Stawamus, and Cheekye. The total land area of the District is 11,730 hectares and relief ranging from 0 - 900m above sea level. (Hawes and Durand, 2015)

The ESA study boundary area is 10,317 hectares (Figure 1). It encompasses the majority of the DOS and includes three biogeoclimatic subzones.

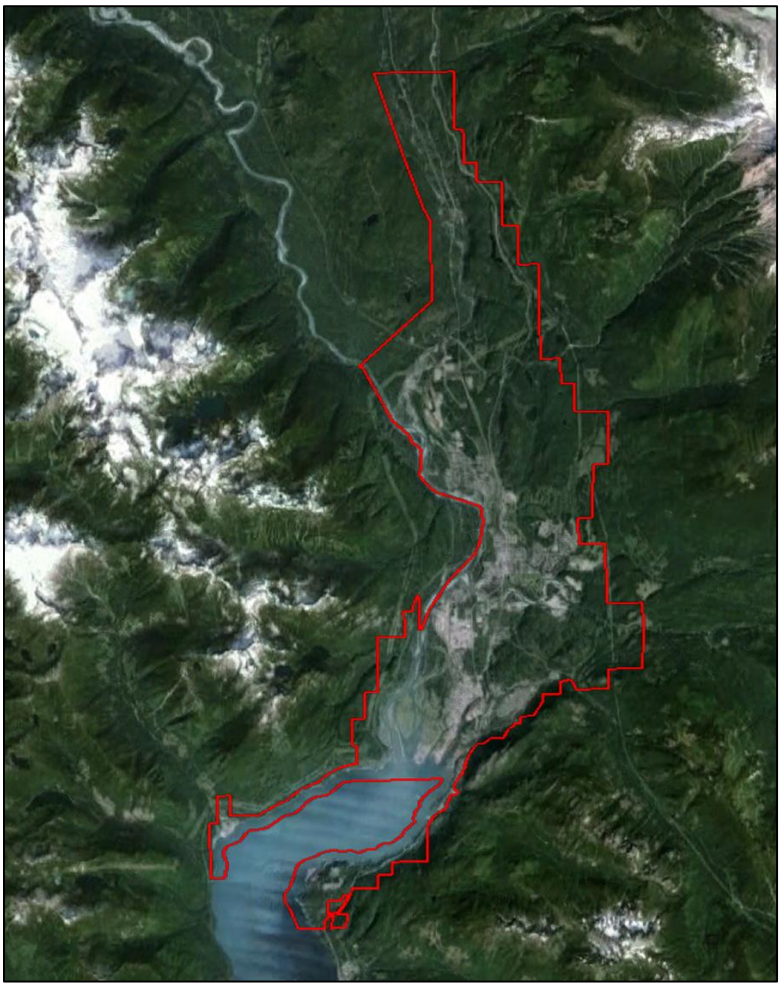

Figure 1. Study Area Boundary (adapted from Google Earth).

2.1 Biogeoclimatic Zone

The study area is located within the Coastal Western Hemlock (CWH) biogeoclimatic (BGC) zone. The CWH occurs at low to mid elevations along the entire coast of BC, mainly on the eastern slopes of the Coastal Mountains. It occurs from sea level to 900m in elevation, and over 1,000m on leeward slopes. The CWH has the highest average rainfall of any BGC zone in the province, although prolonged summer dry spells are common. Western hemlock (*Tsuga heterophylla*) is the most common tree species, along with western redcedar (*Thuja plicata*) Douglas-fir (*Pseudotsuga menziesii*). Shore pine (*Pinus contorta*) often occurs on very dry sites and bogs, while grand fir (*Abies grandis*), western white pine (*Pinus monticola*), and bigleaf maple (*Acer macrophyllum*) occur in the warmer southern portions of the zone. Red alder (*Alnus rubra*) is common on disturbed sites, while black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and Sitka spruce (*Picea sitchensis*) occur in river floodplains. (Meidinger and Pojar, 1991)

Three CWH subzones are located in the study area (Figure 2 and Table 1); dry maritime, dry submaritime, and very wet maritime (which is further divided into two variants). Biogeoclimatic subzones in the CWH are separated based on precipitation and continentality gradients; hypermaritime, maritime, and submaritime subzones (Meidinger and Pojar, 1991).

Table 1. Summary of BGC Subzones in the Study Area.

Code	Zone	Subzone	Variant	Area (ha)	Percent
CWHdm	Coastal Western Hemlock	Dry Maritime		10,157	98.4
CWHds1	Coastal Western Hemlock	Dry Submaritime	Southern	144	1.4
CWHvm1	Coastal Western Hemlock	Very Wet Maritime	Submontane	12	0.1
CWHvm2	Coastal Western Hemlock	Very Wet Maritime	Montane	5	<0.1

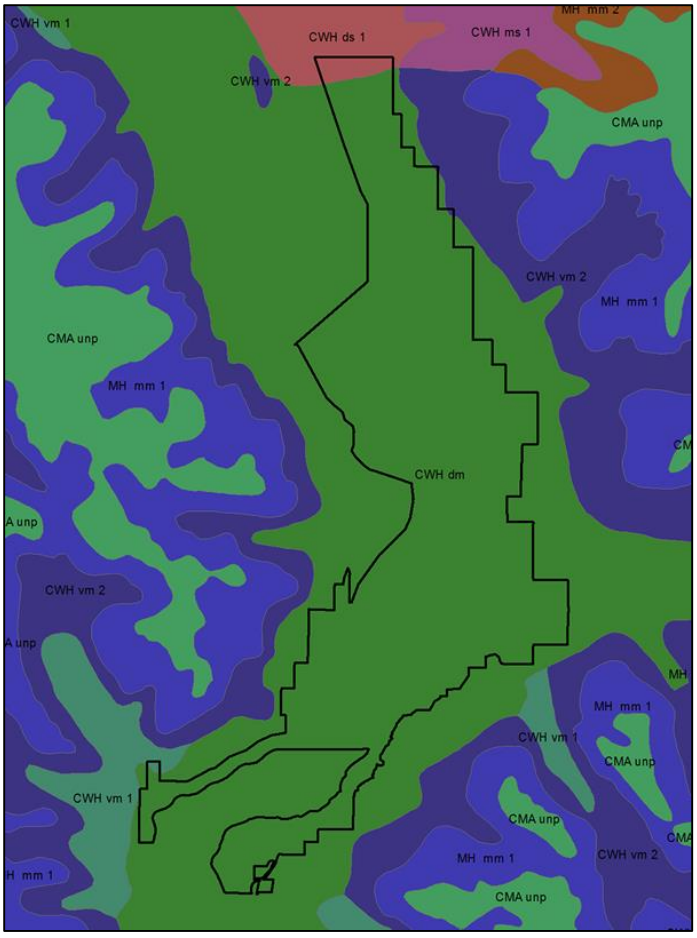

Figure 2. Provincial Biogeoclimatic map with the study area overlain shoing the majority of the study area located in the CWHdm subzone with small portions occurring in the CWHds1 at the north end, CWHvm2 in the northeast, and CWHvm1 in the southwest.

2.2 Species and Ecosystems at Risk

A search of the BC Conservation Data Centre was done on April 17, 2015 to generate a list of all species and ecosystems at risk that are known to occur in the Squamish-Lillooet Regional District. DataBC was also queried to obtain shapefiles of both publically available and masked (sensitive) species and ecosystems at risk occurrences for the District. (Hawes and Durand, 2015)

The CDC currently tracks 28 ecosystems at risk within the SLRD that also occur in the CWHds1 and CWDdm BGC units (Appendix 1). The CDC does not currently track any ecosystems at risk within the District. Table 2 contains a summary of the ecosystem types and provincial status. The mapped ecosystems from the 2015 TEM project were used to determine if ecosystem at risk occurred in the DOS Study Area (see Section 4).

Table 2. Potential ecosystems at risk.

Ecosystem Group	Provincial Rank				Identified Wildlife
	Red	Blue	Yellow	No Status	
Estuarine				1	
Beach	1				
Floodplain	1	3			
Conifer Forest	9	7			3
Forested Swamp		2			
Marsh		1			
Bog		1	1		

3.0 METHODOLOGY

3.1 Sensitive Ecosystems Inventory

SEI mapping was created in 1993 by the Canadian Wildlife Service and the BC Conservation Data Centre. It was created in 'response to a need for inventory of at-risk and ecologically fragile ecosystems, and critical wildlife habitat areas on the east side of Vancouver Island.' Since then, SEI projects have been completed on the Sunshine Coast, the Islands Trust Area, Metro Vancouver, most of the Okanagan, and portions of the Fraser Valley. In 2006 a Standard for Mapping Ecosystems At Risk in British Columbia was created by the Resource Inventory Standards Committee to promote a standardized process province wide (RISC, 2006).

