



**Terrestrial Ecosystem Mapping (TEM) for
Howe Sound Islands – Bowen, Gambier, Keats,
Anvil and Other Associated Islands**

for:

**Kate Emmings
Ecosystem Protection Specialist
Islands Trust Fund
Suite 200 – 1627 Fort Street
Victoria, BC, V8R 1H8**

by:

**MADRONE ENVIRONMENTAL SERVICES LTD.
1081 Canada Avenue, Duncan, BC, V9L 1V2**

October 2, 2009

Dossier 09.0096

EXECUTIVE SUMMARY

This report presents the results of Terrestrial Ecosystem Mapping (TEM) of the Howe Sound Islands, which are situated in the Coastal Western Hemlock (CWH) biogeoclimatic zone of southwestern British Columbia. The study area covers 13,968 hectares across four main Islands (Bowen, Gambier, Anvil, and Keats) located at the entrance to the Squamish River, between Greater Vancouver and the Sunshine Coast Regional Districts.

Terrain and ecosystem mapping, field sampling and air photo interpretations were completed at a scale of 1:10,000 using the appropriate provincial standards and methods (RISC 1996, 1998a, 2000, 2002, and 2004). The original polygon estimation for the study area was 1,200 based on 1:16,000 mapping scale and a study area of 12,000 hectares. Our final product mapped a total of 2,017 forested, non-forested and anthropogenic polygons for the Howe Sound study area, covering 13,968 hectares.

Elevation boundaries for the study area range from sea level to approximately 900 m on Gambier Island (Mount Liddell), starting with the CWHxm1 at lower elevations, the CWHdm in the upper elevations, and only the highest peaks of the islands in the CWHvm2. These biogeoclimatic subzones or variants are very common in southwestern BC, covering much of Vancouver Island and the mainland coast. The temperature and climate in the CWHxm1, dm, and vm2 are generally warm and dry in the summer months with moist, mild winters (Green and Klinka, 1994).

Soil and terrain types present in Howe Sound today are influenced by historical glaciation events and contemporary erosion and deposition. The soils are mainly derived from morainal and colluvial deposits, and to a lesser extent, glaciofluvial and glaciomarine sources. The position of the islands combined with the range of elevations and terrain sources, lead to a variety of vegetation and ecosystem types.

The typical site conditions, such as soil, terrain and climate, combined with the interaction of vegetation, animals and insects, make up the ecosystems in the CWHxm1, dm, and vm2. Site modifiers were applied to the TEM mapcodes to further describe atypical situations, such as shallows soils and steep slopes.

In addition to site modifiers, numerical structural stage codes, ranging from one to seven were added to the TEM mapcode to explain vegetation structure. As per the Provincial TEM Standards, two-letter TEM mapcodes are used for mapping upland sites, and four-letter WREC codes are used for wetland ecosystems.

Mapping of Howe Sound was completed at a finer level of detail compared to the CDF TEM mapping (1:16,000) due to the use of 3D image viewing PurVIEW software. The 3D software enabled the mappers to zoom in to a finer scale to interpret bioterrain and ecosystem types from the orthophoto images with a higher level of confidence. This mapping approach resulted in a smaller overall polygon size than mapped in the CDF (7 ha in Howe Sound vs. 12.5 ha for CDF).

One of the goals achieved for this project was to obtain a high level of field sampling, equivalent to an overall Level 4 survey intensity (15% – 24%) as per the Provincial TEM Standards (RISC, 2001). To achieve this goal, a stratified sampling strategy was designed to collect field data from as many types of ecosystems as possible throughout the study area. An extensive private landowner contact program was completed, as private (non-Crown) land was the focus of field verification. Field inspections were distributed across the study area on a wide range of ecosystems and site conditions throughout Howe Sound.

Field sampling resulted in 324 total plots, as well as 44 background plots from previous Sensitive Ecosystem Inventory (SEI), resulting in 368 plots covering 2,017 polygons (17% of the polygons were sampled); thus achieving an overall survey intensity of Level 4. As planned, the majority of plots were conducted on non-Crown lands, and Level 3 (25% – 50%) and four survey intensities were achieved on pure private polygons and Crown/private overlapping polygons, respectively. The data collected in the field provided ecosystem information to complete a final ecosystem map. If we had completed 368 plots based on our original estimate of 1,200 polygons, for which our budget was based, we would have achieved 31% overall sampling (Level 3) for the entire study area.

In combination with the previously completed CDFmm TEM study and the Gulf Islands National Park ecosystem mapping, Islands Trust now has complete TEM coverage for all of their planning areas. The ecosystem mapping will provide baseline information that can be used in support of future land-use planning initiatives. An expanded legend and map legend accompany this document for interpreting the mapping deliverables.

ACKNOWLEDGEMENTS

This project was the result of the co-operation, organization, and dedication of many people, including the private landowners who provided access to their lands and invaluable information about the islands of Howe Sound. Funding and support for this project was provided by Islands Trust, under the direction of Kate Emmings (Ecosystem Protection Specialist).

Project management was led by Tania Tripp, assisted by Jackie Churchill. Bioterrain mapping was done by Wanda Miller and Sonia Meili, with internal quality assurance (QA) provided by Gordon Butt. Ecosystem mapping was done by Tyler Innes, Tania Tripp, and Jackie Churchill. Field crews included the bioterrain and ecosystem mappers mentioned above, as well as Kathy Dunster, Sid Tsang, and Corey Erwin (MoE). Report writing was a combined effort by Tania Tripp, Tyler Innes, Wanda Miller, Jackie Churchill, Sonia Meili, and Kyle Rezansoff.

External QA and feedback by Kathy Dunster. Additional MoE support by and Corey Erwin and Jo-Anne Stacey.

This mapping project was completed using 3D photo viewing software (PurVIEW). No hard copy air photos were mapped, as all mapping took place directly on screen. The orthophotos and PurVIEW photo models were produced by Integrated Mapping Technologies (IMT – Ian Grady) in Vancouver.

VENUS data entry was completed by Jackie Churchill and Kyle Rezansoff. GIS applications and final map products were completed by Anna Jeffries and Peter Berst.

List of Acronyms

Acronym	Description
ArcGIS	ESRI's Geographic Information System version 9.3
asl	Above Sea Level
B.C.	British Columbia
BEC	Biogeoclimatic Ecosystem Classification
CDC	Conservation Data Centre, a unit within the B.C. Ministry of Environment
CDF	Coastal Douglas-Fir biogeoclimatic zone
CDFmm	Coastal Douglas-Fir biogeoclimatic zone, moist maritime subzone
CWH	Coastal Western Hemlock biogeoclimatic zone
CWHdm	Coastal Western Hemlock biogeoclimatic zone, dry maritime subzone
CWHvm2	Coastal Western Hemlock biogeoclimatic zone, Montane very wet maritime variant
CWHxm1	Coastal Western Hemlock biogeoclimatic zone, very dry maritime variant
DC Tools	Data Capture application tool
GEL	Georgia Lowland
GIF	Ground Inspection Form
GINPR	Gulf Islands National Park Reserve
GIS	Geographic Information System
GPS	Global Positioning System
ILMB	Integrated Land Management Bureau
MAL	Ministry of Agriculture and Lands
m	metres
MoE	Ministry of Environment
PurVIEW	ArcGIS Desktop extension, 3D photo stereo-viewing software
QA	Quality Assurance
RISC	Resource Information Standards Committee
SEI	Sensitive Ecosystem Inventory
TEM	Terrestrial Ecosystem Mapping
TRIM	Terrain Resource Information Management
VENUS	Vegetation and Environmental data NexUS

TABLE OF CONTENTS

EXECUTIVE SUMMARY	I
ACKNOWLEDGEMENTS	III
1.0 INTRODUCTION	1
1.1 Objectives	1
1.2 Deliverables.....	2
1.3 Howe Sound Study Area.....	2
2.0 BIOPHYSICAL SETTING.....	5
2.1 Ecoregion Classification.....	5
2.2 Biogeoclimatic Ecosystem Classification	5
2.3 Howe Sound Vegetation Overview	6
2.3.1 Rare Ecosystems and Plant Species	7
2.4 Geologic Setting	7
2.4.1 Bedrock Geology.....	7
2.4.2 Glacial History	8
2.4.3 Study Area Surficial Geology	9
2.5 Soil Landscapes.....	10
3.0 METHODOLOGY	11
3.1 Background Research and Data Sources	11
3.2 Initial Ecosystem Mapping (Pretyping).....	13
3.2.1 Bioterrain Linework and Labeling	13
3.2.2 Ecosystem Linework and Labeling.....	13
3.2.3 QA of Pretyping	14
3.2.4 Development of a Working Legend.....	15
3.3 Field Sampling and Ground Truthing.....	15
3.3.1 Sampling Intensity	17
3.3.2 Landowner Contact.....	17
3.4 Final Typing and Ecosystem Labeling.....	18
3.5 Database Production	18
3.6 Final GIS Product	19



4.0 RESULTS	19
4.1 Ecosystem Overview	21
4.2 Ecosystem Representation and Condition in the Study Area	24
4.2.1 CWHxm1 Ecosystem Units	24
4.2.1.1 Forested Ecosystems of the CWHxm1	25
4.2.1.2 Non-Forested Ecosystems of the CWHxm1	26
4.2.1.3 Anthropogenic Units of the CWHxm1	27
4.2.2 CWHdm Ecosystem Units	28
4.2.2.1 Forested Ecosystems of the CWHdm	28
4.2.2.2 Non-Forested Ecosystems of the CWHdm	30
4.2.2.3 Anthropogenic Units of the CWHdm	30
4.2.3 CWHvm2 Ecosystem Units	31
4.2.3.1 Forested Ecosystems of the CWHvm2	31
4.2.3.2 Non-Forested Ecosystems and Anthropogenic Units of the CWHvm	32
4.2.4 Structural Stage	33
4.2.5 Disturbance	36
4.2.5.1 Invasive species	37
4.2.6 Rare Elements	37
4.3 Study Area Sub-group Descriptions	40
4.3.1 Bowen Island	40
4.3.1.1 Bioterrain and Soils	40
4.3.1.2 Vegetation and Ecosystems	44
4.3.2 Gambier Island	45
4.3.2.1 Bioterrain and Soils	45
4.3.2.2 Vegetation and Ecosystems	48
4.3.3 Anvil Island	49
4.3.3.1 Bioterrain and Soils	49
4.3.3.2 Vegetation and Ecosystems	51
4.3.4 Keats Island	52
4.3.4.1 Bioterrain and Soils	52
4.3.4.2 Vegetation and Ecosystems	53
4.3.5 Smaller Islands and Islets	54
4.3.5.1 Bioterrain and Soils	54
4.3.5.2 Vegetation and Ecosystems	55
4.4 Project Limitations	55
5.0 CONCLUSION	55
6.0 REFERENCES CITED	57

APPENDIX I.	
RED- AND BLUE-LISTED ECOSYSTEMS IN HOWE SOUND.....	62
APPENDIX II.	
RED- AND BLUE-LISTED PLANT SPECIES IN HOWE SOUND.....	65
APPENDIX III.	
PRIVATE LANDOWNER CONTACT EFFORTS	68
APPENDIX IV.	
TEM MAP LEGEND.....	73
APPENDIX V.	
TERRAIN LEGEND.....	78
APPENDIX VI.	
EXPANDED TEM LEGEND.....	80
APPENDIX VII.	
VASCULAR AND NON-VASCULAR PLANT SPECIES OBSERVED DURING FIELD ASSESSMENTS IN THE STUDY AREA.....	163

List of Tables

Table 1. Islands Located in the Howe Sound TEM Study Area.....	3
Table 2. Field Verification Sampling Goals for Howe Sound TEM.....	17
Table 3. Plot Sampling Summary for Howe Sound.....	20
Table 4. Plot Sampling Summary by Polygon Type.	20
Table 5. Total Polygons Mapped and Minimum/Maximum Sampling Requirements..	21
Table 6. Forested Ecosystems Mapped in the CWHxm1 subzone for Howe Sound Project Area.....	25
Table 6. Forested Ecosystems Mapped in the CWHxm1 subzone for Howe Sound Project Area (continued).	26
Table 7. Non-Forested Ecosystems Mapped in the CWHxm1 subzone for Howe Sound Project Area.....	27
Table 8. Anthropogenic Units Mapped in the CWHxm1 subzone for Howe Sound Project Area.....	27
Table 9. Forested Ecosystems Mapped in the CWHdm subzone for Howe Sound Project Area.....	29
Table 10. Non-Forested Ecosystems Mapped in the CWHdm subzone for Howe Sound Project Area.....	30
Table 11. Anthropogenic Units Mapped in the CWHdm subzone for Howe Sound Project Area.....	30
Table 12. Forested Ecosystems Mapped in the CWHvm2 subzone for Howe Sound Project Area.....	32
Table 13. Non-Forested Ecosystems and Anthropogenic Units Mapped in the CWHvm2 subzone for Howe Sound Project Area.....	33
Table 14. Rare Ecosystem Units Mapped in the Howe Sound Project Area.....	38
Table 15. Conservation Status of Vascular Plants Listed in the CWH zone within the Greater Vancouver and Sunshine Coast Regional Districts.	39

List of Figures

Figure 1. Location of Howe Sound terrestrial ecosystem mapping study area and distribution of the Coastal Western Hemlock biogeoclimatic subzones.	4
Figure 2. Polygon field verification coverage for Howe Sound TEM.	22
Figure 3. Distribution of ecosystem categories in the CWHxm1 by area and percentage.	25
Figure 4. Distribution of forested ecosystem units in the CWHxm1 by area.	26
Figure 5. Distribution of ecosystem categories in the CWHdm by area and percentage.	28
Figure 6. Distribution of forested ecosystem units in the CWHdm by area.	29
Figure 7. Distribution of ecosystem categories in the CWHdm by area and percentage.	31
Figure 8. Distribution of forested ecosystem units in the CWHvm2 by area.	32
Figure 10. Distribution of structural stages in the CWHxm1 by area and percentage.	35
Figure 11. Distribution of structural stages in the CWHdm by area and percentage.	35
Figure 12. Distribution of structural stages in the CWHvm2 by area and percentage.	36

TERRESTRIAL ECOSYSTEM MAPPING OF HOWE SOUND ISLANDS



1.0 INTRODUCTION

This project was initiated by Islands Trust as a means to characterize the ecosystems of the Coastal Western Hemlock (CWH) biogeoclimatic zone for the islands of Howe Sound. Islands Trust requires an accurate terrestrial ecosystem mapping (TEM) product that is consistent with TEM completed for the Coastal Douglas-fir (CDF) zone (Madrone 2008a; 2008b), thus providing a seamless TEM coverage of the Islands Trust Area. The Howe Sound TEM will be used in support of a wide range of land-use planning initiatives, including regional conservation planning and sensitive ecosystem map production.

1.1 Objectives

The purpose of this project was to complete ecosystem mapping for the Howe Sound study area. The mapping was to be completed at a scale of 1:16,000 or finer using Resource Information Standards Committee (RISC) standards at an overall survey intensity level of four, following the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RISC, 1998a). In addition to the standard attributes collected for TEM, further parameters were specified for completion including separating smaller pure polygons containing sensitive ecosystems whenever possible. Conservation evaluation forms were also completed during collection of ground inspections and full plots, in order to be consistent with CDF TEM final products (Madrone 2008a; 2008b).

1.2 Deliverables

To achieve the project objectives, Madrone Environmental Services Ltd. (Madrone) used a standardized set of protocols for bioterrain and ecosystem mapping, supported by field data collection and geographic information systems (GIS) mapping and interpretation, to complete the TEM product to provincial standards (RISC, 1998a). Final deliverables include:

- digital mapping, with final ecosystem and terrain polygons delineated;
- a seamless digital map of ecosystems and plot locations in ARC/INFO Geographical Information System (GIS) format;
- a complete ecosystem and terrain attribute database for all mapped polygons linked to the ARC/INFO polygons;
- a complete, error-free VENUS database containing all field data;
- a report describing methods and results;
- a final expanded legend describing each mapped ecosystem, vegetation data collected in the field, applied site modifiers, plot identification; and
- a TEM map legend.

1.3 Howe Sound Study Area

Howe Sound occurs in southwestern B.C., made up of several island groups between Greater Vancouver and Sunshine Coast Regional Districts, south of the Squamish River valley. The main islands include Anvil, Gambier, Bowen and Keats and also include several smaller islands and islets, mainly between Thornbrough and Queen Charlotte Channels, north of the Strait of Georgia (Table 1 and Figure 1). A large portion of the Howe Sound landbase is privately owned. This contributes to the complexity of developing an overall strategy for managing the landbase for each of the islands.

Table 1. Islands Located in the Howe Sound TEM Study Area.

Major Islands	Main Communities	
Bowen Island	Snug Cove, Channel View Road, Cowan Point, Tunstal Bay, Grafton Road, Windjammer Road, Mt Gardner Road, Hood Point West, Scarborough (Eagles Cliff Road), Millers Landing, and Deep Bay	
Gambier Island	New Brighton, Douglas Bay, Brigade Bay, West Bay, Gambier Harbour	
Anvil Island	Irby Point, Daybreak Point, southeastern area	
Keats Island	East Bourne, Barnabas Camp, Keats Landing	
Smaller Islands and Islets		
Alexandra	Home	Ragged
Bird Islet	Hutt	Shelter Islets
Bowyer	Little Popham	Small
Christie Islet	Mickey	Tolmie
Defence	New Islet (Silver)	White
Finisterre	Paisley	Woolridge
Grace	Passage	Worlcombe
Grebe Islets	Popham	
Hermit	Preston	





Figure 1. Location of Howe Sound terrestrial ecosystem mapping study area and distribution of the Coastal Western Hemlock biogeoclimatic subzones.

2.0 BIOPHYSICAL SETTING

The BC Ecoregion Classification and the Biogeoclimatic Ecosystem Classification (BEC) systems offer a framework for describing the variation of vegetation, climate and topography in the study area. Ecoregions and biogeoclimatic zones represent the broad scale regional and climatic landscape units.

2.1 Ecoregion Classification

Howe Sound is situated within the Lower Mainland Ecoregion, which is divided into Ecoprovinces. Howe Sound is classified as occurring within the Georgia Depression Ecoprovince, which lies at the southern basin of the Coast Mountains. The southern parts of this Ecoprovince have the greatest annual amounts of sunshine in British Columbia. Temperatures throughout the area are modified by the ocean and the Strait of Georgia (Demarchi, 1996). Aspect has a pronounced effect on growing season duration and moisture availability in this Ecoprovince. Perhaps the most important factor affecting terrestrial ecology in this area is the summer moisture deficit, which arises from the relatively dry summers and moist, mild winters. Continuing down in the hierarchy, within this Ecoprovince, Howe Sound is contained in the Georgia Lowland (GEL) Ecosection (Demarchi, 1996). The Georgia Lowland consists of areas of low relief at the base of the Coast Ranges. The Georgia Lowland Ecosection is also classified into a series of biogeoclimatic zones.

2.2 Biogeoclimatic Ecosystem Classification

The Biogeoclimatic Ecosystem Classification (BEC) system is a framework that groups similar sets of landscapes into a site classification. Sites are classified on their potential to produce similar vegetation communities within similar environmental site conditions. Site series are representative ecosystems in each biogeoclimatic subzone in the Province. Site series are specific to a subzone and primarily correspond to forested ecosystems that repeat across each biogeoclimatic subzone. The typical site conditions, such as soil, terrain and climate combined with the interaction of vegetation, animals and insects make up the ecosystems / site series (Green and Klinka, 1994). Additional non-forested ecosystems, such as wetlands, are also based on the BEC system (Mackenzie and Moran, 2004).

The Howe Sound study area is situated within the Coastal Western Hemlock (CWH) biogeoclimatic zone, which is subdivided into subzones and variants.

Howe Sound occupies three subzones or variants, including the Very Dry Maritime subzone variant (CWHxm1); the Montane Very Wet Maritime subzone variant (CWHvm2); and the Dry Maritime subzone (CWHdm).

The CWHxm1 (very dry maritime) subzone variant is located adjacent to the Coastal Douglas Fir (CDF) biogeoclimatic zone. For information on the adjacent CDF ecosystems, please refer to Madrone (2008a; 2008b) and TEM of the Southern Gulf Islands (Green, 2007).

Elevation boundaries for the study area range from sea level to approximately 900 m on Gambier Island (Mount Liddell). The CWHxm1 occurs at lower elevations (typically reaching up to 150 m asl), followed by the CWHdm in the upper elevations (150 m to 650 m). On the northernmost portions of Gambier and Anvil Islands, the CWHdm subzone extends to sea-level replacing the CWHxm1 variant on steep north-facing slopes. Only Gambier and Bowen Islands reach elevations greater than 650 m, and contain the third biogeoclimatic subzone/variant, CWHvm2 (Figure 1).

These three biogeoclimatic subzones or variants are very common in southwestern BC, covering much of Vancouver Island and the mainland coast. The temperature and climate in the CWHxm1, dm, and vm2 are generally warm and dry in the summer months with moist, mild winters (Green and Klinka, 1994). The position of the islands combined with the range of elevations and terrain sources, lead to a variety of vegetation and ecosystem types.

2.3 Howe Sound Vegetation Overview

The ecosystems mapped in Howe Sound include forested site series, non-forested plant communities, wetlands, and sparsely-vegetated units. Douglas-fir and western hemlock forests originally blanketed most of the area, with the exceptions of scattered bedrock outcrops, wetlands, meadows and a small number of non-forested sites. Other tree species found in the Howe Sound study area include western redcedar, grand fir, bigleaf maple, red alder and arbutus. Hundreds of plant species occur in the study area, including a variety of shrubs, herbs, mosses and lichens. A detailed description of the ecosystems mapped in Howe Sound is provided in the Results Section 4.0 and in the Expanded Legend (Appendix VII).

2.3.1 Rare Ecosystems and Plant Species

Natural and anthropogenic disturbances have changed the vegetation structure and stand age of many ecosystems and sites in the study area. As a result of anthropogenic disturbances such as forest harvesting, land clearing and development, many ecosystems throughout Howe Sound are currently listed as critically imperiled in a global context by the B.C. Conservation Data Centre (CDC).

Currently, 33 plant communities are provincially red or blue-listed in the Howe Sound (B.C. C.D.C., 2009) (Appendix I). Most forested site series and wetlands are on these lists, including 16 red-listed forested communities, herbaceous meadows, woodlands, and wetlands and 17 blue-listed herbaceous and forested wetlands. Typically, conservation efforts for red- and blue-listed forested ecosystems focus on mature and old coniferous forests (structural stages 6 and 7; and fine examples of structural stage 5).

A similar search of the database for red- and blue-listed vascular plant species occurring in Howe Sound yielded 39 records (Appendix II). There were 29 blue-listed taxonomic units and 10 red-listed units. Of the total, 10 were provincially listed S1 or S2, with the vast majority having secure or apparently secure populations in terms of their global occurrence.

2.4 Geologic Setting

The islands in the study area are located at the southern end of the Georgia Strait and the opening of Howe Sound (a narrow fjord running northeast-southwest). Howe Sound is located within the Georgia Lowland, which occupies a small portion of a broad physiographic unit known as the Georgia Depression (Holland, 1976). It is a diverse landscape shaped by complex of exotic terranes with diverse bedrock structure, neo-tectonic activity, major glacial events and post-glacial deposits (Gabrielse *et al.*, 1991).

2.4.1 Bedrock Geology

The islands consist of several different types of bedrock belonging to exotic terranes that were agglomerated to the west coast over many time periods. Bedrock outcrops mapped by the B.C. Geological Survey and in part, observed in the field inspections include:

- Lower Cretaceous marine sedimentary and volcanic rocks of the Gambier Group, occurring on Anvil Island, Bowyer Island, and the northern half of Gambier Island.
- Late Jurassic granodioritic intrusive rocks occurring in patchy units on the southern half of Gambier Island and northern half of Bowen Island, Woolridge Island, the southern point of Keats Island, scattered smaller island in the vicinity of the Paisley Group.
- Lower Jurassic to Middle Jurassic argillite, greywacke, wacke, and conglomerate turbidites of the Bowen Island Group. Rocks of the Bowen Island Group are the dominant group on Bowen Island, but also have a patch occurrence on the southwest side of Gambier Island, in the Paisley Group and in the central portion of Keats Island.
- Late Jurassic quartz dioritic intrusive rocks occurring on the north end of Keats Island and in a band across the southern end of Bowen Island.
- Late Jurassic dioritic intrusive rocks occurring in the northern half of the Paisley Group.

According to the BC Minerals Title Online website (2009) states that there are several current and historical mineral titles mainly located on the northeast side of Gambier Island, near the summit of Anvil Island, and on the west side of Bowen Island.

2.4.2 Glacial History

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

The most recent Fraser Glaciation initiated approximately 15,000 years before present, and lasted until the climate began to warm and the ice sheets slowly melted and retreated. The retreat of Fraser Glaciation ice was essentially complete by about 10,000 years, which coincides with the beginning of the Holocene Epoch.

Sea levels fluctuated above and below present levels during the Quaternary Period due to subsidence of the land surface related to the weight of overlying ice, isostatic uplift associated with the removal of the ice, global sea level changes, and tectonism. Within the study area, this uplift has resulted in glaciomarine and in some cases marine deposits at elevations up to around 200 m above sea level (asl).

Much of the deposits were laid down during a period of high sea level between 19,000 and 13,000 years ago (Bichler *et al.*, 2002) and during retreat of the ice sheets. These glacial-related sediments originated largely from marine, deltaic, and fluvial environments near the margins of Pleistocene glaciers (Clague, 1994).

In general, during the Quaternary, thick glacial deposits were laid down during a period of high sea level between 19 000 and 13 000 years ago. According to Bichler *et al.*, 2002, Vashon drift material (in part, silty sandy till and sandy, gravelly glaciofluvial sediments) were initially deposited along margins of overriding ice lobes. Also deposited with the advancing ice fronts were the Quadra sands, which are outwash sediments that are typically cross-stratified, well-sorted glaciofluvial sands that are now found up to 100 m asl. As the study area was ice free 13 000 to 10 000 years ago, thick deposits of the Capilano Sediments, which mark the ice retreat phase, are observed as glaciofluvial, glaciomarine, and marine sediments that were deposited on the seafloor, and are now seen as raised deltas and inter-tidal beach sediments. Capilano Sediments are typically found up to 180 m asl.

2.4.3 Study Area Surficial Geology

The majority of the islands are draped in till deposits with exposed bedrock knobs and colluvium deposits along steeper slopes. Glaciomarine and marine deposits are less common in the area, and in discrete pockets near sea level and the head of small inlets and bays, and along present day lake edges and low-lying areas. Glaciofluvial deposits are most common on Bowen Island with several deposits located along modern small river valley systems. In a general cross-section from the coast to mountain tops, low-lying areas adjacent to shorelines commonly consist of thinner till deposits and scattered glaciomarine and marine deposits. Exposed bedrock hummocks and bluffs with thin colluvial deposits and very thin tills are common along shorelines. Glaciofluvial sands and gravels are also common throughout low-lying areas, river valleys, and where streams exit confined gully systems forming fans.

On middle and upper slopes, surficial material commonly includes silty, diamictic, sandy till mantles, with thin colluvial and till deposits and exposed bedrock outcrops along the uppermost slopes.

2.5 Soil Landscapes

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

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

Regosols occur where there has been little to no soil development overlying parent materials. Surficial materials associated with Regosols in the project area include fluvial and glaciofluvial deposits, thin colluvial deposits, and weathered bedrock. They occur on recent fluvial deposits such as along smaller streams and rivers, where the vegetation includes black cottonwood, red alder, and willow. We also encountered Regosols on steep bedrock-controlled slopes. Some of these sites did not support forest vegetation.

Gleysols occur on very gently sloping to flat terrain, or low-lying moisture receiving areas associated with marine, glaciomarine or fluvial deposits, or saturated thick till deposits. These soils develop on the wetter ecological sites with typical vegetation includes red alder, black cottonwood, willows, skunk cabbage, and hydrophytic sedges.

Organic soils occur where the decay of organic residues is inhibited by a lack of oxygen caused by submersion or saturation. Organic soils were observed in the project area in wetlands and along forested areas adjacent to wetlands.

Mesic , and to a lesser extent, Fibrisols were the most commonly observed organic Great Group, and typically consist of partially decomposed forest floor organics and undecomposed *Sphagnum spp.* and forest litter.

3.0 METHODOLOGY

Mapping was completed according to the methodology outlined in the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RISC, 1998a). The TEM method uses a hierarchical biogeoclimatic ecosystem classification system approach (as outlined in Section 2.2). Polygons were delineated based on differences in bioterrain and ecological features.

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

The following sections describe in further detail how these methods were applied to the Howe Sound TEM project.

3.1 Background Research and Data Sources

Background materials referenced for this project included information on; surficial geology, geomorphic processes, soils, aggregate and other land based resources, vegetation ecology, past and present land use, land management, sensitive ecosystem inventory, rare element occurrences, and rare species. Where available, other ecological assessments that were previously carried out in portions of Howe Sound were collected to provide additional information and data.

Bioterrain-specific background documents researched and reviewed include:

- Sunshine Coast aggregate potential mapping project (Bichler *et al*, 2002).
- Quaternary stratigraphy and history of south-coastal British Columbia (Clague, 1994).
- Morphological belts, tectonic assemblages, and terrains: *in* Geology of the Cordilleran Orogen in Canada (Gabrielse *et al*, 1991).
- Landforms of British Columbia: A Physiographic Outline (Holland, 1976).

- Ministry of Energy, Mines, and Petroleum Resources. The Map Place – BCGS Geology Map (current website).
- Terrain Analysis (Base Data and Interpretation) of Bowen Island 1:10 000-scale maps (MoE, 1975; Maynard, 1977).
- Terrain Mapping 1:20 000-scale map of Gambier and Anvil Islands (MoE, Lacelle, 1984).
- Soils of the Langley-Vancouver Map Area (Luttmerding, 1980; Luttmerding, 1981).
- Soil landscapes of B.C., Ministry of Sustainable Resource Management (MSRM, 2008).

Ecosystem and TEM specific background documents include:

- Old-growth Forests on Gambier Island, BC. (Doyle and Yadao, 1999).
- The crown lands of Bowen Island: an inventory and assessment of resource values. Islands Trust and GVRD. (Dunster and Associates, 2000).
- Biophysical assessment and preliminary planning concept for Cowan Point Lands, Bowen Island, B.C. (Dunster and Associates, 1999).
- Brigade Bay Bluffs and Long Bay Wetland Nature Reserve Management Plan, Gambier Island, BC. Islands Trust Fund. (Cascade, 2005).
- Management Plan for Singing Woods Nature Reserve, Bowen Island, BC. Islands Trust Fund. (PGL, 2000).
- CRC Joint Ventures Overview Environmental Inventory – Cape Roger Curtis, Bowen Island, BC. (PGL, 2005).
- Ecological Assessment and Considerations in Developing the Cape Roger Curtis Property. (Klinka, 2005).
- Management Plan for David Otter Nature Reserve Bowen Island, BC. Islands Trust. (Durand and Durand, 2007).
- Mount Artaban Nature Reserve Management Plan, Gambier Island, BC. Island Trust. (Hopwood, 2009).
- B.C. Conservation Data Centre (CDC), BC Species and Ecosystems Explorer. B.C. Min. Environ., Victoria, B.C. <http://srmapps.gov.bc.ca/apps/eswp/> (CDC, 2009).

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

3.2 Initial Ecosystem Mapping (Pretyping)

Initial ecosystem mapping of linework and labels (referred to as pretyping) was completed using PurVIEW software integrated within ArcGIS 9.3 to view the air photo coverage in stereo (3D) on-screen, instead of the traditional hardcopy air photos viewed with stereoscopes.

3.2.1 Bioterrain Linework and Labeling

Bioterrain linework was completed first, with polygons outlining slope and aspect breaks, surficial geology deposits, material thickness and expression, geomorphic processes, and drainage. The bioterrain labels were entered for each polygon directly into a TEM standard database as polygons were created. Preliminary bioterrain mapping used referenced background material as listed above (Section 3.1), and followed these subsequent guidelines and standards:

- *Guidelines and Standards to Terrain Mapping in British Columbia* (RIC, 1996),
- *Terrain Classification System for British Columbia* (Howes and Kenk, 1997) and
- *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RISC, 1998b).

3.2.2 Ecosystem Linework and Labeling

Following the bioterrain pre-typing, the ecosystem linework and labeling was completed and entered directly into a TEM standard database. Each ecosystem label is coded using a standard format to describe the vegetation, site conditions, structural stage, stand composition, and disturbance. Ecosystems are assigned up to three ecosystem codes, each comprising a quantified proportion of the polygon area using deciles that add to 100% (e.g., decile one could consist of

50% ecosystem Type A, decile two indicates 30% of ecosystem Type B, and decile three indicates that the polygon contains 20% of ecosystem Type C). Pure polygons (100% of one ecosystem type) were mapped whenever possible.

Ecosystems, with the exception of wetlands are coded using two upper case letters indicated in the provincially correlated TEM code list (BCMOE, 2009), including sparsely vegetated, non-vegetated, and anthropogenic units. Wetlands are classified following the Wetland and Riparian Ecosystem Classification system (WREC) which is based on the BEC system (Mackenzie and Moran, 2004). They are assigned a four character code, and are considered a site series number in the database. The first two characters are letters (the first letter uppercase, and the second lower) while the second two characters are numbers. Where an ecosystem does not correspond to a designated unit, new codes were proposed to the Provincial correlators based on the field data collected.

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

An optional structural stage modifier (a single lower case letter) further characterizes the structural stages. A stand composition modifier (single upper case letter) may follow the structural stage and/or structural stage modifier to differentiate forest stands based on proportions of coniferous and broadleaf canopy. For this project and to remain consistent with the CDF TEM (Madrone, 2008b), the coniferous modifier was assumed for all forested stands with a stand composition modifier applied when the situation was otherwise. Disturbance type and subtypes were also mapped when apparent.

3.2.3 QA of Pretyping

Gordon Butt (M. Sc., P. Geo., P. Ag.) of Madrone, provided internal QA for the initial bioterrain mapping. Kathy Dunster provided external QA for the initial ecosystem mapping. Feedback was addressed by the ecologist that mapped the area and reviewed by the other mappers to ensure consistency throughout the study area. An internal QA process was established between Madrone bioterrain and ecosystem mappers, with continual communication, and detailed review of map work.

After the initial mapping was completed approximately 2,000 polygons with an average polygon size of approximately 7 ha were mapped and labeled. Also, during the initial mapping, areas for field verification for both ecosystems and bioterrain were determined and were including in a Sampling Plan. The draft Sampling Plan was submitted to Islands Trust, Kathy Dunster (3rd Party QA), and Corey Erwin of MoE.

3.2.4 Development of a Working Legend

Bioterrain attributes such as surficial material type and surface expression, soil drainage, soil depth, slope, aspect, and slope position were used to guide the development of an ecosystem working legend. Field data from the CDF TEM, which included a minor component of CWH mapping, and existing background information were integrated to develop a working legend prior to beginning field work (RISC, 1998a: Table 6.1). This legend was refined following ground truthing where modifications warranted.

