Durand
Ecological Ltd.

DISTRICT OF SQUAMISH SENSITIVE HABITAT INVENTORY AND MAPPING (SHIM) and WETLAND INVENTORY AND MAPPING

Phase 1 Scoping and Gap Analysis






Prepared For:
District of Squamish
Prepared By:
Ecoscape Environmental Consultants Ltd.
&
Durand Ecological Ltd.

File No.:15-1473
May, 2015

ECOSCAPE
Environmental Consultants Ltd.

DISTRICT OF SQUAMISH
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PHASE 1 - SCOPING AND GAP ANALYSIS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

MAPSHEETS

APPENDICES

1.0 INTRODUCTION

The District of Squamish (here after called the 'District') retained Ecoscape Environmental Consultants Ltd. and Durand Ecological Ltd. to review and analyze the existing ecological information pertaining to the District. The results of these reviews and inventories will feed into a gap analysis that will identify next steps for completing ecological data collection for the District that will be used to aid future land use planning in the region. This project is a desktop exercise only, upon which fieldwork will be planned for future phases. The overall goal of this project is to provide information to direct data collection and develop policies and objectives that will support the upcoming Official Community Plan (OCP) review in 2016.

1.1 Background and Project Understanding

The District has identified sensitive habitat mapping as strategic priority for the 2015-2016 timeframe. Terrestrial Ecosystem Mapping (TEM) and some stream mapping (including some fish presence information) has been completed within the District and this information can be used to support Sensitive Habitat Inventory Mapping (SHIM) of watercourses, ecosystem inventory and Wetland Inventory Mapping (WIM) efforts. The District has indicated that multiple phases may be necessary for this SHIM and WIM project, with the first phase involving a desktop background review of existing data and policy, to identify gaps and priorities for future inventory and planning activities.

At the commencement of Phase 1, the District identified the following priorities:

- Conducting a gap analysis to identify a plan to complete SHIM, WIM, 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 aquatic habitat.

The goal of Phase 1 is to provide baseline inventory for areas that might be subject to municipal development, as well as resource extraction and development on both municipal and Crown Lands in proximity to District boundaries.

A comprehensive SHIM and WIM inventory for the District along with guidelines and recommendations will help facilitate implementation of environmental protection in District policies such as the OCP. Further, inclusion and identification of the sensitivity of existing environmental features and their locations will aid in land use planning to help direct and plan future development in a sustainable manner.

1.2 Project Objective and Goals

The results of the meeting with the District, background review and governance analysis will be combined to determine an overall approach and prioritization for future sensitive habitat mapping and associated policy development within the District. The gap analysis will determine where the greatest risks lie in terms of relative importance of features vs. availability of existing data. Knowledge of areas where development is proposed in the near future will influence the mapping priority along with the presence of sensitive species. Under this approach, existing features that are protected in parks or other reserves would be a lower priority because they are at a lower risk of future development in the short term, noting that this does not indicate that risks are not present. The gap analysis will include prioritization of waterbodies for SHIM and wetland mapping and recommendations to integrate SHIM and wetland data into other plans and initiatives. The results of the gap analysis will include priorities for future phases of this effort.

The results of the Phase 1 Scope and Gap Analysis will provide recommendations on how the existing and proposed data sets and inventories might be useful for other purposes (i.e. floodplain mapping, stormwater management, wildlife corridors and connectivity, parks planning, regional biodiversity and wildlife initiatives, etc.). Some of these data sets might be used by both local and provincial/federal agencies.

2.0 METHODOLOGY

The following section outlines the approach that was adapted for Phase 1 of this project.

2.1 Project Scope

District objectives and priorities were developed in anticipation of the OCP update in 2016. These included:

- Brief overview of data available from District and perceived data gaps
- Challenges associated with administering current policy given available data
- Resources available to implement environmental planning initiatives
- Policies that currently exist (what works, what doesn't)
- Priorities for inventory (i.e. areas where high density development is proposed with build out occurring in the next 3 to 5 years, sensitive areas where inventory is lacking, etc.)

2.2 Background Review and Data Collection

A thorough literature search was carried out to ensure that all relevant information on the study area was reviewed and integrated.

Background data provided by the District for this study included:

- 2008 Terrestrial Ecosystem Mapping
- 2008 Wildlife Interpretations (Wildlife Suitability Mapping)
- 2013 10cm orthophotos (ECW format)
- 2013 LiDAR (slope and hillshade)
- 2013 1-m contours
- District GIS base data (watercourses, roads, management areas, zoning, land designations, development permit areas, parks, etc.)

Additional data sources reviewed included:

- BC Conservation Data Centre tracking lists (for SLRD)
- DataBC (spatial data for sensitive and non-sensitive species and ecosystems at risk and known fish observations/distributions)
- Biogeoclimatic zones
- Municipal boundaries

The following sections summarize the existing data (both those provided by the District and public provincial data) and discuss the quality and comprehensiveness of each type of data. Recommendations are then made within each section regarding how the data could be improved. The background data are summarized in the following categories:

- Terrestrial Ecosystem Mapping (TEM)
- Wetlands
- Watercourses and fish occurrence/distribution
- Species and ecosystems at risk

Data was reviewed and analysed in GIS to determine its completeness, quality and coverage. Data gaps were identified as priorities for future phases of the project.

3.0 GOVERNANCE ANALYSIS

Existing information on environmental (aquatic and terrestrial) related policies in place for the District were reviewed for this project, including assessment triggers (e.g., *Riparian Areas Regulation* for instance) and the existing requirements for protection of the natural environment and riparian areas. We understand that proposed development

within Development Permit Areas 1 and 11 may trigger further assessment under the *Riparian Areas Regulation*.

We reviewed other District policies related to urban/wildlife management and terrestrial management and provide recommendations below on incorporating the results of existing data and future inventories into development permit triggers and other municipal policy.

3.1 Overview

The District of Squamish is located on the Sea-to-Ski 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.

3.2 Growth and Urban Expansion

The Mission of the District is, "to protect and enhance the livability sustainability and quality of the life for the community…" (OCP, 2009). Rapid growth is anticipated to continue for Squamish with the population expected to reach 26,100 by 2021. Growth is constrained by limited land base containing natural hazards, steep slopes, protected areas agricultural lands and environmentally sensitive features. As a result only about one quarter of the Squamish Land base is potentially developable (OCP, 2009).

Key policies relating to growth and urban expansion are to "…Balance growth pressure with environmental factors and conservation activities" (OCP 2009 - Policy 10-5). The long term growth management objective is to focus growth in the downtown, existing neighbourhoods and into new neighbourhoods that are contiguous to the existing serviced urban area and to minimize outward expansion into rural areas and avoiding development in areas of natural hazards, protected and ecologically important areas, and greenways.

3.3 Policies – Natural Environment

Squamish is considered by residents and visitors alike as the Outdoor recreation capital of Canada. For this reason there is a strong appreciation for the natural environment and its integral role in the Communities' natural capital and livability.

The Guiding principles for environmental Protection are to:

- Ensure the protection, restoration and management of aquatic and terrestrial habitats and the maintenance of ecological health for present and future generations. Minimize conflicts by developing and applying clear growth management and land use policies; and

- Support smart growth land use principles and minimize the use of energy and material resources by endorsing sustainable design and land and management practices.

In support of this the District has designated (OCP, 2009 - Schedule B Land Use Designations) land for Parks and Ecological Reserves, and Greenway Corridors and Recreation. Greenways include riparian corridors along larger creeks and streams throughout the city. The District's Protected Areas and Greenway System identifies Environmental Sensitive Areas (Schedule C) and commits to protection of these areas as the primary objective. For example, 1,844 hectares along the Squamish River and Squamish River Estuary, and existing green areas is zoned primarily Resource with small parts as Greenway Corridors and Recreation land use designations.

The District is also committed to off-road cycling, dirt biking, equestrian and other trail users. This requires that watercourse and sensitive habitat information be accurately mapping to ensure adequate protection of these features and to identify areas where restoration or increased maintenance and management are warranted. These areas are identified in Schedule B as Greenway Corridors and Recreation lands.

3.4 Development Permit Areas (OCP Schedule J)

There are 2 primary environment Development Permit Areas (DPAs): Natural Environment and Stream and Riparian Areas.

Natural Environment

DPAs have been defined to protect the Natural Environment. Significant natural assets include the Squamish Estuary, Baynes Island Ecological Reserve, and the Mamquam Blind Channel. These areas are recognized as providing important fish and wildlife habitat. These areas are also important for outdoor recreation pursuits. Lands designated as Parks and Ecological Reserve are intended as protected natural areas in perpetuity. The Squamish estuary is currently managed in accordance with the Squamish Estuary Management Plan (BC MOE, 2007).

The guiding principle is to ensure protection, restoration and management of aquatic and terrestrial habitats and the maintenance of ecological health for present and future generations. Minimize conflicts by developing and applying clear growth management and land use policies.

Promote comprehensive network of riparian and wildlife corridors to help ensure health and viability of aquatic and terrestrial species.

Stream and Riparian Areas

Key riparian corridors are identified as Greenway Corridors and Recreation (Schedule B). Distribution of watercourses in and out of this designation.

Lands within 30m of watercourse or designated as Riparian Assessment area in Schedule J2 Watercourse Atlas shall be subject to Development Permit requirements.

Development Permit guidelines

DPA1 – Natural Environment

Currently, Guidelines for Natural Environment DP are limited. In regards to protection or avoidance of sensitive areas:

> *"…The siting of structures adjacent to watercourses will need to respect natural vegetation which may require additional setbacks beyond those specified in the Zoning Bylaw as recommended by the Ministry of Water, Land and Air Protection or the Department of Fisheries and Oceans."*

DPA11 - Protection of riparian areas

Guidelines for the protection of riparian areas is more comprehensive and in accordance with the Riparian Areas Regulation. At a minimum 30 m riparian assessment areas should be included as DP areas for all watercourses. Challenges can arise where existing line work is spatially inaccurate and 30 riparian assessment areas and DP areas don't capture portions of the watercourse. However, there are still limitation in regards to performance standards/criteria, monitoring, and ensuring faithful completion of the works as per DP Conditions.

Ensuing SHIM inventories should consider requirement under the RAR to flag respective stream reaches/segments accordingly such that stream designation can be assigned and preliminary setbacks considered within future OCP updates.

4.0 ANALYSIS OF EXISTING INFORMATION AND DATA GAPS

The following section summarizes the results of the existing data review and gap analysis.

4.1 Watercourses

Analysis of existing based data indicate that the total linear stream length within District of Squamish watercourse total approximately 246 km. Initial GIS spatial analysis revealed numerous overlaps of streamlines and segments with multiple line fragments. Initial exercises involved dissolving layering and eliminating overlaps to produce a cleaner data set. It is anticipated that with subsequent project phases, this data can be further refined. In addition there were numerous incidents where current base data is spatially inaccurate and misrepresentative with on-the-ground watercourse location and extents (Figure 1).

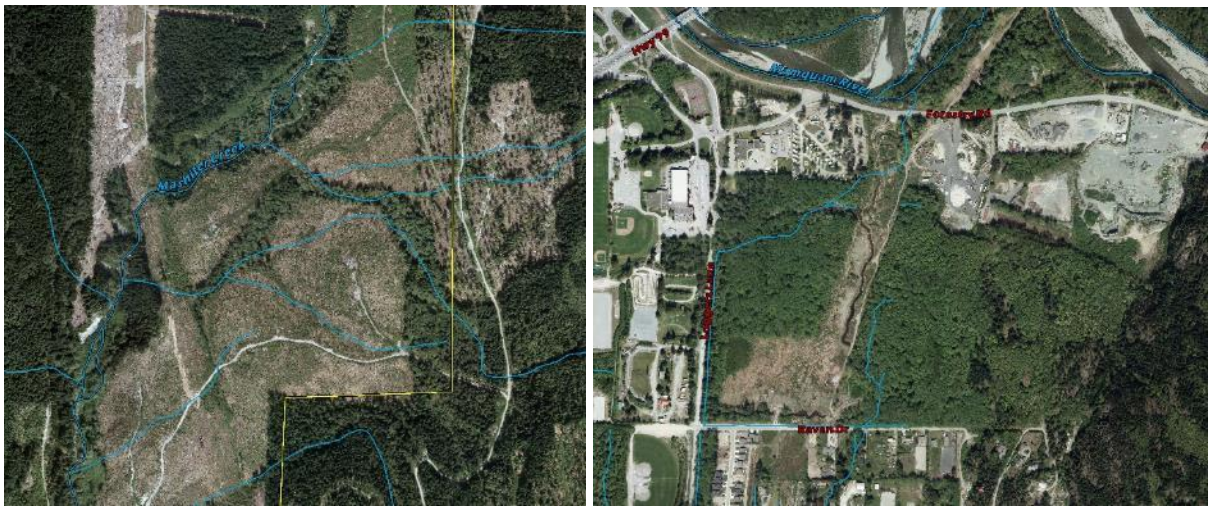

Figure 1. Aerial clip illustrating spatial inaccuracies of creek location versus on-the ground watercourse location.