The main purpose of SEI mapping is to describe the ecological diversity of a given area, and determine the type and extent of vulnerable and rare elements (RISC, 2006). The SEI standard describes an overview of the assessment process as follows:

> *The SEI classification uses two primary groupings of ecosystems:* ***Sensitive Ecosystems*** *and* ***Other Important Ecosystems****. Within each of these groups a series of classes and subclasses is defined that provides a general level of ecosystem description that is appropriate for public education and local planning exercises. Sensitive Ecosystem categories are generalised groupings of ecosystems that share many characteristics, particularly ecological sensitivities, ecosystem processes, at-risk status, and wildlife habitat values. Criteria for ecological sensitivity include:* ***environmental specificity****, susceptibility to hydrological changes, soil erosion, especially on shallow soils, spread of invasive alien plants, and sensitivity to human disturbance. Other Important Ecosystems have significant ecological and biological values associated with them that can be identified and mapped, although they are not defined as Sensitive Ecosystems because they have been substantially altered by human use. Consideration of Other Important Ecosystems is critical to capturing key elements of biodiversity of some project areas; they sometimes provide recruitment sites for ecosystems at risk or important wildlife habitat requiring recovery or restoration.*

Sensitive Ecosystem (SE) classes represent generalized groupings of ecosystems that share many characteristics, particularly ecological sensitivities, ecological processes, rarity and wildlife habitat values (Iverson and Cadrin, 2003). Ecosystems are classed as sensitive in this report if they have one or more of the following attributes:

- are rare or of restricted distribution
- have high biodiversity
- have high values as habitat, especially for known or potentially occurring species at risk
- are sensitive to disturbance and human impacts

Sensitive Ecosystem classes and subclasses used in this project were adapted from previous SEI projects on Vancouver Island (McPhee *et al*., 2000), the Central Okanagan (Iverson and Cadrin, 2003), Fraser Valley (Durand, 2011), Metro Vancouver (Meidinger, Clark & Adamoski, 2012), and Discovery Islands (Durand, 2015). The purpose of the DOS SEI is to provide baseline information that can be used in land use planning and decision making. Technical terminology has been kept to a minimum to make the report user-friendly for all anticipated users, including the general public, landholders, government, industry, developers, consultants and environmental non-governmental organizations.

Other Important Ecosystems (OIE) provide values such as habitat, wildlife corridors and ecosystem services but in most cases have been modified by human use and are not usually considered as environmentally significant or sensitive as designated SEs.

The Not Sensitive (NS) class is a generalized catch all for all other mapped polygons that do not contain significant ecological values, or polygons that contain significant recent or historic disturbance such as logging.

Table 3. Sensitive Ecosystem Classes and Subclasses.

SEI Class	SEI Subclass	Brief Description
OF: Old Forest		Forests > 140 yrs
OF	co: coniferous	Conifer > 75% of stand
OF	mx: mixed	Stand composition > 25% conifer and > 25% broadleaf
MF: Mature Forest		Forests > 80 yrs, < 140 yrs
MF	co: coniferous	Conifer-dominated (> 75% of stand composition)
MF	mx: mixed	Stand composition > 25% conifer and > 25% broadleaf
MF	bd: broadleaf	Broad-leaf dominated (> 75% of stand composition)
WD: Woodland		Dry site, open stands with between 10 and 25% tree cover. Tree species on these sites are usually lodgepole pine and Douglas Fir. Woodlands in this area also tend to occur with herbaceous outcrops.
WD	co: coniferous	Conifer > 75% of stand
WD	mx: mixed	Conifer > 25% and broadleaf > 25% of composition
RI: Riparian		Ecosystems associated with and influenced by freshwater. Nutrient-rich, rapid tree growth and dense under-stories. Higher soil moisture and light conditions.
RI	ff: fringe	Narrow band near ponds or lake shorelines, or streams with no floodplain. Buffer widths: TRIM streamlines (30m), TRIM ponds (50m), wetlands (30m)
RI	fh: high bench	High bench floodplain terraces
RI	fm: mid bench	Mid bench floodplain terraces
RI	fl: low bench	Low bench floodplain terraces
RI	ri: river	Large river watercourses including gravel bars
RI	ca: canyon	Watercourse is within a steep sided U-shaped canyon
WN: Wetland		Terrestrial – freshwater transitional areas.
WN	fn: fen	Groundwater-fed sedge-peat wetlands
WN	ms: marsh	Graminoid or forb-dominated nutrient-rich wetlands
WN	sp: swamp	Shrub or tree-dominated wetlands
WN	sw: shallow water	Permanently flooded, water less than 2m deep at mid-summer.
SV: Sparsely Vegetated		Areas with 5 – 10% vascular vegetation; may have mosses, liverwort and lichen cover. In the Discovery Islands this ecosystem most often occurs along rocky shoreline.
SV	cl: cliff	Steep slopes, often with exposed bedrock.
SV	es: exposed soil	Exposed soil.
SV	ro: rock outcrop	Rock outcrops – areas of bedrock exposure.
SV	ta: talus	Dominated by rubbly blocks of rock
ES: Estuarine		Ecosystems at marine, freshwater & terrestrial interface
ES	md: meadow	Tall forb and graminoid vegetation that develops in the high intertidal and supra-tidal zones of estuaries
ES	ms: marsh	Vegetation of salt-tolerant emergent graminoids and succulents,

SEI Class	SEI Subclass	Brief Description
		flooded and exposed during most tidal cycles
IT: Intertidal & shallow sub-tidal		Ecosystems at marine and terrestrial interface
IT	mf	Mudflats
IT	bs	Beaches and rocky shorelines
FW: Lakes and Ponds (Freshwater)		
FW	pd: pond	Open water > 2 m deep and generally < 50 ha
OC: Ocean		
OC		Ocean
OC	ff: fringe	30 metre buffer on ocean polygons representing the area affected by marine influences.

Table 4. Other Important Ecosystem Classes and Subclasses.

Other important Ecosystem Class	OEI Subclass	Brief Description
YF: Young Forest		Large patches of forest – stands > 30 yrs, < 80 yrs
YF	co: coniferous	Conifer-dominated (> 75% of stand composition)
YF	mx: mixed	Stand composition > 25% conifer and > 25% broadleaf
YF	bd: broadleaf	Broad-leaf dominated (> 75% of stand composition)

Table 5. Not Sensitive Classes and Subclasses.

Not Sensitive	NS Subclass	Brief Description
NS: Disturbed Ecosystems		Areas of permanent or significant disturbance.

The 2015 DOS TEM data were used to model SEI mapping. Each TEM classification was converted to matching SEI classes and subclasses (Tables 6 to 9). The matching was completed based on site series, structural stage, and canopy composition. For this study, additional attributes such as condition, landscape context and minimum size was not included in the SEI mapping. This decision was made due to the highly modified study area, including historic disturbances (extensive logging, estuary fill and modification) and current conditions (the largely urban nature of most of the study area). If the SE designation was dependent on the various disturbance and landscape context factors, then many important areas, especially in developed areas, would not be mapped as sensitive.

Table 6. TEM to SEI Crosswalk Table for CWHdm.

TEM Code/Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status
1	HM	Hw - Flat moss	7	C	OF	co	Blue
1	HM	Hw - Flat moss	6	C,M,B	MF	co,mx,bd	Blue
1	HM	Hw - Flat moss	4,5	C,M,B	YF	co,mx,bd	Blue
2	DC	FdPl - Cladina	3,4,5,6	C,M	WD	co,mx	Red
3	DS	FdHw - Salal	6	C,M	MF	co,mx	Blue
3	DS	FdHw - Salal	4,5	C,M,B	YF	co,mx,bd	Blue
3	DS	FdHw - Salal	7	C	OF	co	Blue
4	DF	Fd - Sword fern	7	C	OF	co	Blue
4	DF	Fd - Sword fern	6	C,M	MF	co,mx	Blue
4	DF	Fd - Sword fern	4,5	C,M,B	YF	co,mx,bd	Blue
5	RS	Cw - Sword fern	7	C	OF	co	Blue
5	RS	Cw - Sword fern	6	C,M	MF	co,mx	Blue
5	RS	Cw - Sword fern	4,5	C,M,B	YF	co,mx,bd	Blue
6	HD	HwCw - Deer fern	6	C,M,B	MF	co,mx,bd	Red
6	HD	HwCw - Deer fern	4,5	C,M,B	YF	co,mx,bd	Red
7	RF	Cw - Foamflower	6	C,M,B	MF	co,mx,bd	Blue
7	RF	Cw - Foamflower	4,5	C,M,B	YF	co,mx,bd	Blue
8	SS	Ss - Salmonberry	3,4,5,6	M,B	RI	fh	Red
Ed	Ed	Estuary meadow - unclassified	2b		ES	md	
Ed01	Ed01	Tufted hairgrass - meadow barley estuary meadow	2b		ES	md	
Em	Em	Estuary march - unclassified	2b		ES	ms	
Em05	Em05	Lyngbye's sedge estuary marsh	2b		ES	ms	
Fl	Fl	Low bench floodplain - unclassified	3,4	B	RI	fl	
Fl06	Fl06	Sandbar willow low bench floodplain	3,4	B	RI	fl	
09/Fm50	CD/Fm50	Cottonwood - red alder - salmon berry mid bench floodplain	3,4,5,6	B,M	RI	fh	Blue
OW	OW	Shallow open water			WN	sw	
Wf	Wf	Fen - unclassified	2b		WN	fn	
Wm	Wm	Marsh - unclassified	2b		WN	ms	
Wm05	Wm05	Cattail marsh	2b		WN	ms	Blue
Wm06	Wm06	Great bulrush marsh	2b		WN	ms	
Ws	Ws	Swamp - unclassified	3,4,5		WN	sp	
Ws06	Ws06	Sitka willow - Sitka sedge swamp	3		WN	sp	
Ws50	Ws50	Pink spirea - Sitka sedge swamp	3		WN	sp	
Ws51	Ws51	Sitka willow - Pacific willow - skunk cabbage swamp	3		WN	sp	