3.3 Field Sampling and Ground Truthing

A stratified sampling plan was completed prior to field surveys ensure that the full range of ecosystems of interest and special features were covered. Ideally, the plots and polygon checks are distributed throughout a study area. However, the focus of this project was sampling on non-Crown lands. Therefore, priority for field verification was on private lands where access was granted. Accessibility was an issue due to lack of roads and a high concentration of private lands along the waterfront. A significant portion of our visual ecosystem confirmation plots were conducted by boat (Gambier Water Taxi), especially for non-Crown lands (*i.e.*, we did not go onshore for any private property without permission). Boat access used public (government) docks, and our field crews used public trails and roads where appropriate. Sampling focused on sites and ecosystems of special interest, in the priority order listed below.

1. old forest ecosystems wherever possible, and where old forest is not available, mature second growth forest;
2. a representative sample of the full range of recognized BEC sites series;
3. non-forested site series, including coastal bluffs and lichen/bryophyte/herbaceous communities;
4. wetlands and riparian areas;

5. sites where bioterrain or ecosystem features large enough to map were not apparent on the air photos; and
6. other special or anomalous features of interest.

Furthermore, transitions between BEC subzones were checked where accessible, and sampled using a transect system along a topographic gradient. During the field sampling program, crews were made aware of the locations of SEI units (SEI polygons were included on the field maps).

Field sampling methods followed provincial standards for TEM data collection (RISC 1998a, 1998b) and included:

- Field Manual for Describing Terrestrial Ecosystems (Luttmerding *et al.* 1998).
- A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region. (Green and Klinka 1994).
- Wetland and Riparian Ecosystem Classification system (WREC) (Mackenzie and Moran 2004, W.H. and A. Banner. 2001).
- Canadian System of Soil Classification (Soil Classification Working Group, 1998).

Sampling efforts were conducted by one or two teams, each led by an ecosystem and a bioterrain specialist. Polygons were sampled using three types of plots: full ecosystem plots with site, soil, and vegetation; ground inspection plots; and visual inspections.

Full and ground plots were concentrated on sites likely to support zonal ecosystems, infrequently-occurring ecosystems, mature stands, and typical ecosystems representing all site series and positions on the edaphic grid mapped. Additional plots were included to confirm structural stages, site series, proposed new or non-correlated ecosystem types, and ecosystem types that were difficult to identify from the air photos (e.g., fluctuating water table sites and some disturbed sites).

Conservation evaluation forms (BCMOE, 2006) were filled out for all full and ground plots in the project area. Parameters include rare elements occurrences, disturbance sources, resilience, fragmentation, and presence of invasive species.

These evaluation forms can be used to prioritize areas for conservation efforts in the future.

Visual inspections were used to confirm site series, structural stages, identification of some disturbed and anthropogenic areas, and areas not accessible for more detailed plots because of access limitations.

Spatial coordinates of each plot were recorded by a handheld GPS unit in addition to plot locations being marked on a hardcopy field map. Photos were taken at each full and ground plot, as well as most of the visual plots.

3.3.1 Sampling Intensity

Land status of Howe Sound created three polygon categories, those that were located entirely within Crown land, entirely within non-Crown land and polygons that overlapped Crown and non-Crown land. Our sampling goals varied within each of these three categories (Table 2). The desired overall sampling intensity was Level 4, an average of the three land status categories.

Table 2. Field Verification Sampling Goals for Howe Sound TEM.

TEM Polygons	Sampling Level	Plot Type Ratio (Full:Ground:Visual)
Private (non-Crown) Land	3 (25% – 50%)	5:20:75
Polygons that overlap non-Crown and Crown Land	4 (15% – 24%)	5:20:75
Crown and Public Land	5 (5% – 14%)	5:20:75
Overall Sampling Intensity Goal	4 (15% – 24%)	5:20:75

Based on a Level 4 sampling intensity, the goal for ratio of plot types (from most detailed with “full” plots, to least amount of detail collected for “visuals”) was 5% full ecosystem plots (completion of required fields in the FS882 plot card), 20% Ground Inspection (completion of required fields in the Ground Inspection Form or GIF - FS212 card) and the remaining 75% visuals (completion of required fields in the FS212 card).

3.3.2 Landowner Contact

Private landowner contacts began in May of 2009 (with field surveys planned for July) with an initial letter mailed out to over 75 landowners (Appendix III).

Landowners were contacted using information provided by Islands Trust by either mail or phone in order to notify and inform area residents of the project and request their cooperation (*i.e.*, permission to access their land). Over 80 hours was dedicated to communications between our GIS department, mappers and private landowners.

The goal was to obtain entry on to a number of private land properties, so that it would be possible to maximize the sampling effort and capture a representative diversity of ecosystems types as well as some special or unique features. In addition to our contact efforts, Islands Trust produced a news release (Appendix III), which was posted at various public locations and picked up by the Bowen Island local newsletter “Undercurrent”. Private lands were not entered by the field crews unless prior access was granted.

3.4 Final Typing and Ecosystem Labeling

Following field work, preliminary bioterrain and ecosystem line work was adjusted by Tyler Innes, Jackie Churchill, Wanda Miller, and Sonia Meili using ArcGIS9.3, 3D PurVIEW software and draft maps. Field work edits were discussed with Gordon Butt, and in part with Sid Tsang. Wanda Miller provided a final QA review of all field work edits, as well as for consistency in the bioterrain labeling and linework throughout the study area.

Each polygon was assigned a unique number labeled within each polygon centroid. The ecosystem mappers reviewed the aerial photographs and applied ecosystem labels integrating all available data sources (e.g., field plots, background research, and bioterrain labels).

3.5 Database Production

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

The subsequent guidelines and standards were followed during database production:

- *Standard for digital terrestrial ecosystem mapping (TEM) data capture in British Columbia* (RISC, 2000),
- *Digital terrestrial ecosystem mapping data capture (DC) user's guide* (RISC, 2002) and
- *Standard for terrestrial ecosystem mapping (TEM) - digital data capture in British Columbia, Version 3.0, Errata No. 1.0.* (RISC, 2004).

3.6 Final GIS Product

The final GIS product, created in ArcGIS 9.3, represents a seamless digital shapefile with corresponding attributes for each polygon. The study area was mapped at 1:10,000 scale, however as per the contract, no overall project hardcopy maps were produced.

4.0 RESULTS

A total of 18 two person crew days were spent on field verification of the draft map product. The surveys were carried out between June 21st – 26th, August 10th – 13th, and on August 17th and 18th, 2009. For all areas sampled, plots were visited by vehicle, on foot, or by water taxi.

During the June survey session, field crews consisted of Tyler Innes, Jackie Chruchill, Wanda Miller, and Sonia Meili. On the first day of field work (June 21st, 2009) the four crew members from Madrone worked together on Bowen Island to correlate methods and interpretations. On June 22nd and 23rd, Dr. Kathy Dunster (private consultant - Unfolding Landscapes) and Corey Erwin (MoE) accompanied teams on Bowen and Gambier Islands to provide ecosystem QA correlation. Field correlations ensured consistent field data collection for all field crews in accordance with the RISC (1998a and 1998b) Standards.

On June 26th, Sid Tsang (Tsang Geoscience Ltd.) accompanied a team on Bowen Island and provided external QA for bioterrain. The remainder of the week the crew split up into two crews of two (each with one bioterrain and ecosystem mapper).

During this time, the field crews focused sampling on Bowen, Gambier, Anvil, Keats, and Bowyer Islands. In August, field crews consisted of Jackie Chruchill, Tania Tripp, Kathy Dunster, and Sonia Meili. During August, the field crews completed plots on Bowen, Gambier, Keats, the Paisleys and many of the smaller islands.

A total of eight full plots, 34 ground inspection plots and 281 visual checks were completed by the Madrone team in 2009 (Tables 3 and 4). Based on the final linework, our average polygon size is 7 ha (2,017 polygons covering approximately 14,000 ha) (Table 5). For comparison, the average polygon size mapped at 1:16,000 for the CDF TEM was 12.5 ha, and for Saltspring Island CDF TEM (mapped at 1:10,000) it was 9.5 ha (Madrone 2008a and 2008b). Based on the final polygon and plot count, we successfully completed a Level 4 sampling intensity of 17% (~368 plots /14,000 ha) (Figure 2).

Sampling included public (Crown) and non-Crown/private lands. Data from 44 plots completed previously for Sensitive Ecosystem Inventory (SEI) were also used to meet project objectives while minimizing duplication of previous efforts.

A total of 368 plots were entered into the provincial database VENUS 5.1 and checked for errors.

Table 3. Plot Sampling Summary for Howe Sound.

Howe Sound Sub-groups	Full plots	Ground plots	Visual plots (including SEI)	Total plots	Conservation evaluation forms
Bowen (including Bowyer and Paisleys)	3	14	164	181	17
Gambier	3	10	116	129	13
Keats	1	8	26	35	9
Anvil	1	2	20	3	3
Totals	8	34	326	368	42

Table 4. Plot Sampling Summary by Polygon Type.

Polygon Type	Full plots	Ground plots	Visual plots (including SEI)	Total plots	Conservation evaluation forms
Non-Crown/Private	4	19	178	201	23
Crown/Public	0	1	24	25	1
Overlap	4	14	124	142	18
Totals	8	34	326	368	42

Table 5. Total Polygons Mapped and Minimum/Maximum Sampling Requirements.

Polygon Type	Total Mapped in Each Category	Minimum Polygon #s by Sampling Level	Maximum Polygon #s by Sampling Level
Non-Crown/Private	735	184	368
Crown/Public	702	105	168
Overlap	580	29	81
Totals	2,017 (final polygon #)	318	617

4.1 Ecosystem Overview

Similar groups of ecosystems were encountered through the Howe Sound islands with some differences in vegetation composition due to elevational variation. For instance, the CWHxm1 subzone, ranging from sea-level to approximately 150 m, contained more anthropogenic units as well as more wetlands, floodplain ecosystems and sparsely vegetated units. As a whole, the study area can be characterized as having rich; sword fern dominated sites in lower elevations; medium-nutrient sites in middle elevations; and dry, shallow mesic sites in the upper elevations.

Sites in the CWHxm1 and CWHdm subzones are comparable in vegetation structure and composition, with slight differences in slope position and disturbance. The ecosystem mapcodes and site series names for these two subzones are all the same except the 01 site series, which can be distinguished by a higher occurrence of Douglas-fir in the lower elevation CWHxm1 subzone.

The number of ecosystems mapped across the study area includes 11 forested site series (including two floodplain units) in the CWHxm1 and CWHdm subzones; whereas, the CWHvm2 subzone contains 8 forested site series. Only five distinct wetland ecosystems were mapped in the study area plus 15 non-forested ecosystems, including seven natural, sparsely-vegetated units and eight anthropogenic units.

Forested ecosystems consist primarily of second-growth stands. Regenerating stands range from recent clearcuts to dense young stands and maturing forests. The majority of Howe Sound was actively logged over the last 80 – 90 years, creating large areas of young and maturing forest (Dunster and Associates, 2000).

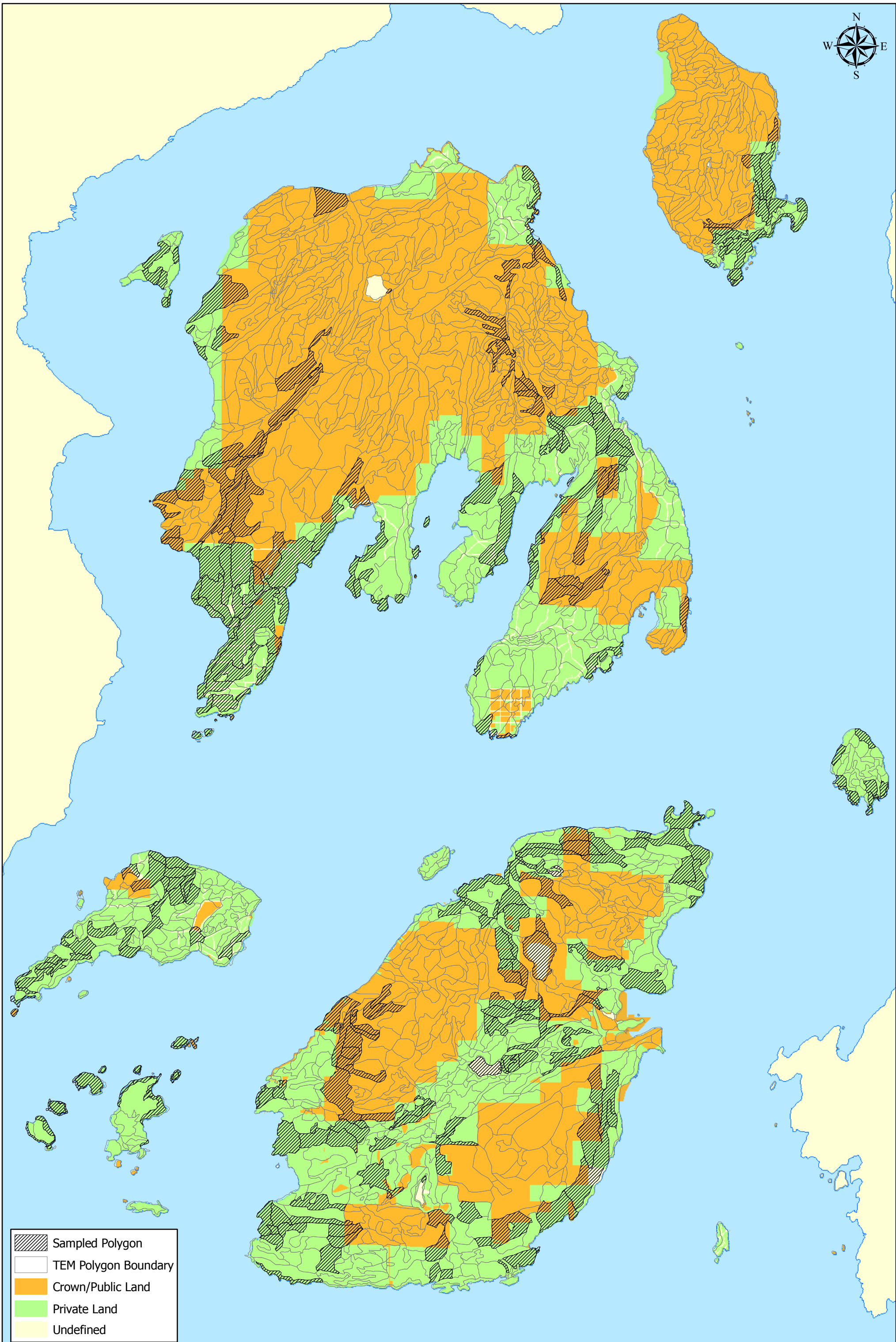


Figure 2: Polygon field verification coverage for Howe Sound TEM

Steep slopes and areas with shallow soils contain patches of old forests that escaped timber harvesting. Productive forested stands on Bowen, Gambier and Keats Islands have seen second cut, and in some cases, a third harvest rotation. Overall, substantial portions of Howe Sound are dominated by young forested ecosystems with negligible old-growth remaining (structural stage 7).

The composition of forest stands is often a mix of coniferous and deciduous broadleaf tree species as a result of timber harvesting and natural succession. Mature forests are dominated by western hemlock (*Tsuga heterophylla*) and the coastal variety of Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) on most of the landscape positions with minor amounts of grand fir (*Abies grandis*) intermixed.

The understory vegetation in upland forests is characterized by sword fern (*Polystichum munitum*), salal (*Gaultheria shallon*), dull Oregon-grape (*Mahonia nervosa*), red huckleberry (*Vaccinium parvifolium*) and feathermoss species, like lanky moss (*Rhytidiadelphus loreus*), Oregon beaked moss (*Kindbergia oregana*), and step moss (*Hylocomium splendens*).

On drier sites and bedrock outcrops, Douglas-fir stands are joined by arbutus (*Arbutus menziesii*) and occasionally shore pine (*Pinus contorta* var. *contorta*). Baldhip rose (*Rosa gymnocarpa*), common snowberry (*Symphoricarpos albus*), oceanspray (*Holodiscus discolor*) and electrified cat's-tail moss (*Rhytidiadelphus triquetrus*) are frequent in the understory.

Forests on lower slopes with moist to subhygric soils will typically contain western redcedar (*Thuja plicata*), red alder (*Alnus rubra*), grand fir (*Abies grandis*), and bigleaf maple (*Acer macrophyllum*) in the canopy. In the understory various shrubs and herbs can be expected, including salmonberry (*Rubus spectabilis*), Indian-plum (*Oemleria cerasiformis*), red elderberry (*Sambucus racemosa*), lady fern (*Athyrium filix-femina*), three-leaved foamflower (*Tiarella trifoliata*), spiny wood fern (*Dryopteris expansa*), skunk cabbage (*Lysichiton americanum*), enchanter's-nightshade (*Circaea alpina*), and leafy moss species, such as coastal leafy moss (*Plagiomnium insigne*), palm tree moss (*Leucolepis acanthoneuron*) and large leafy moss (*Rhizomnium glabrescens*).

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

4.2 Ecosystem Representation and Condition in the Study Area

A total of 2,017 ecosystem polygons were delineated in the project area (13,981 ha), with an average polygon size of approximately 7 ha. The majority of mapped polygons (55.5%) were in the CWHxm1 subzone; with about 41.5% of the area in the CWHdm subzone and 3.0% in the CWHvm2 variant (Figure 1).

A list of the TEM units mapped in the project area is provided in the expanded legend in Appendix VI. The legend includes site descriptions, assumed modifiers, site characteristics, representative photo and plot reference numbers of each ecosystem unit mapped in the study area.

The following results summarize the ecosystems mapped in Howe Sound, including forested, non-forested, sparsely-vegetated, wetland and anthropogenic units. Tables 6 – 12 list the various ecosystem units mapped, the total area of each unit, and the percentage of the total project area by BEC subzone and variant.

4.2.1 CWHxm1 Ecosystem Units

The CWHxm1 accounted for 55.5% of the project study area. In the CWHxm1, 11 forested site series (including two floodplain units and two forested wetland units) comprised 85% (6,651 ha) of the study area. Natural non-forested ecosystems (including two non-forested and five sparsely-vegetated site series) made up 6% (349 ha) of the CWHxm1. Lastly, four wetland and estuary ecosystems and eight anthropogenic units were mapped totaling 1% (10 ha) and 10% (742 ha), respectively (Figure 3).

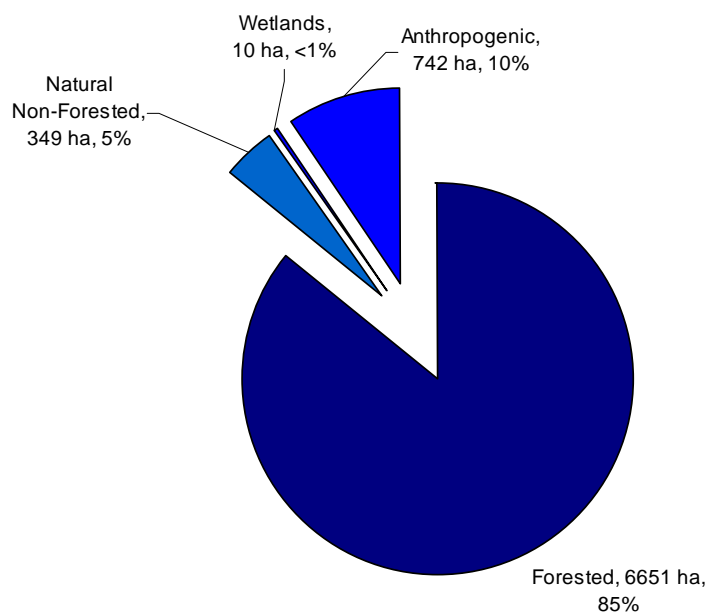


Figure 3. Distribution of ecosystem categories in the CWHxm1 by area and percentage.

4.2.1.1 Forested Ecosystems of the CWHxm1

The most common forested ecosystems within the CWHxm1 study area were the zonal Western hemlock-Douglas-fir-beaked moss and the richer Western redcedar-Sword fern forest type, comprising 30.8% and 4.6% of the study area, respectively. The drier Douglas-fir-Shore Pine-Cladina forest and the Douglas-fir-Sword fern sites both covered 3.8% of the CWHxm1 in Howe Sound (Table 6 and Figure 4).

Table 6. Forested Ecosystems Mapped in the CWHxm1 subzone for Howe Sound Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Forested site series				
HK	01	Western hemlock-Douglas-fir-Oregon beaked moss	4310	30.8
DC	02	Douglas-fir-Shore pine-Cladina	533	3.81
DS	03	Douglas-fir-Western hemlock-Salal	115	0.82
DF	04	Douglas-fir-Sword fern	527	3.77
RS	05	Western redcedar-Sword fern	646	4.63
HD	06	Western hemlock-Western redcedar-Deer fern	207	1.48
RF	07	Western redcedar-Foamflower	263	1.88

Table 6. Forested Ecosystems Mapped in the CWHxm1 subzone for Howe Sound Project Area (continued).

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Forested floodplain site series				
SS	08	Sitka spruce–Salmonberry high bench floodplain	17	0.11
CD Fm50)	09	Black cottonwood–red-osier dogwood medium bench floodplain	10	0.07
Forested wetlands site series				
LS	11	Shore pine - sphagnum	1	0.001
RC Ws53)	12	Western redcedar–Sitka spruce–Skunk cabbage	23	0.16
Total Forested			6651	47.6

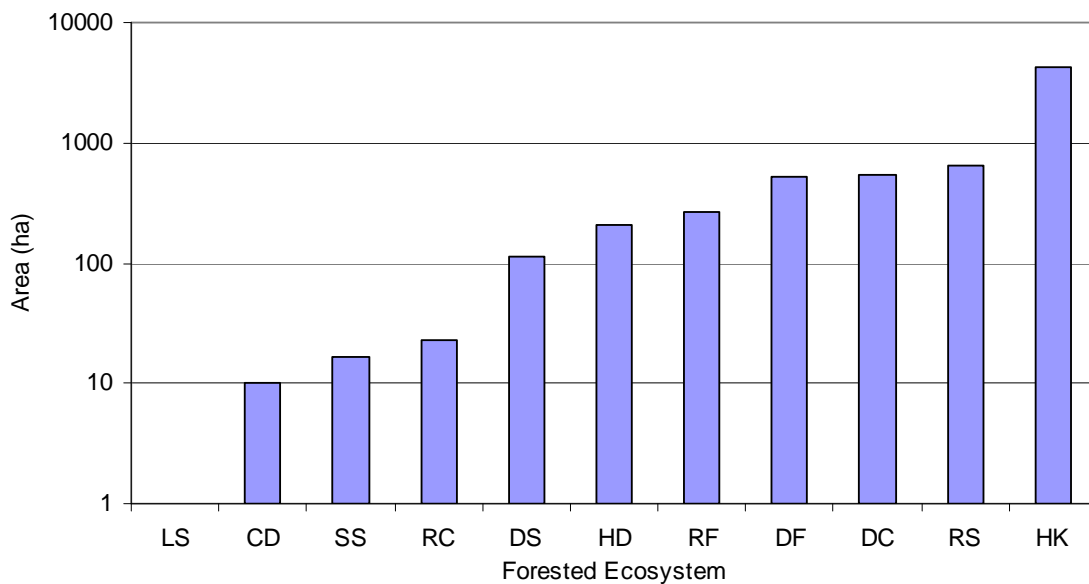


Figure 4. Distribution of forested ecosystem units in the CWHxm1 by area.

4.2.1.2 Non-Forested Ecosystems of the CWHxm1

Natural non-forested ecosystems, including non-forested and sparsely vegetated ecosystems, represented about 2.6% of the study area, however microsites of mapcodes SC and AM, may not be captured at the 1:10,000 map scale and therefore would likely increase the coverage of these non-forest ecosystem types.

Wetlands and estuary ecosystems, including bogs, fens, and marshes represented less than 0.1% of the study area. The most common ecosystem encountered was the Sweet gale – Sitka sedge fen (Table 7).

Table 7. Non-Forested Ecosystems Mapped in the CWHxm1 subzone for Howe Sound Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Non-forested ecosystems				
AM	00	Arbutus–Hairy manzanita	3	0.01
SC	00	Cladina–Wallace’s selaginella	82	0.58
Sparsely vegetated units				
BE		Beach	15	0.10
MU		Mudflat Sediment	2	0.01
LA		Lake	55	0.39
OW		Open water	11	0.07
RO		Rock outcrop	181	1.29
Wetland ecosystems				
Wf52		Sweet gale – Sitka sedge fen	6	0.04
Wf50		Narrow-leaved cottongrass – peat-moss fen	1	0.007
Wm50		Sitka sedge – hemlock-parsley marsh	3	0.02
Wb50		Labrador tea – Bog-laurel – Peat-moss	1	0.002
Em03		Seashore saltgrass	1	0.0002
Total natural non-forested			360	2.6

4.2.1.3 Anthropogenic Units of the CWHxm1

Anthropogenic units cover about 5% of the study area. Ecosystems converted primarily to rural residential land use covered approximately 4.5% of the study area. Fields, including those in use for cultivation and grazing, or fallow fields, covered approximately 0.5% (Table 8 and Figure 3).

Table 8. Anthropogenic Units Mapped in the CWHxm1 subzone for Howe Sound Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Anthropogenic units				
CF		Cultivated field	78	0.56
GC		Golf course	19	0.13
GP		Gravel pit	1	0.004
IN		Industrial	3	0.01
RE		Reservoir	1	0.006
RW		Rural	634	4.54
RZ		Road surface	5	0.03
UR		Urban	2	0.014
Total anthropogenic			743	5.3



4.2.2 CWHdm Ecosystem Units

The CWHdm accounted for 41.5% of the project study area. In the CWHdm, 11 forested site series (including one floodplain ecosystem and two forested wetland units) comprised 94% (5468 ha) of the mapped area. Natural non-forested ecosystems, including one non-forested, three sparsely-vegetated and three wetland ecosystems, made up nearly 2% (174 ha). A total of four anthropogenic unit types were mapped over 0.5% (65 ha) of the CWHdm within the study area (Figure 5).

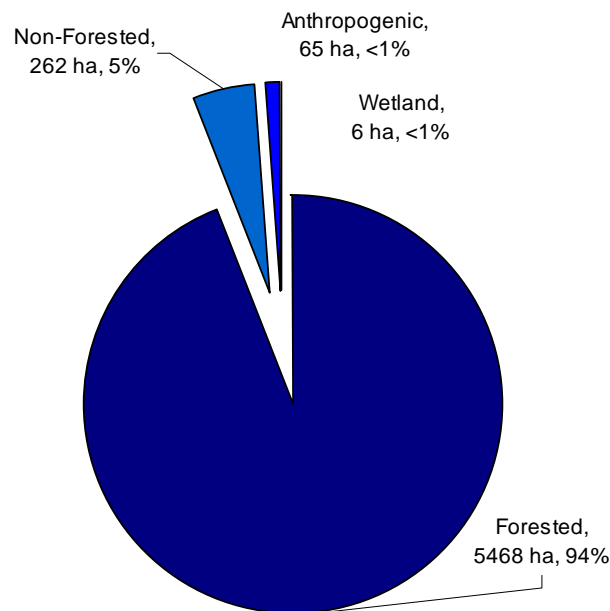


Figure 5. Distribution of ecosystem categories in the CWHdm by area and percentage.

4.2.2.1 Forested Ecosystems of the CWHdm

The most common forested ecosystems mapped within the CWHdm study area were the zonal mesic Western hemlock–flat moss, the slightly drier and richer Douglas-fir–Sword fern, and the very dry Douglas-fir/Shore pine –Cladina site series, which comprised 23.7%, 5.5%, and 4% of the study area, respectively (Table 9; Figure 6). Forested wetland sites and the forested floodplain ecosystems were rare within the study area.

Table 9. Forested Ecosystems Mapped in the CWHdm subzone for Howe Sound Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Forested site series				
HM	01	Western hemlock–Flat moss	3310	23.7
DC	02	Douglas-fir–Shore pine–Cladina	562	4.02
DS	03	Douglas-fir–Western hemlock–Salal	160	1.15
DF	04	Douglas-fir–Sword fern	771	5.52
RS	05	Western redcedar–Sword fern	363	2.60
HD	06	Western hemlock–Western redcedar–Deer fern	118	0.84
RF	07	Western redcedar–Foamflower	144	1.03
Forested floodplain site series				
CD (Fm50)	09	Black cottonwood–red-osier dogwood medium bench floodplain	5	0.03
Forested wetlands site series				
LS	11	Shore pine - sphagnum	13	0.09
RC (Ws53)	12	Western redcedar–Sitka spruce–Skunk cabbage	21	0.15
Total Forested			5467	39.1

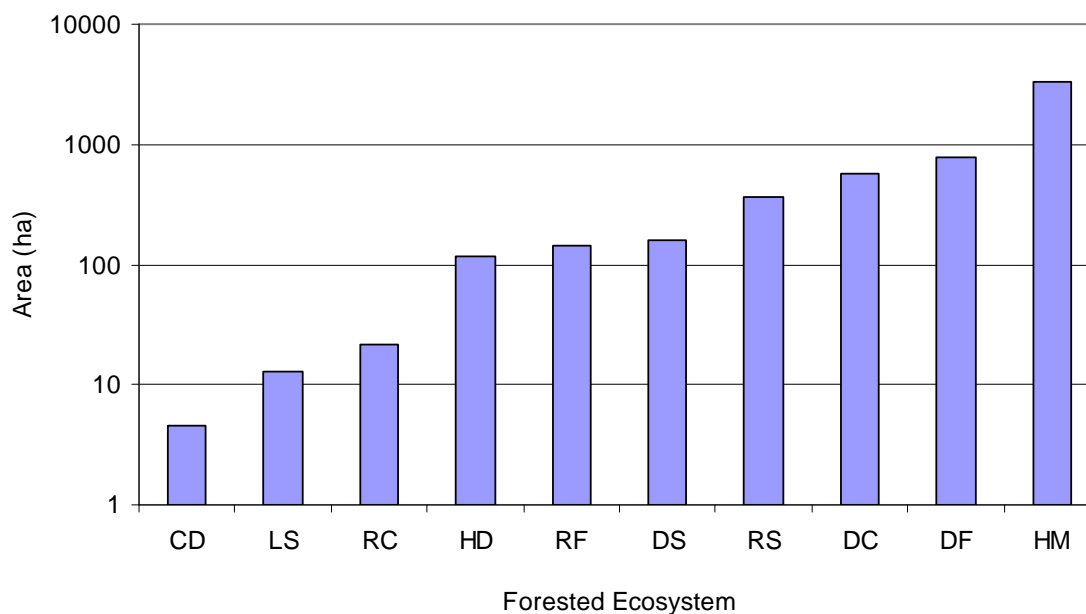


Figure 6. Distribution of forested ecosystem units in the CWHdm by area.

4.2.2.2 Non-Forested Ecosystems of the CWHdm

Natural non-forested ecosystems, including non-forested, sparsely vegetated, and wetland ecosystems, represented almost 2% of the study area mapped. The most common ecosystem was the Rock Outcrop unit which occurred on 1.5% (214 ha) of the study area. Wetland ecosystems in the CWHdm only covered about 7 ha of the study area (Table 10).

Table 10. Non-Forested Ecosystems Mapped in the CWHdm subzone for Howe Sound Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Non-forested ecosystems				
SC	00	Cladina–Wallace’s selaginella	16	0.11
Sparsely vegetated units				
LA		Lake	23	0.16
OW		Open water	9	0.06
RO		Rock outcrop	214	1.53
Wetland ecosystems				
Wb50		Labrador tea–Bog-laurel–Peat-moss bog	2	0.01
Wf52		Sweet gale – Sitka sedge fen	4	0.02
Wf50		Narrow-leaved cottongrass – peat-moss fen	1	0.006
Total natural non-forested			269	1.9

4.2.2.3 Anthropogenic Units of the CWHdm

Anthropogenic units represented 0.5% of the study area mapped with rural residential land use and a gravel pit present (Table 11).

Table 11. Anthropogenic Units Mapped in the CWHdm subzone for Howe Sound Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Anthropogenic units				
GP		Gravel pit	1	0.004
RW		Rural	64	0.46
Total anthropogenic			65	0.5

4.2.3 CWHvm2 Ecosystem Units

The CWHvm2 accounted for approximately 3% of the project study area. In the CWHvm2, 8 forested site series (including one forested wetland) comprised 86% (343 ha) of the mapped area. Natural non-forested ecosystems, including one non-forested, three sparsely-vegetated and one wetland ecosystem, made up nearly 14% (56 ha). Only one anthropogenic unit was mapped in the CWHvm2 (Figure 7).

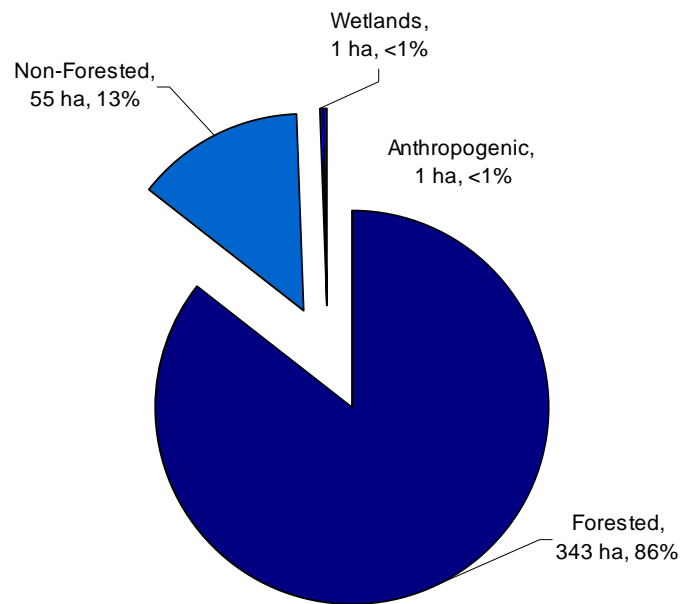


Figure 7. Distribution of ecosystem categories in the CWHdm by area and percentage.

4.2.3.1 Forested Ecosystems of the CWHvm2

The most common forested ecosystems mapped within the CWHvm2 study area were the zonal mesic Western hemlock–flat moss, followed by the slightly drier and richer Douglas-fir–Sword fern site series, which comprised 1.1% and 0.7% of the study area, respectively (Table 12; Figure 8).