Currently Sensitive Habitat Inventory and Mapping (SHIM) has been completed for Little Stawamus Creek and Magnolia Creek totaling about 16.4 km. This amounts to about 7% of the total watercourse length within the District (Table 1).

Table 1. District of Squamish watercourse summary.				
Watercourse		SHIM (m)	Base (m)	Total (m)
Alice Lake	Tributaries		740	740
Brohm Lake	Tributaries		2867	2867
Brohm River	Mainstem		3521	3521
	Tributaries		8436	8436
Cheakamus River	Mainstem		13558	13558
	Tributaries		25319	25319
Cheekye River	Mainstem		4591	4591
	Tributaries		1978	1978
Culliton Creek	Mainstem		365	365
Dryden Creek	Mainstem		2816	2816
	Tributaries		2426	2426
Evans Creek	Mainstem		2186	2186
Fries Creek	Mainstem		396	396
Gonzales Creek	Mainstem		664	664
Hop Ranch Creek	Mainstem		3223	3223
	Tributaries		638	638
Howe Sound	Tributaries		39838	39838
Hut Creek	Mainstem		348	348
Judd Slough	Mainstem		2123	2123
Little Stawamus Creek	Mainstem	5659		5659
	Tributaries	9960		9960
Magnolia Creek	Mainstem	772		772
Mamquam River	Mainstem		13461	13461
	Tributaries		26875	26875
Mashiter Creek	Mainstem		5739	5739
	Tributaries		9836	9836
Mill Creek	Mainstem		653	653
Monmouth Creek	Mainstem		2009	2009
	Tributaries		1121	1121
Olesen Creek	Mainstem		1453	1453
	Tributaries		1220	1220
Raffuse Creek	Mainstem		1412	1412
	Tributaries		1837	1837
Ring Creek	Mainstem		1680	1680
	Tributaries		984	984
Shannon Creek	Mainstem		835	835
	Tributaries		775	775
Squamish Creek	Tributaries		989	989
Squamish River	Mainstem		16123	16123
	Tributaries		14456	14456
Stawamus River	Mainstem		4996	4996
	Tributaries		947	947
Swift Creek	Mainstem		1984	1984
	Tributaries		1213	1213
Tenderfoot Creek	Mainstem		1158	1158
	Tributaries		1480	1480
Woodfibre Creek	Mainstem		110	110
	Total (m)	16391	229382	245773

4.1.1 Fish Distribution

A preliminary data search indicates that fish frequent the majority of watercourses in the District where sufficient flows and residual habitat support general living and reproduction. Upstream migration barriers were not investigated during this project phase since, from the perspective of stream and riparian habitat management, all watercourses with a surface water connection to a fish bearing stream are themselves also regarded as fish habitat. Figure 2 provides an overview of fish occurrence records, while Table summarizes the current understanding of fish species distributions in District watercourse.

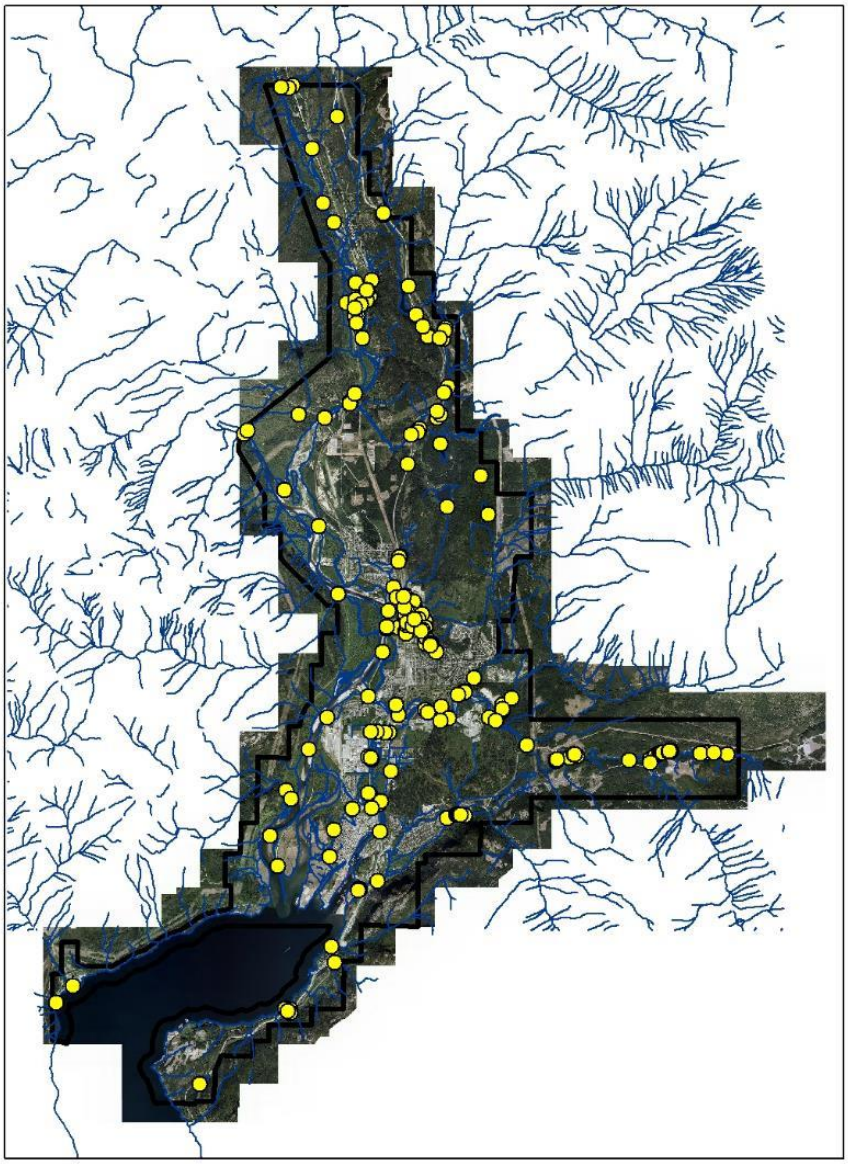

Figure 2. Fish occurrence records in the District as per DataBC (2015).

Table 2. District of Squamish fish species distribution (BC Habitat Wizard, 2015).

Watercourse	Arctic Char	Cutthroat Trout (Anadromous)	Atlantic Salmon	Brown Catfish	Bull Trout	Coastrange Sculpin	Prickly Sculpin	Slimy Sculpin	Coastal Cutthroat Trout	Chinook Salmon	Chum Salmon	Coho Salmon	Cutthroat Trout	Dolly Varden	Brook Trout	Green Sturgeon	Kokanee	Mountain Whitefish	Pink Salmon	Rainbow Trout	River Lamprey	American Shad	Sockeye Salmon	Steelhead	Threespine Stickleback	Anadromous	Richness
Brohm R.				✓						✓		✓	✓	✓						✓			✓	✓		Yes	8
Cheakamus R.					✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	Yes	19
Cheekye R.												✓	✓	✓						✓			✓	✓		Yes	6
Culliton Cr.														✓						✓				✓		Yes	3
Dryden Cr.											✓	✓	✓							✓				✓	✓	Yes	6
Evans Cr.											✓		✓							✓				✓		Yes	4
FRIES CREEK												✓												✓		Yes	2
Gonzales Cr.																				✓						No	1
Hop Ranch Cr.											✓	✓	✓							✓				✓	✓	Yes	6
Judd Slough											✓	✓														Yes	2
Mamquam River	✓				✓	✓	✓			✓	✓	✓	✓	✓					✓	✓			✓	✓	✓	Yes	14
Mashiter Cr.										✓	✓	✓	✓	✓					✓	✓			✓	✓		Yes	9
Mill Cr.												✓		✓										✓		Yes	3
Monmouth Cr.												✓								✓				✓		Yes	3
Olesen Cr.																										No	0
Raffuse Cr.														✓												Yes	1
Ring Cr.										✓		✓	✓	✓						✓				✓		Yes	6
Shannon Cr.										✓	✓	✓	✓	✓												Yes	5
Squamish R.		✓	✓		✓	✓			✓	✓	✓	✓	✓	✓		✓		✓	✓	✓		✓	✓	✓	✓	Yes	18
Stawamus R.							✓		✓	✓	✓	✓	✓	✓					✓	✓				✓		Yes	10
Swift Cr.																										No	0

4.1.2 Land Use Designation and Zoning

Landuse designations (Schedule B) were used to intersect watercourse information to stratify the relative extents to which individual streams and watershed groups are distributed throughout the District based on landuse.

The relative distribution of watercourses within various land use designations can, together with Zoning and Development Permit Areas, provide an understanding about the vulnerability of respective watercourses to alteration, disruption, and destruction. These risks can be considered when prioritizing watercourses for field inventory and assessment to assist with improved resource management, protection, and enhancement. Table 3 summarizes the distribution of District watercourses across land use designations. Currently about 53% of the total cumulative watercourse length in the District occurs in Greenway Corridors and Recreation Land use Designation. Nearly 26% of the cumulative watercourse length occur in Limited Use Land use Designation (Table 3). Intersection of watercourses with Zoning indicates that about 52% of watercourses (by cumulative length) occur in Lands Zoned Resource while close to 10% of watercourses occur in Rural and Residential Zoned lands (Table 4).

Table 3. District of Squamish watercourse distribution by land use designation.

Watercourse		Civic and Institutional	Downtown	Employment and Industrial	Greenway Corridors and Recreation	Indian Reserve	Limited Use	Parks and Ecological Reserves	Residential Neighbourhood	Tourist and Highway	University Neighbourhood	No Designation	Total (m)
Alice Lake	Tributaries						45	696					740
Brohm Lake	Tributaries				30		2837						2867
Brohm River	Mainstem				2793		728						3521
	Tributaries				5106		3330						8436
Cheakamus River	Mainstem				6304	1348	310	1063				4221	13247
	Tributaries				8326	1069	15893					31	25319
Cheekye River	Mainstem				4228							340	4568
	Tributaries				78		1900						1978
Culliton Creek	Mainstem				27		336					2	365
Dryden Creek	Mainstem				1643		1172					2	2816
	Tributaries				118		1171		464				1753
Evans Creek	Mainstem					2186							2186
Fries Creek	Mainstem				389							7	396
Gonzales Creek	Mainstem				649							14	664
Hop Ranch Creek	Mainstem				2879			344					3223
	Tributaries				95		395		147				638
Howe Sound	Tributaries	6	1006	2056	19672		8752	1455	1112			5780	39838
Hut Creek	Mainstem				44		299					5	348
Judd Slough	Mainstem				1658	466						728	2851
Little Stawamus Creek	Mainstem				5364		295						5659
	Tributaries	44			4000		2881	87	2947				9960
Magnolia Creek	Mainstem				33				739				772
Mamquam River	Mainstem				12081							1336	13418
	Tributaries			102	17538	68	8678		462			26	26875
Mashiter Creek	Mainstem				5726							13	5739
	Tributaries				3861		5496	476				2	9835
Mill Creek	Mainstem				653								653
Monmouth Creek	Mainstem				2009							0	2009
	Tributaries				1121								1121
Olesen Creek	Mainstem						48	1275		118		12	1453
	Tributaries							1220					1220
Raffuse Creek	Mainstem				1407							5	1412
	Tributaries				183		1653						1837
Ring Creek	Mainstem				1629						28	23	1680
	Tributaries				189						791	4	984
Shannon Creek	Mainstem						71	357		396		11	835
	Tributaries							775					775
Squamish Creek	Tributaries				105				884				989
Squamish River	Mainstem				5597	403		4821				5303	16123
	Tributaries	230			6766		2710	4561	47			143	14456
Stawamus River	Mainstem				4782	177	37						4996
	Tributaries				61		476		410				947
Swift Creek	Mainstem				32		1953						1984
	Tributaries						1213						1213
Tenderfoot Creek	Mainstem				1158								1158
	Tributaries				829		652						1480
Woodfibre Creek	Mainstem			109								1	110
Total (m)		**280**	**1006**	**2267**	**129838**	**5717**	**63330**	**17129**	**7211**	**514**	**819**	**18011**	**246122**
Relative Distribution (%)		**0.1%**	**0.4%**	**0.9%**	**52.8%**	**2.3%**	**25.7%**	**7.0%**	**2.9%**	**0.2%**	**0.3%**	**7.3%**	