TEM Code/Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status
Ws52	Ws52	Red alder - skunk cabbage swamp	5	B	WN	sp	
Ws53	Ws53	Western redcedar - sword fern - skunk cabbage swamp	4,5	B	WN	sp	
Ws54	Ws54	Western redcedar - western hemlock - skunk cabbage swamp	3,4,5,6	C,M,B	WN	sp	
Non-vegetated Ecosystems							
BE	BE	Beach			IT	bs	
CF	CF	Cultivated field			NS		
CL	CL	Cliff			SV	cl	
ES	ES	Exposed soil			SV	es	
GB	GB	Gravel bar			RI	ri	
GC	GC	Golf course			NS		
GP	GP	Gravel pit			NS		
MU	MU	Mudflat sediment			IT	mf	
OC	OC	Ocean			OC		
PD	PD	Pond			FW	pd	
RI	RI	River			RI	ri	
RI	RI	River (canyon)			RI	ca	
RN	RN	Railway surface			NS		
RO	RO	Rock outcrop			SV	ro	
RW	RW	Rural			NS		
RZ	RZ	Road surface			NS		
TA	TA	Talus			SV	ta	
UR	UR	Urban / Suburban			NS		
		Disturbed Ecosystems			NS		

Table 7. TEM to SEI Crosswalk Table for CWHds1.							
TEM Code/Number	**Map Code**	**Name**	**Structural Stage**	**Stand Comp.**	**SEI Class**	**SEI Subclass**	**CDC Status**
1	HM	HwFd - Cat's-tail moss	6	C	MF	co	Red
1	HM	HwFd - Cat's-tail moss	5	C,M	YF	co,mx	Red
2	DK	FdPl - Kinnikinnick	3,5	C	WD	co	Red
3	FF	FdHw - Falsebox	6	C	MF	co	Blue
3	FF	FdHw - Falsebox	5	C	YF	co	Blue
4	DF	Fd - Fairybells	6	C	MF	co	Red
5	RS	Cw - Solomon's seal	6	C	MF	co	Blue
7	RD	Cw - Devil's club	5	M,B	YF	mx,co	Red
8	SS	Ss - Salmonberry	5	B,C	RI	fh	Red
Ws		Swamp - unclassified	5	B,C	WN	sp	
Ws54		Western redcedar - western hemlock - skunk cabbage swamp	6	C	WN	sp	Blue
OW		Shallow open water			WN	sw	
Non-vegetated Ecosystems							
RI		River			RI	ri	
RN		Railway surface			NS		
RW		Rural			NS		
RZ		Road surface			NS		
TA		Talus			SV	ta	
UR		Urban / Suburban			NS		
		Disturbed Ecosystems			NS		

Table 8. TEM to SEI Crosswalk Table for CWHvm1.							
TEM Code/Number	**Map Code**	**Name**	**Structural Stage**	**Stand Comp.**	**SEI Class**	**SEI Subclass**	**CDC Status**
1	CS	HwBa - Blueberry	5	C	YF	co	
3	HS	HwCw - Salal	5	C	YF	co	Blue
5	AF	BaCw - Foamflower	5	M	YF	mx	
Non-vegetated Ecosystems							
RZ		Road Surface			NS		
		Disturbed Ecosystems			NS		

Table 9. TEM to SEI Crosswalk Table for CWHvm2.							
TEM Code/Number	**Map Code**	**Name**	**Structural Stage**	**Stand Comp.**	**SEI Class**	**SEI Subclass**	**CDC Status**
1	AB	HwBa - Blueberry	5	C	YF	co	

2	LC	HwPl - Cladina	3,5	C	WD	co	
3	HS	HwCw - Salal	6	C	MF	co	Blue
3	HS	HwCw - Salal	5	C	YF	co	Blue
Non-vegetated Ecosystems							
TA		Talus			SV	ta	
		Disturbed Ecosystems			NS		

3.2 Environmentally Sensitive Areas Mapping

An ESA map was modelled from the SEI data using Environmental Sensitivity Ranks (ESR). Each SEI subclass and modelled buffer was given a rank of high, medium or low (Tables 11 to 14). The rank was determined based on the sensitivity of the ecosystem type to disturbance, the ecological importance, and provincial rarity (BC Conservation Data Centre status). Ecosystems that contained a high percent of recent disturbance were ranked as low, as we all developed areas. While young forests are typically considered to have less ecological value that mature forests (and would typically get a medium rank), red-listed young forested ecosystems were given a high ESR.

The following calculation was used in the GIS to create an average value for each SEI polygon.

((Decile 1 x Rank 1) + (Decile 2 x Rank 2) + (Decile 3 x Rank 3)) / 10

Each decile (the percent of the polygon that contains mapped ecosystem type in increments of 10) was multiplied by the ESR assigned to each SE class then divided by 10 (the highest possible decile representing 100% of a polygon). For compound ecosystems (polygons that had two or three mapped ecosystem types) the calculation was repeated for each decile, added together, and divided by 10. This method resulted in an average value for each SEI polygon (Figure 3). The average value was then classified as High, Medium and Low using the ESR ranges in Table 10.

Table 10. ESR Value and averaged polygon range.

ESR Value	ESR Range
High	1.00 - 1.67
Medium	1.68 - 2.33
Low	2.34 - 3.00

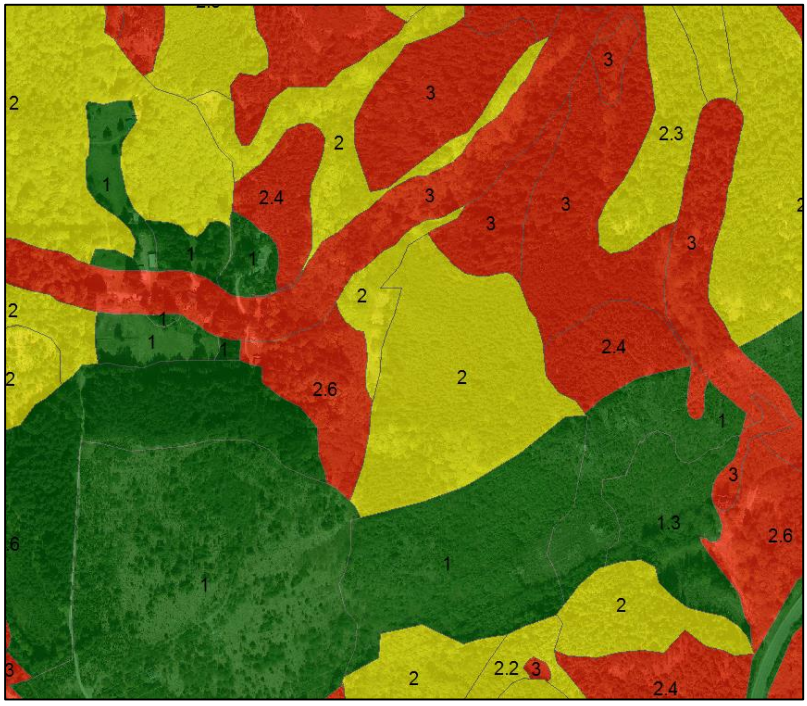

Figure 3. SEI map with averaged ESR values for each polygon. The final ESA ranks are depicted in colour with red (High), yellow (Medium) and green (Low).

Table 11. ESR Values for each TEM unit and SEI subclass for CWHdm.

TEM Code/Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	ESR Value
01	HM	Hw - Flat moss	7	C	OF	co	Blue	3
01	HM	Hw - Flat moss	6	C,M,B	MF	co,mx,bd	Blue	3
01	HM	Hw - Flat moss	4,5	C,M,B	YF	co,mx,bd	Blue	2
02	DC	FdPl - Cladina	3,4,5,6	C,M	WD	co,mx	Red	3
03	DS	FdHw - Salal	6	C,M	MF	co,mx	Blue	3
03	DS	FdHw - Salal	4,5	C,M,B	YF	co,mx,bd	Blue	2
03	DS	FdHw - Salal	7	C	OF	co	Blue	3
04	DF	Fd - Sword fern	7	C	OF	co	Blue	3
04	DF	Fd - Sword fern	6	C,M	MF	co,mx	Blue	3
04	DF	Fd - Sword fern	4,5	C,M,B	YF	co,mx,bd	Blue	2
05	RS	Cw - Sword fern	7	C	OF	co	Blue	3
05	RS	Cw - Sword fern	6	C,M	MF	co,mx	Blue	3
05	RS	Cw - Sword fern	4,5	C,M,B	YF	co,mx,bd	Blue	2
06	HD	HwCw - Deer fern	6	C,M,B	MF	co,mx,bd	Red	3
06	HD	HwCw - Deer fern	4,5	C,M,B	YF	co,mx,bd	Red	3
07	RF	Cw - Foamflower	6	C,M,B	MF	co,mx,bd	Blue	3
07	RF	Cw - Foamflower	4,5	C,M,B	YF	co,mx,bd	Blue	2
08	SS	Ss - Salmonberry	3,4,5,6	M,B	RI	fh	Red	3

TEM Code/Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	ESR Value
Ed	Ed	Estuary meadow - unclassified	2b		ES	md		3
Ed01	Ed01	Tufted hairgrass - meadow barley estuary meadow	2b		ES	md		3
Em	Em	Estuary march - unclassified	2b		ES	ms		3
Em05	Em05	Lyngbye's sedge estuary marsh	2b		ES	ms		3
Fl	Fl	Low bench floodplain - unclassified	3,4	B	RI	fl		3
Fl06	Fl06	Sandbar willow low bench floodplain	3,4	B	RI	fl		3
09/Fm50	CD/Fm50	Cottonwood - red alder - salmon berry mid bench floodplain	3,4,5,6	B,M	RI	fh	Blue	3
OW	OW	Shallow open water			WN	sw		3
Wf	Wf	Fen - unclassified	2b		WN	fn		3
Wm	Wm	Marsh - unclassified	2b		WN	ms		3
Wm05	Wm05	Cattail marsh	2b		WN	ms	Blue	3
Wm06	Wm06	Great bulrush marsh	2b		WN	ms		3
Ws	Ws	Swamp - unclassified	3,4,5		WN	sp		3
Ws06	Ws06	Sitka willow - Sitka sedge swamp	3		WN	sp		3
Ws50	Ws50	Pink spirea - Sitka sedge swamp	3		WN	sp		3
Ws51	Ws51	Sitka willow - Pacific willow - skunk cabbage swamp	3		WN	sp		3
Ws52	Ws52	Red alder - skunk cabbage swamp	5	B	WN	sp		3
Ws53	Ws53	Western redcedar - sword fern - skunk cabbage swamp	4,5	B	WN	sp		3
Ws54	Ws54	Western redcedar - western hemlock - skunk cabbage swamp	3,4,5,6	C,M,B	WN	sp		3
Non-vegetated Ecosystems								
BE	BE	Beach			IT	bs		3
CF	CF	Cultivated field			NS			1
CL	CL	Cliff			SV	cl		3