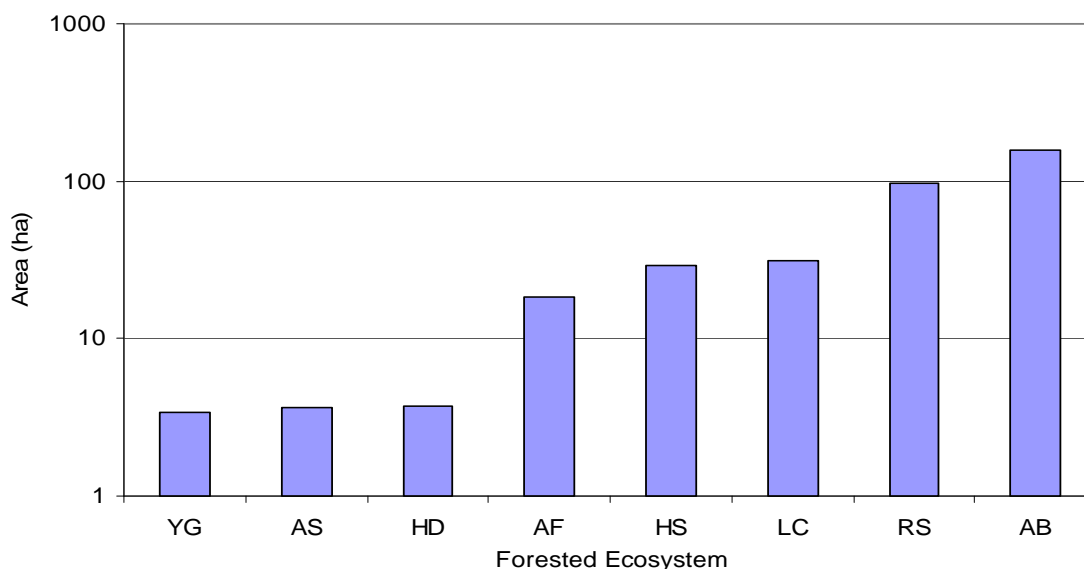


Figure 8. Distribution of forested ecosystem units in the CWHv2 by area.

Table 12. Forested Ecosystems Mapped in the CWHv2 subzone for Howe Sound Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Forested site series				
AB	01	Western hemlock–Flat moss	157	1.12
LC	02	Douglas-fir–Shore pine–Cladina	32	0.22
HS	03	Douglas-fir–Western hemlock–Salal	29	0.21
RS	04	Douglas-fir–Sword fern	97	0.69
AF	05	Western redcedar–Sword fern	18	0.13
HD	06	Western hemlock–Western redcedar–Deer fern	4	0.02
AS	07	Western redcedar–Foamflower	4	0.02
Forested wetlands site series				
YG	09	Western redcedar- Yellow cedar- Goldthread	3	0.02
Total Forested			344	2.4

4.2.3.2 Non-Forested Ecosystems and Anthropogenic Units of the CWHv2

Natural non-forested ecosystems, including non-forested, sparsely vegetated, and wetland ecosystems, represented very small areas of the study area. The most common sparsely vegetated ecosystem was the Rock Outcrop unit which occurred on 51 ha of the study area.

Only one small wetland polygon was mapped in the CWHvm2. Furthermore, one anthropogenic unit (Rural) was mapped in the CWHvm2 and accounted for only 1 ha of the study area (Table 13).

Table 13. Non-Forested Ecosystems and Anthropogenic Units Mapped in the CWHvm2 subzone for Howe Sound Project Area.

Map code	Site series	Ecosystem name	Area (ha)	Area (%)
Non-forested ecosystems				
SC	00	Cladina-Wallace's selaginella	1	0.004
Sparsely vegetated units				
LA		Lake	4	0.02
OW		Open water	1	0.008
RO		Rock outcrop	51	0.35
Wetland ecosystems				
Wf52		Sweet gale – Sitka sedge fen	1	0.007
Total natural non-forested			57	0.4
Anthropogenic units				
RW		Rural	1	0.001
Total anthropogenic			1	0.001

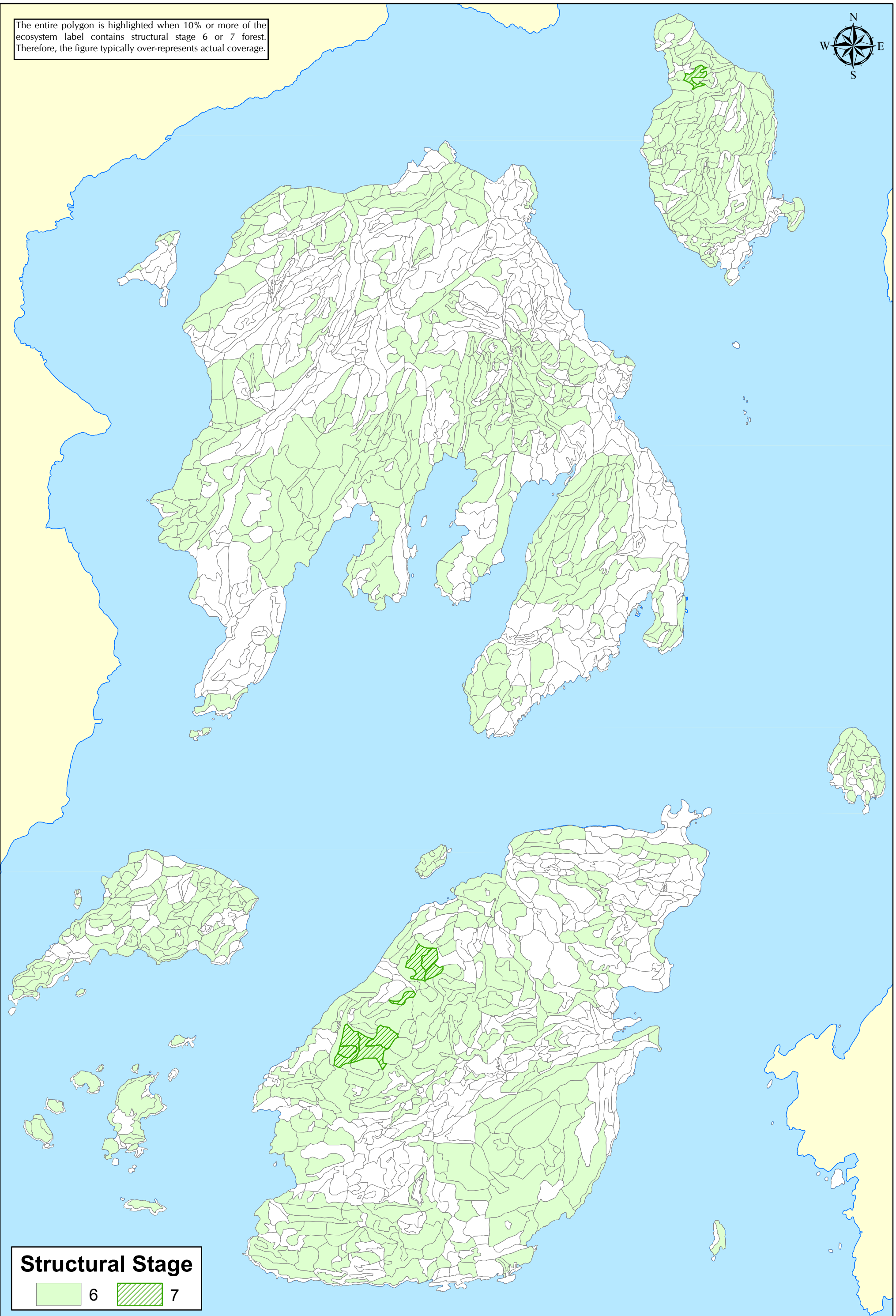
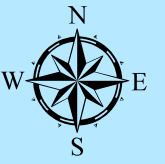
4.2.4 Structural Stage

Mature forests (structural stage 6) are the most common structural stages in the study area, representing 6,313 ha (45%) of the landscape (Figure 9). Mature forests typically range from 80 – 250 years old in this area, consisting of a second cycle of shade-tolerant trees and well developed understory vegetation. There was extremely little old growth, (structural stage 7) mapped in the Howe Sound study area. A total of 53 ha of old growth forest were mapped on Bowen and Anvil Islands.

Young forests (structural stage 5) are the second most common structural stages in the study area, representing 4,849 ha (35%) of the landscape (Figure 9). Young forests typically range from 40 – 80 years old in this area, with self-thinning evident, producing a forest canopy which is beginning to differentiate into distinct layers. Immature forests (structural stage 4), represented 696 ha (5%) of the study area.

Lastly, structural stages 1 – 3 combined occurred over 8.6% (1,203 ha) of the landscape representing logged or otherwise disturbed forests, natural non-forested ecosystems (non-forested, sparsely vegetated, wetland), and a small percentage of anthropogenic areas. Figures 10 – 12 illustrate structural stage coverage for each of the three biogeoclimatic subzone and variants in the study area.

The entire polygon is highlighted when 10% or more of the ecosystem label contains structural stage 6 or 7 forest. Therefore, the figure typically over-represents actual coverage.



Structural Stage



Figure 9: Ecosystem polygons containing at least one decile indicating structural stage 6 or 7 (old forest) within the Howe Sound TEM study area

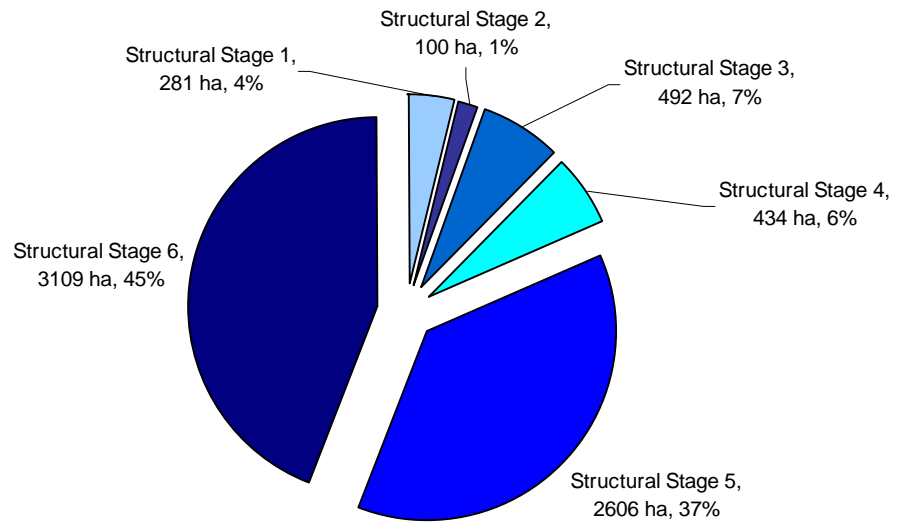


Figure 10. Distribution of structural stages in the CWHxm1 by area and percentage.

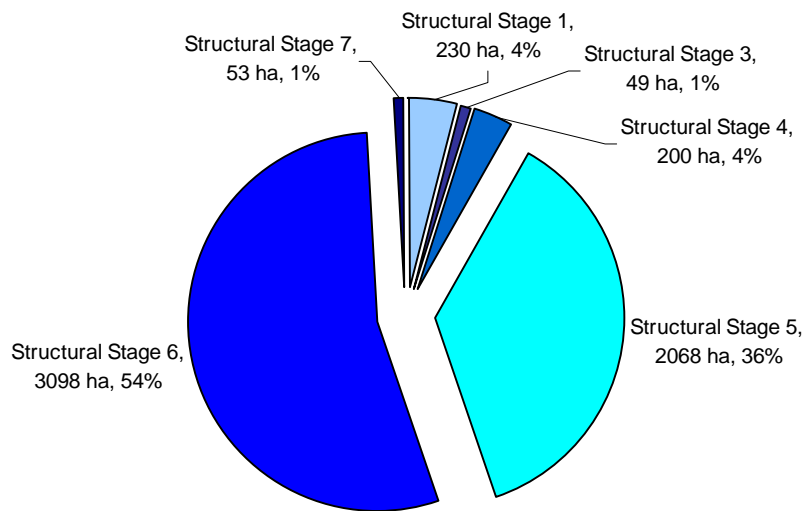


Figure 11. Distribution of structural stages in the CWHdm by area and percentage.

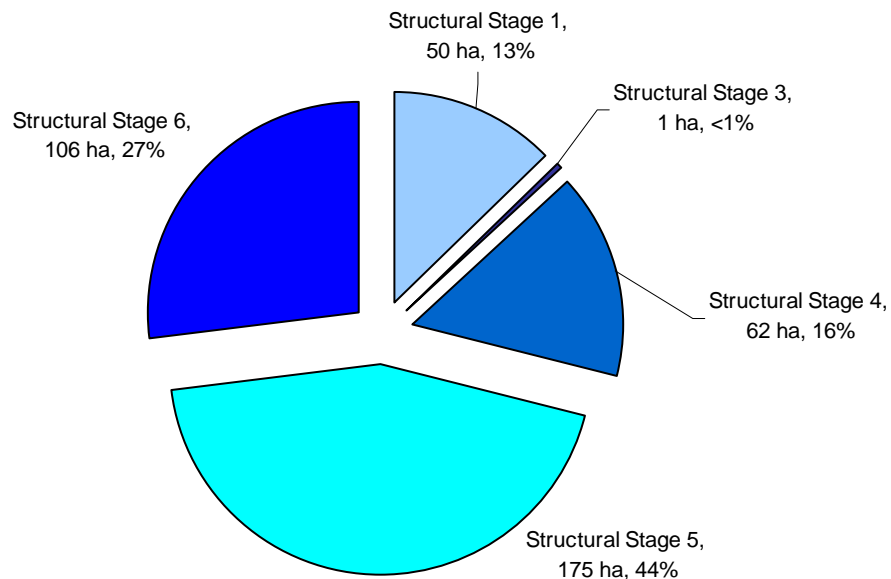


Figure 12. Distribution of structural stages in the CWHvm2 by area and percentage.

4.2.5 Disturbance

The Howe Sound covers a diverse range of land uses, ecosystems, and infrastructure. Historic and modern settlement and resource extraction have displaced some naturally occurring ecosystems across the study area. Disturbances consisted primarily of logging, urban and rural residential development, and agriculture.

Forest harvesting has been occurring in the region for more than 100 years. The dominant silvicultural system is clearcutting with and without reserves, with lesser amounts of single-tree and group selection systems.

Urban and rural residential developments tend to involve land conversion or alienation such that natural processes and functions are hampered or modified to the extent that native plant communities are not supported. In Howe Sound, however, many of the older residential properties consist of a small house footprint surrounded by natural ecosystems.

Cultivated fields are distributed throughout Howe Sound, mainly occurring on deep glaciomarine deposits, used for haying, grazing, and agriculture. Some small-scale orchards and vineyards have been established on gently to moderately sloping well-drained terrain.

4.2.5.1 Invasive species

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

The most prevalent exotic species in the study area are: Scotch broom (*Cytisus scoparius*), common foxglove (*Digitalis purpurea*), English ivy (*Hedera helix*), Daphne-laurel (*Daphne laureola*), agronomic grasses, English holly (*Ilex aquifolium*), and Himalayan blackberry (*Rubus armeniacus*). There are many others that are localized to particular habitats, such as thistles (*Cirsium spp.*), giant cow-parsnip (*Heracleum mantegazzianum*), knotweed species (*Polygonum spp.*), knapweed species (*Centaurea spp.*), carpet burweed (*Soliva sessilis*), yellow-flag iris (*Iris pseudacorus*), Eurasian milfoil (*Myriophyllum spicatum*), and purple loosestrife (*Lythrum salicaria*). Typical strategies of successful invasive and weedy species include the ability to colonize mineral seedbeds, rapid early growth, prolific reproduction, robust seed banks, vegetative spread, apomixes and/or self-fertilization, and dense monotypic growth habits.

4.2.6 Rare Elements

Forestry and development pressure has resulted in fragmentation and reduction of habitat in Howe Sound. The British Columbia Conservation Data Centre (CDC) has listed 33 ecological communities in the Georgia Lowland ecoregion, representing ecosystems within the CWHxm1, CHWdm and CWHvm2 subzones, as provincially at risk (red- or blue-listed) (CDC 2009: see Appendix I and II). Sixteen of these ecosystems are described as “imperiled” (S2) or “critically imperiled” (S1).

Table 14 outlines the ecosystems mapped in the study area that are considered at-risk, including 12 blue-listed and 10 red-listed ecosystems.

Table 14. Rare Ecosystem Units Mapped in the Howe Sound Project Area.

Scientific Name	English Name	BC Status	Ecosystem Mapcode	BGC unit
<i>Arbutus menziesii</i> / <i>Arctostaphylos columbiana</i>	arbutus / hairy manzanita	Red	AM	CWHxm1/00
<i>Myrica gale</i> / <i>Carex sitchensis</i>	sweet gale / Sitka sedge	Red	Wf52	CWHxm1/Wf52
<i>Picea sitchensis</i> / <i>Rubus spectabilis</i> Dry	Sitka spruce / salmonberry Dry	Red	SS	CWHdm/08
<i>Picea sitchensis</i> / <i>Rubus spectabilis</i> Very Dry Maritime	Sitka spruce / salmonberry Very Dry Maritime	Red	SS	CWHxm1/08
<i>Pseudotsuga menziesii</i> - <i>Pinus contorta</i> / <i>Holodiscus discolor</i> / <i>Cladina</i> spp.	Douglas-fir - lodgepole pine / oceanspray / reindeer lichens	Red	DC	CWHdm/02
<i>Pseudotsuga menziesii</i> - <i>Pinus contorta</i> / <i>Racomitrium canescens</i>	Douglas-fir - lodgepole pine / grey rock-moss	Red	DC	CWHxm1/02
<i>Pseudotsuga menziesii</i> / <i>Polystichum munitum</i>	Douglas-fir / sword fern	Red	DF	CWHdm/04; CWHxm1/04
<i>Thuja plicata</i> / <i>Tiarella trifoliata</i> Very Dry Maritime	western redcedar / three-leaved foamflower Very Dry Maritime	Red	RF	CWHxm1/07
<i>Tsuga heterophylla</i> - <i>Pseudotsuga menziesii</i> / <i>Eurhynchium oreganum</i>	western hemlock - Douglas-fir / Oregon beaked-moss	Red	HK	CWHxm1/01
<i>Tsuga heterophylla</i> - <i>Thuja plicata</i> / <i>Blechnum spicant</i>	western hemlock - western redcedar / deer fern	Red	HD	CWHdm/06; CWHxm1/06
<i>Carex sitchensis</i> - <i>Oenanthe sarmentosa</i>	Sitka sedge - Pacific water-parsley	Blue	Wm50	CWHxm1/Wm50
<i>Ledum groenlandicum</i> / <i>Kalmia microphylla</i> / <i>Sphagnum</i> spp.	Labrador tea / western bog-laurel / peat-mosses	Blue	Wb50	CWHxm1/Wb50
<i>Pinus contorta</i> / <i>Sphagnum</i> spp. Very Dry Maritime	lodgepole pine / peat-mosses Very Dry Maritime	Blue	LS	CWHxm1/11
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> - <i>Alnus rubra</i> / <i>Rubus spectabilis</i>	black cottonwood - red alder / salmonberry	Blue	CD	CWHdm/09; CWHxm1/09
<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> / <i>Gaultheria shallon</i> Dry Maritime	Douglas-fir - western hemlock / salal Dry Maritime	Blue	DS	CWHdm/03; CWHxm1/03
<i>Thuja plicata</i> - <i>Picea sitchensis</i> / <i>Lysichiton americanus</i>	western redcedar - Sitka spruce / skunk cabbage	Blue	RC	CWHdm/12; CWHxm1/12
<i>Thuja plicata</i> / <i>Polystichum munitum</i> Dry Maritime	western redcedar / sword fern Dry Maritime	Blue	RS	CWHdm/05
<i>Thuja plicata</i> / <i>Polystichum munitum</i> Very Dry Maritime	western redcedar / sword fern Very Dry Maritime	Blue	RS	CWHxm1/05
<i>Thuja plicata</i> / <i>Tiarella trifoliata</i> Dry Maritime	western redcedar / three-leaved foamflower Dry Maritime	Blue	RF	CWHdm/07
<i>Thuja plicata</i> - <i>Tsuga heterophylla</i> / <i>Polystichum munitum</i>	western redcedar - western hemlock / sword fern	Blue	RS	CWHvm2/04
<i>Tsuga heterophylla</i> / <i>Plagiothecium undulatum</i>	western hemlock / flat-moss	Blue	HM	CWHdm/01
<i>Tsuga heterophylla</i> - <i>Thuja plicata</i> / <i>Gaultheria shallon</i> Very Wet Maritime	western hemlock - western redcedar / salal Very Wet Maritime	Blue	HS	CWHvm2/03

In addition to rare ecosystems, 39 vascular plants are deemed to be at-risk in the CWH zone within the Greater Vancouver and Sunshine Coast Regional Districts (Appendix I). Of these, 29 plants are blue-listed and 10 are red-listed. However, no occurrences of these rare plants are located in the Howe Sound study area and no rare plants were observed during field inspections.

The vegetation of Howe Sound includes ecosystems and species that are considered rare due to their limited occurrences and restricted range. Several of these are at the northern limits of their distribution and include species that occupy seaside, aquatic, rock outcrop, and forested habitats. Unique assemblages of ecosystems and vegetation potentially provide genetic-, species-, and landscape-level components that are important for maintaining biodiversity in the region.

Due to their restricted distribution and the aforementioned impacts, two vascular plant species that could potentially occur in the Howe Sound study area have been listed federally under Schedules of the *Species at Risk Act* (Table 15).

Table 15. Conservation Status of Vascular Plants Listed in the CWH zone within the Greater Vancouver and Sunshine Coast Regional Districts.

Jurisdiction	Conservation Status	Listed Individuals
Provincial Rank	Blue-listed – special concern	29
	Red-listed – endangered or threatened	10
Federal Rank (SARA Schedule 1)	COSEWIC - Special Concern	Streambank lupine (<i>Lupinus rivularis</i>)
	COSEWIC - Endangered	Vancouver Island beggarticks (<i>Bidens amplissima</i>)

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

4.3 Study Area Sub-group Descriptions

This section provides an overview of each of the four major island subgroups in the study area. Based on size and proximity we have grouped and presented our results by Bowen (including Bowyer and the Paisleys), Gambier, Anvil and Keats. The following descriptions provide notes on features with respect to their location, typical surficial material and soils as well as dominant vegetation and ecosystems.

4.3.1 Bowen Island

Bowen Island is the second largest island in Howe Sound, occupying about 5047 ha, 36% of the study area. It is the most southerly island, located across Queen Charlotte Channel, approximately 3 km west of Horseshoe Bay in North Vancouver. Elevational limits extend to 720 m.

4.3.1.1 Bioterrain and Soils

Bowen Island consists of rugged terrain with two major valley systems. The coast line is dominated by steep, tall bedrock bluffs with two main peaks in the west (Mt Gardner) and northeast (Mt Collins). There are also numerous small rocky points, and several small bays where tides run along narrow shorelines leading to the steep cliffs. The larger valley on the island is located along the Grafton Road area, which runs from Grafton Lake southwest towards Tunstall Bay. The other, slightly narrower valley is located along the Mt Gardner road area, running past Killarney Lake and between Grafton and Galbraith Bays to the northwest and Snug Cove and Deep Bay to the southeast. Modern creeks and glacial river systems are located along these valleys. Glaciomarine and marine are less common on Bowen, and are typically located along low elevation shorelines and in some depressional areas near lake systems.

Lower to Mid-Slopes

Surficial Material

The landscape is predominantly draped by diamictic sandy till mantles on gentle to moderately steep slopes (20% – 60% gradients). The mid-to-lower slopes have deposits that range in depth between 0.5 m to 3.0 m and mask the underlying granitic bedrock. These thicker till deposits have 20% – 35% sub-rounded coarse fragments, with very sandy to loamy textures and well to moderately well drained soils. The coast lines and upper slopes are comprised of steeper, hummocky terrain with mantles having depths typically between 0.1 m – 0.5 m.

They are intermixed with exposed bedrock outcrops and minor amounts of thin, rubblely colluvium close to exposed bedrock outcrops. The soils here typically have higher coarse fragment content with shallow soil development and well to rapidly drained soils.

Soil Types

The most common soils associated with these deposits included the Cannell Soils along the mid-to-upper slopes, and the Boose Soils on the mid-to-lower slopes. Cannell soils include moderately coarse textured till and colluvial deposit that are up to 1 m in depth. These soils typically have thin grayish leached upper horizons overlying loose to friable, reddish-brown moderately coarse textured lower horizons. The common soil classifications include Orthic Humo-Ferric Podzols; lithic phase to degraded Orthic or Dystric Brunisols: lithic phase. Bose Soils are associated with the thicker moderately coarse-textured till deposits (commonly covered by marine lag or glaciofluvial deposits). Discontinuous, gray, leached zones lead to dark brown-to-reddish-brown, loose to friable upper horizons. These are typically underlain by a yellowish-brown horizon that in turn overlies a more compact horizon with reddish-brown and grayish-brown mottles. Soil classifications for Bose include Duric and Orthic Humo-Ferric Podzols.

Exposed bedrock bluffs and short cliffs are also very common on Bowen Island, seen along the shorelines and throughout the middle of the island (*i.e.*, along Eagle Cliff and Windjammer Roads). The bluffs range from vertical to steep slopes (>70%) and have very rapid drainage. There is little to no soil development on these areas of exposed bedrock.

Mid to Upper Slopes

Surficial Material

The upper slopes on Bowen consist of thin tills (less than 0.5 m in depth) and colluvial deposits. The colluvial deposits are typically 0.5 m – 1.0 m in depth and at the base of steep slopes can be up to 1.5 m in depth, tapering downslope. The colluvial deposits have angular to sub angular rubblely sandy textures with 35% to 80% coarse fragment content (higher coarse fragment percent closer to the source). Thin colluvial deposits (less than 0.3 m) are located on steep (>70%) bedrock slopes where very small patches of vegetation were observed (*i.e.*, in the Mt Gardner and Mt. Collins areas, as well as along bluffs).

In a few of these steeper areas, older, and a few recent, debris slides were observed, mostly along the west side of Mt Gardner and as small rockslides and rockfalls along bedrock bluffs throughout the island. Exposed bedrock bluffs and short cliffs are also very common in the upper slope and ridge areas, having little to know soil development and very rapid drainage.

Soil Types

Kenworthy soils are associated with the rubbly and sometimes unstable colluvial deposits on steep gradients. They are typically friable, moderately coarse textured loamy sands to sands, with reddish brown to yellowish brown soils (lower horizons). Soils associations typically found with these deposits include Orthic Humo-Ferric Podzol. Where rock is not exposed, the most common soils associated with these areas include the Eunice and Paton Soils (steeper rocky and colluvial slopes) with rapid to very rapid drainage and Cannell Soils (thinner tills with well to rapidly drained soils). Eunice and Paton soils and very steeply slopes gradients. The Eunice Soils occupy the upper slopes and rock ridges have thin partially decomposed surface layers with matted friable grayish, strongly leached (organic) horizons overlying granitic bedrock. Paton Soils include are located along the steeper slopes, with thicker colluvial deposits with very coarse textured soils typically found along or at the base of rocky areas (*i.e.*, talus). The soils are typically loose to very friable, dark reddish brown and can consist of stony angular rubble. Common soil classifications include Orthic Ferro-Humic Podzol, Typic Folisols, and Regosols.

Lower Slopes and Depressional Areas

Surficial Material

The lower slopes and depressional areas with slopes between 0 – 30% were observed in valleys (*i.e.*, Killarney Lake and Mt Gardner Road and Grafton Lake and Road) and terrain leading to modern beaches and areas (*i.e.*, Tunstall Bay and Deep Bay). The terrain includes scattered deposits of marine lag or glaciofluvial (or fluvial) deposits that overly thick, moderately coarse textured till or fine textured glaciomarine sediments. Textures abruptly change from gravelly sands and loamy sands or silty clay loams on the subsurface to sandy loam (till) below. Till deposits in the valleys are typically between 1.0 m – 4.0 m thick (an excavated pit just southwest of Killarney Lake exposed tills that were around 10 m in depth) and were observed as blankets or rolling terrain. The tills have sandy to loamy textures, coarse fragments ranging from 10% – 25%, were moderately well drained, and were similar to till deposits observed on mid-slopes.

In a few locations; glaciomarine deposits between 0.3 m and 1.0 m in depth overlie the tills (*i.e.*, along Mt Gardner Road); or were observed as blanket deposits at least 1.0 m – 2.0 m in depth (in discrete pockets near shorelines and lakes). These deposits were found on level terrain and have loamy to silty clay textures, no to very few coarse fragments, and moderately well to imperfectly drained soils. Coarse textured, well drained glaciofluvial and fluvial deposits were observed west and southwest of the Grafton Lake area towards Tunstall Bay, south of Sunset Park Estates, near Cowan Point and Seymour Bay and in discrete pockets near modern streams. The glaciofluvial deposits were typically between 0.5 m (overlying till or glaciomarine) to 5.0 m (less common blanket deposits) in depth, with greater than 60% rounded to sub-rounded coarse fragments and well to rapidly drained soils. Fluvial sediments were observed along modern creeks and southwest of Grafton Lake as a fluvial fan overlying thick glaciofluvial and till deposits. Gravelly, sandy glaciofluvial deposits located in the southwestern area, as well as in the northern area (above and to the west of Mt Gardner Road) are several active and inactive gravel quarries.

Scattered organic soils were observed in small, discrete pockets, located on level to gently slope or undulating slopes that are less than 5%. They are associated with depressional areas, floodplain areas, and seepage and runoff receiving areas.

Soil Types

Soils associated with the overlying and thick deposits include the Bose, Boosey, Murrayville, and Sunshine Soils. The Bose and Boosey Soils include marine lag or glaciofluvial deposits overlying tills and in some cases glaciomarine deposits. They typically consist of friable, yellowish-brown colored soils with high coarse fragment content overlying the brownish-red till or grayish brown glaciomarine deposits. The Murrayville Soils include coarse textured glaciofluvial and fluvial sediments that typically overlie fine textured marine sediments (these were not commonly observed during the field inspections). The thicker coarse textured glaciofluvial and fluvial deposits that overlie till deposits are associated with Sunshine Soils. Common soil associations include Orthic Humo-Ferric Podzols and Gleyed Humo-Ferric Podzols.

Organic soils consist of decomposed organics or weakly structured, fine textured soils derived from eroded tills or glaciomarine deposits. These soils were seen at the base of steep, narrow ridges (receiving sites), and in small pockets around present day lakes. Typical soil associations include Rego Gleysol and Terric Mesisols. Soils observed on Bowen were classified as Humo Ferric Podzols.

4.3.1.2 Vegetation and Ecosystems

Bowen Island contains all three biogeoclimatic subzones present in the study area, CWHxm1, CWHdm, and CWHvm2. The CWHxm1 subzone dominates the island, but also contains a considerable amount of CWHdm at elevations above 150 m. Above 650 m, on Mount Gardner, the CWHvm2 subzone occurs in three ecosystem polygons.

Bowen Island has been heavily logged in lower elevations, however, several parks and ecological reserves contain mature forests. The remaining young forests are dominated by western hemlock and Douglas-fir, often consisting of planted stands. Residential and agricultural development is scattered throughout the lower elevation valleys and only intensively cleared at a handful of dispersed communities.

The CWHxm1/CWHdm transition was difficult to locate in the field particularly on the southern portions of the island. Coastal bluffs along the south end of Bowen (Cape Roger Curtis), including the Paisley Island group, contained a mixture of dry, sparsely vegetated ecosystems, such as Selaginella-Cladina (mapcode SC), Douglas-fir/shore pine-Cladina (mapcode DC), and rock outcrops (mapcode RO). A unique species of tree/shrub, called seaside juniper (*Juniperus maritima*), was observed along these rocky bluff communities. Seaside juniper is a newly described tree/shrub that was formerly lumped into the Rocky Mountain juniper (*Juniperus scopulorum*) classification.

Rich forests were commonly mixed with medium-nutrient sites in lower elevational forests, often occurring on gently sloped terrain between shallow rock outcrops. At increasing elevations, mid-sloped forests were typical of the biogeoclimatic subzones, but also contained richer ecosystems in moisture receiving areas and dryer sites on shallower soils. Western hemlock, western redcedar and grand fir were common where the ecosystems were moister, while Douglas-fir stands were found on shedding sites. Bigleaf maple and red alder was also a common tree species on Bowen Island and was observed in a variety of rich site conditions.

Bowen Island contained a limited number of wetland ecosystems, often associated with depressional areas around lakes and creeks. The most common wetland type was the Sweet gale – Sitka sedge site association adjacent to Josephine, Grafton and Killarney Lakes. Small marsh communities and swamps were also observed scattered around lake edges and slow moving creeks.

The steep, south-facing slopes of Mount Gardner, Mount Collins and the ecological reserve #48 west of Apodaca Cove contained an abundance of dry, Douglas-fir dominated ecosystems and rock outcrops.

4.3.2 Gambier Island

Gambier Island is the largest island in Howe Sound, occupying about 6930 ha, 49.6% of the study area. It is positioned north of Bowen Island, between Lions Bay and Port Mellon. Gambier Island is about 3 km east of the Sunshine Coast, across Thornbrough Channel. Elevational limits extend to 900 m.

4.3.2.1 Bioterrain and Soils

Northern Gambier Island has several mountain ridges with broad saddles at the upper elevations and steep slopes leading to the ocean. The southern portion of Gambier consists of three elongated bays with areas of low relief on lower elevations, leading into hummocky coast lines, and bluffs along mountain peaks. There are also several deeply incised, bedrock controlled gullies located throughout the island. As the majority of Gambier Island is relatively steep and rocky, the landscape is dominated by till veneers mantles and colluvial deposits. The lower slope and bay areas have smaller deposits of glaciomarine and marine deposits near present day shorelines and only a very small site has glaciofluvial deposits. Organics and lacustrine deposits were observed only in very small pockets. Glaciomarine and marine are less common along low elevation shorelines and in some areas, appear to be under tidal influence.

Low to Mid Slopes

Surficial Material

The most common surficial materials include hummocky till deposits located from sea level to the base of ridges; slopes range from 5% – 70%. These till deposits are similar to those seen on Bowen and surrounding islands. Tills located on the lower slopes include thick blankets between 1.0 m to ~4.0 m in depth, draping low lying narrow valleys between bays and along broad benches between bedrock hummocks. These thicker tills have silty, diamictic, sandy loam textures with sub-rounded and 15% – 30% coarse fragment content. Soils were typically moderately well to well drained depending on percent of sand. Thinner till mantles were interspersed with exposed bedrock hummocks and bluffs throughout the island.

Thinner till deposits are more common on the steeper slopes, as well as upper slopes leading to a broad saddle on top of the island (*i.e.*, terrain surrounding Lost Lake, Gambier Lake and Damsoon Lake between bedrock ridges). Depths ranged from 0.2 m – 2.0 m with silty, diamictic, sandy textures and 20% – 35% sub-angular to sub-rounded coarse fragment content. The soils ranged from well drained along thin deposits on the sides of steeper hummocks, to moderately well and imperfectly drained in deeper pockets between hummocks.

Coarse textured, well drained glaciofluvial were observed and mapped only in the southwestern area of Gambier along Mannion Creek. The glaciofluvial deposits in this area likely range from typically between 0.5 m (overlying till) to several meters in depth, with gravelly, sandy textures and greater than 35% coarse fragment contents. Soils associated with these deposits are typically well to rapidly drained. Scattered, gravelly, sandy modern fluvial sediments were observed along active creeks along gentle terrain.