Table 4. District of Squamish watercourse distribution by Zoning

Watercourse		Comprehensive Development 73	Comprehensive Development Zone	District Assembly	General Industrial	Land Use Contract	Light Industrial	Local Commercial	Log Sort	Multiple Family Residential	Neighbourhood Civic	Park and Public Use	Rail Transportation	Recreation Commercial	Residential	Residential Mobile Home Park	Residential Modular Home Subdivision	Resource	Rock Processing	Rural Residential	Specialized Industrial Business	Tourist Commercial	UNCODED	University Campus	University Housing	Total (m)
Alice Lake	Tributaries											696						44								740
Brohm Lake	Tributaries																	2867								2867
Brohm River	Mainstem																	3521								3521
	Tributaries																	8436				204				8640
Cheakamus River	Mainstem		1109						680				1070					4257		5211		185				12512
	Tributaries		10534										202					7036		6478						24251
Cheekye River	Mainstem											1588	32					4341		202		16				6179
	Tributaries																	1720		259						1978
Culliton Creek	Mainstem																			365						365
Dryden Creek	Mainstem					193						7	30		941			749		767		129				2816
	Tributaries											13	113		1419			820		27		33				2426
Fries Creek	Mainstem																	396								396
Gonzales Creek	Mainstem				50								47					563								660
Hop Ranch Creek	Mainstem											344	32		53			1810		985						3223
	Tributaries														2			396		240						638
Howe Sound	Tributaries		1186	417	1980		955	41	864	11	238	2878	1236		1878			24871	832	1714	580	6				39687
Hut Creek	Mainstem																			348						348
Judd Slough	Mainstem											317						57		1245						1619
Little Stawamus Creek	Mainstem							11		502		948			3459			518					221			5658
	Tributaries			169						273		89			8881			248					271			9932
Magnolia Creek	Mainstem														361			411								772
Mamquam River	Mainstem		93	236								1220	31		218			4747		84			6859			13488
	Tributaries	28	6874					121		82		343	147		1381	225		5547	48	3160			8808			26765
Mashiter Creek	Mainstem		41									170		35	129			4205							1157	5737
	Tributaries											400						7783						180	454	8817
Mill Creek	Mainstem				653																					653
Monmouth Creek	Mainstem																	2009								2009
	Tributaries																	1121								1121
Olesen Creek	Mainstem		4		14								34					1160				240				1453
	Tributaries																	1171				49				1220
Raffuse Creek	Mainstem																						1412			1412
	Tributaries																						1837			1837
Ring Creek	Mainstem																	1190							486	1676
	Tributaries																								980	980
Shannon Creek	Mainstem				16							428	31									361				835
	Tributaries											775														775
Squamish Creek	Tributaries									33					252		4	69		629						988
Squamish River	Mainstem											15						15706								15721
	Tributaries			511														13945								14456
Stawamus River	Mainstem				521		70					415	36		2438			1337								4818
	Tributaries														946											946
Swift Creek	Mainstem												112					1175		697						1984
	Tributaries																	1213								1213
Tenderfoot Creek	Mainstem		639															519								1158
	Tributaries		362															471		648						1480
Woodfibre Creek	Mainstem				109																					109
Total (m)		**28**	**20843**	**1333**	**3343**	**193**	**1025**	**173**	**1544**	**902**	**238**	**10647**	**3152**	**35**	**22358**	**225**	**4**	**126430**	**880**	**23060**	**580**	**1222**	**19408**	**180**	**3077**	**240881**
Relative distribution		**0.01%**	**8.65%**	**0.55%**	**1.39%**	**0.08%**	**0.43%**	**0.07%**	**0.64%**	**0.37%**	**0.10%**	**4.42%**	**1.31%**	**0.01%**	**9.28%**	**0.09%**	**0.00%**	**52.49%**	**0.37%**	**9.57%**	**0.24%**	**0.51%**	**8.06%**	**0.07%**	**1.28%**	

4.1.3 Agriculture

The district recognizes the importance of agriculture and food production throughout the community and will work with local organizations to promote and identify additional opportunities (Policy 10-9). This Spatial analysis indicates that about 29.5 km of watercourse occur within or bisect agriculturally zoned lands. Improved spatial information about respective watercourse and their size, and natural resource values and/or current impairments will help support sustainable agricultural practices.

Table 5. District of Squamish watercourse distribution by Agricultural Land Reserve.

Watercourse		Total Stream length (m)
Cheakamus River	Mainstem	4366
	Tributaries	10876
Dryden Creek	Mainstem	664
Evans Creek	Mainstem	1648
Hop Ranch Creek	Mainstem	127
Mamquam River	Mainstem	291
	Tributaries	1168
Monmouth Creek	Mainstem	1182
Squamish River	Mainstem	4482
	Tributaries	3381
Swift Creek	Mainstem	549
Tenderfoot Creek	Mainstem	76
	Tributaries	673
Total (m)		**29482 (12%)**

4.1.4 Elevational Development Constraints

The OCP (Policies 10-18, 10-19) generally state that future urban development will occur below an elevation of 200m. Analysis of watercourses based on elevation indicate that about 192 km (78%) of the total watercourse length within the District occurs below 200m contour while about 54 km of stream occur in the District above this elevation (Table 6).

4.1.5 Sub-Plan Areas

Neighbourhood growth and expansion areas (Schedule I) were analysed spatially with respect to existing watercourse information (Table 7). Updated field inventory data (SHIM and SEI) will help to inform Neighbourhood and Sub area plans in regards to identification of environmentally sensitive areas, natural hazards, environmental impact assessment, and greenway corridors.

4.1.6 Development Permit Areas

The existing Development Permit Area (DPA) boundary was reviewed against the spatial extents of water courses within the District. Currently land within these areas cannot be subdivided and a building permit cannot be issues until a Development Permit is first obtained in accordance with the relevant development Permit Area Guidelines.

Currently about 68 km (28% by total combined stream length) of watercourse are considered in DP areas (Table 8). However, about 177 m of watercourse still occur beyond existing DP area boundaries.

Table 6. Distribution of watercourses relative to 200 m elevation development threshold.

Watercourse		Above 200 m	Below 200 m	Grand Total
Alice Lake	Tributaries	374	366	740
Brohm Lake	Tributaries	2867		2867
Brohm River	Mainstem	2159	1363	3521
	Tributaries	7633	803	8436
Cheakamus River	Mainstem		13558	13558
	Tributaries	5249	20071	25319
Cheekye River	Mainstem	1316	3276	4591
	Tributaries	818	1160	1978
Culliton Creek	Mainstem		365	365
Dryden Creek	Mainstem	176	2640	2816
	Tributaries	214	2212	2426
Evans Creek	Mainstem		2186	2186
Fries Creek	Mainstem		396	396
Gonzales Creek	Mainstem	118	546	664
Hop Ranch Creek	Mainstem	87	3137	3223
	Tributaries		638	638
Howe Sound	Tributaries	1195	38644	39838
Hut Creek	Mainstem		348	348
Judd Slough	Mainstem		2123	2123
Little Stawamus Creek	Mainstem		5659	5659
	Tributaries	48	9912	9960
Magnolia Creek	Mainstem		772	772
Mamquam River	Mainstem	4310	9151	13461
	Tributaries	7307	19568	26875
Mashiter Creek	Mainstem	1983	3756	5739
	Tributaries	8363	1473	9836
Mill Creek	Mainstem		653	653
Monmouth Creek	Mainstem	289	1720	2009
	Tributaries	154	968	1121
Olesen Creek	Mainstem	701	752	1453
	Tributaries	835	385	1220
Raffuse Creek	Mainstem	1412		1412
	Tributaries	1837		1837
Ring Creek	Mainstem		1680	1680
	Tributaries		984	984
Shannon Creek	Mainstem		835	835
	Tributaries	288	487	775
Squamish Creek	Tributaries		989	989
Squamish River	Mainstem		16123	16123
	Tributaries	1689	12767	14456
Stawamus River	Mainstem		4996	4996
	Tributaries	222	725	947
Swift Creek	Mainstem	643	1342	1984
	Tributaries	1213		1213
Tenderfoot Creek	Mainstem	240	918	1158
	Tributaries	247	1234	1480
Woodfibre Creek	Mainstem		110	110
Grand Total (m)		**53984**	**191789**	**245773**
Relative Distribution		**22%**	**78%**	

Table 7. District of Squamish watercourse distribution by Schedule I Sub-Plan Area.

Watercourse		Plan Areas										Outside Sub-Area	Total (m)
		Business Park Sub-area	Centennial Way	Downtown	East Lands	Interfor	Merrill and Ring Lands	Nexen	Sea to Sky University Sub-	South of Mamquam Area	South of Mamquam Area		
Alice Lake	Tributaries											740	740
Brohm Lake	Tributaries											2867	2867
Brohm River	Mainstem											3521	3521
	Tributaries											8436	8436
Cheakamus River	Mainstem											13558	13558
	Tributaries											25319	25319
Cheekye River	Mainstem											4591	4591
	Tributaries											1978	1978
Culliton Creek	Mainstem											365	365
Dryden Creek	Mainstem											2816	2816
	Mainstem											672	672
	Tributaries											1753	1753
Evans Creek	Mainstem											2186	2186
Fries Creek	Mainstem											396	396
Gonzales Creek	Mainstem											664	664
Hop Ranch Creek	Mainstem											3223	3223
	Tributaries											638	638
Howe Sound	Tributaries	1591		2741						111		35395	39838
Hut Creek	Mainstem											348	348
Judd Slough	Mainstem											2123	2123
Little Stawamus Creek	Mainstem											5659	5659
	Tributaries										1265	8695	9960
Magnolia Creek	Mainstem											772	772
Mamquam River	Tributaries		760		569		3978					21568	26875
	Mainstem		1070								104	12287	13461
Mashiter Creek	Mainstem						279		1157			4304	5739
	Tributaries								634			9203	9836
Mill Creek	Mainstem											653	653
Monmouth Creek	Mainstem											2009	2009
	Tributaries											1121	1121
Olesen Creek	Mainstem											1453	1453
	Tributaries											1220	1220
Raffuse Creek	Mainstem											1412	1412
	Tributaries											1837	1837
Ring Creek	Mainstem				946				486			248	1680
	Tributaries								980			4	984
Shannon Creek	Mainstem											835	835
	Tributaries											775	775
Squamish Creek	Tributaries											989	989
Squamish River	Mainstem											16123	16123
	Tributaries											14456	14456
Stawamus River	Mainstem											4996	4996
	Tributaries											947	947
Swift Creek	Mainstem											1984	1984
	Tributaries											1213	1213
Tenderfoot Creek	Mainstem											1158	1158
	Tributaries											1480	1480
Woodfibre Creek	Mainstem											110	110
		1591	1830	2741	1515	0	4257	0	3257	111	1368	229103	245773

Table 8. District of Squamish watercourse distribution by Development Permit Area.