TEM Code/Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	ESR Value
ES	ES	Exposed soil			SV	es		3
GB	GB	Gravel bar			RI	ri		3
GC	GC	Golf course			NS			1
GP	GP	Gravel pit			NS			1
MU	MU	Mudflat sediment			IT	mf		3
OC	OC	Ocean			OC			3
PD	PD	Pond			FW	pd		3
RI	RI	River			RI	ri		3
RI	RI	River (canyon)			RI	ca		
RN	RN	Railway surface			NS			1
RO	RO	Rock outcrop			SV	ro		3
RW	RW	Rural			NS			1
RZ	RZ	Road surface			NS			1
TA	TA	Talus			SV	ta		3
UR	UR	Urban / Suburban			NS			1
		Disturbed Ecosystems			NS			1

Table 12. ESR Values for each TEM unit and SEI subclass for CWHds1.

TEM Code/Number	Map Code	Name	Structual Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	ESR Value
01	HM	HwFd - Cat's-tail moss	6	C	MF	co	Red	3
01	HM	HwFd - Cat's-tail moss	5	C,M	YF	co,mx	Red	3
02	DK	FdPl - Kinnikinnick	3,5	C	WD	co	Red	3
03	FF	FdHw - Falsebox	6	C	MF	co	Blue	3
03	FF	FdHw - Falsebox	5	C	YF	co	Blue	2
04	DF	Fd - Fairybells	6	C	MF	co	Red	3
05	RS	Cw - Solomon's seal	6	C	MF	co	Blue	3
07	RD	Cw - Devil's club	5	M,B	YF	mx,co	Red	3
08	SS	Ss - Salmonberry	5	B,C	RI	fh	Red	3
Ws		Swamp - unclassified	5	B,C	WN	sp		3
Ws54		Western redcedar - western hemlock - skunk cabbage swamp	6	C	WN	sp	Blue	3
OW		Shallow open water			WN	sw		3
Non-vegetated Ecosystems								
RI		River			RI	ri		3
RN		Railway surface			NS			1
RW		Rural			NS			1
RZ		Road surface			NS			1
TA		Talus			SV	ta		3
UR		Urban / Suburban			NS			1
		Disturbed Ecosystems			NS			1

Table 13. ESR Values for each TEM unit and SEI subclass for CWHvm1.								
TEM Code/Number	**Map Code**	**Name**	**Structual Stage**	**Stand Comp.**	**SEI Class**	**SEI Subclass**	**CDC Status**	**ESR Value**
01	CS	HwBa - Blueberry	5	C	YF	co		2
03	HS	HwCw - Salal	5	C	YF	co	Blue	2
05	AF	BaCw - Foamflower	5	M	YF	mx		2
Non-vegetated Ecosystems								
RZ		Road Surface			NS			0.01
		Disturbed Ecosystems			NS			1

Table 14. ESR Values for each TEM unit and SEI subclass for CWHvm2.								
TEM Code/Number	**Map Code**	**Name**	**Structual Stage**	**Stand Comp.**	**SEI Class**	**SEI Subclass**	**CDC Status**	**ESR Value**
01	AB	HwBa - Blueberry	5	C	YF	co		2
02	LC	HwPl - Cladina	3,5	C	WD	co		3
03	HS	HwCw - Salal	6	C	MF	co	Blue	3
03	HS	HwCw - Salal	5	C	YF	co	Blue	2
Non-vegetated Ecosystems								
TA		Talus			SV	ta		3
		Disturbed Ecosystems			NS			1

4.0 RESULTS

The following sections contain a summary of the 2015 Terrestrial Ecosystem Mapping (TEM), then the modelled SEI and ESA mapping.

4.1 Terrestrial Ecosystem Mapping

A total of 454 sample plots were completed for the project, representing 24% of the total mapped polygons, and 40% of the polygons that were primarily classified by a vegetated ecosystem (i.e. excluding polygons mapped ocean, gravel pit, road, urban, etc.). Table 15 contains a summary of the number and type of sample plots completed for the project.

Figure 4 presents a map of the plot locations. The site series was determined for each of the full and site visit (SIVI) plots, and for most of the visual plots. As the CWHvm1 and vm2 was limited to small fragments on the outskirts of the study area, they were not sampled. One full plot was completed due to time restraints (several hours required per full plot) and a lack of disturbance-free land that was available for field sampling[1].

[1] The detailed data collected during a full plot are most beneficial in undisturbed areas with a climax vegetation comminuty.

Table 15. Summary of plots and polygons sampled by subzone.						
Description	**Area (ha)**	**Polygons**	**Number of Plots**			***Total***
BGC Subzone			*Full*	*SIVI*	*Visual*	
CWHdm	10,161.2	1,331	1	58	382	441
CWHds1	137.5	35		2	11	13
CWHvm1	13.8	4				0
CWHvm2	4.9	5				0
Total	**10,317.4**	**1,375**	**1**	**60**	**393**	**454**

The plot data were used to confirm the accuracy of the ecosystem mapping. A total of 57 ecosystem types were mapped for this project. The ecosystems includes those that could be classified to the provincial biogeoclimatic ecosystem system, and others that could only be classified to a higher level (e.g. swamp, floodplain, etc.) due to disturbance history or a poor fit with recognized ecosystems. Plots included:

- 21 forested ecosystems (from three subzones)
- 2 classified and 1 unclassified floodplain ecosystems
- 2 classified and 2 unclassified estuary wetland associations
- 8 wetland associations and 4 unclassified wetlands
- 10 natural non-vegetated ecosystem types
- 7 anthropogenically modified map units

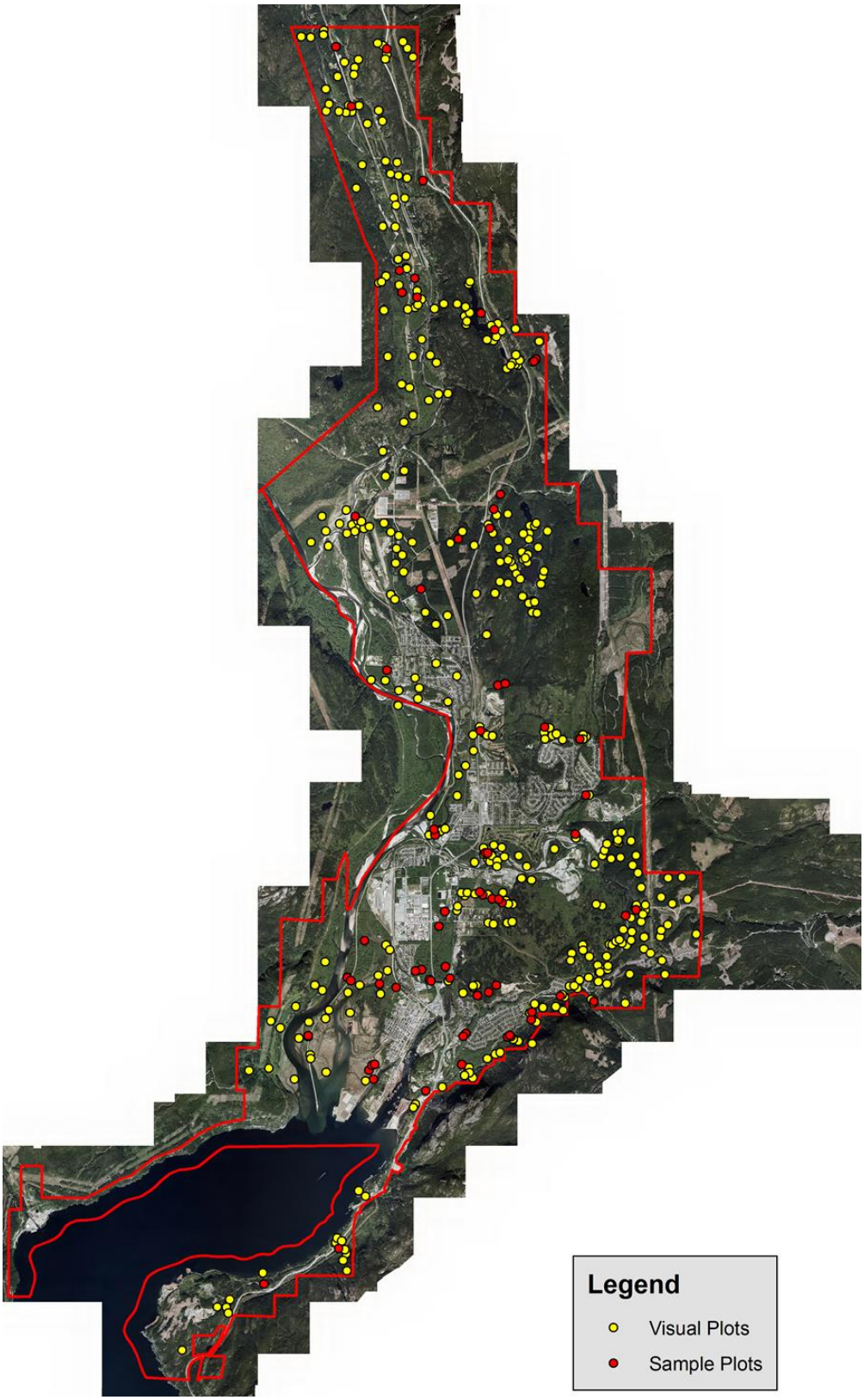

Figure 4. Map of sample plot locations and visual plots.