Soil Types

The most common soils associated with the till deposits are the Bose, Cannell, and Buntzen Soils. The Bose and Cannell soils generally have a loose to friable, leached sandy layer overlying reddish-brown and grayish-brown soils. Buntzen soils are typically located on steeper slopes and are moderately coarse textured, dark reddish brown in upper horizons to yellowish brown lower horizons. Common soil classifications include Orthic Humo-Ferric Podzols and Duric Ferro-Humic Podzols.

The thicker coarse textured glaciofluvial and fluvial deposits that overly till deposits are associated with Hopedale and Sunshine Soils. Hopedale soils have developed from more recent streams and are typically medium textured, occasionally gravelly stream deposits and fan deposits. They are typically up to 0.5 m thick and overly coarse textured sediments, and have loamy textures with poor drainage. Hopedale soils are mapped, and were in part, observed, along the stream flowing into Port Graves. Typical classifications include Rego Gleysols and Orthic Gleysols. Sunshine Soils, as seen on Bowen, have developed from glaciofluvial and fluvial deposits usually between 1 m – 2 m thick and overly till deposits on Gambier. Typical Sunshine Soil classifications include Orthic Humo-Ferric Podzols.

Lower Slopes and Depressional Areas

Surficial Material

In a few locations; glaciomarine deposits between 2.0 m to 3.5 m+ were observed on lower slopes leading to bays (*i.e.*, north-northwest of the end of Port Graves and upslope from Douglas Bay). These deposits have silty clay to loamy textures, no coarse fragments, and imperfectly to moderately well drained soils. An exposure along a small creek leading to Port Graves showed ~3 m thick, glaciomarine deposit overlain by a 1.5 m thick sandier, higher coarse fragment unit. Thin glaciomarine and marine (< 0.3 m in depth) were also observed as discontinuous pockets between coastline hummocks.

Scattered organic soils were observed in small, discrete pockets in seepage and runoff receiving areas and were seen at the base of steep, narrow ridges (receiving sites), and in small pockets around present day lakes (*i.e.*, Lost Lake). They consist of decomposed organics (mesic) or weakly structured, fine textured soils derived from eroded tills or glaciomarine deposits. One area in the receiving basin at the headwaters of Mannion Creek has mapped and observed glaciolacustrine deposits around a small lake.

Soil Types

These are also mapped as the Bose and Boosey soils, with marine lag overlying glaciomarine sediments. Common soil associations include Orthic and Duric Humo-Ferric Podzols and Rego Humic Gleysols. The organics includes thick fine textured sediments with poor drainage. Typical soil associations include Rego Gleysol and Terric Mesisols.

Mid to Upper Slopes

Surficial Material

Also very common on Gambier Island are bedrock outcrops and steep bluffs with steep uniform slopes leading from prominent ridgelines (Mt. Lidel, Mt. Kilham, and Mt. Artaban), as well as gullied creek channels along these steep slopes. Steep 60% – 90% gradients with uniform slopes consisting of sandy, rubbly colluvium and sandy diamictic till veneers are located in the northern and south western areas of the island. They are typically between 0.2 m and 1.0 m in depth and have rapidly to well-drained soils. Very thin (<0.3 m deep) veneers located on forested patches between vertical bluffs and have rapidly drained soils.

Thicker colluvial deposits (1.0 m – 2.0 m in depth) are located near the base of steep slopes in the form of blankets, or cones and fans. There are several gullies and mass movement processes that are associated with this steep terrain, predominantly in the northern area of the island. This includes fairly recent rockslides and debris slides, with smaller debris flows along gullied channels.

Soil Types

Where rock is not exposed, the most common soils associations are the Eunice Soils, and to a lesser extent the Paton and Kenworthy soils. The Eunice Soils on Gambier are associated with the thin colluvium and tills found between bedrock bluffs and include partially decomposed, strongly leached (grayish) horizons with decomposed bedrock overlying granitic bedrock. The Paton Soils are seen along the steeper uniform slopes, with thicker colluvial deposits.

Kenworthy soils are also likely in these areas where unstable colluvial deposits and active geomorphic processes are occurring. Soils associations typically found with these deposits include Orthic Humo-Ferric Podzols, Orthic Ferro-Humic Podzol, Typic Folisols, and Regosols.

Soils observed on Gambier were classified as Humo Ferric Podzols and Humic Gleysols.

4.3.2.2 Vegetation and Ecosystems

Gambier Island contains all three biogeoclimatic subzones present in the study area, CWHxm1, CWHdm, and CWHvm2. The CWHxm1 subzone dominates the island on the lower slopes with almost an equal portion of the CWHdm on the middle and upper slopes. A substantial amount of CWHxm occurs on the southern fingers below 150 m but does not extend to the northern slopes of the island. Due to the very steep slopes and northerly position of the island, the CWHxm subzone does not continue around the island. Above 650 m, the CWHvm2 variant occurs on two western peaks, Mount Killam and Mount Liddell.

The lower elevations of Gambier Island have been logged several times; however the upper steep slopes still contain substantial mature forests. Young forests are dominated by western hemlock and Douglas-fir, with various deciduous tree species, like bigleaf maple and red alder.

Residential development is growing on Gambier, mainly on the southernmost level portions, but has begun to reach upper slopes. The southeastern divide between Port Graves and Brigade Bay, north of Mount Artaban is highly developed and the eastern slopes of Gambier Island has experienced extensive logging.

The most prominent features of Gambier Island are the deep inlets between the southern land masses to the south. These bays contain mudflats at the mouths of the rivers entering Howe Sound. Steep forested slopes and bedrock outcrops cover much of the island landscape. The dry, rocky areas are associated with shallow forests dominated by Douglas-fir and western hemlock. Western redcedar is also dispersed throughout much of the island in moisture receiving areas.

4.3.3 Anvil Island

Anvil Island is the third largest island in Howe Sound, occupying about 2500 ha, 6.7% of the study area. It is the most northerly island, located across Montagu Channel, approximately 3 km west of Porteau Cove. Anvil Island is positioned at the mouth of Squamish Harbour leading out to Howe Sound. Elevational limits extend to 750 m.

4.3.3.1 Bioterrain and Soils

Anvil Island is very rugged, with Leading Peak in the centre and steep slopes leading to a broad saddle in the north towards Domett Point, and a smaller bench along the shoreline towards Irby Point in the south. The top of Anvil Island consists of a small plateau leading to the steep bedrock bluffs. The western and eastern slopes are also very steep, and leading to narrow benches of hummocky terrain before reaching the ocean.

Lower to Mid-slopes

Surficial Materials

The hummocky terrain located along the central plateau, the northern saddle, and the lower slope benches consists of till mantles and exposed bedrock. The tills are 0.5 m – 3.0 m in thickness with diamictic sandy textures and 20% – 40% coarse fragment content. Slopes range from 10% – 60% and have well and rapidly drained soils. Thinner tills (0.1 m – 0.3 m in depth) were observed on bedrock hummocks with scattered pockets of vegetation along coast lines.

Soil Types

As with the neighboring Gambier Island, the most common soils associated with the till deposits are the Bose, Cannell, and Buntzen Soils with common soil classifications including Orthic Humo-Ferric Podzols and Duric Ferro-Humic Podzols.

Mid to Upper Slopes

Surficial Materials

Thick colluvial deposits, with a mix of thinner till deposits, are located along the majority of the upper and middle slopes. The colluvial deposits consist of 0.5 m – 2.0 m thick, blocky, rubbly soils with 40% – 80% angular coarse fragments. The soils are rapidly to well-drained. Inactive rockfall and rockslides are common with these deposits.

Exposed bedrock was also common throughout the steeply sloped area with very thin colluvium (less than 0.3 m) and/or decomposed bedrock, with very rapidly drained soils.

Soil Types

Similar to Gambier Island, where rock is not exposed, the most common soils associations are the Eunice Soils, and to a lesser extent the Paton and Kenworthy soils. Soils associations include Orthic Humo-Ferric Podzol, Orthic Ferro-Humic Podzol, Typic Folisols, and Regosols.

Lower Slopes and Depressional Areas

Surficial Materials

The southeastern area of Anvil Island consists of gentle terrain with a mix of thick glaciomarine, marine, and till deposits. The glaciomarine deposits are located between Points with exposed bedrock hummocks and the steep slopes leading to the peak. They are 1.0 m – 5.0 m+ deep and have clayey, silty textures and no coarse fragments. Pockets of higher clay percent are located in the southern tip area just north of Irby Point. In places (*i.e.*, along tributaries flowing from Champside Creek to the ocean), the clayey deposits are overlain by silty, loamy soils with 15% – 25% coarse fragments. The glaciomarine deposits are imperfectly to moderately well-drained.

The thicker till deposits are located near the base of the steep slopes and further northeast of Irby Point along Montagu Channel. Here, they are likely 0.5 m – 2.0 m in depth and are located along slightly more hummocky terrain. The soils are moderately well to well drained.

Soil Types

These areas are mapped as the Bose and Boosey soils, with marine lag overlying glaciomarine sediments. Common soil associations include Orthic and Duric Humo-Ferric Podzols and Rego and Orthic Humic Gleysols, and likely variants of Luvisols depending on clay content.

Soils observed on Anvil were classified as Humo Ferric Podzols.

4.3.3.2 Vegetation and Ecosystems

Anvil Island contains two biogeoclimatic subzones present in the study area, CWHxm1 and CWHdm. The CWHdm subzone dominates the island and only contains a small strip of CWHxm at the south and east elevations below 150 m. Due to the very steep slopes and northerly position of the island, the CWHxm subzone does not continue around the island. Above 650 m, the CWHdm is still present on Leading Peak.

Anvil Island has been logged in lower elevations; however the upper steep slopes have substantial mature forests. The young forests are dominated by western hemlock and Douglas-fir, with various deciduous tree species, like bigleaf maple and red alder. Residential development is limited to small cottages on the southernmost level portions. A brick manufacturing plant was once located on the southern shore of the island and today rejected bricks can be found strewn along the beaches. The southeastern point of Anvil Island contains a large stand of red alder as a result of blowdown from a recent wind storm.

The most striking feature of Anvil Island is the amount of bedrock outcrops and steep unvegetated cliffs that cover much of the landscape. The rocky areas are associated with dry, shallow forests dominated by Douglas-fir and western hemlock. Western redcedar is also dispersed throughout much of the island in moisture receiving areas.

4.3.4 Keats Island

Keats Island is the fourth largest island in Howe Sound, occupying about 596.5 ha, 4.3% of the study area. It is the most westerly island, located across Shoal Channel, approximately 2 km east of Gibsons. Keats Island is positioned west of Bowen Island with the Paisley Island group to the south. Elevational limits extend to 2000 m.

4.3.4.1 Bioterrain and Soils

Keats Island consists of hummocky terrain with gentle to moderately steep slopes. The eastern side of Keats has several bedrock outcrops and small bluffs with till mantles. The western area is narrower, and consists of till blankets on lower slopes with scattered exposed bedrock hummocks and thinner tills on higher elevations. Central Keats is dominated by thicker till deposits on gentler terrain, with a small pocket of exposed glaciofluvial deposits. Glaciomarine and marine are less common along low elevation shorelines and in some areas, appear to be under tidal influence.

Lower Slopes

The shoreline of Keats includes scattered exposed bedrock hummocks (*i.e.*, Easterbourne, Plumper Cove, and Beachcomber Point areas) with uniform slopes of thick tills between outcrops (*i.e.*, Barnabas Camp and Keats Landing areas). This lower elevation hummocky terrain ranges from 10% – 50%, with till mantles typically ranging from 0.3 m – 2.0 m in depth. They have diamictic, sandy textures, with loose to slightly friable horizons and well drained and rapidly drained soils and 20% – 35% sub-rounded to sub-angular coarse fragment content (similar to tills observed on Bowen and Gambier).

Lower to Mid Slopes

Uniform slopes leading from the shore inland range from 5% – 40% and are typically thick tills (1.0 m – 5.0 m in depth) and are well to moderately well-drained. Coarse fragment content is 15% – 25% with sub-rounded clasts and diamictic sandy to loamy textures. Similar characteristic thick till deposits are also located on pockets of gentle terrain between bedrock outcrops throughout the island (*i.e.*, just west of Keats Camp and the eastern branch of Eastbourne Road).

Mid to Upper slopes

Surficial Geology

The higher elevations on Keats (*i.e.*, the Skookum Chief in the north, and small hills in the south east and western tip of the island) are dominated by bedrock. These areas consist of steeper hummocks and exposed bedrock, with slopes ranging between 40% – 70%. Here tills are thinner, between 0.3 m and 1.0 m in depth, and are interspersed with numerous exposed bedrock outcrops. In a few places where slopes are longer (*i.e.*, northwestern slopes leading to Sandy Beach and northeastern slopes of Skookum Chief), minor traces of rubblely colluvium were observed. Soils in these areas are rapidly and well drained, have sandy, diamictic textures, with 20% – 40% coarse fragment content.

In the north central area of Keats just north of the junction between Eastbourne Road and Corkum Road, is a small gravel quarry. The terrain here includes a 3 m – 5 m thick gravelly, sandy glaciofluvial fan deposit overlying 4 m – 6 m thick diamictic, sandy tills. The soils here are well to rapidly drained, and grade into thick till blankets downslope.

Soil Types

Soil associations for Keats Island include Cannell and Bose soils. Cannell soils here are found in the more hummocky terrain and include shallower till deposits and some colluvium. The soils are typically reddish brown with sandy textures, and drape granitic bedrock. Common soil classifications are Orthic Humo-Ferric Podzol, lithic phase, or Dystric Brunisol; lithic phase. The Bose soils on Keats are found where till deposits are more thick and uniform, and where the glaciofluvial deposits overly the till. The Bose soils here are loose, and grade from gravelly more coarse textured to finer sand and loamy textures, with dark, reddish brown horizons. In places, grayish to yellowish-brown mottles were observed.

Soils observed on Keats were classified as Humo Ferric Podzols.

4.3.4.2 Vegetation and Ecosystems

Keats Island contains only one of the biogeoclimatic subzones present in the study area, CWHxm1, as the island is essentially below 150 m elevation.

The majority of Keats Island has been previously logged, however, young and mature forests are now present throughout much of the landscape.

The upper and mid slopes on Keats Island are dominated by a mixture of the Western hemlock/Douglas-fir – *Kindbergia* (HK) and the Western redcedar – Sword fern (RS) ecosystems. Lower slope and level sites were dominated by the HK and Western hemlock/Western redcedar – Deer fern (HD) ecosystems, especially in the north central portion of the island. The Douglas-fir/Lodgepole pine – *Cladina* (DC) ecosystem was common in crest positions and associated predominantly with the *Selaginella* – *Cladina* (SC) and rock outcrop ecosystems, with the HK and *Arbutus* – Hairy manzanita (AM) ecosystems also occurring as a minor component in these areas.

Residential development occurs throughout Keats Island with the majority along the coast and in the southeast portion of the island. There are also two large camps present on the island where land clearing has occurred previously, Keats Camp to the southwest and Barnabas Camp to the north.

4.3.5 Smaller Islands and Islets

Many smaller islands and islets occupy Howe Sound, distributed adjacent to the larger islands. In the northwest, Woolridge Island is one of the larger of the small island groups protected by Gambier Island, whereas Passage Island, in the southeast, is exposed to the winds from the Strait of Georgia.

4.3.5.1 Bioterrain and Soils

Exposed bedrock hummocks and short bluffs are the dominant landscape on most of these islands. Surficial materials on these islands include very thin tills (0.1 m – 0.3 m) along tops of bedrock hummocks where small forest patches are located, and likely thicker tills between 0.3 m – 1.0 m in deep pockets between bedrock outcrops. The soils are rapidly and very rapidly drained along bedrock hummocks, and well drained where till mantles occur. Glaciomarine and marine are less common along low elevation shorelines and in some areas, appear to be under tidal influence.

Soil associations for these islands include Cannell and Bose soils. Cannell soils here include the hummocky bedrock and till mantle deposits with soil classifications typically including Orthic Humo-Ferric Podzol, lithic phase, or Dystric Brunisol; lithic phase. The Bose soils on these islands are likely located with the till mantles are deeper and more developed, and where glaciomarine lag deposits are located near shorelines.

4.3.5.2 Vegetation and Ecosystems

Similar to Keats Island, all of the smaller islands and islets in the study area lie in the CWHxm1, as these island groups are all below 150 m elevation.

These islands are often uninhabited and are composed of scattered vegetation, sometimes almost completely bare rock. On some of the smaller islands, assemblages of vegetation are unique due to their exposed status. For example, Christie Island is home to a variety of bird and mammal species well adapted to the harsh marine environment.

Common ecosystems on these small islands include the Selaginella – Cladina unit (SC) and the dry Douglas-fir/shore pine –Cladina site series (DC). In some instances, such as the Grace Islands, the Arbutus – Hairy Manzanita shrub unit (AM) has developed, which is considered imperiled in BC (CDC, 2009).

4.4 Project Limitations

Project limitations were few and included poor site accessibility, and lack of background plot data. Access to private property was the primary limitation to sampling. Private land access was not as successful as we had hoped due to the low response from private landowners. In addition, public/Crown land was inaccessible when surrounded by unroaded private lands. While every effort to sample consistently across the study area was made, not all ecosystem types could be directly observed. In an effort to minimize this limitation, we based our mapping around these questionable areas on supporting information and background research, such as previous SEI sampling.

Also, we had planned on using data collected for a number of ecosystem assessments in Howe Sound provided to us by Islands Trust. Unfortunately, although the reports contained excellent ecosystem descriptions and plant lists which were used to aid mapping, no plot specific data was available, which ultimately decreased our use of historic data counting towards plot data.

5.0 CONCLUSION

One of the goals achieved for this project was to obtain a high level of field sampling, equivalent to an overall Level 4 survey intensity (15% – 24%) as per the Provincial TEM Standards (RISC, 2001). To achieve this goal, a stratified sampling strategy was designed to collect field data from as many types of ecosystems as possible throughout the study area.

An extensive private landowner contact program was completed, as private (non-Crown) land was the focus of field verification. Field inspections were distributed across the study area on a wide range of ecosystems and site conditions throughout Howe Sound.

Mapping revealed that although the project area contains a diverse range of forested and non-forested ecosystems, including wetlands, and coastal bluffs, many areas have been impacted by logging over the past century. While some of these patterns are certainly associated with land tenure, an integrated framework for land use can be used to guide priorities for regional outcomes. Considering the islands in Howe Sound as a single, integrated system may aid planners to better evaluate the potential impacts of resource and land use decisions across jurisdictions.

In combination with the previously completed CDFmm TEM study and the Gulf Islands National Park ecosystem mapping, Islands Trust now has complete TEM coverage for all of their planning areas. The ecosystem mapping will provide baseline information that can be used in support of future land-use planning initiatives.

6.0 REFERENCES CITED

- AXYS Environmental Consulting Ltd. 2005. Redigitizing of sensitive ecosystems inventory polygons to exclude disturbed areas. Report to Canadian Wildlife Service. Sidney, B.C. 27 pp.
- B.C. Conservation Data Centre (CDC). 2009. BC Species and Ecosystems Explorer. B.C. Min. Environ., Victoria, B.C. <http://srmapps.gov.bc.ca/apps/eswp/> (accessed September 1, 2009).
- B.C. Ministry of Energy and Mines. 2009. B.C. Geological Survey Geology. Victoria, B.C MapPlace <http://webmap.em.gov.bc.ca/mapplace/minpot/bcgscfm>. Accessed August 28, 2009.
- B.C. Ministry of Environment. 1975. Bowen Island Terrain Analysis: Slope Analysis. 1:10,000-scale map (77-104T-O). Ministry of Environment Surveys and Mapping Branch, Victoria BC.
- B.C. Ministry of Environment. 2006. Standard for mapping ecosystems at risk in British Columbia: An approach to mapping ecosystems at risk and other sensitive ecosystems. Version 1. B.C. Min. Environ., Victoria, B.C. 98 pp.
- B.C. Ministry of Sustainable Resource Management (MSRM). 2008. The Soil Landscapes of British Columbia. <http://www.env.gov.bc.ca/soils/landscape/index.html>. Accessed September 1, 2009.
- B.C. Ministry of Environment. 2009. Ecosystems Branch, Ecology: Terrestrial & Predictive Ecosystem Mapping. Provincial Site Series & Map Code List. – March 2006. <http://www.env.gov.bc.ca/ecology/tem/list.html> Accessed January 5, 2009.
- Bichler, A.J., E.D. Brooks, and P.T. Bobrowsky. 2002. Sunshine Coast aggregate potential mapping project. *In*: B.C. Ministry of Energy and Mines, Geological Fieldwork 2001, Paper 2002-1, pp. 147-153.

- Cascade Environmental Resource Group Ltd. (Cascade). 2005. Brigade Bay Bluffs and Long Bay Wetland Nature Reserve Management Plan, Gambier Island, BC. Islands Trust Fund.
- Clague, J.L. 1994. Quaternary stratigraphy and history of south-coastal British Columbia. *In: Geology and geological hazards of the Vancouver region, southwestern British Columbia*, J.W.H. Monger (ed.) Geological Survey of Canada, Bull. 481:181-192.
- Demarchi, D.A. 1996. An Introduction to the Ecoregions of British Columbia. Wildlife Branch, Ministry of Environment, Lands and Parks. Victoria, British Columbia
- Doyle, D and T. Yadao. 1999. Old-Growth Forests on Gambier Island, BC.
- Dunster and Associates Env. Cons. Ltd. 1999. Biophysical assessment and preliminary planning concept for Cowan Point Lands, Bowen Island, B.C.
- Dunster and Associates Env. Cons. Ltd. 2000. The crown lands of Bowen Island: an inventory and assessment of resource values. Islands Trust and GVRD.
- Durand, Meeri and Ryan Durand. (Taara Environmental). 2007. Management Plan for David Otter Nature Reserve Bowen Island, BC. Islands Trust.
- Gabrielse, H., J.W.H. Monger, J.O. Wheeler, and C.J. Yorath. 1991. Morphological belts, tectonic assemblages, and terrains. *In: Geology of the Cordilleran Orogen in Canada*. H. Gabrielse and C.J. Yorath (eds.); Geological Survey of Canada, Geology of Canada. 4(2/A):15-28.
- Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. Land Manage. Handb. 28. B.C. Min. For., Victoria, B.C.
- Green, R.N. 2007. Terrestrial Ecosystem Mapping of the Southern Gulf Islands. B.A. Blackwell and Associates Ltd.
- Holland, S.S. 1976. Landforms of British Columbia: A Physiographic Outline. Bulletin 48. Province of British Columbia.
- Hopwood, Doug. 2009. Mount Artaban Nature Reserve Management Plan, Gambier Island, BC. Island Trust.

- Howes, D.E. and E. Kenk. 1997. Terrain classification system for British Columbia. Revised edition. Manual 10. B.C. Ministry of Environment, Lands, and Parks. Victoria, B.C.
- Klinka, Karel. 2005. Ecological Assessment and Considerations in Developing the Cape Roger Curtis Property.
- Lacelle, L., 1984. Ministry of Environment. Gambier – Anvil Islands Terrain Mapping. 1:20,000- scale map published by the Surveys and Resource Mapping Branch for the MoE, Kelowna, BC.
- Luttmerding, H.A., 1980. Soils of the Langley-Vancouver Map Area (RAB Bulletin 18, Report No. 15): Volume 2 Soils Maps and Legend Sunshine Coast and Southern Coast Mountains (Scale 1:50 000). British Columbia Soil Survey, Kelowna, BC.
- Luttmerding, H.A., 1981. Soils of the Langley-Vancouver Map Area (RAB Bulletin 18, Report No. 15): Volume 3 Description of the Soils. British Columbia Soil Survey, Kelowna, BC.
- Luttmerding, H.A., D.A. Demarchi, E.C. Lea, D.V. Meidinger, and T. Vold. 1998. Describing Ecosystems in the Field. Manual 11. B.C. Ministry of Environment, Lands, and Parks. Victoria, B.C.
- Madrone Environmental Services Ltd. 2008a. Terrestrial Ecosystem Mapping of Saltspring Island (1:10,000). Contract report to Integrated Land Management Bureau. 103 pp.
- Madrone Environmental Services Ltd. 2008b. Terrestrial Ecosystem Mapping of the Coastal Douglas-fir Biogeoclimatic zone Island (1:16,000). Contract report to Integrated Land Management Bureau. 74 pp.
- Mackenzie, W.H. and A. Banner. 2001. A Classification Framework for Wetlands and related Ecosystems in British Columbia: third approximation. <http://www.for.gov.bc.ca/research/becweb/> (accessed January, 2008).
- Mackenzie, W.H. and J.R. Moran. 2004. Wetlands of British Columbia: a guide to identification. Res. Br., B.C. Min. For., Victoria, BC. Land Manage. Handb. No. 52.

- Maynard D., Ministry of Environment (1977-fieldwork; Pub. Date unknown). Bowen Island Terrain Analysis: Base Data. 1:10,000-scale map (77-104T-O). Ministry of Environment Surveys and Mapping Branch, Victoria BC.
- Pottinger Gaherty Environmental Consultants Ltd. (PGL). 2000. Management Plan for Singing Woods Nature Reserve, Bowen Island, BC. Islands Trust Fund
- Pottinger Gaherty Environmental Consultants Ltd. (PGL). 2005. CRC Joint Ventures Overview Environmental Inventory – Cape Roger Curtis, Bowen Island, BC
- Province of British Columbia. 2009. BC Minerals Title Online website Available at: <http://www.mtonline.gov.bc.ca/mtov/home.do>. Accessed September 1, 2009.
- Resources Inventory Committee (RIC). 1996. Standards and guidelines for terrain mapping in British Columbia. RISC, Surficial Geology Task Group, Victoria, B.C.
- Resources Inventory Standards Committee (RISC). 1998a. Standard for terrestrial ecosystem mapping in British Columbia. Ecosystems Working Group, Resources Inventory Standards Committee. Victoria, B.C.
- Resource Inventory Standards Committee (RISC). 1998b. Field manual for describing terrestrial ecosystems. Co-published by B.C. Min. For. and B.C. Min. Environ. Prov. of B.C., Victoria, BC.
- Resource Inventory Standards Committee (RISC). 2000. Standard for digital terrestrial ecosystem mapping (TEM) data capture in British Columbia. Ecosystem Technical Standards & Database Manual, Version 3.0. RISC, Ecosystems Working Group, Victoria, B.C.
- Resource Inventory Standards Committee (RISC). 2002. Digital terrestrial ecosystem mapping data capture (DC) user's guide. RISC, Ecosystems Working Group, Victoria, B.C.
- Resource Inventory Standards Committee (RISC). 2004. Standard for terrestrial ecosystem mapping (TEM) - digital data capture in British Columbia, Version 3.0, Errata No. 1.0. RISC, Ecosystems Working Group, Victoria, B.C.

Soil Classification Working Group. 1998. The Canadian System of Soil Classification, 3rd Edition. Research Branch, Agriculture and Agri-Food Canada Publication: National Research Council of Canada, Ottawa.

Ward, P., G. Radcliffe, J. Kirkby, J. Illingworth and C. Cadrin. 1998. Sensitive Ecosystems Inventory: East Vancouver Island and Gulf Islands, 1993-1997. Volume 1: Methodology, Ecological Descriptions and Results. Technical Report Series No. 320, Canadian Wildlife Service, Pacific and Yukon Region, B.C.



APPENDIX I

Red- and Blue-listed Ecosystems in Howe Sound

Appendix I. Red- and Blue-listed Ecosystems in Howe Sound

Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit
<i>Arbutus menziesii</i> / <i>Arctostaphylos columbiana</i>	arbutus / hairy manzanita	G2	S2	Red	CWHxm1/00
<i>Carex lasiocarpa</i> - <i>Rhynchospora alba</i>	slender sedge - white beak-rush	G2	S2	Red	CWHxm1/Wf53
<i>Carex sitchensis</i> / <i>Sphagnum</i> spp.	Sitka sedge / peat-mosses	G2	S2	Red	CWHvm2/Wf51
<i>Leymus mollis</i> ssp. <i>mollis</i> - <i>Lathyrus japonicus</i>	dune wildrye - beach pea	GNR	S1S2	Red	CWHdm;CWHxm1
<i>Myrica gale</i> / <i>Carex sitchensis</i>	sweet gale / Sitka sedge	G3	S2	Red	CWHxm1/Wf52
<i>Picea sitchensis</i> / <i>Rubus spectabilis</i> Dry	Sitka spruce / salmonberry Dry	G1G2	S1S2	Red	CWHdm/08
<i>Picea sitchensis</i> / <i>Rubus spectabilis</i> Very Dry Maritime	Sitka spruce / salmonberry Very Dry Maritime	G3	S2	Red	CWHxm1/08
<i>Pseudotsuga menziesii</i> - <i>Pinus contorta</i> / <i>Holodiscus discolor</i> / <i>Cladina</i> spp.	Douglas-fir - lodgepole pine / oceanspray / reindeer lichens	G2G3	S2	Red	CWHdm/02
<i>Pseudotsuga menziesii</i> - <i>Pinus contorta</i> / <i>Racomitrium canescens</i>	Douglas-fir - lodgepole pine / grey rock-moss	GNR	S2	Red	CWHxm1/02
<i>Pseudotsuga menziesii</i> / <i>Polystichum munitum</i>	Douglas-fir / sword fern	G2G4	S2	Red	CWHdm/04;CWHxm1/04
<i>Sidalcea hendersonii</i> Tidal Marsh	Henderson's checkermallow Tidal Marsh	G1	S1	Red	CWHxm1/00
<i>Thuja plicata</i> / <i>Lonicera involucrata</i>	western redcedar / black twinberry	GNR	S2	Red	CWHdm/14;CWHxm1/14
<i>Thuja plicata</i> / <i>Rubus spectabilis</i>	western redcedar / salmonberry	GNR	S1S2	Red	CWHdm/13;CWHxm1/13
<i>Thuja plicata</i> / <i>Tiarella trifoliata</i> Very Dry Maritime	western redcedar / three-leaved foamflower Very Dry Maritime	G3	S2	Red	CWHxm1/07
<i>Tsuga heterophylla</i> - <i>Pseudotsuga menziesii</i> / <i>Eurhynchium oregonum</i>	western hemlock - Douglas-fir / Oregon beaked-moss	G3G4	S2	Red	CWHxm1/01
<i>Tsuga heterophylla</i> - <i>Thuja plicata</i> / <i>Blechnum spicant</i>	western hemlock - western redcedar / deer fern	G2G3	S2	Red	CWHdm/06;CWHxm1/06
<i>Abies amabilis</i> - <i>Picea sitchensis</i> / <i>Oplopanax horridus</i>	amabilis fir - Sitka spruce / devil's club	GNR	S3	Blue	CWHvm2/08
<i>Carex sitchensis</i> - <i>Oenanthe samentosa</i>	Sitka sedge - Pacific water-parsley	G3	S3	Blue	CWHxm1/Wm50
<i>Ledum groenlandicum</i> / <i>Kalmia microphylla</i> / <i>Sphagnum</i> spp.	Labrador tea / western bog-laurel / peat-mosses	G4	S3	Blue	CWHxm1/Wb50
<i>Pinus contorta</i> / <i>Sphagnum</i> spp. Very Dry Maritime	lodgepole pine / peat-mosses Very Dry Maritime	GNR	S3	Blue	CWHxm1/11
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> - <i>Alnus rubra</i> / <i>Rubus spectabilis</i>	black cottonwood - red alder / salmonberry	GNR	S3	Blue	CWHdm/09;CWHxm1/09



Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Salix sitchensis</i>	black cottonwood / Sitka willow	GNR	S2S3	Blue	CWHdm/10;CWHxm1/10
<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> / <i>Gaultheria shallon</i> Dry Maritime	Douglas-fir - western hemlock / salal Dry Maritime	G3G4	S2S3	Blue	CWHdm/03;CWHxm1/03
<i>Salix sitchensis</i> / <i>Carex sitchensis</i>	Sitka willow / Sitka sedge	G3	S3	Blue	CWHvm2/Ws06
<i>Thuja plicata</i> / <i>Carex obnupta</i>	western redcedar / slough sedge	GNR	S2S3	Blue	CWHdm/15;CWHxm1/15
<i>Thuja plicata</i> - <i>Picea sitchensis</i> / <i>Lysichiton americanus</i>	western redcedar - Sitka spruce / skunk cabbage	G3?	S3?	Blue	CWHdm/12;CWHxm1/12
<i>Thuja plicata</i> / <i>Polystichum munitum</i> Dry Maritime	western redcedar / sword fern Dry Maritime	G2G3	S2S3	Blue	CWHdm/05
<i>Thuja plicata</i> / <i>Polystichum munitum</i> Very Dry Maritime	western redcedar / sword fern Very Dry Maritime	GNR	S2S3	Blue	CWHxm1/05
<i>Thuja plicata</i> / <i>Tiarella trifoliata</i> Dry Maritime	western redcedar / three-leaved foamflower Dry Maritime	G3	S2S3	Blue	CWHdm/07
<i>Thuja plicata</i> - <i>Tsuga heterophylla</i> / <i>Polystichum munitum</i>	western redcedar - western hemlock / sword fern	GNR	S3?	Blue	CWHvm2/04
<i>Tsuga heterophylla</i> / <i>Plagiothecium undulatum</i>	western hemlock / flat-moss	G3G4	S2S3	Blue	CWHdm/01
<i>Tsuga heterophylla</i> - <i>Thuja plicata</i> / <i>Gaultheria shallon</i> Very Wet Maritime	western hemlock - western redcedar / salal Very Wet Maritime	G3	S3	Blue	CWHvm2/03
<i>Typha latifolia</i> Marsh	common cattail Marsh	G5	S3	Blue	CWHdm/Wm05;CWHxm1/Wm05

Search Criteria

Ecological Communities

AND BC Conservation Status:Red (Extirpated, Endangered, or Threatened) OR Blue (Special Concern)

AND BGC Zone, Subzone, Variant, Phase:CWHxm1, CHWdm, CWHvm2

Ecosection: GEL

Sort Order:Red, Blue Ascending

Accessed Sept 1 2009





APPENDIX II

Red- and Blue-listed Plant Species in Howe Sound

Appendix II. Red- and Blue-listed Plant Species in Howe Sound

Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit
<i>Allium amplexans</i>	slimleaf onion	G4	S3	Blue	CDFmm;CWHxm
<i>Alopecurus carolinianus</i>	Carolina meadow-foxtail	G5	S2	Red	CDFmm;CWHdm
<i>Anagallis minima</i>	chaffweed	G5	S3	Blue	CDFmm;CWHxm
<i>Bidens amplissima</i>	Vancouver Island beggarticks	G3	S3	Blue	CWHdm;CWHxm
<i>Callitriche heterophylla</i> ssp. <i>heterophylla</i>	two-edged water-starwort	G5T5	S2S3	Blue	CWHvm;CWHxm
<i>Caltha palustris</i> var. <i>palustris</i>	yellow marsh-marigold	G5T5	S2S3	Blue	CWHvm
<i>Cardamine parviflora</i> var. <i>arenicola</i>	small-flowered bitter-cress	G5T5	S1	Red	CWHdm
<i>Carex interrupta</i>	green-fruited sedge	G4	S2	Red	CWHdm;CWHxm
<i>Carex scoparia</i>	pointed broom sedge	G5	S2S3	Blue	CWHdm;CWHxm
<i>Carex vulpinoidea</i>	fox sedge	G5	S2S3	Blue	CWHdm;CWHxm
<i>Claytonia washingtoniana</i>	Washington springbeauty	G2G4	S2	Red	CWHdm;CWHxm
<i>Cuscuta campestris</i>	field dodder	G5	S2S3	Blue	CWHdm;CWHxm
<i>Elatine rubella</i>	three-flowered waterwort	G5	S2S3	Blue	CWHdm;CWHxm
<i>Eleocharis kamtschatica</i>	Kamchatka spike-rush	G4	S2S3	Blue	CWHvm
<i>Eleocharis parvula</i>	small spike-rush	G5	S2S3	Blue	CWHvm;CWHxm
<i>Eleocharis rostellata</i>	beaked spike-rush	G5	S2S3	Blue	CWHdm;CWHxm
<i>Elodea nuttallii</i>	Nuttall's waterweed	G5	S2S3	Blue	CWHdm
<i>Epilobium ciliatum</i> ssp. <i>watsonii</i>	purple-leaved willowherb	G5T3T5	S2S3	Blue	CWHvm;CWHxm
<i>Epilobium leptocarpum</i>	small-fruited willowherb	G5	S2S3	Blue	CWHdm;CWHvm;CWHxm
<i>Glyceria leptostachya</i>	slender-spiked mannagrass	G3	S2S3	Blue	CWHdm;CWHxm
<i>Helenium autumnale</i> var. <i>grandiflorum</i>	mountain sneezeweed	G5T3T5	S2S3	Blue	CWHdm;CWHxm
<i>Hypericum scouleri</i> ssp. <i>nortoniae</i>	western St. John's-wort	G5T3T5	S2S3	Blue	CWHvm;CWHxm



Scientific Name	English Name	Global Rank	Prov Rank	BC Status	BGC unit
<i>Isoetes nuttallii</i>	Nuttall's quillwort	G4?	S3	Blue	CDFmm;CWHxm
<i>Juncus oxymeris</i>	pointed rush	G5	S2S3	Blue	CWHdm;CWHxm
<i>Lilaea scilloides</i>	flowering quillwort	G5?	S2S3	Blue	CWHdm;CWHvm;CWHxm
<i>Lindernia dubia</i> var. <i>anagallidea</i>	false-pimpernel	G5T4	S2S3	Blue	CWHdm;CWHxm
<i>Lindernia dubia</i> var. <i>dubia</i>	yellowseed false pimpernel	G5T5	S1	Red	CWHxm
<i>Lupinus rivularis</i>	streambank lupine	G2G4	S1	Red	CWHdm;CWHxm
<i>Myriophyllum hippuroides</i>	western water-milfoil	G5	S3	Blue	CWHdm
<i>Myriophyllum pinnatum</i>	green parrot's-feather	G5	S1	Red	CWHdm
<i>Myriophyllum ussuriense</i>	Ussurian water-milfoil	G3	S3	Blue	CWHdm
<i>Navarretia intertexta</i>	needle-leaved navarretia	G5	S2	Red	CWHxm
<i>Persicaria hydropiperoides</i>	water-pepper	G5	S2S3	Blue	CWHdm;CWHxm
<i>Persicaria punctata</i>	dotted smartweed	G5	S2S3	Blue	CWHdm;CWHxm
<i>Pleuropogon refractus</i>	nodding semaphoregrass	G4	S3	Blue	CWHdm;CWHvm;CWHxm
<i>Rubus nivalis</i>	snow bramble	G4?	S3?	Blue	CWHdm;CWHvm;CWHxm
<i>Rupertia physodes</i>	California-tea	G4	S3	Blue	CWHxm
<i>Sidalcea hendersonii</i>	Henderson's checker-mallow	G3	S3	Blue	CWHxm
<i>Verbena hastata</i> var. <i>scabra</i>	blue vervain	G5T5	S2	Red	CWHdm;CWHxm
<i>Wolffia borealis</i>	northern water-meal	G5	S2	Red	CWHdm;CWHxm

Search Criteria

Species Group: Vascular Plants

AND BC Conservation Status: Red (Extirpated, Endangered, or Threatened) OR Blue (Special Concern)

AND BGC Zone: CWH

Regional Districts: GVRD & SCR D

Sort Order: Scientific Name Ascending

Accessed Sept 1, 2009





APPENDIX III

Private Landowner Contact Efforts

May 13, 2009

To Whom It May Concern:

RE: Terrestrial Ecosystem Mapping Project: Field Sampling in Howe Sound

Madrone Environmental Services Ltd. (Madrone) is a consulting company that has been hired to map the ecology of Howe Sound, including Bowen and Gambier Islands.