Watercourse		Development Permit Area								No DPA	Total (m)	% Outside DPA
		Business Park	Downtown South	Highway 99 Corridor	Mamquam Blind Channel	Other Commercial and Industrial	Natural Environment	Squamish Industrial Park & Industrial	University Campus and Residential			
Alice Lake	Tributaries									740	740	100
Brohm Lake	Tributaries									2867	2867	100
Brohm River	Mainstem									3521	3521	100
	Tributaries									8436	8436	100
Cheakamus River	Mainstem						1999			11559	13558	85.3
	Tributaries									25319	25319	100
Cheekye River	Mainstem									4591	4591	100
	Tributaries									1978	1978	100
Culliton Creek	Mainstem									365	365	100
Dryden Creek	Mainstem									3488	3488	100
	Tributaries									1753	1753	100
Evans Creek	Mainstem									2186	2186	100
Fries Creek	Mainstem						396				396	0
Gonzales Creek	Mainstem									664	664	100
Hop Ranch Creek	Mainstem									3223	3223	100
	Tributaries									638	638	100
Howe Sound	Tributaries	300	78	357	193		19340	1607		17964	39839	45.1
Hut Creek	Mainstem									348	348	100
Judd Slough	Mainstem						1622			501	2123	23.6
Little Stawamus Creek	Mainstem									5659	5659	100
	Tributaries									9960	9960	100
Magnolia Creek	Mainstem									772	772	100
Mamquam River	Mainstem					658	438	400		11921	13418	88.8
	Tributaries					3710	1866	280		21018	26875	78.2
Mashiter Creek	Mainstem								1142	4597	5739	80.1
	Tributaries								635	9201	9836	93.5
Mill Creek	Mainstem							589		64	653	9.8
Monmouth Creek	Mainstem						2008			1	2009	0.1
	Tributaries						1118			3	1121	0.3
Olesen Creek	Mainstem			121						1332	1453	91.7
	Tributaries									1220	1220	100
Raffuse Creek	Mainstem									1412	1412	100
	Tributaries									1837	1837	100
Ring Creek	Mainstem								487	1193	1680	71.0
	Tributaries								984	0	984	0
Shannon Creek	Mainstem			395						441	835	52.8
	Tributaries									775	775	100
Squamish Creek	Tributaries						156			833	989	84.2
Squamish River	Mainstem						15405			719	16123	4.5
	Tributaries						11328			3127	14456	21.6
Stawamus River	Mainstem						539			4457	4996	89.2
	Tributaries									947	947	100
Swift Creek	Mainstem									1984	1984	100
	Tributaries									1213	1213	100
Tenderfoot Creek	Mainstem									1158	1158	100
	Tributaries									1480	1480	100
Woodfibre Creek	Mainstem							100		10	110	8.8
Total (m)		**300**	**78**	**872**	**193**	**4369**	**56215**	**2977**	**3248**	**177478**	**245731**	
Relative Distribution (%)		**0.12**	**0.03**	**0.36**	**0.08**	**1.78**	**22.88**	**1.21**	**1.32**	**72.22**		

4.2 Terrestrial Ecosystem Mapping

The TEM was completed in 2007-08. It is our understanding the mapping was done using 2D interpretation of digital orthophotos (date of imagery is unknown). Terrain mapping was not completed; therefore mapping was not completed to provincial standards. Polygon verification was completed at Survey Intensity Level 3, with 17% of the polygons field checked (143 plots in total, with 4 full, 21 ground, and 118 visual).

The mapping codes generally followed the TEM standard at the time, with the inclusion of some non-standard map codes to reflect disturbance and anthropogenic modifications. Polygon data included deciles, site series (and map codes) site modifiers, and stand structure. Canopy composition and structural modifiers were not included.

Some portions of the mapped area to the west had generic polygons with no data (limitations of original mapping), and other areas (such as IRs, woodlots, and parks) were not mapped. While it is understandable that these areas were not mapped, as the District does not control development activities within, they are useful in terms of assessing landscape level connectivity and the regional occurrence/rarity of ecosystems and species at risk.

Specific information as to how the mapping was completed is limited. The TEM Legend indicates that CWHds1 and CWHdm were mapped, but the TEM shapefile provided by the District only indicates the Zone (CWH) and not the subzones (ds1, dm). Additionally, the current provincial BGC mapping indicates that the vast majority of the District occurs within CWHdm, with roughly 160 hectares of CWHds1 in the north, and even smaller areas of CWHvm2 to the east and southeast and CWHvm1 to the southwest (Figure 3). It is not known if the 2008 TEM was based on older versions of the BGC mapping, or this omission was intentional.

The lack of terrain information (i.e. terrain mapping not completed before TEM) reduces the accuracy of the TEM classifications and polygon boundaries polygons in many areas. There are instances where TEM polygons follow vegetation and ignore changes in terrain, slope and aspect. For example, Figure 4 (LiDAR 2m hillshade with TEM polygons and watercourses overlain) shows a polygon that includes roughly 60% hillside – glacial till, 30% flat inactive floodplain – fluvial, and 10% till veneer over bedrock, in addition to a creek or stream. The same polygon is overlain on the provided 2013 othrophoto. The polygon clearly contains areas with pure, young deciduous forest cover, pure young coniferous forest cover, and small areas of mixed cover. In addition, about 10% of the polygon is occupied by two residences on the western side.

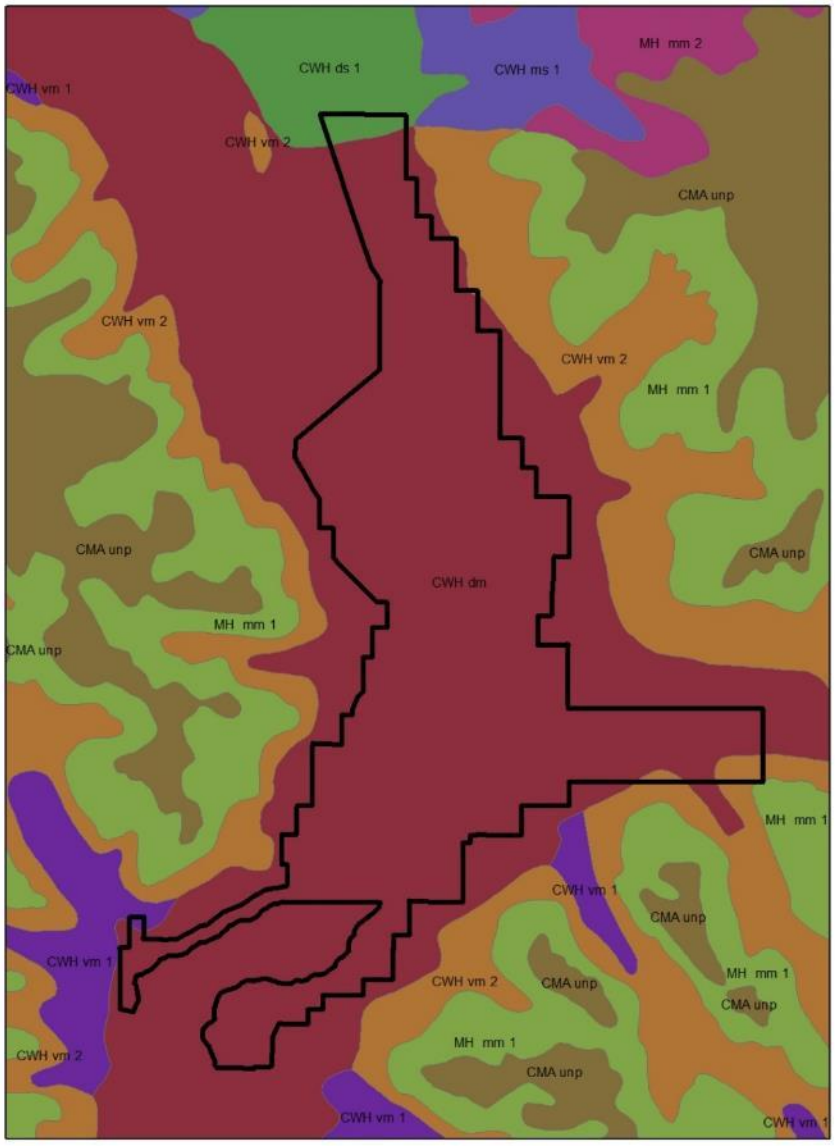

Figure 3. Provincial Biogeoclimatic map with the District boundary overlain.

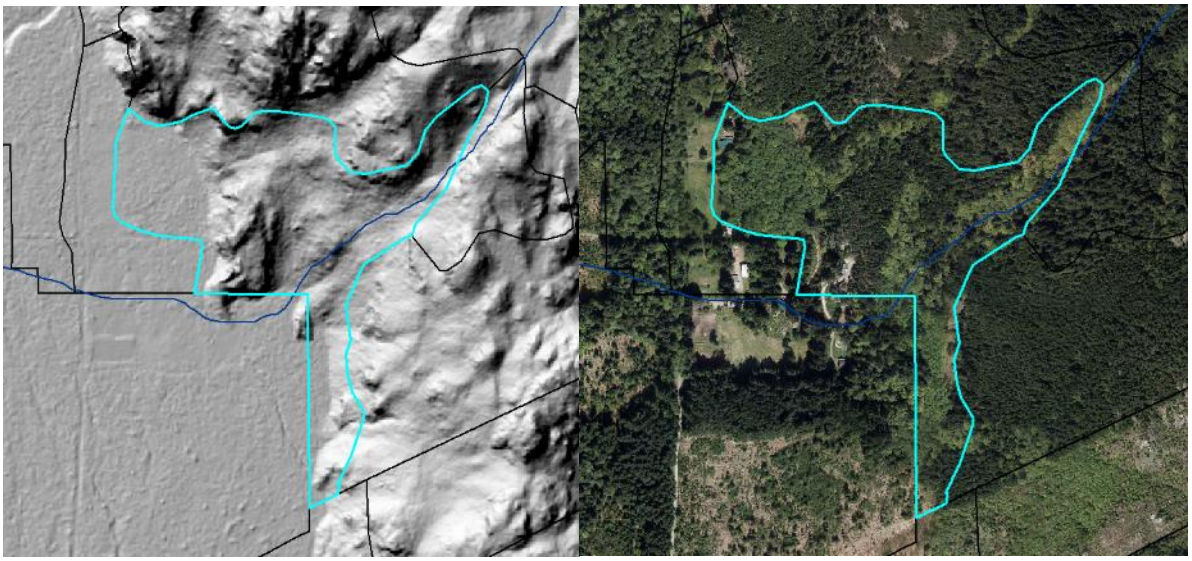

Figure 4. Example of a polygon that does not follow obvious terrain features that would significantly modify the expected ecosystem types (left). Same polygon showing the influence of a stream that was not included, and the broadleaf vs conifer components (right).

There are also errors in classification, and omissions of significant sensitive features. Figure 5 (left image) shows an example of a tall shrub to young broadleaf mid-bench floodplain that was mapped as RI (River). Figure 5 (right image) shows a polygon that was mapped as 100% young forest. This polygon is 20 to 30% creek and the irregular, patchy forest cover to the east and south east suggests treed swamps. It is also not 100% terrace as mapped.

Figure 5. Example of a mid-bench floodplain that was mapped as river (left). Example of polygon that did not include a large creek in the classification, and likely contains other classification errors (right).

Some wetlands do not appear to be mapped, and those that are mapped are classified to the older more simplistic BEC site series, not the newer Wetlands of BC Associations, or do not properly complex the numerous wetland types present. For example, Figure 6 (left image) illustrates an area mapped as Shallow Open Water, but clearly also contains at least two types of marsh and one type of swamp. Figure 6 (right image) is incorrectly classified as cultivated field and the wetlands were not pulled out as District polygons, or classified as a decile). The marine interface is not distinctly classified, with large polygons that are lumped into the MU (mudflat) class.

Figure 6. Inaccurate wetland classification and simplication of ecosystem types (left). Example of inaccrate or outdated classification and large wetlands that were not mapped or classified (right).

At least one polygon (Figure 7) was erroneously not split into to two separate polygons.

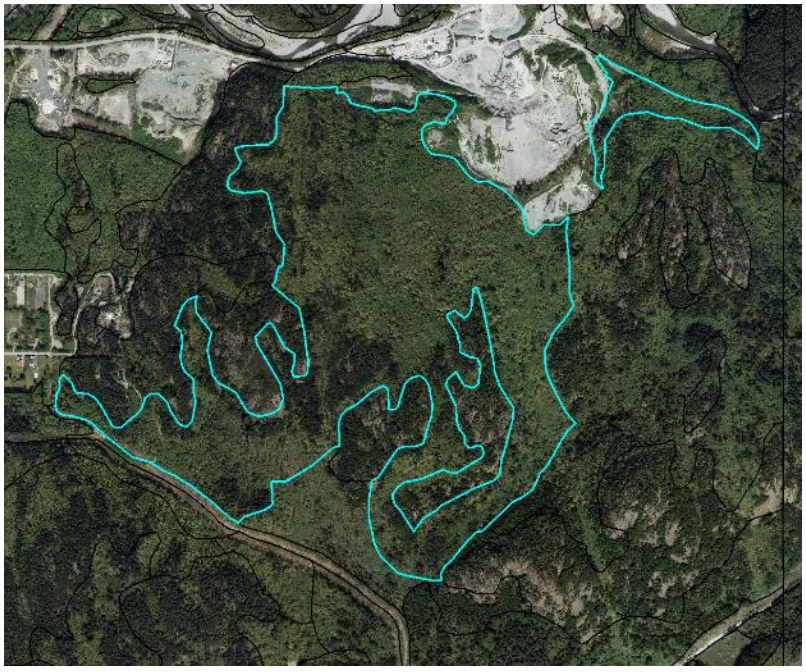

Figure 7. Example of a polygon that should have been split into two polygons.