4.2 Sensitive Ecosystems Inventory Mapping

The following section provides a summary of the SEI classes and subclasses that were used in this project. Each class and subclass is described below, including representative photographs. Table 16 contains a summary of the SE classes, along with the area mapped.

Table 16. Summary of Mapped Sensitive Ecosystems.

SE Class	Hectares	Percent of Study Area
Sensitive Ecosystems		
Old Forest	15.21	0.15%
Mature Forest	475.00	4.62%
Woodland	478.67	4.64%
Riparian	1,885.07	18.27%
Wetland	209.35	2.04%
Sparsely Vegetated	194.44	1.89%
Estuarine	126.16	1.22%
Intertidal	12.74	0.12%
Fresh Water	76.01	0.74%
Ocean	892.42	8.65%
Total	***4,365.07***	***42.34%***
Other Important Ecosystems		
Young Forest	3,085.73	29.89%
Total	***3,085.73***	***29.89%***
Not Sensitive		
Not Sensitive	2,866.20	27.78%
Total	**10,317.00**	**100.00%**

4.2.1 Old Forest (OF)

Old Forests are defined as forests with tress mostly 140 years or older. One subclass, conifer (co) was mapped in the study area and it only occurred in the CDHdm. Old forests occurred as remnant patches in parks and areas with naturally sparse tree cover and steep rocky terrain where logging is difficult (Figure 5). They were typically dominated by an open canopy of large Douglas-fir trees, with thick understory vegetation including salal, dull Oregon-grape and red huckleberry. No pure old forest polygons were mapped, rather they typically occurred as a small portion of a polygon that contained second-growth young or mature stands. Old forests were mapped on 15.2 hectares of the study area, accounting for less than 1% of the total area (Table 17).

Table 17. Area of Old Forest mapped in the Study Area.									
TEM Code or Number	**Map Code**	**Name**	**Structural Stage**	**Stand Comp.**	**SEI Class**	**SEI Subclass**	**CDC Status**	**Area (ha)**	**% of Study Area**
CWHdm									
01	HM	Hw - Flat moss	7	C	OF	co	Blue	10.89	0.11%
03	DS	FdHw - Salal	7	C	OF	co	Blue	1.30	0.01%
04	DF	Fd - Sword fern	7	C	OF	co	Blue	1.51	0.01%
05	RS	Cw - Sword fern	7	C	OF	co	Blue	1.51	0.01%
Total								**15.21**	**0.15%**

Figure 5. Patches of Old Forest (right side of photo) on the slopes above Brohm Lake.

4.2.2 Mature Forest (MF)

Mature Forests are generally >80 and < 140 years old, with no disturbance for at least 80 years. These forests are not typically as structurally complex as old forest ecosystems, but can function as essential habitat areas for many wildlife species and as primary connections between ecosystems in a highly fragmented landscape (Figure 6 and 7). Three subclasses were mapped; co – conifer dominated (> 75% coniferous species), mx – mixed conifer and deciduous (<75% coniferous and < 75% broadleaf composition), bd – broadleaf dominated (> 75% deciduous species). Differentiating between second growth young and mature forests was difficult in much of the study area, as many of the younger stands are on the cusp of being classified as mature due to the time since disturbance and structural characteristics. A total of 475 hectares of Mature Forest was mapped in the study area, representing almost 5% of the total area

(Table 18). This total is likely somewhat underestimated with a portion of the mapped Young Forest meeting the criteria for Mature Forest.

Table 18. Area of Mature Forest mapped in the Study Area.

TEM Code or Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	Area (ha)	% of Study Area
CWHdm									
01	HM	Hw - Flat moss	6	C,M,B	MF	co,mx,bd	Blue	150.82	1.46%
03	DS	FdHw - Salal	6	C,M	MF	co,mx	Blue	100.06	0.97%
04	DF	Fd - Sword fern	6	C,M	MF	co,mx	Blue	42.86	0.42%
05	RS	Cw - Sword fern	6	C,M	MF	co,mx	Blue	68.02	0.66%
06	HD	HwCw - Deer fern	6	C,M,B	MF	co,mx,bd	Red	26.34	0.26%
07	RF	Cw - Foamflower	6	C,M,B	MF	co,mx,bd	Blue	67.79	0.66%
CWHds1									
01	HM	HwFd - Cat's-tail moss	6	C	MF	co	Red	3.76	0.04%
03	FF	FdHw - Falsebox	6	C	MF	co	Blue	4.21	0.04%
04	DF	Fd - Fairybells	6	C	MF	co	Red	4.99	0.05%
05	RS	Cw - Solomon's seal	6	C	MF	co	Blue	4.07	0.04%
CWHvm2									
03	HS	HwCw - Salal	6	C	MF	co	Blue	2.08	0.02%
Total								**475.00**	**4.62%**

Figure 6. Mature conifer forest with remnant old veteran trees.

Figure 7. Mature mixed forest that is in the later stanges of self thinning (moving from young to mature status).

4.2.3 Woodland (WD)

Woodlands are open forests, generally between 10 and 30% tree cover. They are found on dry sites, typically on south facing slopes of rocky knolls and bedrock-dominated areas with shallow soils. The stands are typically conifer dominated with less common mixed stands (Figure 8 and 9). Because of the open canopy they often include non-forested herbaceous openings. Two subclasses are recognized: co – conifer dominated ecological woodlands (greater than 75% coniferous composition), and mx – mixed conifer and broadleaf ecological woodlands (minimum of 25% composition of each group comprises the total tree cover). A total of 479 hectares of Woodland was mapped in the study area, representing almost 5% of the total area (Table 19).

Table 19. Area of Woodland mapped in the Study Area.

TEM Code or Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	Area (ha)	% of Study Area
CWHdm									
02	DC	FdPl - Cladina	3,4,5,6	C,M	WD	co,mx	Red	455.73	4.42%
CWHds1									
02	DK	FdPl - Kinnikinnick	3,5	C	WD	co	Red	22.09	0.21%
CWHvm2									
02	LC	HwPl - Cladina	3,5	C	WD	co		0.85	0.01%
Total								**478.67**	**4.64%**

Figure 8. Example of a Conifer Woodland on the upper slopes of a cliff and bedrock outcrop.

Figure 9. Example of a Conifer Woodland with moss and lichen cover bedrock outcrop.

4.2.4 Riparian (RI)

The Riparian class includes ecosystems that are associated with and influenced by freshwater such as along rivers, streams, creeks, and fringes around lakes (Figures 10 to 17). These ecosystems are influenced by factors such as erosion, sedimentation, flooding, or seasonally fluctuating groundwater due to proximity to the water body. This class includes all structural stages and stand composition. These ecosystem range from large floodplain forests along rivers, to a fringe or gully due to generally smaller stream systems. Six subclasses are recognized:

- **fl** – low bench floodplain: flooded at least every other year for moderate periods of growing season; plant species adapted to extended flooding and abrasion, low or tall willow, cottonwood, or alder form sparse to dense monocultures.

- **fm** – medium bench floodplain: flooded every 1-6 years for short periods (10-25 days); deciduous or mixed forest dominated by species tolerant of flooding and periodic sedimentation. Fm includes extensive cottonwood floodplain forests along the larger rivers in the study area.

- **fh** – high bench floodplain: only periodically and briefly inundated by high waters, but lengthy subsurface flow in the rooting zone; typically conifer-dominated floodplains of larger coastal rivers. Fh typically occurs complexed with Fm in slightly higher elevations, and along the edges of many smaller creeks.

- **ff** – fringe: narrow linear communities along open water bodies (rivers, lakes and ponds) where there is no floodplain, irregular flooding with the potential for regular subsurface flooding of rooting zone. The fringe subclass was largely modelled from TRIM stream lines and is expected to contain a moderate degree of inaccuracy (including riparian areas mapped where streams may not occur or have been heavily modified).

- **ca –** canyon**:** watercourse is within a steep sided U-shaped canyon; generally only minimal area of flooding but canyon is important due to proximity to water, steep valley walls, and somewhat unique microclimate of canyon.

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

A total of 1,885 hectares of Riparian was mapped in the study area, representing over 18% of the total area (Table 20). The Riparian SE class contained almost half of the area mapped as SE in the study area.

Table 20. Area of Riparian mapped in the Study Area.									
TEM Code or Number	**Map Code**	**Name**	**Structural Stage**	**Stand Comp.**	**SEI Class**	**SEI Subclass**	**CDC Status**	**Area (ha)**	**% of Study Area**
CWHdm									
08	SS	Ss - Salmonberry	3,4,5,6	M,B	RI	fh	Red	370.64	3.59%
Fl	Fl	Low bench floodplain - unclassified	3,4	B	RI	fl		38.87	0.38%
Fl06	Fl06	Sandbar willow low bench floodplain	3,4	B	RI	fl		37.39	0.36%
09/Fm50	CD/Fm50	Cottonwood - red alder - salmon berry mid bench floodplain	3,4,5,6	B,M	RI	fh	Blue	422.12	4.09%
GB	GB	Gravel bar			RI	ri		75.35	0.73%
RI	RI	River			RI	ri		296.16	2.87%
RI	RI	River (canyon)			RI	ca		3.27	0.03%
CWHds1									
08	SS	Ss - Salmonberry	5	B,C	RI	fh	Red	1.14	0.01%
RI		River			RI	ri		3.51	0.03%
All Subzones									
		Modelled fringe			OC	ff		636.62	0.43%
Total								**1,885.07**	**18.27%**

Figure 10. Low-bench Floodplain with a sparse cover of low cottonwood shrubs.