Your property was selected because we are simply confirming that our interpretation of air photos is correct. A team of Ecologists and Geoscientists will be visiting private properties on Bowen and Gambier Island between June 21 and 30th, 2009. They are interested in inventorying plant species existing on the property, classifying soil types and noting any wildlife observations. In some areas they will be digging a small soil pit to determine soil types. This hole will be no larger than 1 square foot in surface area by 40cm deep, and will be filled in.

We would like to know if you would be willing to have an ecologist from Madrone Environmental Services visit your property to identify and classify the ecosystems and soil types on your land?

The mapping project is for the Islands Trust Fund which is a regional land trust which operates in the Gulf Islands.

If you are willing to let us access your property during the last week in June, it would be very helpful to provide us with your unique property ID (PID), for us to avoid going to another property by accident. Your support is greatly appreciated.

If you have any questions or concerns with the work being completed, please do not hesitate to contact Tania Tripp at (250)746-5545.

Yours sincerely,

Tania Tripp



Project Manager & Sr. Terrestrial Biologist
Madrone Environmental Services Ltd.

Example of Updated Letter to Landowners for July 2009

Dear (Landowner name)

The **Howe Sound Terrestrial Ecosystem Mapping Project** is part of the Islands Trust Fund's regional conservation planning program for the Islands Trust Area. The Islands Trust Fund is the conservation land trust of the Islands Trust that works in the Howe Sound and Gulf Islands. The mapping project will create an inventory of the natural and human ecosystems of the Howe Sound islands. Madrone Environmental Services Ltd. has been hired by the Islands Trust Fund to map the ecology of Howe Sound. The mapping project will create an inventory of the natural and human ecosystems.,

In the coming weeks we will be visiting private properties on islands in the Howe Sound to verify ecological data gathered through air photo information. We would like to observe the plant communities and soil types on these properties, noting any wildlife observations. A property visit is between ten to thirty minutes and we can work a time convenient to you.

We will be telephoning to request permissions to conduct property visits. If you are interested and wish to be visited in the near future, you can call our office at 250-746-5545.

Property visits are important to ensure that mapping completed is of the highest standard. We hope that you will be interested in this project and grant us the opportunity to improve the quality of the existing ecosystem mapping on your land. Terrestrial Ecosystem Mapping from other parts of the Province is already being used to plan for land conservation as well as other land uses. This product in the Howe Sound islands will bring a new level of understanding of our environment, allowing decision-makers to focus on the types of ecosystems in most need of conservation activities. We are grateful for your assistance and hope you will take advantage of this opportunity to get to know more about the special features on your property.

If you have any questions about this project, or conservation planning in the Islands Trust Area, please contact the Islands Trust Fund at 250-405-5186 (toll free through Enquiry BC by dialing 800-663-7867 or 604-660-2421 in Vancouver).

Yours sincerely,

Anna Wilkerson
GIS Analyst – Private Land Sampling Coordinator for Howe Sound TEM
Madrone Environmental Services Ltd.
250-746-5545



News Release

200 -1627 Fort Street Victoria BC V8R 1H8

Telephone **250. 405.5151** FAX: 250 405.5155

Toll Free via Enquiry BC in Vancouver 604.660.2421. Elsewhere in BC **1.800.663.7867**

information@islandstrust.bc.ca www.islandstrust.bc.ca

July 3, 2009

2009-06-ITF

PRIVATE LANDOWNERS HELP MAP HOWE SOUND ECOSYSTEM

VICTORIA — Howe Sound residents are playing an important role in mapping their island ecosystems. This summer ecologists working for the Islands Trust Fund are contacting landowners for permission to visit their property to verify air photo information. This ecosystem mapping project identifies natural island habitats needed by at-risk species. The site visits help community members, planners and decision-makers plan for the future of the islands and gives landowners an opportunity to learn more about their properties.

“The site visits are necessary to confirm our data, to ensure consistency and to meet the provincial standard for ecosystem mapping,” said Kate Emmings, Ecosystem Protection Specialist with the Islands Trust Fund. “Without the help of private landowners who allow scientists to come onto their land to conduct field checks, the final maps would be merely an interpretation of air photos and would lack the accuracy that can only be confirmed on the ground. We are grateful to all the landowners who choose to contribute to this project and hope they enjoy knowing more about the special features on their property.”

The Islands Trust Fund started the Terrestrial Ecosystem Mapping project in the Howe Sound in early 2009, using existing data and air photos to identify the variety of ecosystems across the Howe Sound landscape. With funding from the Islands Trust and the Sunshine Coast Regional District, the Islands Trust Fund contracted Madrone Environmental Services to incorporate data collected through site visits into the maps.

Typically, a two-person crew from Madrone visits a site to identify natural vegetation, and, in some cases, examine the soil structure. Each visit is between ten to thirty minutes at a time convenient to the resident. Any landowners in the Howe Sound islands willing to have the ecologists explore the ecosystems of their property are encouraged to contact Anna Wilkerson of Madrone Environmental Services at (250) 746-5545.

Terrestrial Ecosystem Mapping uses information about geology, soil, site characteristics and vegetation to describe the type of ecosystem found in an area. As well as identifying forest, riparian and shoreline habitats, terrestrial ecosystem maps recognize human habitats, allowing communities and land use planners to identify ecosystems not recommended for development.

After the on-site checks are complete, the Islands Trust Fund will contact local community groups and agencies for feedback on the accuracy of the maps. The Islands Trust Fund plans to finalize the ecosystem mapping for Howe Sound by the end of the year. When complete, the data will be used to create a Regional Conservation Plan that will prioritize habitats and areas for voluntary conservation activities. The mapping will also be shared with local and regional government for land use planning purposes.

For more information on the ecosystem mapping activities in the Howe Sound, or the upcoming Regional Conservation Plan, contact the Islands Trust Fund at (250) 405-5186 (Victoria) or toll free through Enquiry BC at 1-800-663-7867 (604-660-2421 in Vancouver), or visit online at www.islandstrustfund.bc.ca.

The Islands Trust Fund is a regional land trust established in 1990 to help preserve and protect the unique character and environment of the islands in the Strait of Georgia and Howe Sound. The Islands Trust Fund

Preserving island communities, culture and environment

Bowen, Denman, Hornby, Gabriola, Galiano, Gambier, Lasqueti, Mayne, N. Pender, Salt Spring, Saturna, S. Pender, Thetis

protects natural areas through voluntary land donations, conservation covenants, land purchase and stewardship education programs. With the generous support of island communities and landowners, the Islands Trust Fund has protected more than 975 hectares of natural and cultural values on 75 properties.

– 30 –

CONTACT

Kate Emmings
Ecosystem Protection Specialist
250.405.5176

Christine Torgrimson
Chair, Islands Trust Fund Board
250.538.0199



APPENDIX IV

TEM Map Legend

TERRESTRIAL ECOSYSTEM MAPPING OF HOWE SOUND

Map sheets: 92G/033, 034, 043, 044, 053, 054

Scale 1: 10,000
September 2009

INTRODUCTION					
<p>This project synthesizes results of bioterrain and terrestrial ecosystem mapping of Howe Sound including the CWHxm1, CWHdm and CWHvm2 biogeoclimatic subzones. The Howe Sound study area covers approximately 14,000 hectares and is located within the Bowen Island Municipality, the Gambier Local Trust Areas and the Greater Vancouver Regional District. Howe Sound includes Bowen Island, Gambier Island, Keats Island, Anvil Island, Bowyer Island and associated other islands/islets.</p> <p>Digital maps will aid interpretation for resource management and land use planning; identified wildlife habitat capability and suitability; and sensitive ecosystem mapping. A seamless database of polygon attributes and the associated bioterrain and ecosystem data, as well as other features and parameters of interest accompanies this legend. Mapping was completed following the methods outlined in Standard for Terrestrial Ecosystem Mapping in British Columbia¹. Field work was completed in June and August of 2009 at modified survey intensity levels and an overall Level 4 survey intensity was completed with 17% or 340 of the 2017 polygons sampled.</p>					
ECOSECTION & BIOGEOCLIMATIC UNITS			ECOSYSTEM UNIT LABEL		
MAP SYMBOLS					
<p>Ecosection </p> <p>Biogeoclimatic Unit </p> <p>Ecosystem Unit </p>			<p>Study Area Boundary </p> <p>Plot Location </p>		
<p>Ecosections GEL: Georgia Lowland</p>		<p>Biogeoclimatic Units: CWHxm1: Coastal Western Hemlock zone, very dry maritime subzone, eastern variant CWHdm: Coastal Western Hemlock zone, dry maritime subzone CWHvm2: Coastal Western Hemlock zone, very wet maritime subzone, montane variant</p>			
ECOSYSTEM UNITS					
CWHxm1					
Site Code	Description	Site Series	Assumed Modifiers	Soil Moisture Regime	Mapped Modifiers
AM	Arbutus-Hairy manzanita	00	j, r, s	xeric	-
CD	Act—Red-osier dogwood	09	a, d, j, m	subhygric - hygric	-
DC	FdPI-Cladina	02	j, m, r, s	very xeric	h, k, v, w
DF	Fd-Sword fern	04	d, j, m	xeric - subxeric	g, k, n, s, v, w
DS	FdHw-Salal	03	d, m, w	xeric - subxeric	j, k, s, v
HD	HwCw-Deer fern	06	d, j, m	subhygric - hygric	s, w
HK	HwFd-Kindbergia	01	d, j, m	submesic - mesic	g, h, k, s, v, w
LS	Shore pine - Sphagnum	11	d, j, p	subhydric	-
RC	CwSs-Skunk cabbage (Ws53-Cw-Sword fern-Skunk cabbage)	12	d, j, m	subhydric	-

ECOSYSTEM UNITS					
CWHxm1 (continued)					
Site Code	Description	Site Series	Assumed Modifiers	Soil Moisture Regime	Mapped Modifiers
RF	Cw-Foamflower	07	d, j, m	subhygric - hygric	g, k, n, s, w
RS	Cw-Sword fern	05	d, m	submesic - mesic	g, j, k, n, s, w
SS	Ss-Salmonberry	08	a, d, j, m	subhygric - hygric	-
SC	Cladina - Wallace's selaginella	00	j, m, r, v	very xeric subhydric	h, k, s, w
Em03	Seashore saltgrass	Em03	-	hydric	-
Wb50	Labrador tea - Bog-laurel - Peat-moss	Wb50	-	subhydric	-
Wf50	Narrow-leaved cotton-grass - Peat-moss	Wf50	-	subhydric	-
Wf52	Sweet gale - Sitka sedge	Wf52	-	subhydric	-
Wm50	Sitka sedge - Hemlock -parsley	Wm50	-	hydric	-
CWHdm					
Site Code	Description	Site Series	Assumed Modifiers	Soil Moisture Regime	Mapped Modifiers
CD	Act—Red-osier dogwood	09	a, j, m	subhygric - hygric	-
DC	FdPl-Cladina	02	j, r, s	xeric	h, k, v, w, z
DF	Fd-Sword fern	04	d, m	xeric - subxeric	g, h, k, n, s, v, w
DS	FdHw-Salal	03	d, m, w	xeric - subxeric	k, s, v
HD	HwCw-Deer fern	06	d, j, m d, m	subhygric - hygric	h, s, w g, h, k, n, r, s,
HM	Hw-Flat moss	01		mesic	v, w
LS	Shore pine - Sphagnum	11	d, j, p	subhydric	-
RC	CwSs-Skunk cabbage (Ws53-Cw-Sword fern-Skunk cabbage)	12	d, j, m	subhydric	-
RF	Cw-Foamflower	07	d, j, m	subhygric - hygric	g, k, s, w
RS	Cw-Sword fern	05	d, m	submesic - mesic	g, j, k, n, s, v, w
SC	Cladina - Wallace's selaginella	00	j, m, r, v	very xeric	k, w
Wb50	Labrador tea - Bog-laurel - Peat-moss	Wb50	-	subhydric	-
Wf50	Narrow-leaved cotton-grass - Peat-moss	Wf50	-	subhydric	-
Wf52	Sweet gale - Sitka sedge	Wf52	-	subhydric	-
CWHvm2					
Site Code	Description	Site Series	Assumed Modifiers	Soil Moisture Regime	Mapped Modifiers
AB	HwBa-Blueberry	01	d, j, m	submesic - mesic	h, k, s, v, w
AF	BaCw-Foamflower	05	d, m	submesic - mesic	g, j, k, s
AS	BaCw-Salmonberry	07	d, j, m	subhygric - hygric	w
HD	HwBa-Deer fern	06	d, m	subhygric xeric -	j, k
HS	HwCw-Salal	03	j, m, s	subxeric	h, w
LC	HwPl-Cladina	02	j, r, s	very xeric	h, k, v, w
RS	CwHw-Sword fern	04	d, m	xeric - subxeric	g, h, j, k, s, v, w
YG	CwYc-Goldthread	09	d, j, p	subhygric - hygric	-
Wf52	Sweet gale - Sitka sedge	Wf52	-	subhydric	-

Non-Vegetated / Sparsely Vegetated / Anthropogenic	
Site Code	Description
BE	Beach
CF	Cultivated Field
GC	Golf Course
GP	Gravel Pit
IN	Industrial
LA	Lake
MU	Mudflat Sediment
OW	Shallow Open Water
RE	Reservoir
RO	Rock Outcrop
RW	Rural
RZ	Road Surface
UR	Urban/ Suburban

SITE MODIFIERS	
Code	Topography
g	gullying ¹ : occurs within a gully, or with gullying throughout the delineated area
h	hummocky ¹ terrain: indicated by the terrain surface expression
j	gentle slope: < 35% in the CWH and CDF zones
k	cool aspect: occurs on aspects 285°–135°, on moderately steep slopes (35%–100% in the CWH and CDF)
n	fan ¹ : occurs on a fluvial fan or on a colluvial fan or cone
q	very steep cool aspect–very steep slopes (< 100%) with aspects 285°–135°
r	ridge ¹ : occurs throughout an area of ridged terrain, or on a ridge crest
w	warm aspect: 135°–285°, on moderately steep slopes (35%–100% slope in the CWH and CDF zones)
z	very steep warm aspect –slopes > 100% on aspects 135°–285°
Code	Soil
s	shallow soils: 20–100 cm to bedrock
v	very shallow soils: < 20 cm to bedrock
STRUCTURAL STAGE	
Code	Structural Stage
1	Sparse (1a) bare rock or ground / bryoid (1b) bryophytes and lichens dominant, may reflect recent disturbance
2	Herb some invading or residual shrubs and trees may be present, may reflect recent disturbance
3	Forb-dominated (2a) / Graminoid-dominated (2b) / Aquatic (2c) / Dwarf shrub (2d) Shrub Early successional stage or maintained by environmental conditions or disturbance
4	Low shrub (3a) < 2 m tall / Tall shrub (3a) 2–10 m tall
5	Pole/Sapling Trees > 10 m tall, often densely stocked, no vertical canopy structure, typically < 40 years since disturbance
6	Young Forest Self-thinning and canopy differentiation initiated, typically 40–80 years since disturbance
7	Mature Forest Mature tree canopy, typically 80–250 years since disturbance
	Old Forest Structurally complex stands comprised mainly of shade-tolerant and regenerating tree species; snags and coarse woody debris and patchy understories, typically > 250 years since disturbance.
STAND COMPOSITION	
Code	Stand Composition
B	Broadleaf – greater than ¾ of total tree layer cover is broadleaf
M	Mixed – neither coniferous or broadleaf account for greater than ¾ of total tree layer cover

DISTURBANCE MODIFIERS			
L	Forest harvesting	T	Terrain-related effects
c	▪ clearcut system	s	▪ terrain failures (active/recent slumps, slides, solifluction, etc.)
e	▪ selection system		
l	▪ land clearing		
W	Water-related effects		
i	▪ inundation (including temporary inundation resulting from beaver activity)		

DATA SOURCES

This mapping project is based on colour aerial photography at a 1:20000 scale from 2004 and 2006, provided by the Islands Trust. Base map data is from Terrain Resource Inventory Mapping (TRIM) and provided by Islands Trust. An overall total of 17% polygon inspection was achieved. Eight full plots, 41 ground inspections and 319 visual checks were completed.

CREDITS

Bioterrain Mappers:	Wanda Miller, Sonia Meili
Bioterrain Q/A:	Gordon Butt
Ecosystem Mapping:	Tyler Innes, Tania Tripp, Jackie Churchill
Ecosystem Q/A:	Kathy Dunster
Field Data Collection:	Tyler Innes, Jackie Churchill, Tania Tripp, Kathy Dunster, Wanda Miller, Sonia Meili, Corey Erwin (MoE), Sid Tsang
Project Manager:	Tania Tripp, assisted by Jackie Churchill
GIS/Map Production:	Anna Jeffries, Peter Berst
Funding:	Islands Trust

LITERATURE CITED

¹Resources Inventory Committee [RIC]. 1998. Standard for terrestrial ecosystem mapping in British Columbia. Ecosystems Working Group, Terrestrial Ecosystems Task Force, Resources Inventory Committee. Vancouver, B.C. 100 pp.

²Howes, D.E. and E. Kenk (contributing eds.). 1997. Terrain classification system for British Columbia. V.2. Resource Inventory Branch, Min. Env., Lands and Parks. MOE Manual 10. Victoria, B.C. 99 pp.

³Soil Classification Working Group. 1998. The Canadian System of Soil Classification. Agric. and Agri-Food Can. Publ. 1646 (Revised) 187 pp. NRC Research Press, Ottawa, Ont.



APPENDIX V

Terrain Legend

Appendix V. Terrain Legend

MINERAL SOIL TEXTURE

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

SURFICIAL MATERIALS

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

SURFACE EXPRESSION

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

GEOMORPHOLOGICAL PROCESS

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

MASS MOVEMENT SUBCLASSES (USED WITH PROCESS F AND/OR R)

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

SOIL DRAINAGE

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





APPENDIX VI

Expanded TEM Legend


Complete accounts for each map unit found in the study area are presented below within the expanded legend (Appendix VI). A description of each ecosystem includes a site description, assumed modifiers, site characteristics, photographs and plot reference numbers. These descriptions are specific to the study area for CWHxm1 and CWHdm. No plot sampling occurred in the CWHvm2 because almost all of this variant was on Crown Land; therefore legend information is limited to general descriptions.

For all forested units in the study area (except CWHvm2 ecosystems) characteristic plant species and landscape position for each ecosystem are described by common site observations. Site descriptions also rely on background information from Vancouver Region Field Guide (Green and Klinka, 1994) as well as interpretations from aerial photography.

Non-forested and sparsely vegetated ecosystems are described based on a combination of plot vegetation data and background information, but not separated by structural stage. Anthropogenic units are defined based on the Standards for Terrestrial Ecosystem Mapping in BC (RISC, 1998) in association with field observations specific to each unit in the study area. Background information for classifying ecosystems was based on the Vancouver Region Field Guide (Green and Klinka, 1994) and Wetlands of BC (MacKenzie and Moran, 2004). It must be noted that some ecosystems had very few plots, which limits the ability to describe plant species lists for each ecosystem.

Ecosystems that occur in Howe Sound are accompanied by a distribution map. The distribution maps depict the presence of an ecosystem within a polygon. It should be noted that the ecosystem is not necessarily the dominant ecosystem type within the polygon.

Ecosystems in the CWHxm1 and CWHdm subzone

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series	
CWHxm1/HK CWHdm/HM	Western hemlock–Douglas-fir–Oregon beaked moss Hw - Flat moss	01	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The 01 site series in the CWHxm1 and CWHdm occurs typically on gentle slopes, with medium textured soils. This 'zonal' ecosystem is the matrix forest community in Howe Sound and is represented at all elevations, on most slope positions, soil depths and aspects. Western hemlock occurs as the dominant trees species in association with Douglas-fir and western redcedar. Western hemlock occurs in all layers of the tree canopy including regeneration layers. The understory is well developed with shrubs such as dull Oregon grape and red huckleberry with lower abundance of salal. Oregon beaked moss, flat moss, and other feathermosses and are present on the forest floor.</p> <p>Assumed modifiers: d, j, m (CWHxm1/HK); d, m (CWHdm/HM)</p>		<p>Elevation (m):</p> <p>Slope (%):</p> <p>Aspect (°):</p> <p>Surficial material:</p> <p>Drainage:</p> <p>SMR:</p> <p>SNR:</p>	<p>0-650</p> <p>Variable</p> <p>Variable</p> <p>M, F^G</p> <p>m-w</p> <p>3-4</p> <p>A-C</p>
		<p>Plots:</p> <p>H1985A, I1715, I1892A, I1907A, I1987, JCG01, JCG31, JCG83, JCG86, JCG94, JCG134, JCV03, JCV06, JCV07, JCV08, JCV10, JCV12, JCV13, JCV17, JCV19, JCV20, JCV28, JCV32, JCV33, JCV35, JCV36, JCV39, JCV40, JCV41, JCV50, JCV53, JCV55, JCV56, JCV64, JCV66, JCV67, JCV68, JCV69, JCV71, JCV72, JCV82, JCV84, JCV85, JCV87, JCV88, JCV89, JCV90, JCV91, JCV92, JCV95, JCV97, JCV102, JCV103, JCV104, JCV107, JCV111, JCV124, JCV125, JCV126, JCV127, JCV128, JCV132, JCV135, JCV136, JCV138, JCV141, JCV147, JCV149, JCV150, JCV151, JCV152, JCV154, JCV159, JCV163, JCV165, SM2, SM3, SM5, SM9, SM14, SM16, SM17, SM18, SM20, SM21, SM29, SM31, SM35, SM36, SM38, SM43, SM44, SM46, SM47, SM49, SM51, SM52, SM53, TIG22, TIG29, TIG60, TIG81, TIV08, TIV13, TIV14, TIV15, TIV17, TIV18, TIV21, TIV23, TIV24, TIV30, TIV31, TIV32, TIV33, TIV37, TIV38, TIV40, TIV46, TIV51, TIV54, TIV59, TIV63, TIV66, TIV67, TIV68, TIV71, TIV73, TIV74, TIV75, TIV76, TIV78, TIV80, TIV82, TIV83, TIV88, TIV91, TIV93, TIV94, 4820, 6137, 6155</p>	

Site modifiers for atypical conditions

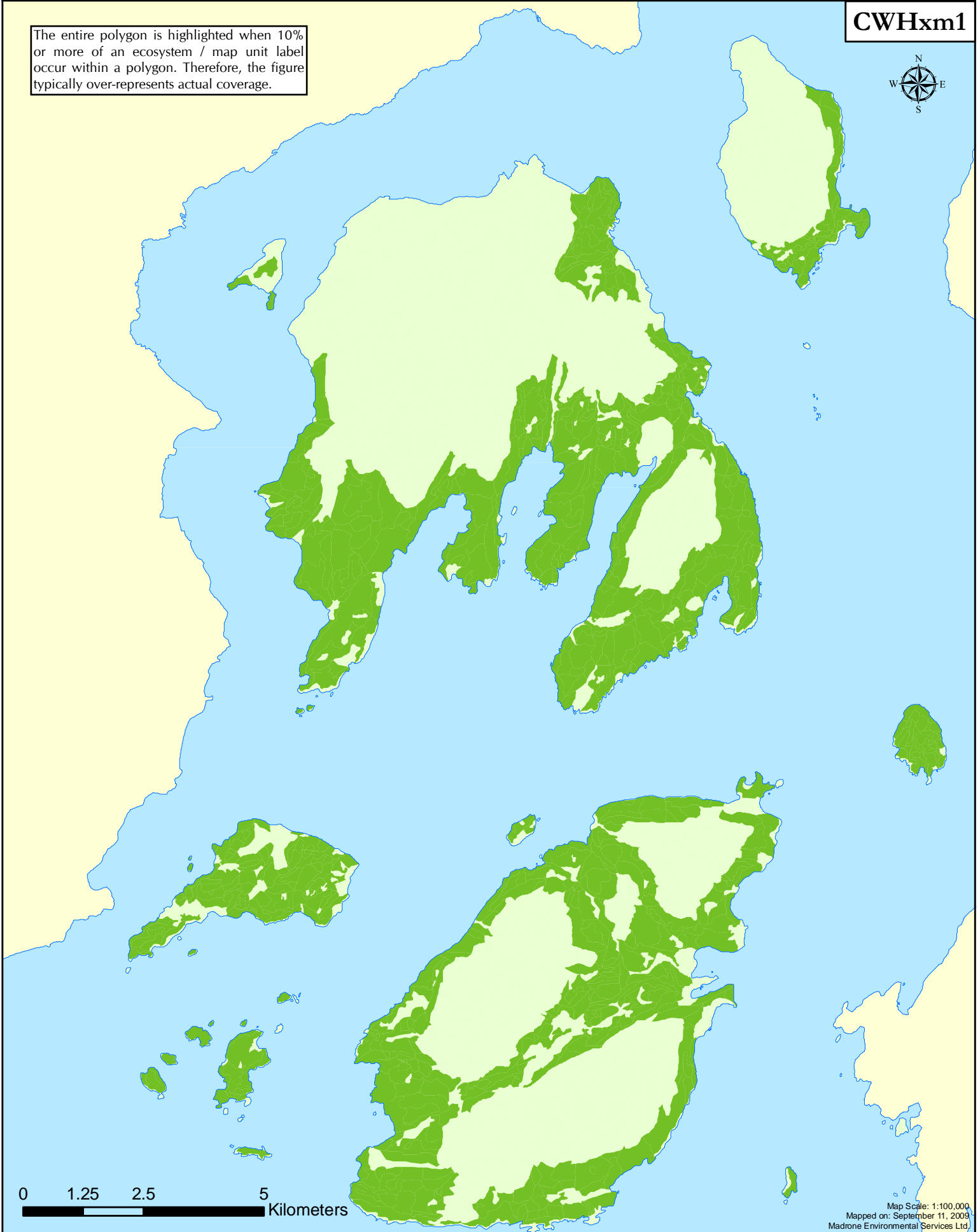
TEM Map Code	Site Series Name	CWHxm1 Site Series
CWHxm1/HK	Western hemlock–Douglas-fir–Oregon beaked moss	01
HK typic	HKkv cool aspect; very shallow soil	HKgs gully, shallow soil
HKs shallow soil	HKw warm aspect	
HKsw shallow soil; warm aspect	HKhs hummocky; shallow soil	
HKk cool aspect	HKv very shallow soil	
HKks cool aspect; shallow soil	HKvw very shallow soil; warm aspect	

TEM Map Code	Site Series Name	CWHdm Site Series
CWHdm/HM	Hw - Flat moss	01
HM typic	HMkv cool aspect; very shallow soil	HMgs gully, shallow soil
HMs shallow soil	HMw warm aspect	HMn fan
HMsw shallow soil; warm aspect	HMhs hummocky; shallow soil	
H Mk cool aspect	HMv very shallow soil	
H Mks cool aspect; shallow soil	HMvw very shallow soil; warm aspect	

Distribution of Polygons Containing HK Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



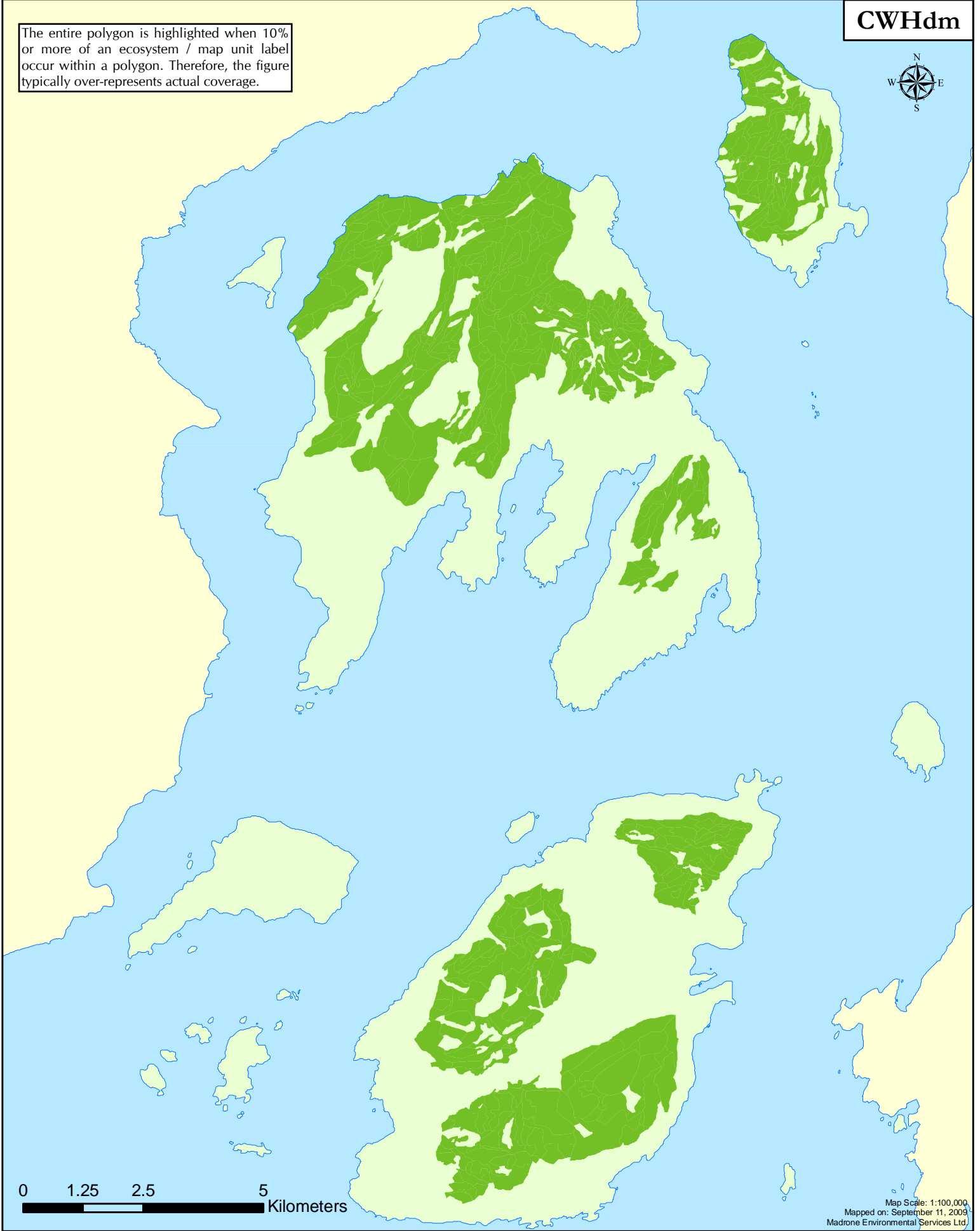
0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing HM Map Units