Line work errors are also apparent, such as the 5-metre wide gap between the two polygons in Figure 8.

Figure 8. Example of poor line work with a gap between polygon boundaries.

4.3 Wetlands

The provincial wetland mapping contains eight wetlands within the District, excluding estuaries and floodplains. The provincial layer contains different wetlands and wetland boundaries than the 2008 TEM. The 2008 TEM contains limited information on wetlands (See Section 4.2), and does not differentiate non-forested wetland classifications, with multiple wetland associations often occurring in a single polygon. Table 9 contains the number and type of TEM polygons that contain, or may contain, wetlands. No additional information is available on the type, location or condition of wetlands.

Table 9. TEM polygons that may have a wetland component.

Mapped or Potential Wetlands	Number of TEM Polygons
Mudflat sediments	11
Shallow open water	12
Bog	1
Ponds	10
Forested Swamp	7
Marsh	0
Lakes	2

4.4 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.

The CDC currently tracks 28 ecosystems at risk within the SLRD that also occur in the CWHds1 and CWDdm BGC units (Appendix A). Table 10 contains a summary of the ecosystem types and provincial status.

Table 10. 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		

The CDC does not currently track any ecosystems at risk within the District. The 2008 TEM data was queried to determine the potential for ecosystems at risk to occur. The identification of listed ecosystems in the TEM does not mean that they occur, as there is a rigorous process used by the CDC to determine if a mapped ecosystem meets the criteria for listing as red or blue (such as size, structural stage, condition, connectivity, etc.). Of the 28 tracked ecosystems at risk, 20 are mapped in the 2008 TEM and were mapped with structural stages that indicate that they may be classified as listed ecosystems (Appendix B).

The CDC currently tracks 122 species at risk within the SLRD that may occur in the District (Appendix C). Table 11 contains a summary of the potential species at risk and provincial and federal status.

Table 11. Potential species at risk.							
Species Category	**Provincial Rank**			**COSEWIC**			**Identified Wildlife**
	Red	**Blue**	**Yellow**	**Endangered**	**Threatened**	**Special Concern**	
Invertebrate Animals	4	8			1	1	
Nonvascular Plant	10	21		1			
Vascular Plant	8	22		1		1	
Vertebrate Animal	12	28	4	8	10	20	24

Of the 122 potential species, only three are known to occur in the District (Table 12).

Table 12. Known species at risk.				
Common Name	**Scientific Name**	**Provincial Rank**	**COSEWIC**	**Identified Wildlife**
Vancouver Island Beggarticks	*Bidens amplissima*	Blue	SC(Nov 2001)	
Pacific Water Shrew	*Sorex bendirii*	Red	E (Apr 2006)	Y (May 2004)
Roell's Brotherella Moss	*Brotherella roellii*	Red	E (Nov 2010)	

5.0 RECOMMENDATIONS

Policy 16-14 (OCP 2009) states that, "The District shall map and inventory sensitive environmental areas and update Schedule C when the mapping has been completed." No development shall be permitted in Future Sub area plans (Schedule I) until ESAs have been mapped and appropriate mitigation strategies are established.

Based on the results of the gap analysis and governance analysis, recommendations have been provided for the improvement of ecological baseline data for the District. The recommendations include a combination of improving existing data, and new mapping and field inventories that could be completed. These include:

- Watercourses
- Ecosystem Mapping
- Wetlands
- Species and Ecosystems at Risk
- Marine shoreline inventory and mapping

5.1 Governance

Currently, only about 28% of watercourses (by stream length) are bound by a Development Permit Area and are afforded some level of protection at the local government level through the District Policies and Guidelines. Beyond the Squamish

River and Estuary, sensitive wetland and terrestrial ecosystems are not currently considered in DPAs unless they are associated with the limited extent of watercourses currently within DPAs. Incomplete mapping and understanding about the location and spatial extents of watercourses, wetlands and sensitive ecosystems impairs the ability of the District to fulfil existing Policies relating to natural environment protection and enhancement. The following governance recommendations are intended to advance environmental protection within the District:

- Expand Development Permit Guidelines for the protection of Sensitive Terrestrial and Wetland Ecosystems.
- Require that performance objectives are established for individuals effecting natural environments and sensitive aquatic and terrestrial ecosystems.
- Develop a Terms of Reference for site survey and environmental assessment standards.
- Require performance bonding for all projects requiring Natural Environment and Aquatic/Riparian Development Permits to ensure faithful completion of works
- Require that applicant/proponent provide confirmation (e.g. with notification of contract) that a Qualified Environmental Professional has been retained to provide environmental monitoring for the project to ensure that the development Permit guidelines are adhered to and that the specific recommendations outlined in the Environmental Report are fulfilled.
- For projects involving mitigation or compensation in the form of habitat restoration and enhancement, the District should maintain a holdback (e.g. 10%) of security funds (bond) for a maintenance period (e.g. 2-3 years) to ensure that total performance of the specified project objectives is achieved (e.g. acceptable plant survival and prescribed habitat structure and function).

5.2 Watercourses

Prioritization of watercourses (Table 13) for field inventories was based on following criteria:

- Complete SHIM for all named watercourses and tributaries that intersect Sub-Plan Areas.
- Complete SHIM for all named watercourses and tributaries that intersect agricultural lands.
- Complete SHIM on the balance of named watercourses and tributaries not captured by year 1 and 2 criteria.

- Consider completion of large river inventory (RIM) and Aquatic habitat Index (AHI) on large river systems (e.g. Squamish, Cheakamus, and Mamqwam mainstems).

The Districts' commitment to off-road cycling, dirt biking, equestrian and other trail users requires that watercourse and sensitive habitat information be accurately mapped to ensure adequate protection of these features and to identify areas where restoration or increased maintenance and management are warranted. These areas are identified in Schedule B as Greenway Corridors and Recreation lands.

Table 13. Preliminary watercourse prioritization for Sensitive Habitat Inventory and Mapping (SHIM).

Row Labels		SHIM Completed	Year 1 (Priority 1)	Year 2 (Priority 2)	Year 3 (Priority 3)	Years 4-5 (Priority 4)	Total (m)
Alice Lake	Tributaries			740			740
Brohm Lake	Tributaries				2867		2867
Brohm River	Mainstem				3521		3521
	Tributaries				8436		8436
Cheakamus River	Mainstem					13558	13558
	Tributaries			25319			25319
Cheekye River	Mainstem		4591				4591
	Tributaries		1978				1978
Culliton Creek	Mainstem			365			365
Dryden Creek	Mainstem			2816			2816
	Tributaries			2426			2426
Evans Creek	Mainstem			2186			2186
Fries Creek	Mainstem				396		396
Gonzales Creek	Mainstem				664		664
Hop Ranch Creek	Mainstem			3223			3223
	Tributaries			638			638
Howe Sound	Tributaries		2542		15318	15150	33010
Hut Creek	Mainstem			348			348
Judd Slough	Mainstem		2123			0	2123
Little Stawamus Creek	Mainstem	5659					5659
	Tributaries	9960					9960
Magnolia Creek	Mainstem	772					772
Mamquam River	Mainstem					13461	13461
	Tributaries		17080		9795		26875
Mashiter Creek	Mainstem		5739				5739
	Tributaries		9836				9836
Mill Creek	Mainstem					653	653
Monmouth Creek	Mainstem			2009			2009
	Tributaries			1121			1121
Olesen Creek	Mainstem				1453		1453
	Tributaries				1220		1220
Raffuse Creek	Mainstem				1412		1412
	Tributaries				1837		1837
Ring Creek	Mainstem		1680				1680
	Tributaries		984				984
Shannon Creek	Mainstem				835		835
	Tributaries				775		775
Squamish Creek	Tributaries			989			989
Squamish River	Mainstem					16123	16123
	Tributaries			14456			14456
Stawamus River	Mainstem					4996	4996
	Tributaries		725		222		947
Swift Creek	Mainstem			1984			1984
	Tributaries			1213			1213
Tenderfoot Creek	Mainstem			1158			1158
	Tributaries			1480			1480
Woodfibre Creek	Mainstem					110	110
Total (m)		**16391**	**47279**[1]	**62472**	**48752**	**64051**	**238945**

1. Refined terrestrial ecosystem mapping has also been identified as a year-1 priority.

The watercourses should be mapped along the center of the bankfull (not floodplain) width. Each watercourse should be stratified into a series of successive sections (segments), each possessing and being characterized by different attributes or biophysical characteristics (i.e. hydraulic class, channel characteristics, substrates composition, and riparian class, etc.). This segmentation and associated attributes will be fundamental to the centerline survey with point features providing a more quantitative measure of relative disturbance/modification and aquatic habitat quality/complexity (i.e. area abundance of deep pools, spawning substrates, large woody debris, bank erosion, etc.).

Table 14 provides a complete list of features and corresponding attributes that should be recorded in field inventories as per SHIM standards (Mason and Knight, 2001).

Table 14. Overview of watercourse and habitat attributes to be collected using the SHIM Data Dictionary (Module 3, Mason and Knight, 2001).

Survey Component	Main Attribute	Detailed Feature Collected
Stream Centre Line	Stream Reference Information	Name; Watershed Code; Date; Time; Survey Conditions; Surveyors
	Stream Segment Points	Start; Stop; Reach Break; Elevation; Representative Photographs
	Stream Segment Class	Stream Section; State of Section (i.e. natural/modified/channelized); Dominant Hydraulic Type
	Segment Characteristics	Section Gradient; Fish Spawning; Canopy; Access; Gravel
	Segment Substrate Attributes	Dominant Substrate Type; Compaction
	Segment Channel Attributes	Widths (wetted, bankfull), Depths (wetted, bankfull)
	Segment Instream Cover	% Total Cover; % by Feature/Cover Type (large woody debris/deep pool/over stream vegetation etc.)
	Segment Riparian Attributes	Left and Right Bank Riparian Class (vegetation association; structural stage; bank slope; material etc.)
		Segment Summary Description
	Level of Impairment	Score 0 (Severely impaired) – 6 (Natural); Rationale
	Enhancement Opportunity Rating	0 (Nil) – 4 (Very High); Rationale
Watercourse and Habitat Features	Culvert Attributes	Type-Material; Condition; Barrier; Size; Baffles
	Obstruction Attributes	Type-Material; Barrier; Size; Photo
	Stream Discharge Attributes	Point of Discharge; Type-material; Size
	Erosion Feature	Type of Erosion; severity; exposure; material
	Fish Habitat Attributes	Type of Habitat (Spawning/rearing/cover); Size; Slope; Photo
	Enhancement Areas	Type of Enhancement; Potential or existing enhancement
	Wildlife Observations	Type of Observation; Wildlife species; Photo
	Wildlife Tree Attributes	Type of Tree; Size; Location
	Near Waterbody Attributes	Type of Waterbody (spring/side channel/pond etc.); Size
	Wetland Attributes (Polygon feature)	Wetland Type-Class; Photo
	Photograph Location	Location; Direction.

5.3 Ecosystem Mapping

Some of the previously noted errors and omissions in the 2008 TEM may have been related to the project scope and criteria given to the mappers, and the limitations of the project, budget, and/or imagery. The mapping is problematic and often simplistic. The polygon boundaries are inaccurate in many places as they lack the topographical control that mapping from a terrain layer would provide. All of these errors also mean that the wildlife suitability mapping that was completed in 2008 contain the same spatial and

classification errors. If the TEM is to be used as the basis for local or regional planning, the following changes should be made:

- The mapping should be updated using current imagery (particularly in respect to the numerous expected changes from the last 8 years of development), ideally using 3D stereo imagery.

- The Mapping should be updated using the most recent provincial BGC mapping and the correct CWH subzones.

- Terrain mapping should be done prior to the update, or at the minimum, the existing TEM polygons be modified using LiDAR to correct the obvious issues.

- TEM codes should be updated to include the new standard disturbance codes, TEM codes, and Wetlands of BC site associations. All the classification should be checked, as the percent with obvious errors is currently high.