Figure 11. Low-bench Floodplain with dense cover of tall willow shrubs.

Figure 12. Mature mid-bench flood plain forest with a cottonwood dominanted stand.

Figure 13. Young mid-bench flood plain forest with a cottonwood and red alder dominanted stand along a constructed fish channel.

Figure 14. High-bench floodplain forest beside a low gradient modified channel.

Figure 15. Small high-bench floodplain forest (right) along a small stream. The forest to the left of the stream would be included within the Fluvial Fringe buffer.

Figure 16. Canyon with steep rock faces and limited vegetation cover.

Figure 17. River and exposed gravel bars.

4.2.5 Wetland (WN)

Wetland ecosystems are found where soils are saturated by water for enough time that the excess water and resulting low oxygen levels influence the vegetation and soil. The water influence is generally seasonal or year-round and occurs either at or above the soil surface or within the root zone of plants. Wetlands are usually found in areas of flat or undulating terrain. They encompass a range of plant communities that includes western red cedar/skunk cabbage swamps, willow swamps, cattail and bulrush marshes, and shallow open water (Figure 18 to 22). Two small fens were mapped during the study, but were not field verified. No bogs were mapped in the study area. Estuarine wetlands are in a separate class for this SEI to emphasize the different flooding frequency (mostly diurnal) and water chemistry (brackish). Therefore, the wetland class is for freshwater wetlands only. Four subclasses are recognized:

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

- **ms** – marsh: characterized by permanent or seasonal flooding by nutrient-rich waters. May include some areas of diurnal flooding of fresh water above the normal high high-tide, due to high river water levels. Examples include freshwater marshes that are dominated by rushes, sedges or grasses.

- **sp** – swamp: wooded wetlands dominated by 25% or more cover of flood-tolerant trees or shrubs. Characterized by periodic flooding and nearly permanent sub-surface waterflow through mixtures of mineral and organic materials, swamps are high in nutrient, mineral and oxygen content.

- **sw** – shallow water: wetlands characterized by water less than 2 m in depth in mid-summer; transition between deep water bodies and other wetland ecosystems (i.e. bogs, swamps, fens, etc.); often with vegetation rooted below the water surface.

The study area also contains a large number of modified wetlands (Figures 23 to 25). These areas typically have a high cover of introduced species, and physical modifications such as excavations, drainage alterations (ditches, roads, dikes), or historic logging. In some cases they can still be classified using the remnant vegetation and environmental characteristics (mainly soils and water chemistry), more often they were classified as generic swamps, marshes, etc.

A total of 209 hectares of Wetlands were mapped in the study area, representing 2% of the total area (Table 21).

Table 21. Area of Wetland mapped in the Study Area.									
TEM Code or Number	**Map Code**	**Name**	**Structural Stage**	**Stand Comp.**	**SEI Class**	**SEI Subclass**	**CDC Status**	**Area (ha)**	**% of Study Area**
CWHdm									
OW	OW	Shallow open water			WN	sw		5.20	0.05%
Wf	Wf	Fen - unclassified	2b		WN	fn		0.59	0.01%
Wm	Wm	Marsh - unclassified	2b		WN	ms		12.63	0.12%
Wm05	Wm05	Cattail marsh	2b		WN	ms	Blue	3.92	0.04%
Wm06	Wm06	Great bulrush marsh	2b		WN	ms		2.77	0.03%
Ws	Ws	Swamp - unclassified	3,4,5		WN	sp		70.29	0.68%
Ws06	Ws06	Sitka willow - Sitka sedge swamp	3		WN	sp		7.56	0.07%
Ws50	Ws50	Pink spirea - Sitka sedge swamp	3		WN	sp		7.16	0.07%
Ws51	Ws51	Sitka willow - Pacific willow - skunk cabbage swamp	3		WN	sp		1.23	0.01%
Ws52	Ws52	Red alder - skunk cabbage swamp	5	B	WN	sp		2.74	0.03%
Ws53	Ws53	Western redcedar - sword fern - skunk cabbage swamp	4,5	B	WN	sp		1.72	0.02%
Ws54	Ws54	Western redcedar - western hemlock - skunk cabbage swamp	3,4,5,6	C,M,B	WN	sp		91.34	0.89%
CWHds1									
Ws		Swamp - unclassified	5	B,C	WN	sp		1.37	0.01%
Ws54		Western redcedar - western hemlock - skunk cabbage swamp	6	C	WN	sp	Blue	0.73	0.01%
OW		Shallow open water			WN	sw		0.10	0.00%
Total								**209.35**	**2.04%**

Figure 18. Typical Western redcedar – western hemlock - skunk cabbage swamp. Mature cedar trees grow on slightly elevated mounds, while the wetter depression have standing water and skunk cabbage.

Figure 19. Narrow bands of cattail marsh on the edges of shallow open water.

Figure 20. Dense Sitka willow – Pacific willow – skunk cabbage swamp with thick invasive reed canarygrass.

Figure 21. Sitka willow – Sitka sedge swamp on the outer edge of a slough complex.

Figure 22. Wetland complex with a hard hack swamp growing on the outer edges of a large bulrush marsh.

Figure 23. Hardhack swamp with thick invasive reed canarygrass.

Figure 24. Marsh-like community dominated by a thick cover of orchard grass and bluejoint.

Figure 25. Slough with near stangant water and few native species.

4.2.6 Sparsely Vegetated (SV)

The Sparsely Vegetated class includes areas of low vascular vegetation cover. They often have a high cover of mosses, liverworts and lichens, but skeletal soils and moisture deficits limit the potential for substantial tree or shrub growth (Figures 26 to 27). This class occurs throughout the study area, and includes large areas of substantial cliffs. Rock outcrops are generally complexed with the WD class. Four subclasses are recognized:

- **cl** – cliff: steep to very steep slopes with exposed bedrock. Cliffs are generally sparsely vegetated, with vegetated limited to ledges and crevices.

- **es** – exposed soil: areas of exposed soil due to failing slopes or other environmental conditions.

- **ro** – rock outcrop: exposed bedrock, usually at the top of knolls or on portions of steeper slopes. These areas typically have a very high cover of moss and lichens, while small shrubs or trees occasionally grown in cracks. Near the ocean or in areas of seepage, vascular plants may occur, particularly spring species.

- **ta** – talus: generally steep slopes comprised of rubbly blocks of rock that are actively moving downslope. These areas have little to no vegetation.

A total of 194 hectares of Sparsely Vegetated was mapped in the study area, representing almost 2% of the total area (Table 22).

Table 22. Area of Sparsely Vegetated mapped in the Study Area.

TEM Code or Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	Area (ha)	% of Study Area
CWHdm									
CL	CL	Cliff			SV	cl		24.67	0.24%
ES	ES	Exposed soil			SV	es		1.02	0.01%
RO	RO	Rock outcrop			SV	ro		75.83	0.74%
TA	TA	Talus			SV	ta		90.28	0.88%
CWHds1									
TA		Talus			SV	ta		2.40	0.02%
CWHvm2									
TA		Talus			SV	ta		0.24	0.00%
Total								**194.44**	**1.89%**

Figure 26. Example of a small cliff (used for rock climbing) on a forested slope.

Figure 27. Example of a Rock Outcrop complexed with Woodland.

4.2.7 Estuarine (ES)

Estuarine ecosystems are found at the confluence of rivers with the sea where they are influenced by occasional or diurnal tidal inundation and brackish water. The vegetation reflects the brackish water conditions to varying degrees, depending on the position in the estuary and the magnitude of freshwater outflow (Figures 28 to 29). Estuarine ecosystems are distinguished from intertidal ecosystems by the degree of freshwater input – intertidal ecosystems are influenced by saltwater tidal inundation with little to no freshwater input, except by rainfall runoff. Two subclasses are recognized:

- **md –** estuarine meadow: found in the high intertidal zone of estuaries where tidal flooding occurs less frequently than daily and is tempered by freshwater mixing. Species composition is relatively diverse, typically with a mix of graminoids and forbs. Due to the time of year in which the survey was completed, only one estuarine meadow (tuffed hairgrass – meadow barley) was classified, while the remainder was mapped as a generic meadow.

- **ms –** estuarine marsh: intertidal ecosystem that is flooded and exposed during most tidal cycles; usually simple communities dominated by salt-tolerant emergent graminoids and succulents. The majority of the estuarine marshes mapped in the study area were Lyngbye's sedge marsh, with a small area of unclassified marsh.

A total of 126 hectares of Estuarine was mapped in the study area, representing just 1% of the total area (Table 23).

Table 23. Area of Estuarine mapped in the Study Area.

TEM Code or Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	Area (ha)	% of Study Area
CWHdm									
Ed	Ed	Estuary meadow - unclassified	2b		ES	md		46.46	0.45%
Ed01	Ed01	Tufted hairgrass - meadow barley estuary meadow	2b		ES	md		30.07	0.29%
Em	Em	Estuary march - unclassified	2b		ES	ms		2.51	0.02%
Em05	Em05	Lyngbye's sedge estuary marsh	2b		ES	ms		47.12	0.46%
Total								**126.16**	**1.22%**

Figure 28. Lyngbye's sedge estuarine marsh. These wetlands were common and extensive in the study area.

Figure 29. Tuffed hairgrass – meadow barley estuarine meadow on the raised areas with Lyngbye's sedge estuarine marsh in the foreground.