CWHdm

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series	
DC	Douglas-fir—Shore pine—Cladina	02	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The Douglas-fir-Shore pine-Cladina unit was commonly mapped, generally occurring on water-shedding ridge crests and convex upper slopes with very thin till or bedrock outcrops. Douglas-fir and shore pine were dominant in the canopy, with more pine occurring where soil conditions were driest. Canopy cover was sparse (20-40%), with much of the forest floor exposed. Dominant shrubs included salal and dull Oregon-grape. Shore pine and regenerating canopy species were frequent associates that occupied the shrub layer. Bedrock and shallow substrates were often covered by <i>Cladina</i> lichen species and dominant mosses including step moss, juniper haircap moss, curly heron's bill-moss, broom moss and red-stemmed feather moss.</p> <p>Assumed modifiers: j, m, r, s (CWHxm1/DC); j, r, s (CWHdm/DC)</p>		<p>Elevation (m) 0-650</p> <p>Slope (%) 5-65</p> <p>Aspect (°) 999</p> <p>Surficial material Mv, Mx</p> <p>Drainage r</p> <p>SMR 0</p> <p>SNR A (B)</p>	
		<p>Plots: H1978A, H1994, I1889, I1894, JCV18, JCV37, JCV38, JCV43, JCV52, JCV57, JCV59, JCV60, JCV62, JCV63, JCV74, JCV75, JCV76, JCV77, JCV78, JCV80, JCV81, JCV93, JCV99, JCV100, JCV101, JCV106, JCV108, JCV113, JCV114, JCV116, JCV117, JCV121, JCV123, JCV157, SM1, SM10, SM12, SM27, SM41, SM50, TIV10, TIV57, TIV62, TIV64, TIV70, TTV001</p>	

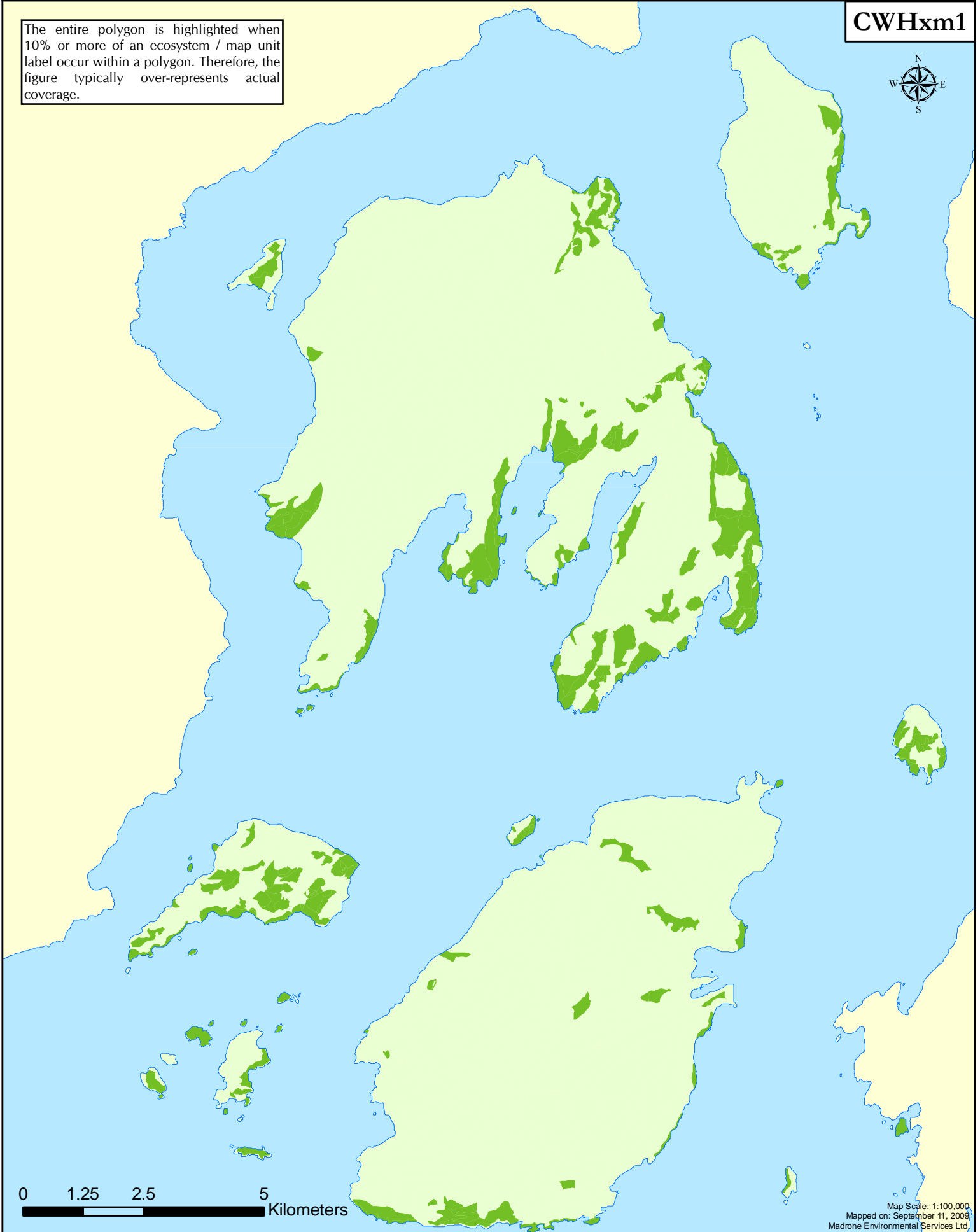
Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series
DC	Douglas-fir—Shore pine—Cladina	02
DCK cool aspect	DCv very shallow soil	
DCkv cool aspect; very shallow soil	DCvw very shallow soil; warm aspect	
DCh hummocky	DCvz very shallow soil; very steep warm aspect	
DChv hummocky; very shallow soil	DCw warm aspect	

Distribution of Polygons Containing DC Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



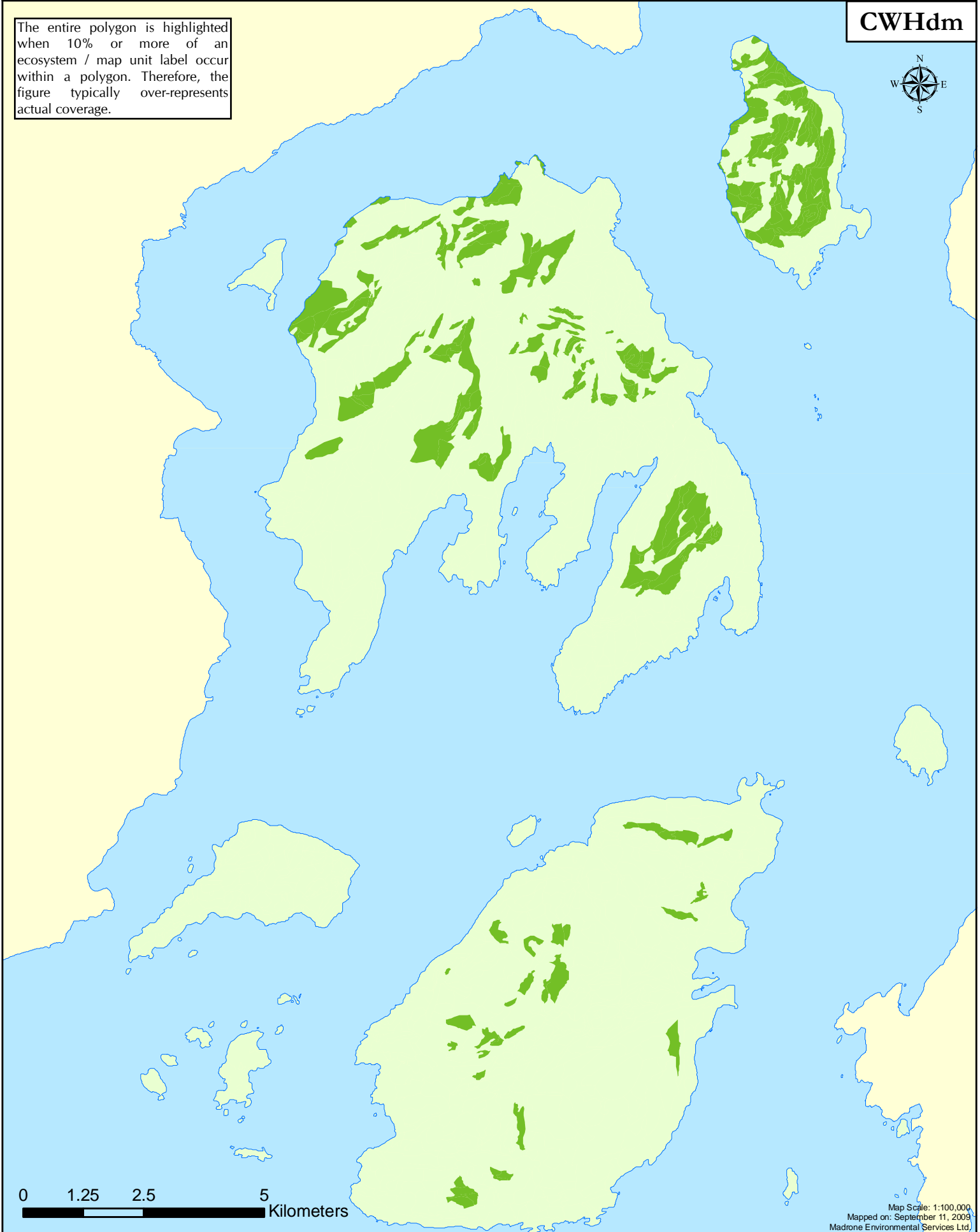
0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing DC Map Units


CWHdm

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series	
DS	Douglas-fir—Western hemlock—Salal	03	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The Douglas-fir – Western hemlock – Salal sites occurred on well-drained, nutrient very poor to medium upper slopes, typically on warm aspects. Substrate was generally till of various depths, infrequently co-occurring with colluvium. The canopy closure of structural stage 4-5 stands was dense (often greater than 50%), opening up with succession. Dominant tree species included Douglas-fir, western redcedar and western hemlock. Regeneration of hemlock tended to be abundant in the understorey, with little Douglas-fir regeneration, reflecting the low shade tolerance of Douglas-fir and its mineral seedbed requirement. Salal formed dense thickets and was a constant dominant in the shrub layer, with little other plant cover except dull Oregon grape as a frequent associate. Step moss, Oregon beaked-moss, electrified cat's tail moss and curly heron's bill mosses were common in the bryophyte layer.</p> <p>Assumed modifiers: d, m, w</p>		<p>Elevation (m) 0-650</p> <p>Slope (%) 5-60</p> <p>Aspect (°) variable</p> <p>Surficial material M (C)</p> <p>Drainage w-r</p> <p>SMR 1-2</p> <p>SNR A-C</p>	
		<p>Plots: H1870A, H2020, I1905A, JCV115, JCV118, JCV119, 4843, SM28, SM30, SM33, SM34, TIV06, TIV11, TIV20, TIV48</p>	

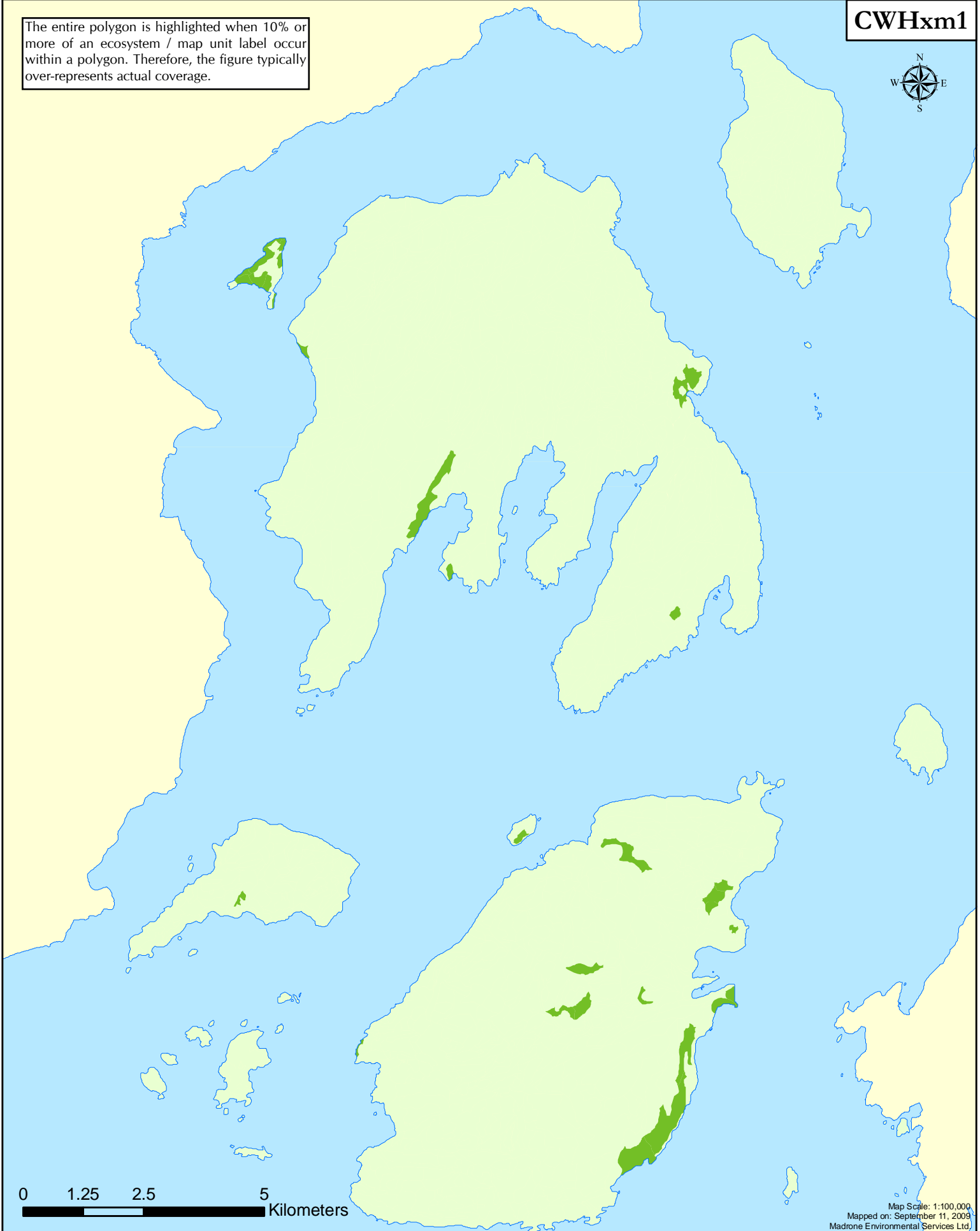
Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series
DS	Douglas-fir—Western hemlock—Salal	03
DSv very shallow soil DSk cool aspect DSks cool aspect; shallow soil DSs shallow soil DSjs gentke slope; shallow soil		

Distribution of Polygons Containing DS Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



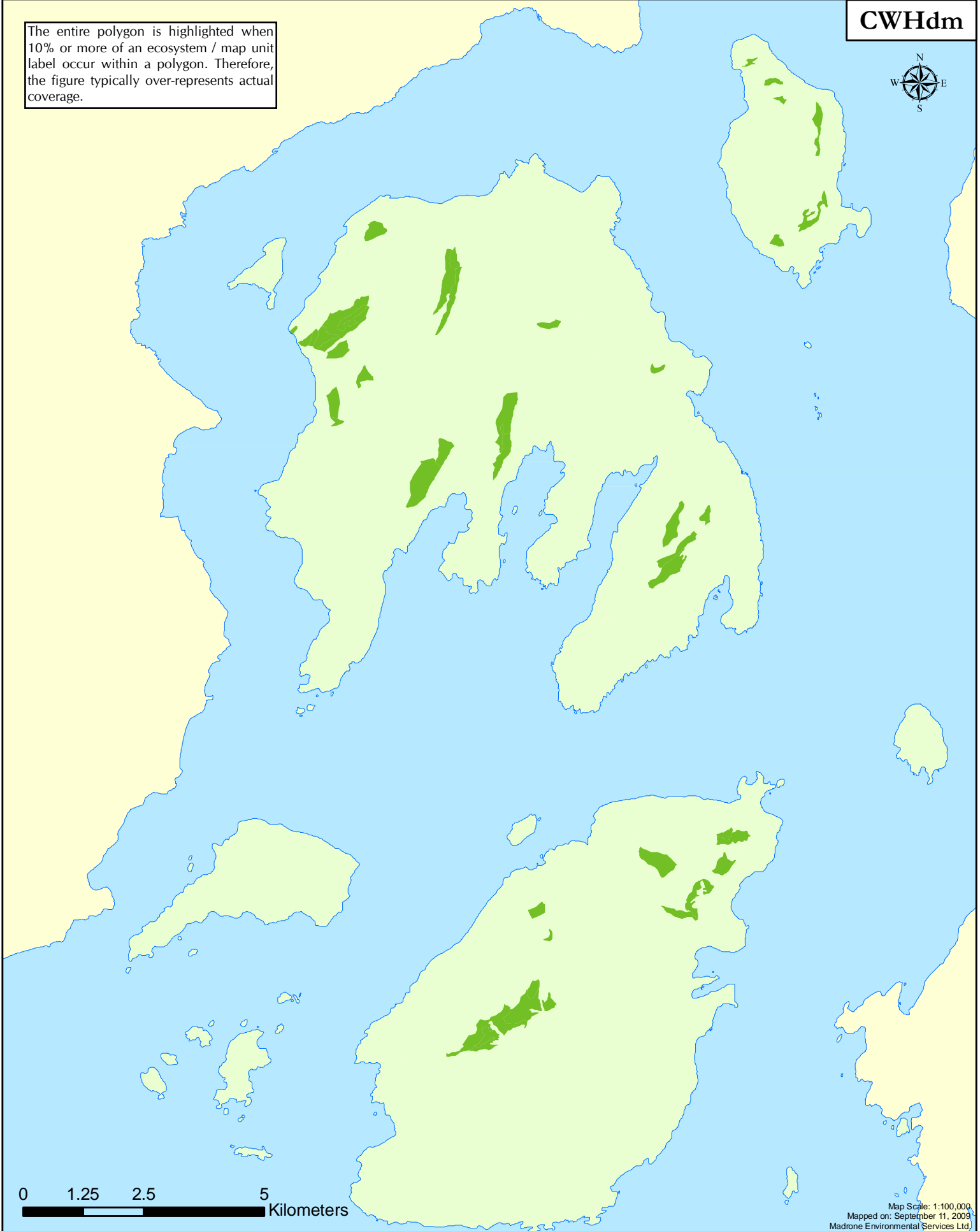
0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing DS Map Units


CWHdm

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series	
DF	Douglas-fir—Sword fern	04	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The Douglas-fir – Sword fern ecosystems were mapped on well drained upper to mid-slopes with variable thicknesses of till and colluvium, typically of coarser texture than sites supporting site series 03. Douglas-fir was the most common canopy dominant, but western hemlock was a frequent associate in all canopy layers. Grand fir was an infrequent associate. Shrubs occupied low to moderate cover (15-30%), with dull Oregon-grape, red huckleberry, common snowberry, and trailing blackberry constant associates. Sword fern dominated the herb layer, with relatively few other species. The bryophyte layer was dominated by Oregon beaked moss.</p> <p>Assumed modifiers: d, j, m (CWHxm1/DF); d, m (CWHdm/DF)</p>		<p>Elevation (m) 0-650</p> <p>Slope (%) 25-70</p> <p>Aspect (°) variable</p> <p>Surficial material M</p> <p>Drainage w</p> <p>SMR 1-2</p> <p>SNR C-E</p>	
		<p>Plots: I1782, JCG133, JCV148, SM19, SM37, TIG56</p>	

Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series
DF	Douglas-fir—Sword fern	04
DFw warm aspect	DFkv cool aspect; very shallow soil	DFgw gully; warm aspect
DFsw shallow soil; warm aspect	DFvw very steep cool aspect; shallow soil	DFn fan
DFk cool aspect	DFs shallow soil	DFhk hummocky; cool aspect
DFks cool aspect; shallow soil	DFv very shallow soil	

Distribution of Polygons Containing DF Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing DF Map Units


The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.

CWHdm



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series	
RS	Western redcedar—Sword fern	05	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The Western redcedar – Sword fern ecosystem was very commonly mapped mid to lower slopes with well to moderately well-drained soils derived from till and occasionally colluvium. Western redcedar, western hemlock, grand fir, and Douglas-fir were frequent, represented in all canopy layers. Coarse woody debris was often moderately abundant to abundant on these sites. The understorey was dominated by swordfern, with variable amounts of salal, and occasionally dull Oregon-grape in the shrub layer. The herb layer featured the dominant species sword fern and bracken fern, occasionally with spiny wood fern and vanilla-leaf.</p> <p>Assumed modifiers: d, m</p>		<p>Elevation (m) 0-650</p> <p>Slope (%) 5-70</p> <p>Aspect (°) 285-135 (135-285)</p> <p>Surficial material M, C</p> <p>Drainage w-m</p> <p>SMR 3-4</p> <p>SNR D (E)</p>	
		<p>Plots:</p> <p>H1986A, I1753, JCG04, JCG09, JCG22, JCG48, JCG54, JCG130, JCG131, JCG137, JCG143, JCV11, JCV23, JCV24, JCV25, JCV26, JCV29, JCV30, JCV34, JCV42, JCV45, JCV46, JCV47, JCV51, JCV73, JCV98, JCV139, JCV140, JCV144, JCV162, SM25, SM26, TIG05, TIG42, TTIG84, TI01, TIV02, TIV12, TIV16, TIV25, TIV35, TIV41, TIV43, TIV47, TIV49, TIV50, TIV52, TIV53, TIV65, TIV72, TIV85, TIV89, TIV92, TIV96, TIV97, TIV98, 6143, 6156</p>	

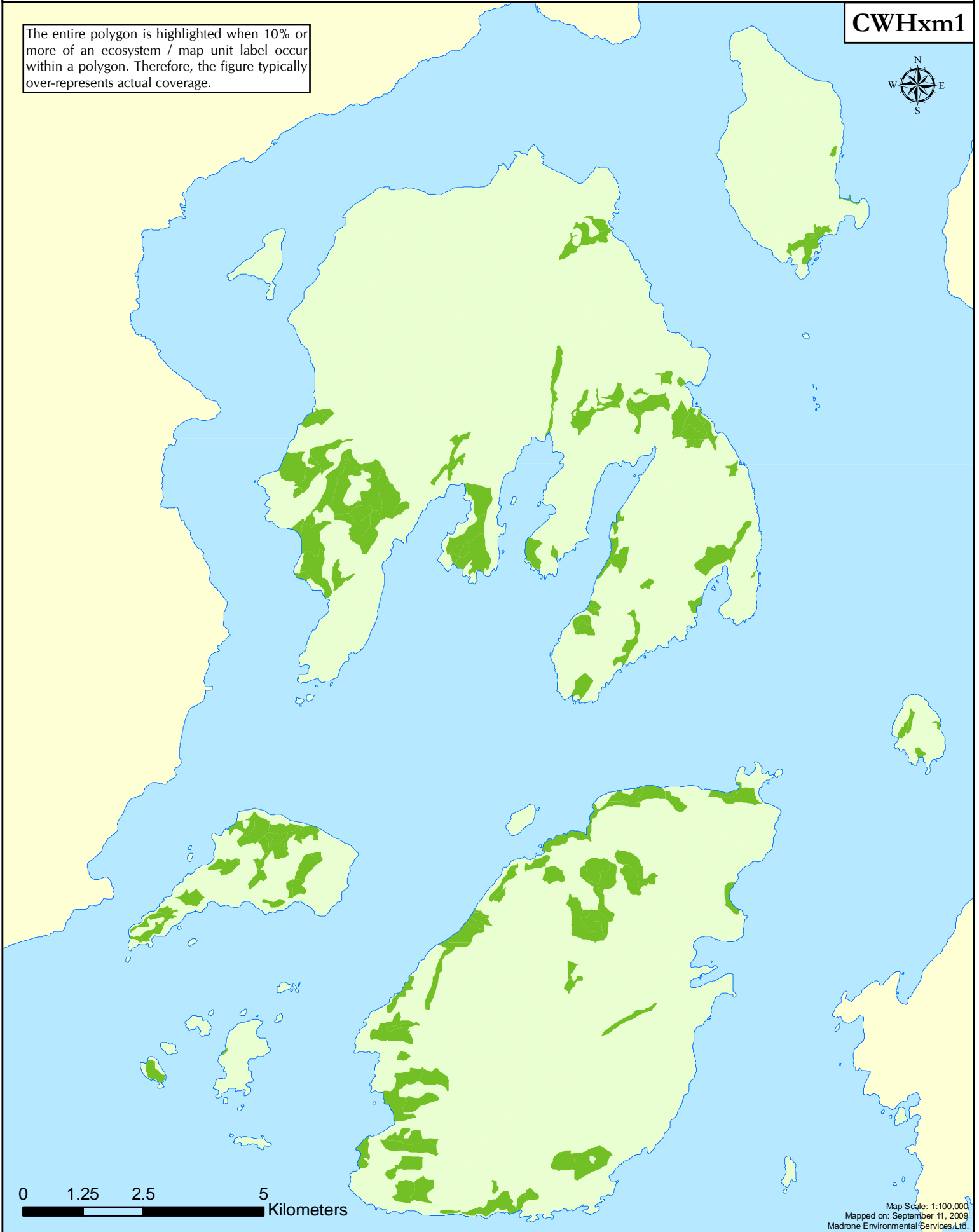
Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series
RS	Western redcedar—Sword fern	05
RSj gentle slope	RSks cool aspect; shallow soil	RSkv cool aspect; very shallow soil
RSjs gentle slope; shallow soil	RSs shallow soil	RSqs gully; shallow soil
RSw warm aspect	RSsw shallow soil; warm aspect	RSqk gully; cool aspect
RSk cool aspect	RSvw very shallow soil; warm aspect	RSqw gully; warm aspect
RSg gully	RSkv cool aspect; very shallow soil	RSn fan

Distribution of Polygons Containing RS Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



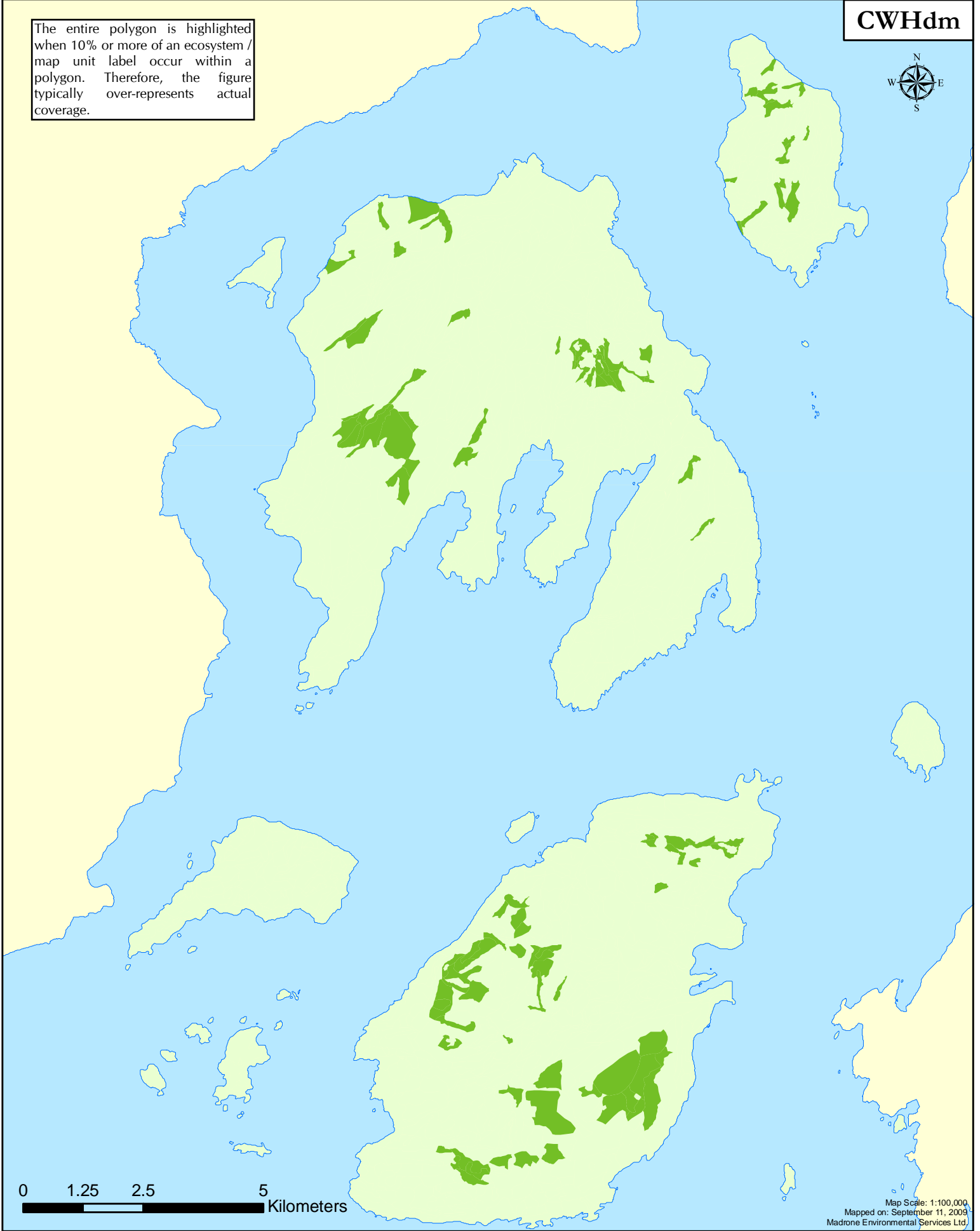
0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing RS Map Units

CWHdm

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series
HD	Western hemlock—Western redcedar—Deer fern	06
SITE DESCRIPTION		SITE CHARACTERISTICS
<p>The Western hemlock – Western redcedar – Deer fern site was uncommon in Howe Sound, but tended to develop on lower slopes with moderately to imperfectly drained soils derived from till. Douglas-fir and western hemlock were the most abundant tree and constant dominant, with lesser amounts of frequent associates western redcedar and grand fir. Bigleaf maple and red alder were often present in seral stands. Diagnostic species deer fern was infrequent in these stands. The understorey featured salal, salmonberry, and dull Oregon-grape in the shrub layer, with sword fern, bracken dominants in the herb layer. Occasionally spiny wood fern and lady fern also occurred. The moss layer was dominated by Oregon beaked moss with lesser amounts of coastal leafy moss.</p> <p>Assumed modifiers: d, j, m</p>		<p>Elevation (m) 0-650</p> <p>Slope (%) 5-25</p> <p>Aspect (°) variable</p> <p>Surficial material M</p> <p>Drainage w-m</p> <p>SMR 5-6</p> <p>SNR A-C</p>
No photo available		Plots: JCV05, JCV153, SM4, SM8, SM11, SM13, SM42, SM45, SM48, TIG87

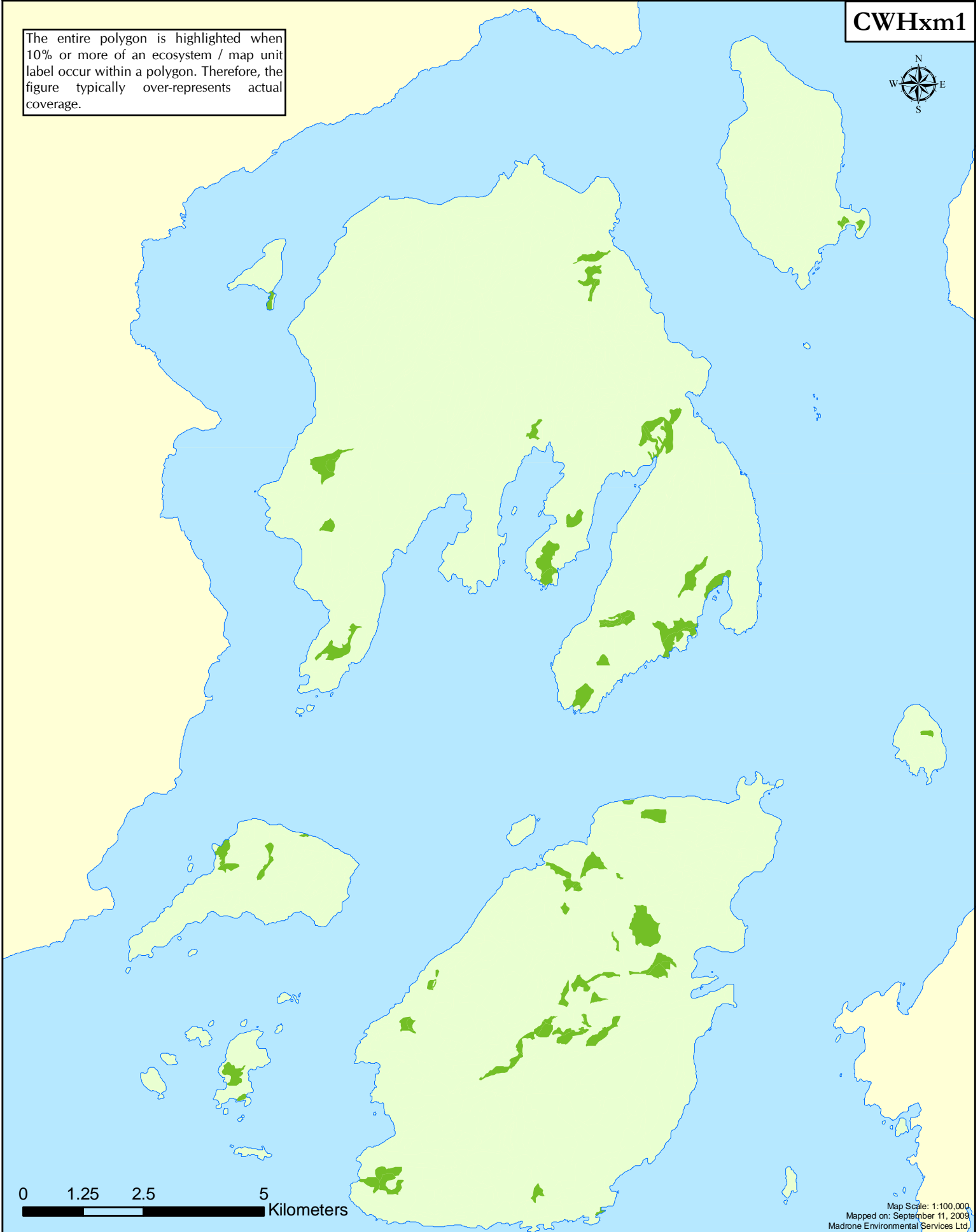
Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series
HD	Western hemlock—Western redcedar—Deer fern	06
HD typic	HDh hummocky	
HDs shallow soil		
HDw warm aspect		
HDsw shallow soil; warm aspect		