- Canopy composition should be added (and if the mapping is re-done, structure modifiers added).

- The TEM site modifiers should be checked against the provincial mapcode database (available at: http://www.env.gov.bc.ca/ecology/tem/list.html) as some appear to conflict, and some are listed that should be assumed and not included in the database.

- A proper QA/QC process should be included to ensure that the resultant mapping is accurate and to provincial standards.

Based on these recommendations, it would likely be more economical and more accurate, to re-map the entire area, as modifying existing polygons often takes as much time or longer then starting new.

Once the mapping is improved, additional data should be added to the mapping to reflect:

- Current and historic disturbance levels.

- Conservation Data Centre ecosystems-at-risk classification (based on site classification, disturbance, stand age, polygon size, etc.).

- Conversion to Sensitive Ecosystems Inventory (SEI) classes and subclasses. Using the provincial standards, the TEM could then be converted to the SEI mapping system that is both easier for the lay person to understand and use, and provides an easy template from which to create ecosystem sensitivity ratings.

5.4 Wetlands

Based on the above analysis of the current wetland mapping and classification in the District, we recommend that:

- Detailed wetland mapping be performed. This could be a component of the previously recommended TEM revision, or a standalone project.

- Wetland mapping could be done on a fine scale (1:1000) on the existing digital imagery for the majority of the areas. Forested wetlands would not be reliably mapped on orthos and would require proper terrain and ecosystem mapping using stereo imagery. Fine scale mapping would allow for the proper delineation of all wetland associations from within the obvious complexes and the estuary. TEM is typically mapped at a scale of 1:20 000 which precludes the mapping of individual associations within complexes, however it could be a specific objective of the TEM and easily integrated. Based on the number and extent of wetlands observed in on the District orthophoto, it would not be an onerous job.

- Field verification of wetlands should be completed using the standard assessment and classification methodologies found in Wetlands of BC and the Field Manual for Describing Terrestrial Ecosystems, 2nd edition.

- A CDC Conservation Evaluation Form for each wetland should be completed to determine if it meets the criteria for classification as an ecosystem at risk.

5.5 Species and Ecosystems At Risk

Based on the species and ecosystems at risk data searches, there is a high potential for the occurrence of numerous species at risk in the District. The current data appears to be limited and incomplete. Based on the 2008 TEM data, it is also apparent that a large number of ecosystems at risk occur within the District. We therefore recommend that:

- Species at risk surveys should be completed in high potential areas (relative to the species habitat requirements and the level of disturbance) by species experts.

- Once the TEM mapping is corrected and refined (See Section 4.2), an analysis of potential ecosystems at risk that meet the CDC/NatureServe criteria for inclusion as Element Occurrences should be completed. The TEM polygons that are identified should then be field verified to confirm classification and condition.

- A CDC Conservation Evaluation Form for each field truthed polygon should be completed to determine if it meets the criteria for classification as an ecosystem at risk.

6.0 WORK PLAN PRIORITIZATION

Table 15 provides a prioritized summary of recommended aquatic and terrestrial inventory needs to support improved environmental land use planning within the District to sustain the Mission of the Official Community Plan (2009).

Table 15. Summary of Recommended District of Squamish Environmental Planning and Management.

Program Component	Priority	Approx. Time Required	Activity
Watercourse			
SHIM year 1	1	2015	Complete SHIM for all named watercourses and tributaries that intersect Sub-Plan Areas
SHIM year 2	2	2016	Complete SHIM for all named watercourses and tributaries that intersect agricultural lands
SHIM year 3	3	2017	Complete SHIM on the balance of named watercourses and tributaries
Marine shoreline Mapping	4	2018	Complete shoreline inventory and mapping of Howe Sound adapting Foreshore Inventory and Mapping Standards.
SHIM/RIM	4-5	2018-19	Complete watercourse Inventory catalogue report once all field inventories are complete. This will focus budget in earlier years on completing field inventories with priority on updating and refining Aquatic/riparian DPAs. Consider completion of large river inventory (RIM) and Aquatic habitat Index (AHI) on large river systems (e.g. Squamish, Cheakamus, and Mamqwam mainstems).
Terrestrial Ecosystems			
Update TEM	1	Dependent on area and methodology. 10-15 days for mapping, 15 days field work, 5 days reporting.	Refine 2008 TEM with bioterrain control and recent stereo imagery. If imagery is not available, a combination of LiDAR and recent orthophotos could be used to significantly improve the mapping. Correct errors and refine ecosystem classification, particularly for wetlands and floodplains. Mapping could be limited to priority areas to reduce cost and time required, but preference would be to map entire District to make a comprehensive layer.
Sensitive Ecosystems Inventory Mapping	2	5 to 10 days mapping	Model SEI using standard classification system (see Metro Van Parks SEI for template) from TEM to create easy to use ecosystem map of the District.
Ecosystem Sensitivity Ratings	3	5 to 10 days mapping	Model SEI and/or TEM to map sensitivity (e.g. high, med, low) to create simple, easy to use District wide mapping. See Vernon 2008 OCP EMA Strategy (Page 18 at: http://www.vernon.ca/services/pde/documents/ema_strategy_final.pdf) for an example.
Wetlands and Estuaries			
Map and Classify Wetlands	1	Standalone – 2 days mapping, 5 to 7 days field.	Conduct wetland mapping and inventory to Wetland Association level. Could be integrated with TEM update, or a fine scale stand-alone project.
Map and Classify Estuary	1	Standalone – 1 day mapping – 3 to 5 field days	Conduct estuary mapping and inventory to Wetland Association level. Could be integrated with TEM update, or a fine scale stand-alone project.
Species and Ecosystems at Risk			
Ecosystems at Risk Mapping	2	2 to 5 days modelling, 2 to 5 days added to TEM field work	Model potential ecosystems at risk from TEM and field sample to confirm. Could be a component of the TEM update.
Species at Risk Surveys	3	Dependent on species, expert availability, and area assessed.	Complete species at risk surveys in high priority areas. Areas could be defined based on habitat type, development pressure, or a variety of criteria (i.e. limited value in surveying built up or disturbed areas).
Governance			
Development Permit Area Designation	1	2015/16	• Establish DPA for all mapped watercourses, riparian communities, and wetlands (identified by TRIM, SHIM, or ecosystem mapping) • Establish New Sensitive Terrestrial DPA • Inform and update Table 1 and explanatory Notes (DPA11)
Development Permit Guideline Development (Terrestrial and Aquatic DP)	1	2015/16	• DPA guideline refinement can occur in advance of completed inventories for the entire District Area • Expand DPA guidelines for Natural Environment with specific guidelines for sensitive terrestrial ecosystems, wetlands and estuaries • Develop Terms of Reference for Environmental Reports • Establishment of performance bonding (by the Applicant) for projects requiring measures to mitigate or compensate for impacts to the natural environment and sensitive habitats

7.0 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

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MAPSHEETS

APPENDIX A

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)
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)

APPENDIX B

Ecosystems at Risk likely to occur in the District based on TEM data.

Scientific Name	English Name	Biogeoclimatic Units	2008 TEM	Likely to Occur
Typha latifolia Marsh	common cattail Marsh	CWHdm/Wm05	No	Yes. Common wetland type in area.
Populus trichocarpa - Alnus rubra / Rubus spectabilis	black cottonwood - red alder / salmonberry	CWHdm/09;CWHds1/09	Yes	Two polygons mapped as mature along river
Rhododendron groenlandicum / Kalmia microphylla / Sphagnum spp.	Labrador-tea / western bog-laurel / peat-mosses	CWHdm/Wb50	No	Unknown
Leymus mollis ssp. *mollis - Lathyrus japonicus*	dune wildrye - beach pea	CWHdm;CWHds1	No	No
Zostera marina Herbaceous Vegetation	common eel-grass Herbaceous Vegetation	CWHdm	No	Yes (TEM only maps 11 polygons as Mudflat Sediment, but polygons include estuary and intertidal areas.
Tsuga heterophylla / Buckiella undulata	western hemlock / flat-moss	CWHdm/01	Yes	Extensive. 2 polygons mapped as old forest, 27 mapped as mature.
Pseudotsuga menziesii - Pinus contorta / Holodiscus discolor / Cladina spp.	Douglas-fir - lodgepole pine / oceanspray / reindeer lichens	CWHdm/02	Yes	Extensive. 1 polygon mapped as old, 10 as mature.
Pseudotsuga menziesii - Tsuga heterophylla / Gaultheria shallon Dry Maritime	Douglas-fir - western hemlock / salal Dry Maritime	CWHdm/03	Yes	Extensive. 13 polygons mapped as old, 12 as mature.
Pseudotsuga menziesii / Polystichum munitum	Douglas-fir / sword fern	CWHdm/04	Yes	No mature or old mapped.
Thuja plicata / Polystichum munitum Dry Maritime	western redcedar / sword fern Dry Maritime	CWHdm/05	Yes	9 polygons mapped as mature.
Tsuga heterophylla - Thuja plicata / Blechnum spicant	western hemlock - western redcedar / deer fern	CWHdm/06	Yes	Extensive. 1 polygon mapped as old, 10 as mature.
Thuja plicata / Tiarella trifoliata Dry Maritime	western redcedar / three-leaved foamflower Dry Maritime	CWHdm/07	Yes	Extensive. 2 polygons mapped as old, 15 as mature.
Picea sitchensis / Rubus spectabilis Dry	Sitka spruce / salmonberry Dry	CWHdm/08;CWHds1/08	Yes	Extensive. 14 polygons mapped as mature.
Populus trichocarpa / Salix sitchensis	black cottonwood / Sitka willow	CWHdm/10	Yes	Two polygons mapped as mature, more as young.
Pinus contorta / Sphagnum spp.	lodgepole pine / peat-mosses	CWHdm/11;CWHds1/11	Yes	Yes
Thuja plicata - Picea sitchensis / Lysichiton americanus	western redcedar - Sitka spruce / skunk cabbage	CWHdm/12;CWHds1/12	Yes	One mapped as pole-sapling. Would not qualify as listed ecosystem.

Thuja plicata / Rubus spectabilis	western redcedar / salmonberry	CWHdm/13	No	Unknown
Thuja plicata / Lonicera involucrata	western redcedar / black twinberry	CWHdm/14	No	Unknown
Thuja plicata / Carex obnupta	western redcedar / slough sedge	CWHdm/15	No	Unknown
Tsuga heterophylla - Pseudotsuga menziesii / Rhytidiadelphus triquetrus Dry Submaritime 1	western hemlock - Douglas-fir / electrified cat's-tail moss Dry Submaritime 1	CWHds1/01	Yes	One polygon mapped as mature.
Pseudotsuga menziesii - Pinus contorta / Arctostaphylos uva-ursi Dry Submaritime	Douglas-fir - lodgepole pine / kinnikinnick Dry Submaritime	CWHds1/02	Yes	One polygon mapped as mature.
Pseudotsuga menziesii - Tsuga heterophylla / Paxistima myrsinites	Douglas-fir - western hemlock / falsebox	CWHds1/03	Yes	6 polygons mapped as old, 1 as mature.
Pseudotsuga menziesii / Acer glabrum / Prosartes hookeri	Douglas-fir / Douglas maple / Hooker's fairybells	CWHds1/04	No	Unknown
Thuja plicata - Pseudotsuga menziesii / Acer circinatum	western redcedar - Douglas-fir / vine maple	CWHds1/05	Yes	One polygon mapped as mature.
Tsuga heterophylla / Clintonia uniflora	western hemlock / queen's cup	CWHds1/06	Yes	One polygon mapped as old.
Thuja plicata / Oplopanax horridus	western redcedar / devil's club	CWHds1/07	Yes	5 polygons mapped as mature.
Populus trichocarpa / Salix spp. Dry Submaritime	black cottonwood / willows Dry Submaritime	CWHds1/10	No	Unknown