4.2.8 Intertidal (IT)

Intertidal ecosystems include mudflats, beaches and rocky shorelines that are influenced by diurnal tidal cycles with little to no freshwater input (primarily through rainfall runoff). The intertidal ecosystems link the marine and terrestrial environments (Figures 30 to 31). Three subclasses are recognized:

- **mf** – mudflats. Large areas that are exposed during low tide. Little or no vegetation occurs.

- **bs** – beaches and shorelines. Areas along the upper limit of the tidal influence where wood and other debris often accumulate.

A total of 13 hectares of Intertidal was mapped in the study area, representing almost 13% of the total area (Table 24).

Table 24. Area of Intertidal mapped in the Study Area.

TEM Code or Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	Area (ha)	% of Study Area
CWHdm									
BE	BE	Beach			IT	bs		5.85	0.06%
MU	MU	Mudflat sediment			IT	mf		6.89	0.07%
Total								**12.74**	**0.12%**

Figure 30. Beach with accumulations of logs and woody debris. These areas at the upper limit of the tidal influence.

Figure 31. Intertidal mudflat at low tide.

4.2.9 Freshwater (FW)

Freshwater ecosystems include bodies of water such as lakes (greater than 50 hectares) and ponds (less than 50 hectares) that usually lack floating vegetation. Ponds of various sizes are common in the study area, while no lakes were mapped (Figures 32 to 33). Ponds are considered to be naturally (generally) occurring, small body of open water, greater than 2 m deep and generally less than 50 ha, with little to no floating vegetation. A total of 76 hectares of Freshwater was mapped in the study area, representing 76% of the total area (Table 25).

Table 25. Area of Freshwater mapped in the Study Area.

TEM Code or Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	Area (ha)	% of Study Area
CWHdm									
PD	PD	Pond			FW	pd		76.01	0.74%
Total								**76.01**	**0.74%**

Figure 32. Small beaver pond with a swamp fringe.

Figure 33. Large pond with a rocky, forested shoreline.

4.2.10 Ocean (OC)

A large portion of Ocean was mapped within the study area (Figures 34 to 35). It included open ocean and the normal tidal limit in the rivers and estuary. In addition, a 30m fringe was modelled from the mapped Ocean polygons. This fringe was designed to capture the ocean shoreline where ecosystems most likely have a marine influence (mainly salt water spray and accumulation). This method was chosen instead of the more conventional mapping of a variety of marine influenced ecosystem types (such as coastal herbaceous, etc.) as many of these areas extended up in elevation from the ocean and it was not clear where the marine influence ended. The ocean fringe buffer was superseded by other SE classes such as the riparian fringe buffer, estuarine ecosystems, and floodplains as these areas are known to be highly sensitive, have high ecological values, and are easily mapped. A total of 892 hectares of Ocean was mapped in the study area, representing almost 9% of the total area (Table 26).

Table 26. Area of Ocean mapped in the Study Area.

TEM Code or Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	Area (ha)	% of Study Area
CWHdm									
OC	OC	Ocean			OC			848.34	8.22%
		Modelled fringe			OC	ff		44.08	0.43%
Total								**892.42**	**8.65%**

Figure 34. Typical undeveloped shoreline from the ocean. Example of an area that is contained with the modelled buffer (ocean fringe).

Figure 35. Example of a rock outcrop and woodland that would fall within the modelled ocean fringe.

4.2.11 Young Forest (YF)

Forests generally >30 – 40 yrs old and < 80 yrs old. Young Forests can be important habitat areas for many wildlife species and serve as primary connections between ecosystems in a highly fragmented landscape (Figures 36 to 38). These are also recruitment areas for mature and old forests. As previously mentioned, many of the Young Forest stands are on the cusp of being classified as Mature Forest due to the time since the last stand replacing disturbance. Three subclasses are recognized:

- **co** – conifer dominated (> 75% coniferous species).
- **mx** – mixed conifer and deciduous (<75% coniferous and < 75% broadleaf composition).
- **bd** – broadleaf dominated (>75% broad-leaved species).

A total of 3,086 hectares of Young Forest was mapped in the study area, representing almost 30% of the total area and the most common mapped SE class (Table 27).

Table 27. Area of Young Forest mapped in the Study Area.									
TEM Code or Number	**Map Code**	**Name**	**Structural Stage**	**Stand Comp.**	**SEI Class**	**SEI Subclass**	**CDC Status**	**Area (ha)**	**% of Study Area**
CWHdm									
1	HM	Hw - Flat moss	4,5	C,M,B	YF	co,mx,bd	Blue	1,252.73	12.14%
3	DS	FdHw - Salal	4,5	C,M,B	YF	co,mx,bd	Blue	744.18	7.21%
4	DF	Fd - Sword fern	4,5	C,M,B	YF	co,mx,bd	Blue	167.46	1.62%
5	RS	Cw - Sword fern	4,5	C,M,B	YF	co,mx,bd	Blue	342.14	3.32%
6	HD	HwCw - Deer fern	4,5	C,M,B	YF	co,mx,bd	Red	216.54	2.10%
7	RF	Cw - Foamflower	4,5	C,M,B	YF	co,mx,bd	Blue	292.28	2.83%
CWHds1									
1	HM	HwFd - Cat's-tail moss	5	C,M	YF	co,mx	Red	31.73	0.31%
3	FF	FdHw - Falsebox	5	C	YF	co	Blue	23.11	0.22%
7	RD	Cw - Devil's club	5	M,B	YF	mx,co	Red	7.07	0.07%
CWHvm1									
1	CS	HwBa - Blueberry	5	C	YF	co		5.01	0.05%
3	HS	HwCw - Salal	5	C	YF	co	Blue	2.33	0.02%
5	AF	BaCw - Foamflower	5	M	YF	mx		0.49	0.00%
CWHvm2									
1	AB	HwBa - Blueberry	5	C	YF	co		0.29	0.00%
3	HS	HwCw - Salal	5	C	YF	co	Blue	0.37	0.00%
Total								**3,085.73**	**29.89%**

Figure 36. Young conifer stand. This stand is close to a mature stand, with a shade tolerant understory of cedar and hemlock developing.

Figure 37. Young second growth mixed forest.

Figure 38. Young second growth broadleaf stand with regenerating conifers.

4.2.12 Not Sensitive (NS)

Areas that contained significant recent disturbance or modification were mapped as Not Sensitive. These areas included urban and rural residential areas, industrial sites, golf courses (excluding natural areas within some golf courses), gravel pits, roads, maintained powerlines, railway corridors, dikes, farmland, and recently logged areas. A total of 2,866 hectares of Not Sensitive was mapped in the study area, representing 28% of the total area (Table 28).

Table 28. Area of Not Sensitive mapped in the Study Area.

TEM Code or Number	Map Code	Name	Structural Stage	Stand Comp.	SEI Class	SEI Subclass	CDC Status	Area (ha)	% of Study Area
CWHdm									
CF	CF	Cultivated field			NS			8.00	0.08%
GC	GC	Golf course			NS			66.45	0.64%
GP	GP	Gravel pit			NS			111.47	1.08%
RN	RN	Railway surface			NS			81.31	0.79%
RW	RW	Rural			NS			103.13	1.00%
RZ	RZ	Road surface			NS			306.63	2.97%
UR	UR	Urban / Suburban			NS			1,398.96	13.56%
		Disturbed Ecosystems			NS			767.93	7.44%
CWHds1									
RN		Railway surface			NS			4.51	0.04%
RW		Rural			NS			1.66	0.02%
RZ		Road surface			NS			3.87	0.04%
UR		Urban / Suburban			NS			2.31	0.02%
		Disturbed Ecosystems			NS			4.31	0.04%
CWHvm1									
RZ		Road Surface			NS			0.58	0.01%
		Disturbed Ecosystems			NS			4.01	0.04%
CWHvm2									
		Disturbed Ecosystems			NS			1.07	0.01%
Total								**2,866.20**	**27.78%**

4.3 Environmentally Sensitive Areas Mapping

An ESA map was created using the results of the SEI mapping. As previously described, the SE classes and subclasses were given a numeric rank (ESR) then a final value calculated for each polygon to represent the multiple ecosystems that were mapped in many of the polygons. The final values were then groups into three ranks; High, Medium and Low. Table 29 provides a summary of the ESA mapping, and Figure 39 presents an overview map (large format mapping was provided in addition to this report to depict the mapping in detail).

As with the SEI, roughly half of the study area was mapped as having a high environmental sensitivity value, mainly due to the large portion of the study area that contained riparian ecosystems and ocean. Medium and low sensitivity areas were roughly even at 25% and 27% respectively. It should be noted, that there are both known and likely inaccuracies in the Riparian Fringes that were modelled from TRIM stream lines. We recommend that planned watercourse mapping be utilized to improve the accuracy of the Fluvial Fringes and subsequent SEI and ESA mapping.

Table 29. Summary of Environmentally Sensitive Areas Mapping.