Distribution of Polygons Containing HD Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



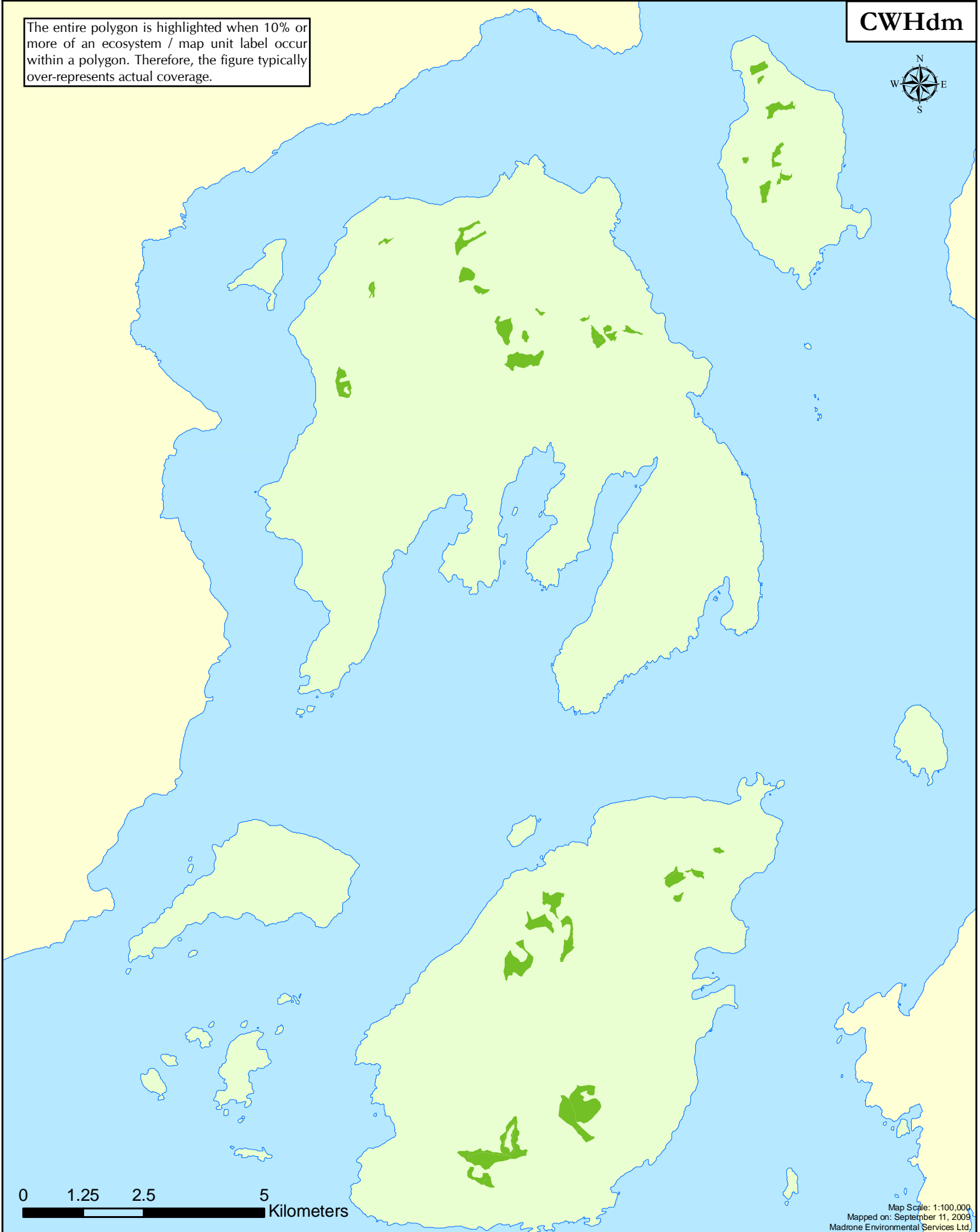
0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing HD Map Units


CWHdm

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series	
RF	Western redcedar—Foamflower	07	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The Western redcedar - Foamflower ecosystems occurred on moisture-receiving toe slopes, some seepage sites, and level sites with thick relatively rich, moderately well to imperfectly drained soils. Western redcedar was often associated in the semi-open canopy with constant associates western hemlock, red alder, grand fir and bigleaf maple; Douglas-fir was infrequent to absent on most RF sites. Shrubs included dense cover of the dominant species salmonberry and thimbleberry. Herbs also occupied a high cover proportion, with lady fern, spiny wood fern, foamflower, vanilla-leaf and small-flowered rush typically present in varying amounts on most sites. Step moss, curly heron's-bill moss, lanky moss and Oregon-beaked moss was dominant in the bryophyte layer.</p> <p>Assumed modifiers: d, j, m</p>		<p>Elevation (m)</p> <p>Slope (%)</p> <p>Aspect (°)</p> <p>Surficial material</p> <p>Drainage</p> <p>SMR</p> <p>SNR</p>	<p>0-650</p> <p>0-35</p> <p>variable</p> <p>M</p> <p>m</p> <p>5-6</p> <p>D-E</p>
		<p>Plots: H1753, I1870A, JCG65, JCG142, JCV96, JCV145, JCV105, SM39, SM40, TIG09, TIG26, TIG39, TIG61, TIV04, TIV55, TIV86, TIV90, TIV95</p>	

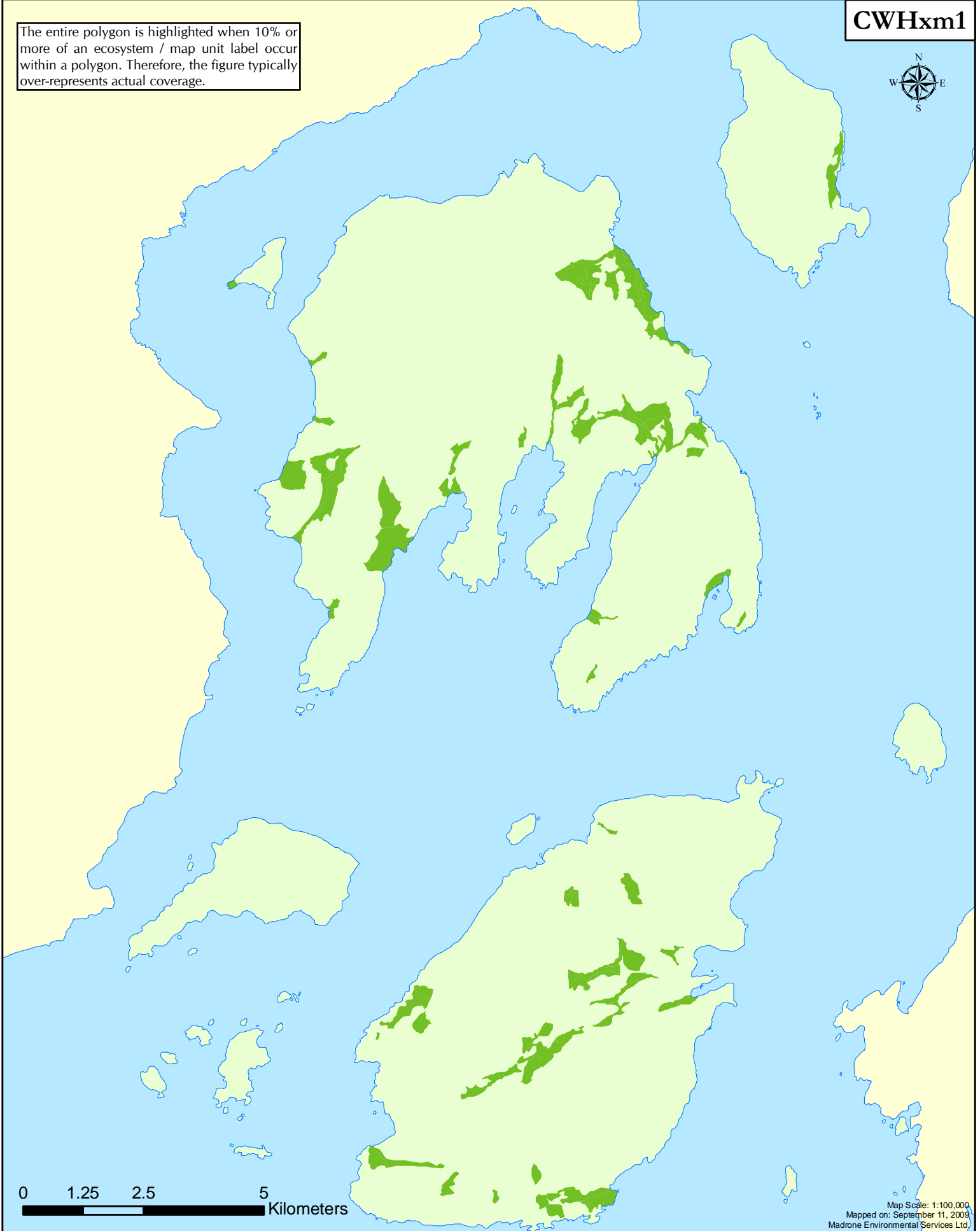
Site modifiers for atypical conditions

TEM Map Code	Site Series Name		CWHxm1/CWHdm Site Series
RF	Western redcedar—Foamflower		07
RFw warm aspect	RFks cool aspect; shallow soil	RSgw gully; warm aspect	
RFk cool aspect	RSn fan	RSgs gully; shallow soil	
RFs shallow soil	RSg gully	RSgk gully; cool aspect	
RFsw shallow soil; warm aspect			

Distribution of Polygons Containing RF Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



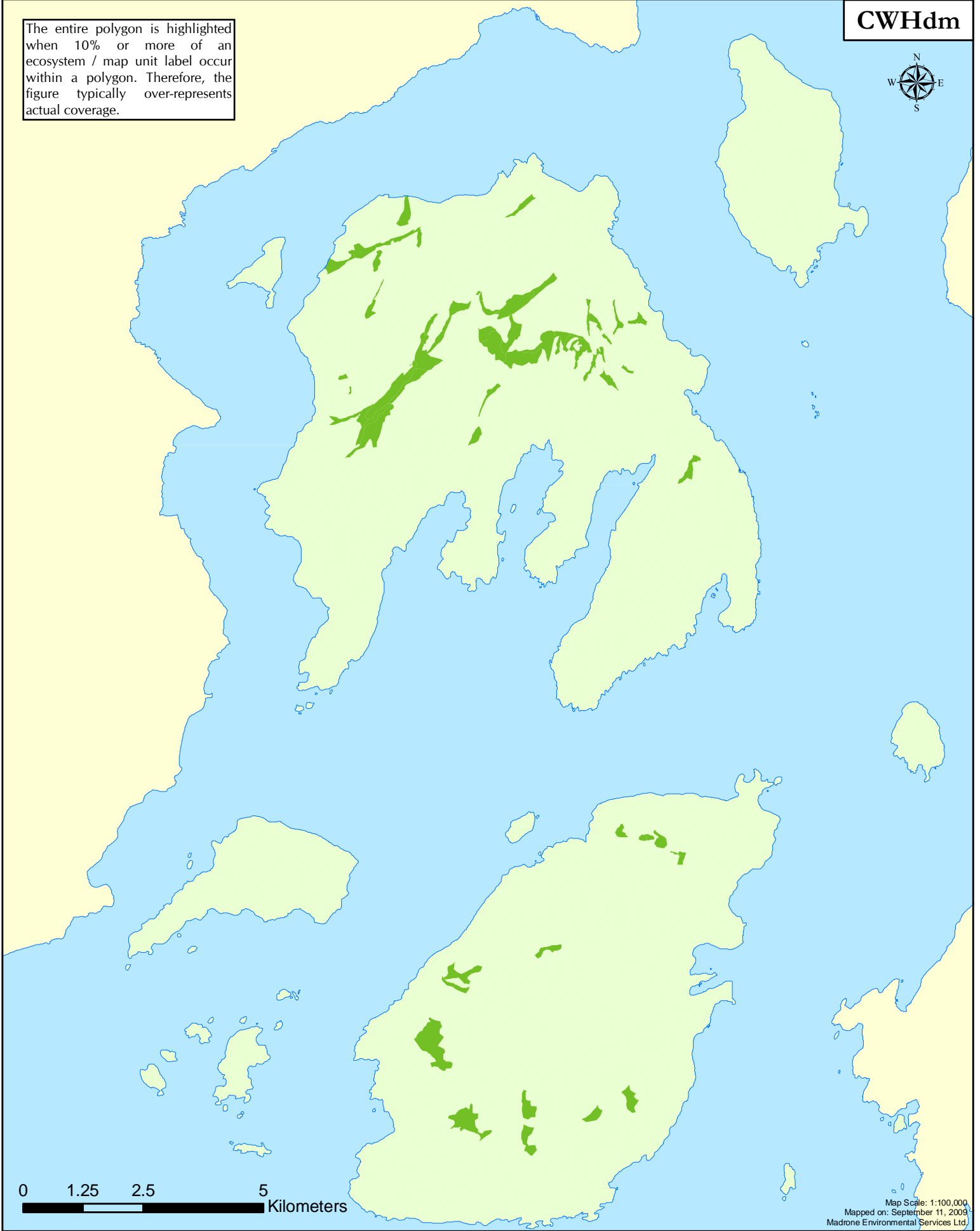
0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing RF Map Units

CWHdm

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

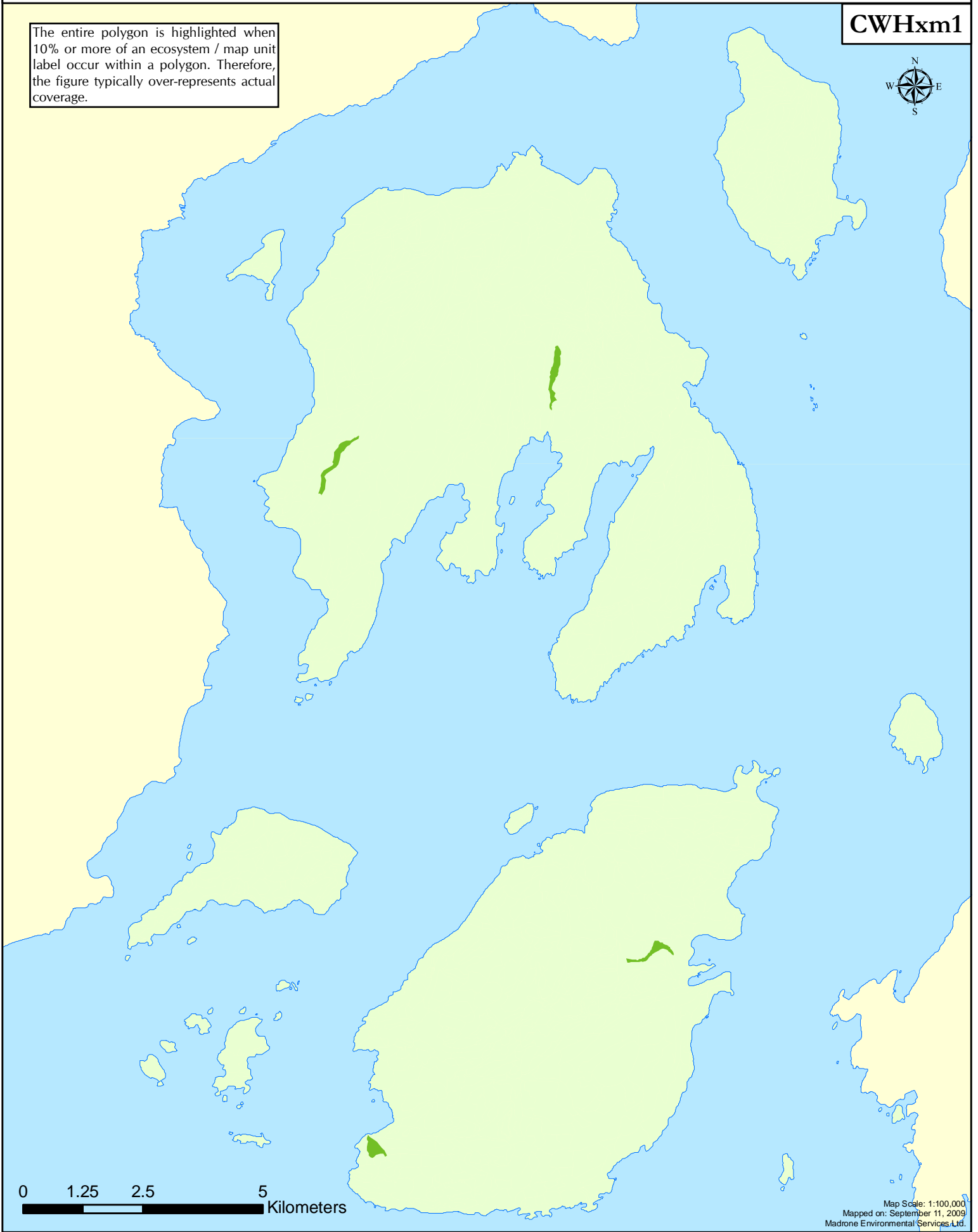
TEM Map Code	Site Series Name	CWHxm1 Site Series	
SS	Sitka spruce—Salmonberry	08	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Sitka spruce - Salmonberry high bench site series was infrequently mapped in the study area. Fluvial materials and landscape position contribute to highly productive, moderately-well drained sites with relatively open canopies (more open as stands age) Sitka spruce was not commonly found in the study area; broadleaf species including black cottonwood, red alder and bigleaf maple were dominant, with varying amounts of frequent associate western redcedar. Shrubs were highly variable in cover and diversity, with salmonberry and thimbleberry dominating, and less abundant associates: Pacific ninebark, red-osier dogwood, cascara, red elderberry, bitter cherry, and Pacific crabapple. Herbs also varied, with relatively low cover compared to shrubs. The common associate species were vanilla-leaf, lady fern, sweet-cicely, and false lily-of-the-valley. Coastal leafy moss was a common colonizer on woody substrate.</p> <p>Assumed modifiers: a, d, j, m</p>		<p>Elevation (m) 0-650</p> <p>Slope (%) 5-15</p> <p>Aspect (°) variable</p> <p>Surficial material F</p> <p>Drainage m</p> <p>SMR 5-6</p> <p>SNR C-E</p>	
No photo available		Plots: I1761, SM15	

No site modifiers mapped for atypical conditions

Distribution of Polygons Containing SS Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

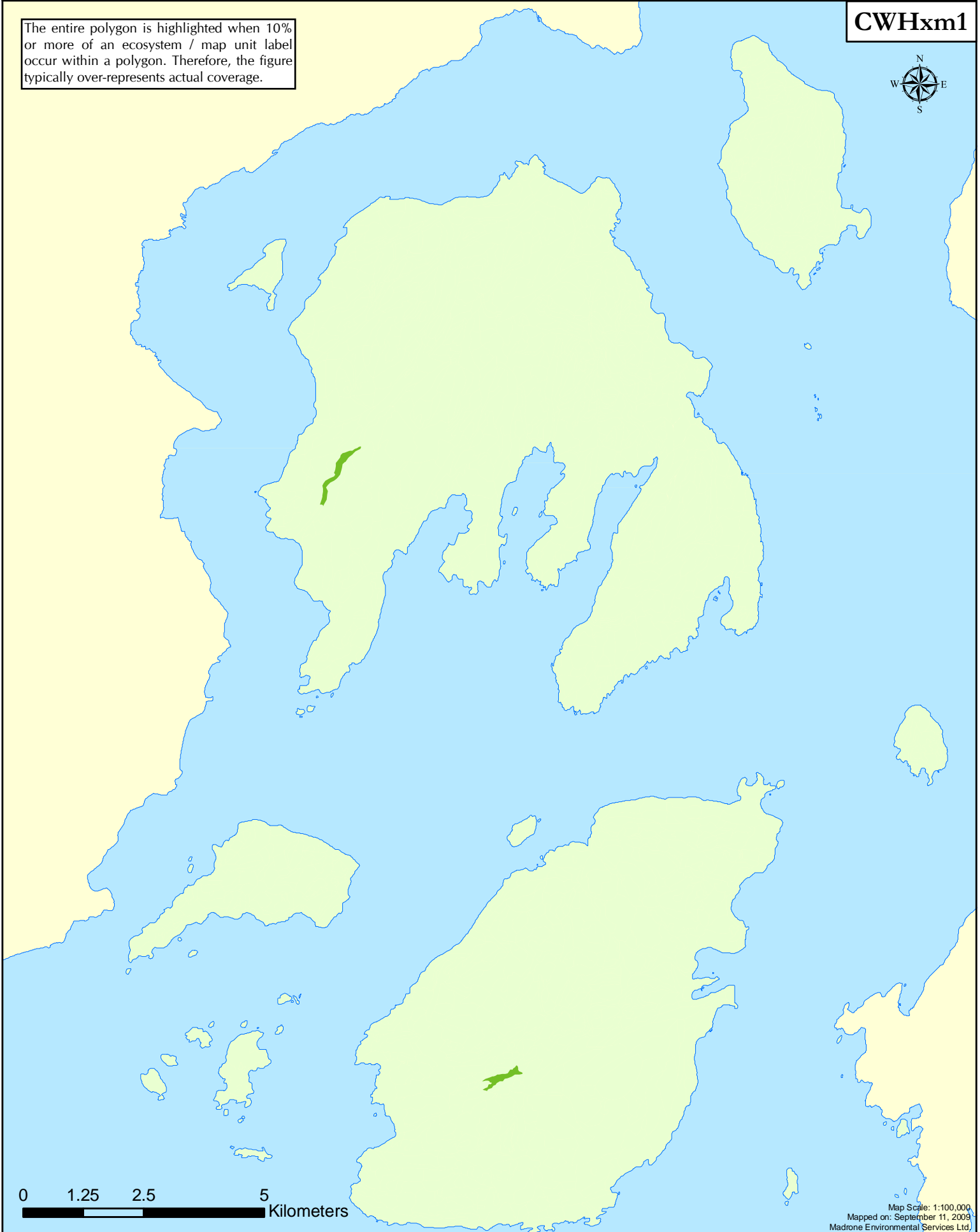
TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series	
CD	Black Cottonwood—Red-osier dogwood	09	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>These deciduous dominated floodplain ecosystems occupy medium bench active floodplains and are limited in occurrence to large creeks and rivers in Howe Sound. The black cottonwood – red-osier dogwood shrub-dominated floodplain ecosystem is frequently inundated and supports species adapted to periodic flooding or high water tables.</p> <p>The vegetation on mid bench floodplains are usually composed of black cottonwood, red alder, willows, red-osier dogwood and salmonberry. Herb species include piggy-back plant, lady fern, and common horsetail. It occurred adjacent to other rich sites such as western redcedar – foamflower sites (mapcode: RF).</p> <p>Assumed modifiers: a, d, j, m (CWHxm1/CD); a, j, m (CWHdm/CD)</p>		Elevation (m) Slope (%) Aspect (°) Surficial material Drainage SMR SNR	0-650 5-15 variable F m 5-6 C-E
No photo available		Plots: N/A	

No site modifiers mapped for atypical conditions

Distribution of Polygons Containing CD Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



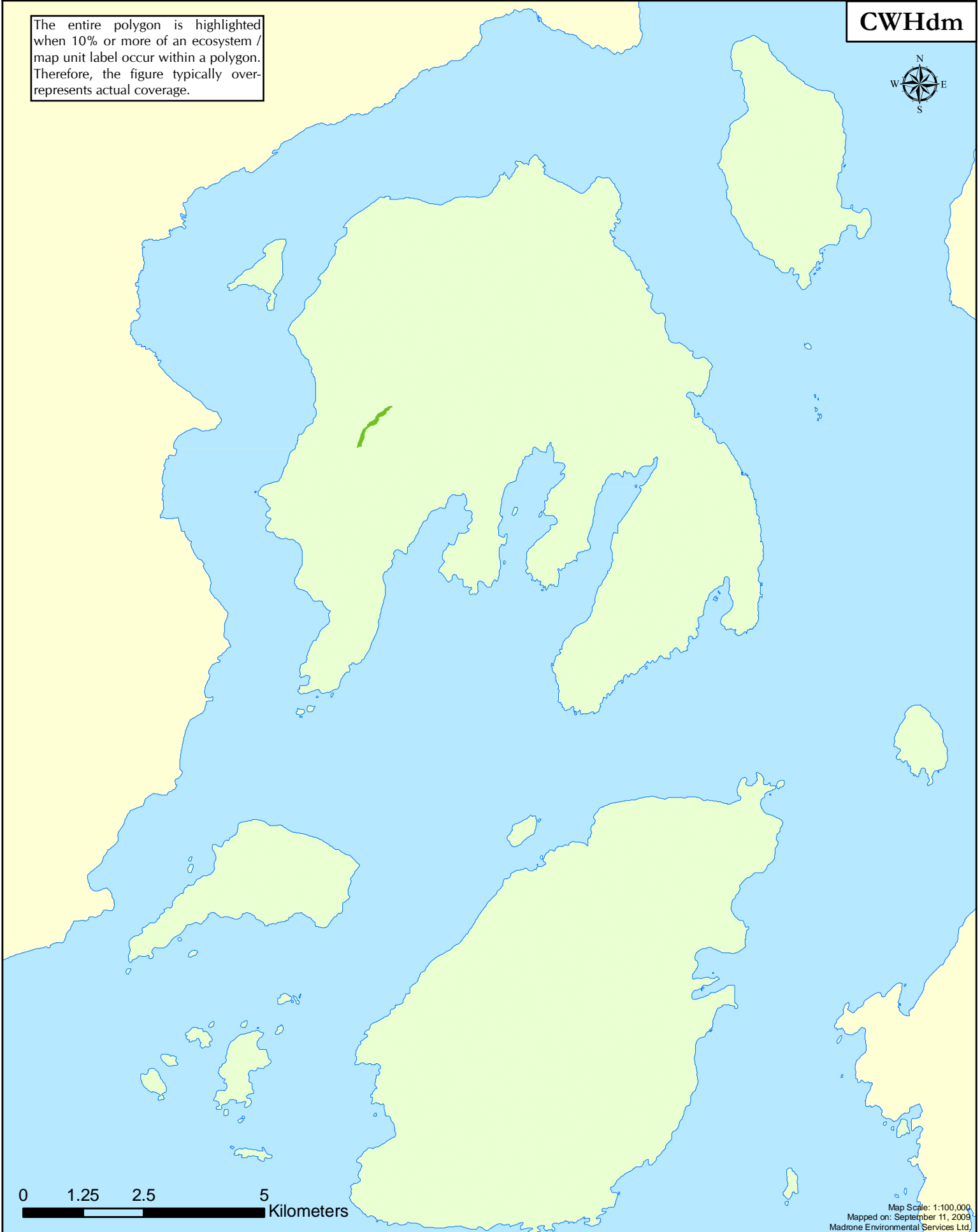
0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing CD Map Units

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.

CWHdm



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

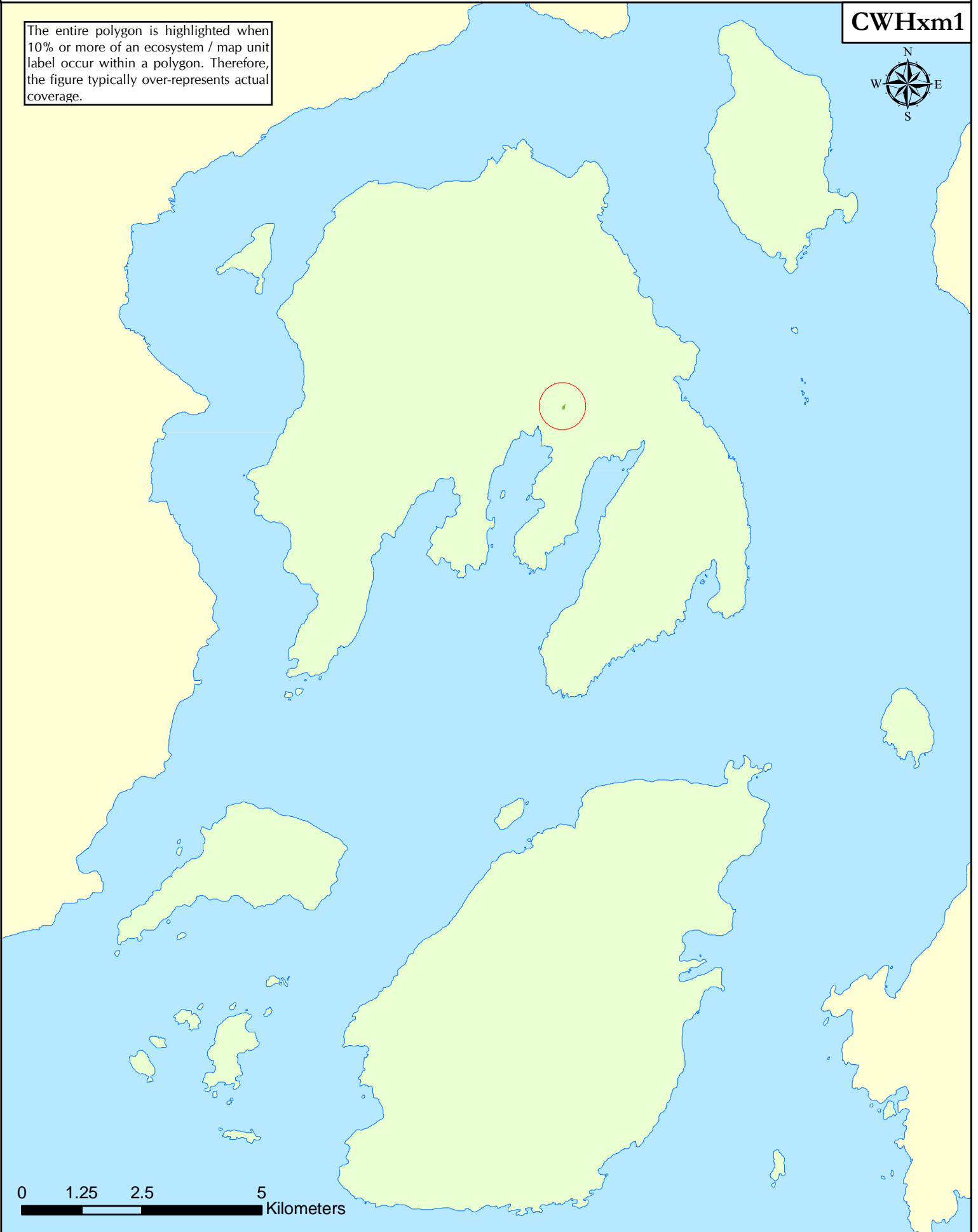
TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series
LS	Shore pine - Sphagnum	11
SITE DESCRIPTION		SITE CHARACTERISTICS
<p>The shore pine – peat moss unit represents a forested bog ecosystem that is uncommon in the Howe Sound study area. This ecosystem occurred adjacent to bogs and open water wetlands at all elevations. Sweet gale and salal are common on these sites. Other shrubs include Labrador tea, western bog-laurel, and peat mosses. These ecosystems consist of very open redcedar and pine trees with a wide variety of herbs and mosses.</p> <p>Assumed modifiers: d, j, p</p>		<p>Elevation (m) 0-650</p> <p>Slope (%) <10</p> <p>Aspect (°) n/a</p> <p>Surficial material Ov, Ob</p> <p>Drainage i - p</p> <p>SMR 6 - 7</p> <p>SNR A - C</p>
No photo available		Plots: N/A

No site modifiers mapped for atypical conditions

Distribution of Map Units Containing LS Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.