APPENDIX C

Potential Species at Risk in the Squamish-Lillooet Regional District

Name Category	Scientific Name	English Name	BC List	Prov Status	COSEWIC	Identified Wildlife	Habitat Subtype
Invertebrate Animal	*Argia emma*	Emma's Dancer	Blue	S3S4			Riparian Shrub;Stream/River;Lake;Pond/Open Water;Riparian Herbaceous
Invertebrate Animal	*Argia vivida*	Vivid Dancer	Red	S2			Stream/River;Hot Spring;Warm Spring;Cold Spring
Invertebrate Animal	*Callophrys eryphon sheltonensis*	Western Pine Elfin, *sheltonensis* subspecies	Blue	S3			Bog;Shrub - Natural;Krummholtz
Invertebrate Animal	*Danaus plexippus*	Monarch	Blue	S3B	SC (Apr 2010)		Pasture/Old Field;Cultivated Field;Hedgerow;Meadow;Grassland;Sagebrush Steppe;Urban/Suburban
Invertebrate Animal	*Erynnis propertius*	Propertius Duskywing	Red	S2			Meadow;Mixed Forest (deciduous/coniferous mix);Garry Oak Woodland
Invertebrate Animal	*Euphyes vestris*	Dun Skipper	Red	S2	T (Apr 2013)		Vernal Pools/Seasonal Seeps;Meadow
Invertebrate Animal	*Hesperia nevada*	Nevada Skipper	Blue	S3S4			Grassland;Sagebrush Steppe;Conifer Forest - Dry
Invertebrate Animal	*Limenitis archippus*	Viceroy	Red	SX			Marsh;Riparian Forest;Riparian Shrub;Pasture/Old Field;Cultivated Field;Meadow;Shrub - Natural;Deciduous/Broadleaf Forest;Urban/Suburban;Riparian Herbaceous;Gravel Bar
Invertebrate Animal	*Parnassius clodius claudianus*	Clodius Parnassian, *claudianus* subspecies	Blue	S3S4			
Invertebrate Animal	*Parnassius clodius pseudogallatinus*	Clodius Parnassian, *pseudogallatinus* supspecies	Blue	S3S4			
Invertebrate Animal	*Pholisora catullus*	Common Sootywing	Blue	S3			Pasture/Old Field;Cultivated Field;Hedgerow;Urban/Suburban
Invertebrate Animal	*Satyrium californica*	California Hairstreak	Blue	S3			Meadow;Grassland;Sagebrush Steppe;Antelope-brush Steppe
Nonvascular Plant	*Andreaea heinemannii*		Red	S1			
Nonvascular Plant	*Atrichum flavisetum*		Blue	S2S3			
Nonvascular Plant	*Atrichum tenellum*		Blue	S2S3			
Nonvascular Plant	*Brachydontium olympicum*		Red	S1S2			

Nonvascular Plant	*Brachythecium holzingeri*		Blue	S2S3			
Nonvascular Plant	*Brotherella roellii*	Roell's brotherella	Red	S1S2	E (Nov 2010)		
Nonvascular Plant	*Bryum calobryoides*		Red	S1S2			
Nonvascular Plant	*Bryum schleicheri*		Blue	S2S3			
Nonvascular Plant	*Callicladium haldanianum*		Blue	S3?			
Nonvascular Plant	*Campylium radicale*		Blue	S2S3			
Nonvascular Plant	*Claopodium pellucinerve*		Red	S1S2			
Nonvascular Plant	*Diphyscium foliosum*		Blue	S2S3			
Nonvascular Plant	*Encalypta spathulata*		Blue	S2S3			
Nonvascular Plant	*Funaria muhlenbergii*		Blue	S3?			
Nonvascular Plant	*Grimmia anomala*		Blue	S2S3			
Nonvascular Plant	*Grimmia incurva*		Red	S2			
Nonvascular Plant	*Hygrohypnum alpinum*		Blue	S3			
Nonvascular Plant	*Meesia longiseta*		Blue	S3			
Nonvascular Plant	*Mnium arizonicum*		Blue	S2S3			
Nonvascular Plant	*Orthotrichum pylaisii*		Blue	S3			
Nonvascular Plant	*Pohlia andalusica*		Red	S2			
Nonvascular Plant	*Pohlia cardotii*		Red	S2			
Nonvascular Plant	*Pohlia elongata*		Blue	S3			
Nonvascular Plant	*Pohlia tundrae*		Red	S2			

Nonvascular Plant	*Polytrichastrum sexangulare* var. *vulcanicum*		Red	S1S3			
Nonvascular Plant	*Racomitrium pygmaeum*		Blue	S3?			
Nonvascular Plant	*Schistidium boreale*		Blue	S2S3			
Nonvascular Plant	*Sphagnum contortum*		Blue	S3			
Nonvascular Plant	*Timmia norvegica*		Blue	S3			
Nonvascular Plant	*Tortula leucostoma*		Blue	S3			
Nonvascular Plant	*Tripterocladium leucocladulum*		Blue	S3			
Vascular Plant	*Allium geyeri* var. *tenerum*	Geyer's onion	Blue	S2S3			Vernal Pools/Seasonal Seeps;Rock/Sparsely Vegetated Rock;Riparian Herbaceous;Garry Oak Vernal Pool
Vascular Plant	*Bidens amplissima*	Vancouver Island beggarticks	Blue	S3	SC (Nov 2001)		Estuary;Marsh;Beach;Mudflats - Intertidal
Vascular Plant	*Boechera paupercula*	tiny suncress	Red	SH			
Vascular Plant	*Botrychium simplex* var. *compositum*	least moonwort	Blue	S2S3			
Vascular Plant	*Carex enanderi*	Enander's sedge	Blue	S2S3			Vernal Pools/Seasonal Seeps;Stream/River;Tundra;Glacier/Icefield;Krummholtz;Riparian Herbaceous;Alpine/Subalpine Meadow;Alpine Grassland;Heath;Fellfield;Nivation;Zoogenic
Vascular Plant	*Carex incurviformis* var. *incurviformis*	curved-spiked sedge	Blue	S2S3			Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Meadow
Vascular Plant	*Carex lenticularis*	lakeshore sedge	Blue	S3			Marsh;Lake;Riparian Herbaceous;Gravel Bar
Vascular Plant	*Carex sychnocephala*	many-headed sedge	Blue	S3			Bog;Fen;Swamp;Marsh;Meadow;Riparian Herbaceous
Vascular Plant	*Ceratophyllum echinatum*	spring hornwort	Blue	S3			Lake;Pond/Open Water
Vascular Plant	*Cicuta maculata* var. *maculata*	spotted cowbane	Red	S1			Marsh;Hot Spring
Vascular Plant	*Claytonia washingtoniana*	Washington springbeauty	Red	S2			Cliff;Talus;Conifer Forest - Dry;Mixed Forest (deciduous/coniferous mix)

Vascular Plant	*Draba glabella* var. *glabella*	smooth draba	Blue	S2S3			Stream/River;Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Meadow;Beach
Vascular Plant	*Dryopteris marginalis*	marginal wood fern	Red	S1			
Vascular Plant	*Epilobium glaberrimum* ssp. *fastigiatum*	smooth willowherb	Blue	S2S3			Stream/River;Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Glacier/Icefield;Avalanche Track;Krummholtz;Alpine/Subalpine Meadow;Alpine Grassland;Heath;Fellfield;Nivation;Zoogenic
Vascular Plant	*Gayophytum humile*	dwarf groundsmoke	Blue	S2S3			Vernal Pools/Seasonal Seeps;Meadow;Grassland;Conifer Forest - Dry
Vascular Plant	*Gentianella tenella* ssp. *tenella*	slender gentian	Red	S1S3			Tundra;Meadow;Alpine/Subalpine Meadow
Vascular Plant	*Juncus albescens*	whitish rush	Blue	S2S3			Fen;Pond/Open Water;Heath
Vascular Plant	*Lomatium triternatum* ssp. *platycarpum*	nine-leaved desert-parsley	Red	S2			Rock/Sparsely Vegetated Rock;Grassland;Sagebrush Steppe;Conifer Forest - Dry
Vascular Plant	*Mimulus breweri*	Brewer's monkey-flower	Blue	S2S3			Vernal Pools/Seasonal Seeps;Riparian Forest;Riparian Shrub;Rock/Sparsely Vegetated Rock;Conifer Forest - Moist/wet
Vascular Plant	*Myriophyllum ussuriense*	Ussurian water-milfoil	Blue	S3			Lake;Riparian Herbaceous
Vascular Plant	*Pinus albicaulis*	whitebark pine	Blue	S2S3	E (Apr 2010)		Cliff;Rock/Sparsely Vegetated Rock;Talus;Conifer Forest - Mesic (average);Conifer Forest - Dry
Vascular Plant	*Pleuropogon refractus*	nodding semaphoregrass	Blue	S3			Riparian Forest;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix)
Vascular Plant	*Polemonium elegans*	elegant Jacob's-ladder	Blue	S2S3			Cliff;Rock/Sparsely Vegetated Rock;Talus
Vascular Plant	*Polystichum kruckebergii*	Kruckeberg's holly fern	Blue	S2S3			Cliff;Rock/Sparsely Vegetated Rock;Talus
Vascular Plant	*Potentilla diversifolia* var. *perdissecta*	diverse-leaved cinquefoil	Blue	S2S3			Tundra
Vascular Plant	*Potentilla paradoxa*	bushy cinquefoil	Red	S1			Bog;Fen;Swamp;Marsh;Vernal Pools/Seasonal Seeps;Riparian Shrub;Meadow
Vascular Plant	*Ranunculus pedatifidus* ssp. *affinis*	birdfoot buttercup	Blue	S2S3			Rock/Sparsely Vegetated Rock;Tundra;Meadow;Deciduous/Broadleaf Forest

Vascular Plant	*Salix boothii*	Booth's willow	Blue	S2S3			Riparian Forest;Riparian Shrub;Meadow
Vascular Plant	*Schoenoplectus americanus*	Olney's bulrush	Red	S1			Estuary;Bog;Fen;Swamp;Marsh;Alkali Ponds/Salt Flats
Vascular Plant	*Stellaria obtusa*	blunt-sepaled starwort	Blue	S2S3			Riparian Forest;Riparian Shrub;Meadow;Alpine/Subalpine Meadow
Vertebrate Animal	*Accipiter gentilis laingi*	Northern Goshawk, *laingi* subspecies	Red	S2B	T (Apr 2013)	Y (May 2004)	Estuary;Riparian Forest;Pasture/Old Field;Cultivated Field;Hedgerow;Meadow;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Krummholtz
Vertebrate Animal	*Acipenser medirostris*	Green Sturgeon	Red	S1N	SC (Nov 2013)		Kelp Bed;Intertidal Marine;Subtidal Marine;Marine Island;Reefs;Eelgrass Beds;Sheltered Waters - Marine;Pelagic
Vertebrate Animal	*Acipenser transmontanus*	White Sturgeon	No Status	S2	E (Nov 2003)		Estuary;Kelp Bed;Stream/River;Lake;Intertidal Marine;Subtidal Marine;Marine Island;Pond/Open Water;Reefs;Eelgrass Beds;Sheltered Waters - Marine;Pelagic
Vertebrate Animal	*Acipenser transmontanus* pop. 6	White Sturgeon (Middle Fraser River population)	Red	S2	E (Nov 2003)		Stream/River
Vertebrate Animal	*Anaxyrus boreas*	Western Toad	Blue	S3S4	SC (Nov 2012)		Bog;Fen;Swamp;Marsh;Riparian Forest;Riparian Shrub;Stream/River;Lake;Meadow;Grassland;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Pond/Open Water;Riparian Herbaceous;Warm Spring;Gravel Bar
Vertebrate Animal	*Ardea herodias fannini*	Great Blue Heron, *fannini* subspecies	Blue	S2S3B,S4N	SC (Mar 2008)	Y (May 2004)	Estuary;Swamp;Marsh;Vernal Pools/Seasonal Seeps;Riparian Forest;Lake;Pasture/Old Field;Cultivated Field;Hedgerow;Intertidal Marine;Meadow;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Marine Island;Beach;Urban/Suburban;Pond/Open Water;Reefs;Eelgrass Beds;Riparian Herbaceous;Mudflats - Intertidal;Sheltered Waters - Marine