ESR Rank	Hectares	Percent of Study Area
High	4,880.5	47.3%
Medium	2,614.5	25.3%
Low	2,821.9	27.4%
Total	10,317.0	100.0%

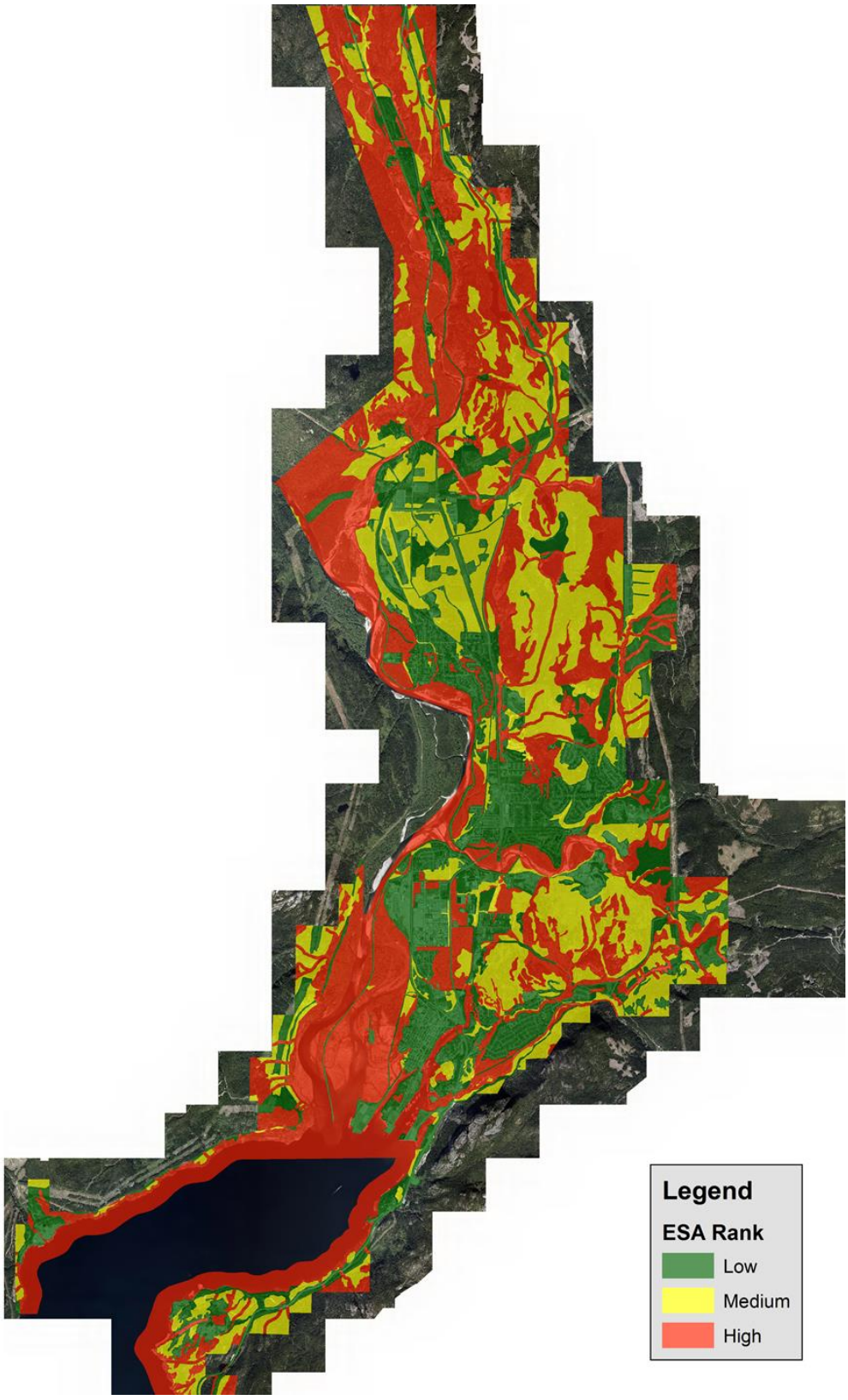

Figure 39. Environmentally Sensitive Areas Map

5.0 CLOSURE

This report has been prepared for the exclusive use of the District of Squamish.

If you have any questions pertaining to this report, you may contact the undersigned at your convenience.

Respectfully submitted,
Ecoscape Environmental Consultants

Prepared by:

Ryan Durand, R.P.Bio.
Senior Ecologist
Durand Ecological Ltd.

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Appendix 1

Potential Ecosystems at Risk that may occur in the District

Potential Ecosystems at Risk that may occur in the District

Scientific Name	English Name	Global Status	Prov. Status	BC List	Identified Wildlife	Ecosystem Group
Leymus mollis ssp. *mollis - Lathyrus japonicus*	dune wildrye - beach pea	GNR	S1S2	Red		Terrestrial - Beach: Beach Beachland (Bb)
Picea sitchensis / Rubus spectabilis Dry	Sitka spruce / salmonberry Dry	G1G2	S1S2	Red		Terrestrial - Flood: Flood (Highbench);Terrestrial - Forest: Mixed - moist/wet
Pinus contorta / Sphagnum spp.	lodgepole pine / peat-mosses	GNR	S4S5	Yellow		Wetland - Peatland: Wetland Bog (Wb)
Populus trichocarpa - Alnus rubra / Rubus spectabilis	black cottonwood - red alder / salmonberry	GNR	S3	Blue		Terrestrial - Flood: Flood Midbench (Fm);Terrestrial - Forest: Broadleaf - moist/wet
Populus trichocarpa / Salix sitchensis	black cottonwood / Sitka willow	GNR	S2S3	Blue		Terrestrial - Flood: Flood Midbench (Fm);Terrestrial - Forest: Broadleaf - moist/wet
Populus trichocarpa / Salix spp. Dry Submaritime	black cottonwood / willows Dry Submaritime	GNR	S2S3	Blue		Terrestrial - Flood: Flood Midbench (Fm);Terrestrial - Forest: Broadleaf - moist/wet
Pseudotsuga menziesii / Acer glabrum / Prosartes hookeri	Douglas-fir / Douglas maple / Hooker's fairybells	GNR	S2	Red		Terrestrial - Forest: Coniferous - dry;Terrestrial - Forest: Coniferous - mesic
Pseudotsuga menziesii - Pinus contorta / Arctostaphylos uva-ursi Dry Submaritime	Douglas-fir - lodgepole pine / kinnikinnick Dry Submaritime	G2G4	S2	Red		Terrestrial - Forest: Coniferous - dry
Pseudotsuga menziesii - Pinus contorta / Holodiscus discolor / Cladina spp.	Douglas-fir - lodgepole pine / oceanspray / reindeer lichens	G2G3	S2	Red		Terrestrial - Forest: Coniferous - dry
Pseudotsuga menziesii / Polystichum munitum	Douglas-fir / sword fern	G2G4	S2S3	Blue		Terrestrial - Forest: Coniferous - dry
Pseudotsuga menziesii - Tsuga heterophylla / Gaultheria shallon Dry Maritime	Douglas-fir - western hemlock / salal Dry Maritime	G3G4	S2S3	Blue		Terrestrial - Forest: Coniferous - dry
Pseudotsuga menziesii - Tsuga heterophylla / Paxistima myrsinites	Douglas-fir - western hemlock / falsebox	GNR	S3	Blue		Terrestrial - Forest: Coniferous - dry
Rhododendron groenlandicum / Kalmia microphylla / Sphagnum spp.	Labrador-tea / western bog-laurel / peat-mosses	G4	S3	Blue		Wetland - Peatland: Wetland Bog (Wb)

Scientific Name	English Name	Global Status	Prov. Status	BC List	Identified Wildlife	Ecosystem Group
Thuja plicata / Carex obnupta	western redcedar / slough sedge	GNR	S2S3	Blue		Terrestrial - Forest: Coniferous - moist/wet;Wetland - Mineral: Wetland Swamp (Ws)
Thuja plicata / Lonicera involucrata	western redcedar / black twinberry	GNR	S1	Red		Terrestrial - Forest: Coniferous - moist/wet
Thuja plicata / Oplopanax horridus	western redcedar / devil's club	G2G4	S1S2	Red	Y (Jun 2006)	Terrestrial - Forest: Coniferous - moist/wet
Thuja plicata - Picea sitchensis / Lysichiton americanus	western redcedar - Sitka spruce / skunk cabbage	G3?	S3?	Blue		Terrestrial - Forest: Coniferous - moist/wet;Wetland - Mineral: Wetland Swamp (Ws)
Thuja plicata / Polystichum munitum Dry Maritime	western redcedar / sword fern Dry Maritime	G2G3	S2S3	Blue		Terrestrial - Forest: Coniferous - mesic
Thuja plicata - Pseudotsuga menziesii / Acer circinatum	western redcedar - Douglas-fir / vine maple	G2G3	S2S3	Blue	Y (Jun 2006)	Terrestrial - Forest: Coniferous - mesic
Thuja plicata / Rubus spectabilis	western redcedar / salmonberry	GNR	S1S2	Red		Terrestrial - Forest: Coniferous - moist/wet
Thuja plicata / Tiarella trifoliata Dry Maritime	western redcedar / three-leaved foamflower Dry Maritime	G3	S2S3	Blue		Terrestrial - Forest: Coniferous - moist/wet
Tsuga heterophylla / Buckiella undulata	western hemlock / flat-moss	G3G4	S2S3	Blue		Terrestrial - Forest: Coniferous - mesic
Tsuga heterophylla / Clintonia uniflora	western hemlock / queen's cup	G3G4	S2	Red		Terrestrial - Forest: Coniferous - moist/wet
Tsuga heterophylla - Pseudotsuga menziesii / Rhytidiadelphus triquetrus Dry Submaritime 1	western hemlock - Douglas-fir / electrified cat's-tail moss Dry Submaritime 1	G2G3	S2	Red	Y (Jun 2006)	Terrestrial - Forest: Coniferous - mesic
Tsuga heterophylla - Thuja plicata / Blechnum spicant	western hemlock - western redcedar / deer fern	G2G3	S2	Red		Terrestrial - Forest: Coniferous - moist/wet
Typha latifolia Marsh	common cattail Marsh	G5	S3	Blue		Wetland - Mineral: Wetland Marsh (Wm)
Zostera marina Herbaceous Vegetation	common eel-grass Herbaceous Vegetation	GNR	SNR	No Status		Estuarine: Estuary Tidal Flat (Et)