Vertebrate Animal	*Ardea herodias herodias*	Great Blue Heron, *herodias* subspecies	Blue	S3B,S4N		Y (Jun 2006)	Swamp;Marsh;Vernal Pools/Seasonal Seeps;Riparian Forest;Stream/River;Lake;Pasture/Old Field;Cultivated Field;Hedgerow;Meadow;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Urban/Suburban;Pond/Open Water;Riparian Herbaceous
Vertebrate Animal	*Ascaphus truei*	Coastal Tailed Frog	Blue	S3S4	SC (Nov 2011)	Y (May 2004)	Riparian Forest;Stream/River;Meadow;Alpine/Subalpine Meadow
Vertebrate Animal	*Brachyramphus marmoratus*	Marbled Murrelet	Blue	S3B,S3N	T (May 2012)	Y (May 2004)	Kelp Bed;Riparian Forest;Stream/River;Lake;Rock/Sparsely Vegetated Rock;Conifer Forest - Mesic (average);Conifer Forest - Moist/wet;Subtidal Marine;Sheltered Waters - Marine
Vertebrate Animal	*Butorides virescens*	Green Heron	Blue	S3S4B			Estuary;Swamp;Marsh;Riparian Forest;Riparian Shrub;Stream/River;Lake;Urban/Suburban;Pond/Open Water;Riparian Herbaceous
Vertebrate Animal	*Charina bottae*	Northern Rubber Boa	Yellow	S4	SC (May 2003)		Riparian Forest;Stream/River;Sub-soil;Rock/Sparsely Vegetated Rock;Talus;Meadow;Grassland;Sagebrush Steppe;Conifer Forest - Mesic (average);Conifer Forest - Dry;Mixed Forest (deciduous/coniferous mix);Antelope-brush Steppe
Vertebrate Animal	*Chordeiles minor*	Common Nighthawk	Yellow	S4B	T (Apr 2007)		Bog;Fen;Swamp;Marsh;Stream/River;Lake;Pasture/Old Field;Cultivated Field;Hedgerow;Cliff;Rock/Sparsely Vegetated Rock;Talus;Meadow;Grassland;Sagebrush Steppe;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Urban/Suburban;Pond/Open Water;Antelope-brush Steppe;Gravel Bar
Vertebrate Animal	*Coluber constrictor*	North American Racer	Blue	S3	SC (Nov 2004)	Y (Jun 2006)	Cliff;Rock/Sparsely Vegetated Rock;Talus;Meadow;Grassland;Sagebrush Steppe;Conifer Forest - Dry;Antelope-brush Steppe

Vertebrate Animal	*Contia tenuis*	Sharp-tailed Snake	Red	S1S2	E (Nov 2009)		Caves;Sub-soil;Rock/Sparsely Vegetated Rock;Talus;Meadow;Conifer Forest - Dry;Garry Oak Coastal Bluffs
Vertebrate Animal	*Contopus cooperi*	Olive-sided Flycatcher	Blue	S3S4B	T (Nov 2007)		Bog;Fen;Swamp;Riparian Forest;Conifer Forest - Mesic (average);Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Pond/Open Water
Vertebrate Animal	*Dendragapus fuliginosus*	Sooty Grouse	Blue	S3S4			Riparian Forest;Pasture/Old Field;Cultivated Field;Hedgerow;Meadow;Shrub - Natural;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Krummholtz;Shrub - Logged
Vertebrate Animal	*Euderma maculatum*	Spotted Bat	Blue	S3S4	SC (Nov 2014)	Y (May 2004)	Marsh;Riparian Shrub;Pasture/Old Field;Cliff;Rock/Sparsely Vegetated Rock;Talus;Sagebrush Steppe;Conifer Forest - Dry
Vertebrate Animal	*Euphagus carolinus*	Rusty Blackbird	Blue	S3S4B	SC (Apr 2006)		Bog;Fen;Swamp;Marsh;Lake;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Urban/Suburban;Pond/Open Water;Industrial
Vertebrate Animal	*Falco mexicanus*	Prairie Falcon	Red	S1S2B	NAR (May 1996)	Y (Jun 2006)	Pasture/Old Field;Cultivated Field;Hedgerow;Cliff;Tundra;Meadow;Grassland;Sagebrush Steppe;Antelope-brush Steppe
Vertebrate Animal	*Falco peregrinus*	Peregrine Falcon	No Status	S3B	SC (Apr 2007)		
Vertebrate Animal	*Falco peregrinus anatum*	Peregrine Falcon, *anatum* subspecies	Red	S2?B	SC (Apr 2007)		Bog;Fen;Swamp;Marsh;Alkali Ponds/Salt Flats;Stream/River;Lake;Pasture/Old Field;Cultivated Field;Hedgerow;Cliff;Rock/Sparsely Vegetated Rock;Talus;Meadow;Grassland;Shrub - Natural;Sagebrush Steppe;Beach;Urban/Suburban;Pond/Open Water;Riparian Herbaceous;Antelope-brush Steppe;Gravel Bar
Vertebrate Animal	*Falco peregrinus pealei*	Peregrine Falcon, *pealei* subspecies	Blue	S3B	SC (Apr 2007)		Estuary;Marsh;Stream/River;Lake;Pasture/Old Field;Cultivated Field;Hedgerow;Cliff;Rock/Sparsely Vegetated Rock;Intertidal Marine;Meadow;Marine Island;Beach;Urban/Suburban;Pond/Open Water;Riparian Herbaceous;Gravel Bar;Mudflats - Intertidal;Sheltered Waters - Marine
Vertebrate Animal	*Gulo gulo*	Wolverine	No Status	S3	SC (May 2014)		

Vertebrate Animal	*Gulo gulo luscus*	Wolverine, *luscus* subspecies	Blue	S3	SC (May 2014)	Y (May 2004)	Bog;Fen;Swamp;Marsh;Riparian Forest;Stream/River;Cliff;Rock/Sparsely Vegetated Rock;Talus;Avalanche Track;Meadow;Grassland;Shrub - Natural;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Krummholtz;Alpine/Subalpine Meadow;Alpine Grassland
Vertebrate Animal	*Hirundo rustica*	Barn Swallow	Blue	S3S4B	T (May 2011)		Estuary;Bog;Fen;Swamp;Marsh;Riparian Forest;Riparian Shrub;Stream/River;Lake;Pasture/Old Field;Cultivated Field;Hedgerow;Meadow;Grassland;Shrub - Natural;Sagebrush Steppe;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Urban/Suburban;Pond/Open Water;Riparian Herbaceous;Antelope-brush Steppe;Gravel Bar;Shrub - Logged;Industrial
Vertebrate Animal	*Megascops kennicottii*	Western Screech-Owl	No Status	S4	T (May 2012)		
Vertebrate Animal	*Megascops kennicottii kennicottii*	Western Screech-Owl, *kennicottii* subspecies	Blue	S3	T (May 2012)		Riparian Forest;Pasture/Old Field;Hedgerow;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Urban/Suburban
Vertebrate Animal	*Megascops kennicottii macfarlanei*	Western Screech-Owl, *macfarlanei* subspecies	Red	S2	T (May 2012)	Y (May 2004)	Riparian Forest;Pasture/Old Field;Cultivated Field;Hedgerow;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Urban/Suburban
Vertebrate Animal	*Melanerpes lewis*	Lewis's Woodpecker	Red	S2B	T (Apr 2010)	Y (May 2004)	Riparian Forest;Pasture/Old Field;Cultivated Field;Hedgerow;Meadow;Grassland;Sagebrush Steppe;Deciduous/Broadleaf Forest;Conifer Forest - Dry;Urban/Suburban;Antelope-brush Steppe

Vertebrate Animal	*Myotis keenii*	Keen's Myotis	Blue	S2S3	DD (Nov 2003)	Y (May 2004)	Riparian Forest;Caves;Cliff;Rock/Sparsely Vegetated Rock;Talus;Conifer Forest - Mesic (average);Conifer Forest - Moist/wet;Hot Spring;Urban/Suburban;Industrial
Vertebrate Animal	*Myotis lucifugus*	Little Brown Myotis	Yellow	S4	E (Nov 2013)		
Vertebrate Animal	*Numenius americanus*	Long-billed Curlew	Blue	S3B	SC (May 2011)	Y (May 2004)	Pasture/Old Field;Cultivated Field;Intertidal Marine;Meadow;Grassland;Mudflats - Intertidal
Vertebrate Animal	*Oncorhynchus clarkii clarkii*	Cutthroat Trout, *clarkii* subspecies	Blue	S3S4			
Vertebrate Animal	*Oncorhynchus kisutch*	Coho Salmon	Yellow	S4	E (May 2002)		
Vertebrate Animal	*Ovis canadensis*	Bighorn Sheep	Blue	S3		Y (Jun 2006)	Cliff;Rock/Sparsely Vegetated Rock;Talus;Tundra;Avalanche Track;Meadow;Grassland;Shrub - Natural;Sagebrush Steppe;Conifer Forest - Mesic (average);Conifer Forest - Dry;Krummholtz;Antelope-brush Steppe;Alpine/Subalpine Meadow;Alpine Grassland
Vertebrate Animal	*Patagioenas fasciata*	Band-tailed Pigeon	Blue	S3S4B	SC (Nov 2008)		Riparian Forest;Pasture/Old Field;Cultivated Field;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Hot Spring;Urban/Suburban;Warm Spring;Cold Spring
Vertebrate Animal	*Pekania pennanti*	Fisher	Blue	S2S3		Y (Jun 2006)	Bog;Fen;Swamp;Marsh;Riparian Forest;Riparian Shrub;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Krummholtz;Riparian Herbaceous;Gravel Bar
Vertebrate Animal	*Perognathus parvus*	Great Basin Pocket Mouse	Red	S2			Sub-soil;Grassland;Sagebrush Steppe;Antelope-brush Steppe
Vertebrate Animal	*Pituophis catenifer*	Gopher Snake	No Status	S2S3			
Vertebrate Animal	*Pituophis catenifer deserticola*	Gopher Snake, *deserticola* subspecies	Blue	S2S3	T (Apr 2013)	Y (May 2004)	Riparian Forest;Riparian Shrub;Sub-soil;Rock/Sparsely Vegetated Rock;Talus;Meadow;Grassland;Sagebrush Steppe;Urban/Suburban;Riparian Herbaceous;Antelope-brush Steppe;Gravel Bar;Industrial

Vertebrate Animal	*Psiloscops flammeolus*	Flammulated Owl	Blue	S3S4B	SC (Apr 2010)	Y (May 2004)	Conifer Forest - Mesic (average);Conifer Forest - Dry
Vertebrate Animal	*Rana aurora*	Northern Red-legged Frog	Blue	S3S4	SC (Nov 2004)	Y (May 2004)	Bog;Fen;Swamp;Marsh;Riparian Forest;Riparian Shrub;Stream/River;Lake;Meadow;Deciduous/Broadleaf Forest;Pond/Open Water;Riparian Herbaceous;Gravel Bar
Vertebrate Animal	*Salvelinus confluentus*	Bull Trout	Blue	S3S4	SC (Nov 2012)	Y (Jun 2006)	
Vertebrate Animal	*Salvelinus confluentus - coastal lineage*	Bull Trout - Coastal Lineage	Blue	S3	SC (Nov 2012)		
Vertebrate Animal	*Sorex bendirii*	Pacific Water Shrew	Red	S1S2	E (Apr 2006)	Y (May 2004)	Estuary;Bog;Fen;Swamp;Marsh;Riparian Forest;Riparian Shrub;Stream/River;Conifer Forest - Moist/wet;Riparian Herbaceous;Gravel Bar
Vertebrate Animal	*Strix occidentalis*	Spotted Owl	Red	S1	E (Mar 2008)	Y (May 2004)	Riparian Forest;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet
Vertebrate Animal	*Taxidea taxus*	American Badger	Red	S1	E (Nov 2012)	Y (May 2004)	Sub-soil;Pasture/Old Field;Talus;Meadow;Grassland;Shrub - Natural;Sagebrush Steppe;Conifer Forest - Mesic (average);Conifer Forest - Dry;Krummholtz;Antelope-brush Steppe;Shrub - Logged;Alpine Grassland
Vertebrate Animal	*Tympanuchus phasianellus columbianus*	Sharp-tailed Grouse, *columbianus* subspecies	Blue	S2S3		Y (Jun 2006)	Riparian Forest;Pasture/Old Field;Cultivated Field;Hedgerow;Meadow;Grassland;Sagebrush Steppe;Deciduous/Broadleaf Forest;Conifer Forest - Dry
Vertebrate Animal	*Ursus arctos*	Grizzly Bear	Blue	S3	SC (May 2002)	Y (May 2004)	Estuary;Bog;Fen;Swamp;Marsh;Riparian Forest;Riparian Shrub;Stream/River;Caves;Pasture/Old Field;Talus;Tundra;Avalanche Track;Meadow;Grassland;Sagebrush Steppe;Deciduous/Broadleaf Forest;Conifer Forest - Mesic (average);Conifer Forest - Dry;Conifer Forest - Moist/wet;Mixed Forest (deciduous/coniferous mix);Beach;Urban/Suburban;Riparian Herbaceous;Gravel Bar