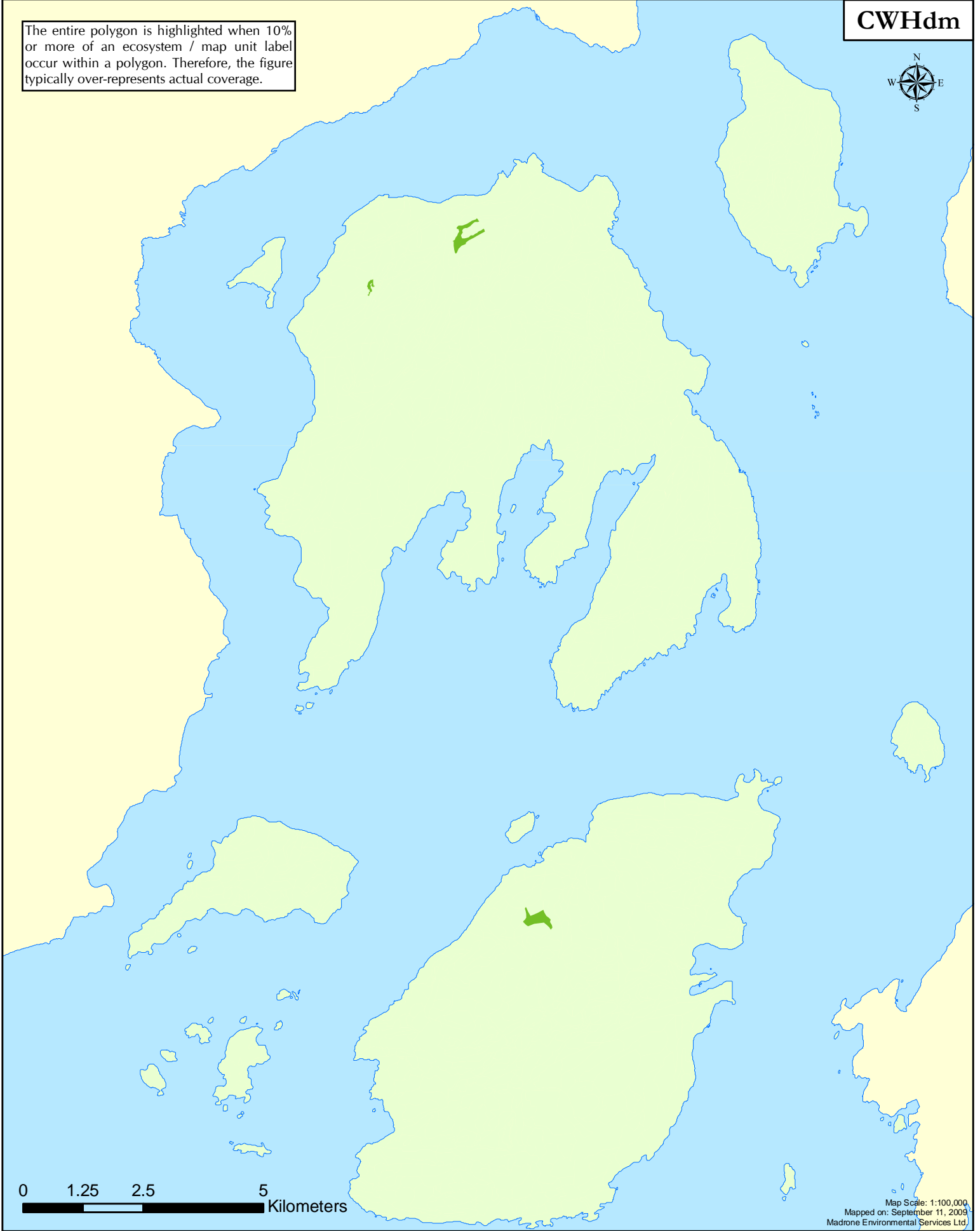


0 1.25 2.5 5 Kilometers

Distribution of Polygons Containing LS Map Units


CWHdm

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

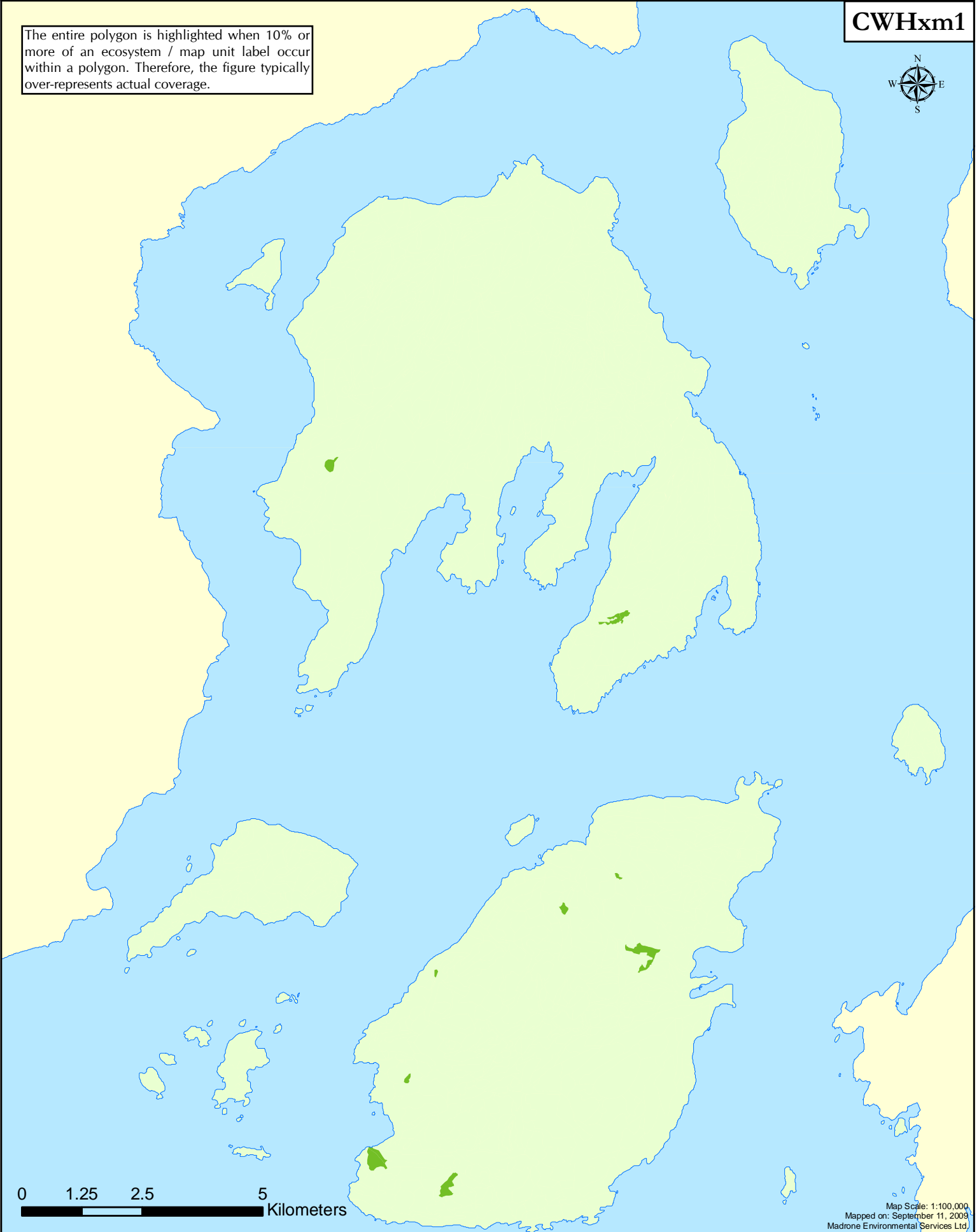
TEM Map Code	Site Series Name	CWHxm1/CWHdm Site Series	
RC	Western redcedar—Sitka spruce—Skunk cabbage	12	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Western redcedar – Sitka spruce – Skunk cabbage are rich, moist to wet sites which occurred in moisture-receiving depressions with fine to medium soils, possibly including a minor component of organics. Western redcedar was a typical dominant with lesser amounts of associated Sitka spruce, red alder, bigleaf maple, and grand fir on the margins. Alder abundance decreased with stand age. Sites often had abundant moderate to large woody debris. Shrubs observed included salmonberry, thimbleberry, and occasionally salal on hummocks. The most common associate species were slough sedge, lady fern, deer fern, and skunk cabbage. Bryophytes associated with this site series were coastal and large leafy moss and slender beaked moss.</p> <p>Assumed modifiers: d, j, m</p>		<p>Elevation (m) 0-650</p> <p>Slope (%) 0-10</p> <p>Aspect (°) variable</p> <p>Surficial material M (0)</p> <p>Drainage p</p> <p>SMR 7</p> <p>SNR C-E</p>	
		<p>Plots: H1981C, TIV03, TIV36, TIV45, 6154, 6169</p>	

No site modifiers mapped for atypical conditions

Distribution of Polygons Containing RC Map Units

CWHxm1

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



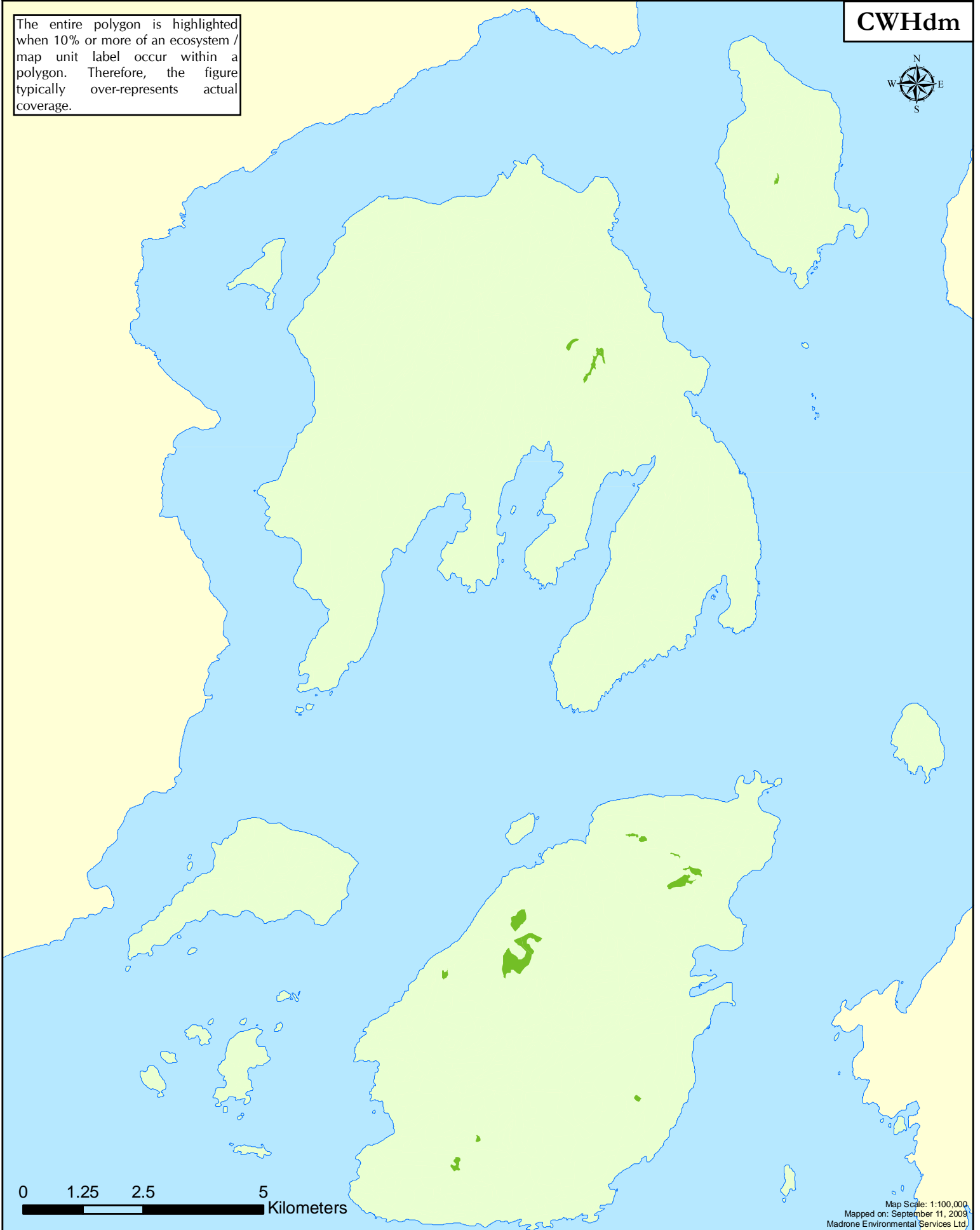
0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing RC Map Units

CWHdm

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Ecosystems in the CWHvm2 subzone¹

TEM Map Code	Site Series Name	CWHvm2 Site Series
AB	Western hemlock–Grand fir–Blueberry	01
SITE DESCRIPTION		SITE CHARACTERISTICS
<p>The 01 site series in the CWHvm2 occurs typically on gentle to mid slopes on medium textured soils. Western hemlock occurs as the dominant trees species in association with Douglas-fir and western redcedar. The understory is well developed with salal as the dominant shrub and associates such as dull Oregon grape and red huckleberry.</p> <p>Assumed modifiers: d, j, m</p>		<p>Elevation (m): >650</p> <p>Slope (%): Variable</p> <p>Aspect (°): Variable</p> <p>Surficial material: M, F^G</p> <p>Drainage: m-w</p> <p>SMR: 3-4</p> <p>SNR: A-C</p>

Site modifiers for atypical conditions

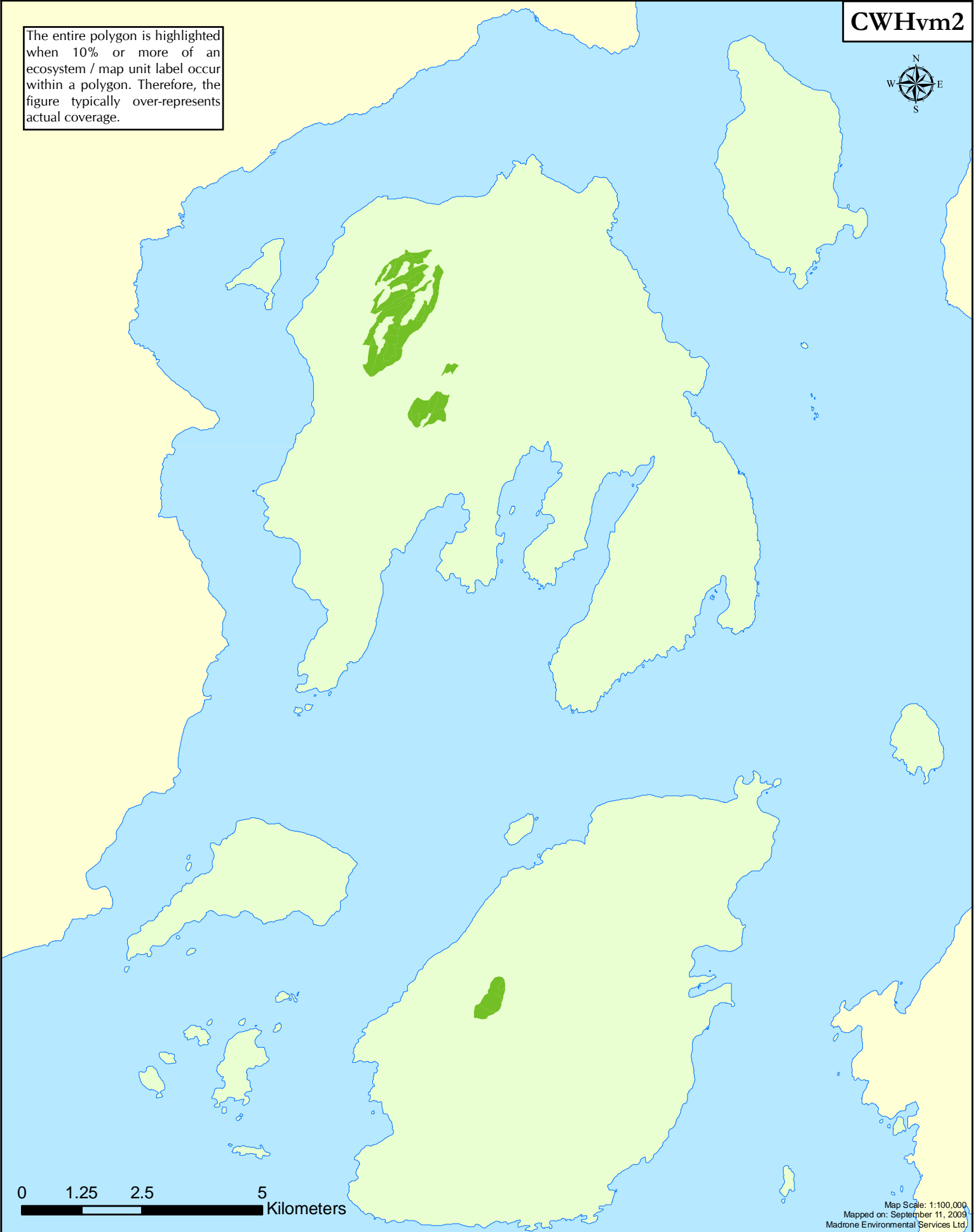
TEM Map Code	Site Series Name	CWHvm2 Site Series
AB typic	ABks cool aspect; shallow soil	
ABs shallow soil	ABh hummocky	
ABsw shallow soil; warm aspect	ABw warm aspect	
ABk cool aspect	ABv very shallow soil	

¹ No plot sampling occurred in the CWHvm2, therefore legend information is limited to general descriptions and mapped modifiers.

Distribution of Polygons Containing AB Map Units

CWHvm2

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

TEM Map Code	Site Series Name	CWHvm2 Site Series
LC	Western hemlock—Shore pine—Cladina	02
SITE DESCRIPTION		SITE CHARACTERISTICS
<p>The LC ecosystem was commonly mapped on water-shedding ridge crests and convex upper slopes with very thin till or bedrock outcroppings. Western and shore pine were dominant in the canopy, with more pine occurring where soil conditions were driest. Canopy cover appears to be sparse with much of the forest floor exposed. Dominant shrubs likely include salal and dull Oregon-grape.</p> <p>Assumed modifiers: j, r, s</p>		<p>Elevation (m) >650</p> <p>Slope (%) 5-65</p> <p>Aspect (°) 999</p> <p>Surficial material Mv, Mx</p> <p>Drainage r</p> <p>SMR 0</p> <p>SNR A (B)</p>

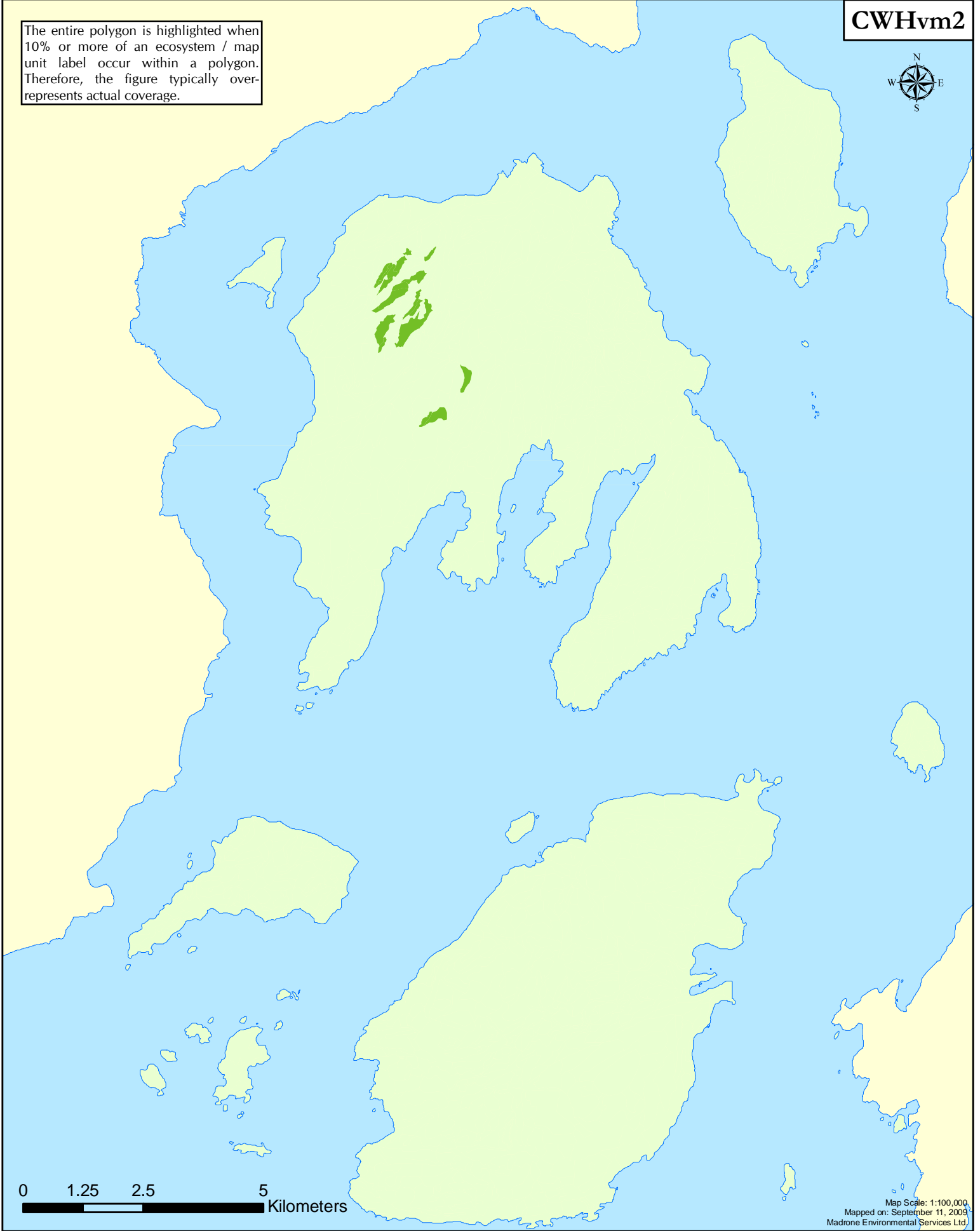
Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHvm2 Site Series
LCw warm aspect	LCKv cool aspect; very shallow soil	
LCK cool aspect	LCh hummocky	
LCv very shallow soil		
LCvw warm aspect; very shallow soil		

Distribution of Polygons Containing LC Map Units

CWHvm2

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

TEM Map Code	Site Series Name	CWHvm2 Site Series
HS	Western hemlock—Western redcedar—Salal	03
SITE DESCRIPTION		SITE CHARACTERISTICS
<p>The Western hemlock – Western redcedar–Salal sites were mapped on well-drained, nutrient very poor to medium upper slopes, typically on warm aspects. Dominant tree species included western redcedar and western hemlock. Salal was likely a constant dominant in the shrub layer, with dull Oregon grape as a frequent associate.</p> <p>Assumed modifiers: j, m, s</p>		<p>Elevation (m) >650</p> <p>Slope (%) 5-60</p> <p>Aspect (°) variable</p> <p>Surficial material M, F^G (C)</p> <p>Drainage w-r</p> <p>SMR 1-2</p> <p>SNR A-C</p>

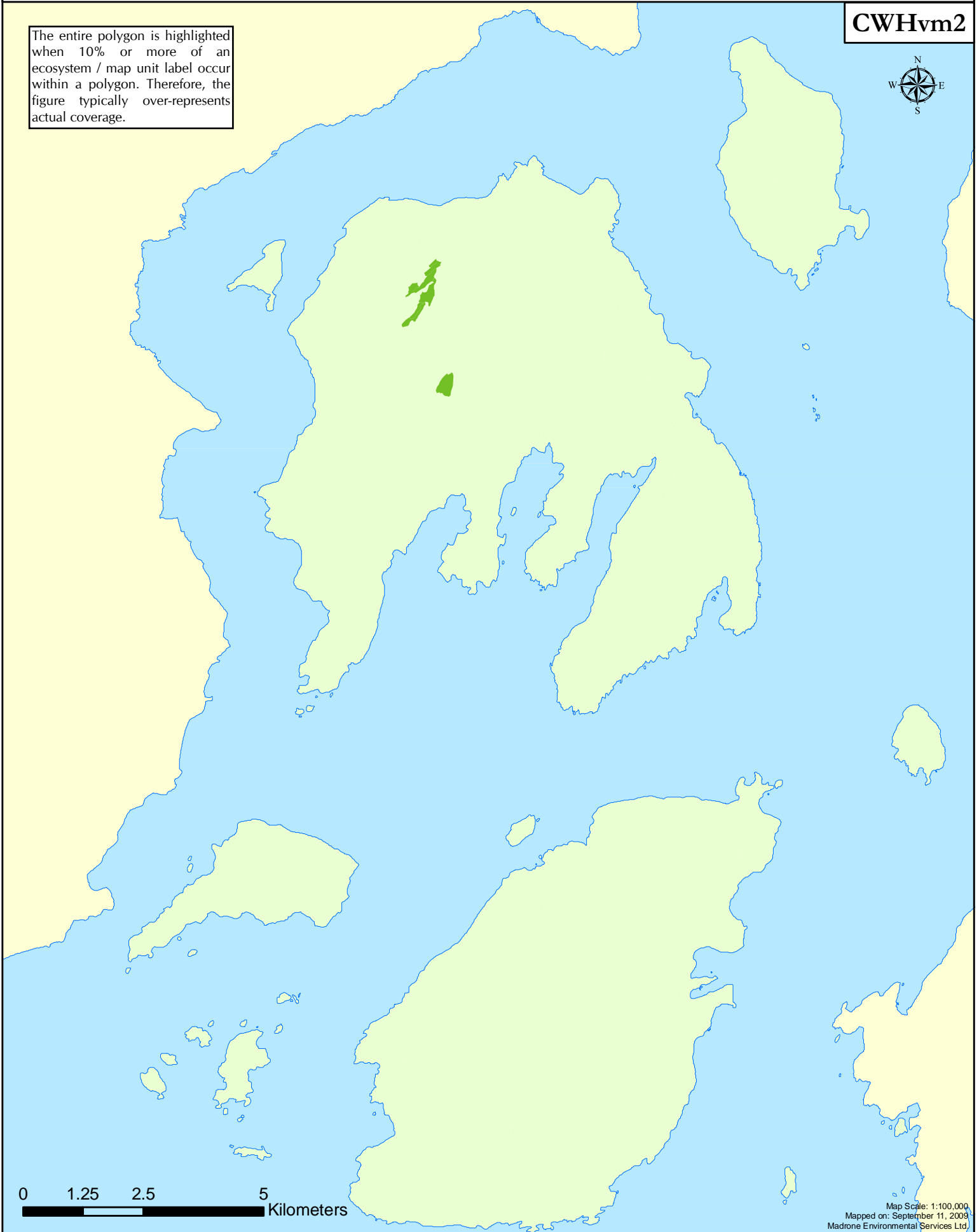
Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHvm2 Site Series
HS typic		
HSh hummocky		

Distribution of Polygons Containing HS Map Units

CWHvm2

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

TEM Map Code	Site Series Name	CWHvm2 Site Series
RS	Western redcedar—Western hemlock— Sword fern	04
SITE DESCRIPTION		SITE CHARACTERISTICS
<p>The Douglas-fir – Sword fern ecosystems were infrequently mapped occurring on well drained upper to mid-slopes with variable thicknesses of till and colluvium. Western hemlock is likely the most common canopy dominant, but redcedar was a frequent associate in all canopy layers. Similar to the lower subzones shrubs likely include dull Oregon-grape, red huckleberry, common snowberry, and trailing blackberry. Sword fern dominates the herb layer, with relatively few other species. The bryophyte layer was dominated by Oregon beaked moss.</p> <p>Assumed modifiers: d, m</p>		<p>Elevation (m) >650</p> <p>Slope (%) 25-70</p> <p>Aspect (°) variable</p> <p>Surficial material M, F^G</p> <p>Drainage w</p> <p>SMR 1-2</p> <p>SNR C-E</p>

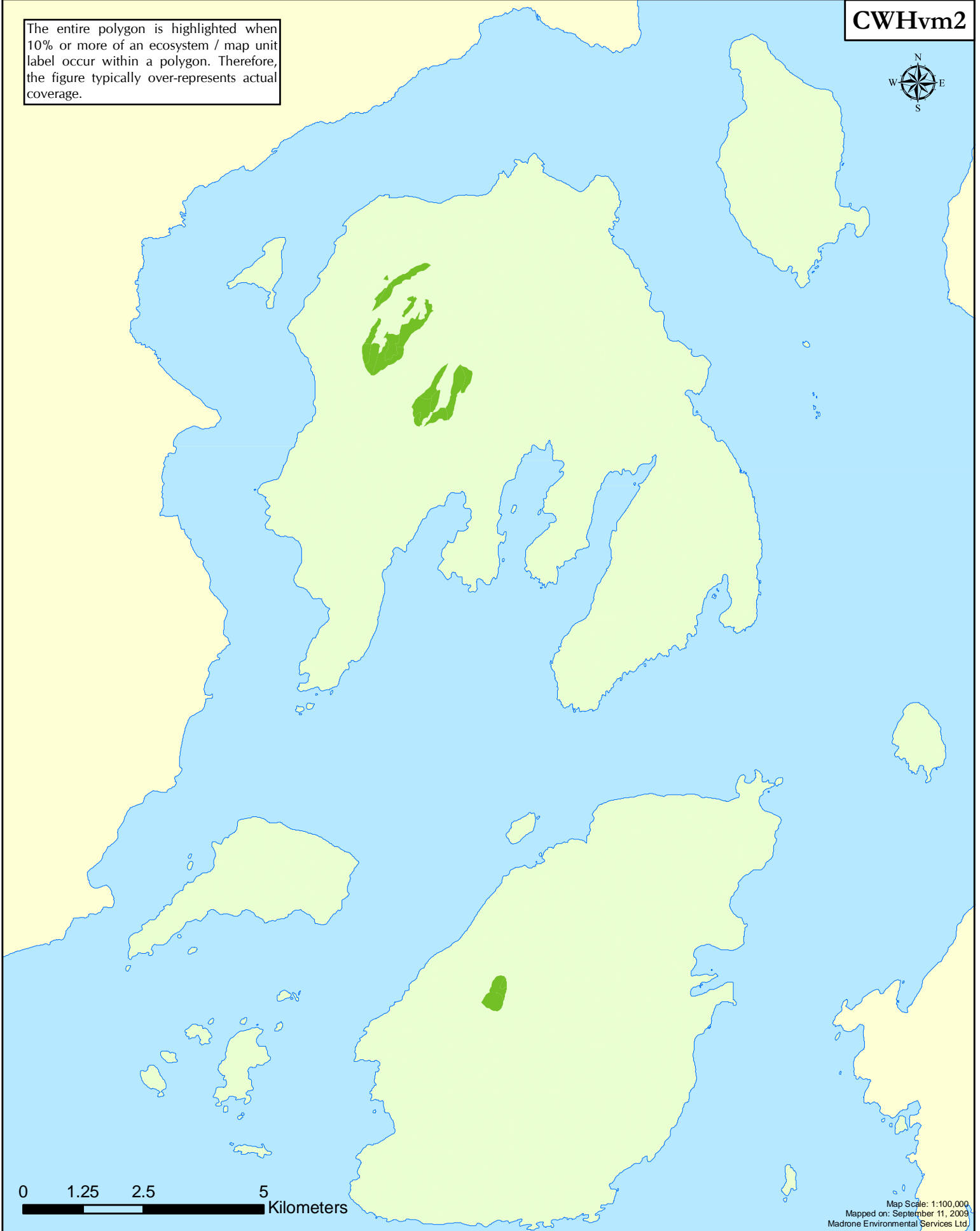
Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHvm2 Site Series
RSj gentle slope	RSsw shallow soil; warm aspect	RSg gully
RSjs gentle slope; shallow soil	RSkv kool aspect; very shallow soil	RSqw gully; warm aspect
RSk cool aspect	RSks cool aspect; shallow soil	RSn fan
Rshs Hummocky; shallow soil		

Distribution of Polygons Containing RS Map Units

CWHvm2

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

TEM Map Code	Site Series Name	CWHvm2 Site Series
AF	Grand fir—Western redcedar—Foamflower	05
SITE DESCRIPTION		SITE CHARACTERISTICS
<p>The Grand fir - Western redcedar - Foamflower ecosystems were mapped on moisture-receiving toe slopes, some seepage sites, and level sites with thick relatively rich, moderately well to imperfectly drained soils. The AF site was also mapped in gully situations. It appears that Western redcedar was often associated in the semi-open canopy with constant associates western hemlock, red alder, grand fir and bigleaf maple; Douglas-fir was infrequent to absent on most RF sites.</p> <p>Assumed modifiers: d, m</p>		<p>Elevation (m) >650</p> <p>Slope (%) 0-35</p> <p>Aspect (°) variable</p> <p>Surficial material M, F^G</p> <p>Drainage m</p> <p>SMR 5-6</p> <p>SNR D-E</p>

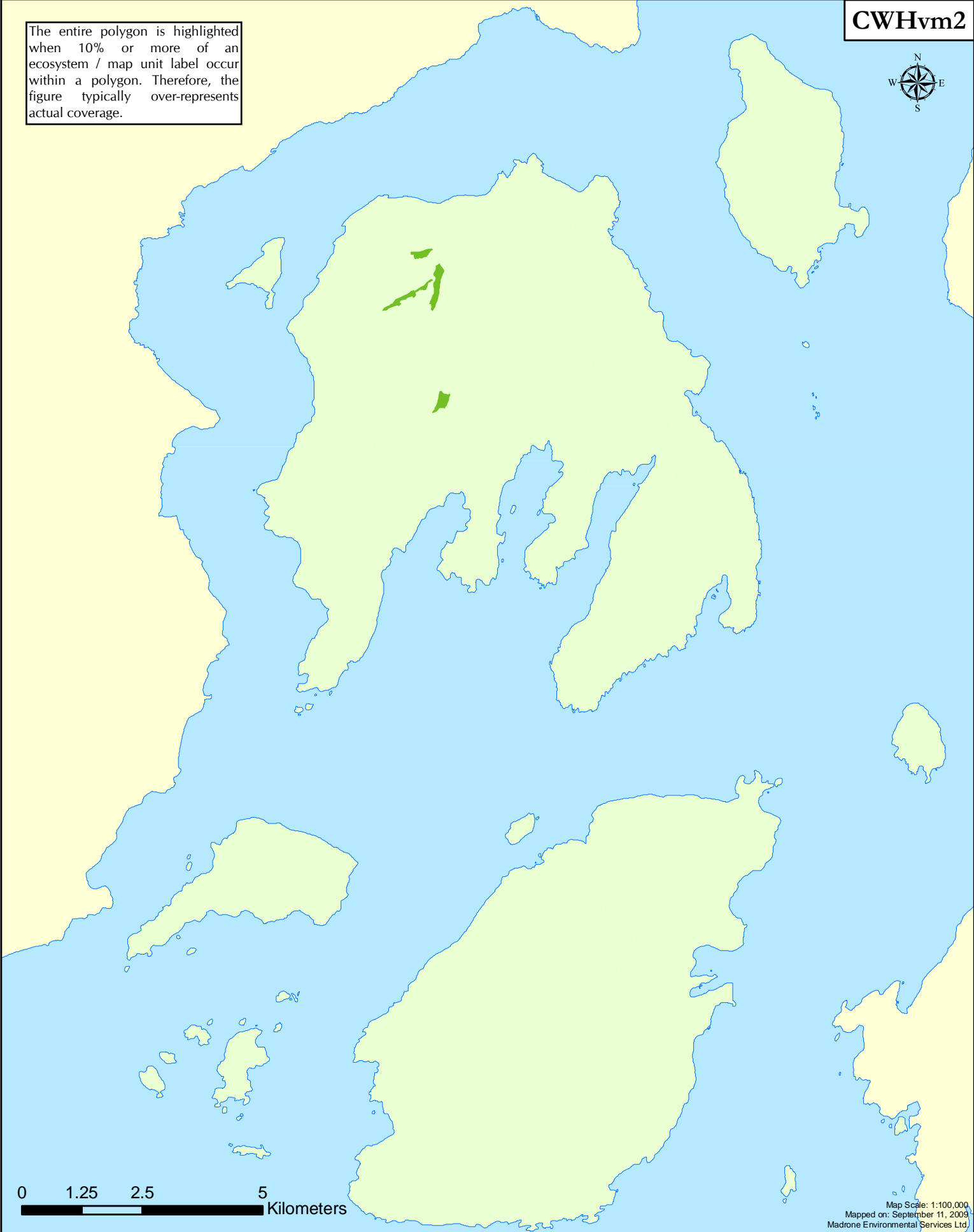
Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHvm2 Site Series
AFk cool aspect	AFqs gully; shallow soil	
AFjs gentle slope; shallow soil	AFqk gully; cool aspect	
AFg gully		

Distribution of Polygons Containing AF Map Units

CWHvm2

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



TEM Map Code	Site Series Name	CWHvm2 Site Series														
HD	Western hemlock—Grand fir—Deer fern	06														
SITE DESCRIPTION		SITE CHARACTERISTICS														
<p>The Western hemlock – Grand fir – Deer fern site was uncommonly mapped in Howe Sound, but likely occurred on lower slopes with moderately to imperfectly drained soils. Western hemlock is expected to be the most abundant tree and constant dominant, with lesser amounts of frequent associates western redcedar and grand fir. Bigleaf maple and red alder were often present in seral stands.</p> <p>Assumed modifiers: d, m</p>		<table border="1"> <tr> <td>Elevation (m)</td> <td>>650</td> </tr> <tr> <td>Slope (%)</td> <td>5-25</td> </tr> <tr> <td>Aspect (°)</td> <td>variable</td> </tr> <tr> <td>Surficial material</td> <td>M</td> </tr> <tr> <td>Drainage</td> <td>w-m</td> </tr> <tr> <td>SMR</td> <td>5-6</td> </tr> <tr> <td>SNR</td> <td>A-C</td> </tr> </table>	Elevation (m)	>650	Slope (%)	5-25	Aspect (°)	variable	Surficial material	M	Drainage	w-m	SMR	5-6	SNR	A-C
Elevation (m)	>650															
Slope (%)	5-25															
Aspect (°)	variable															
Surficial material	M															
Drainage	w-m															
SMR	5-6															
SNR	A-C															

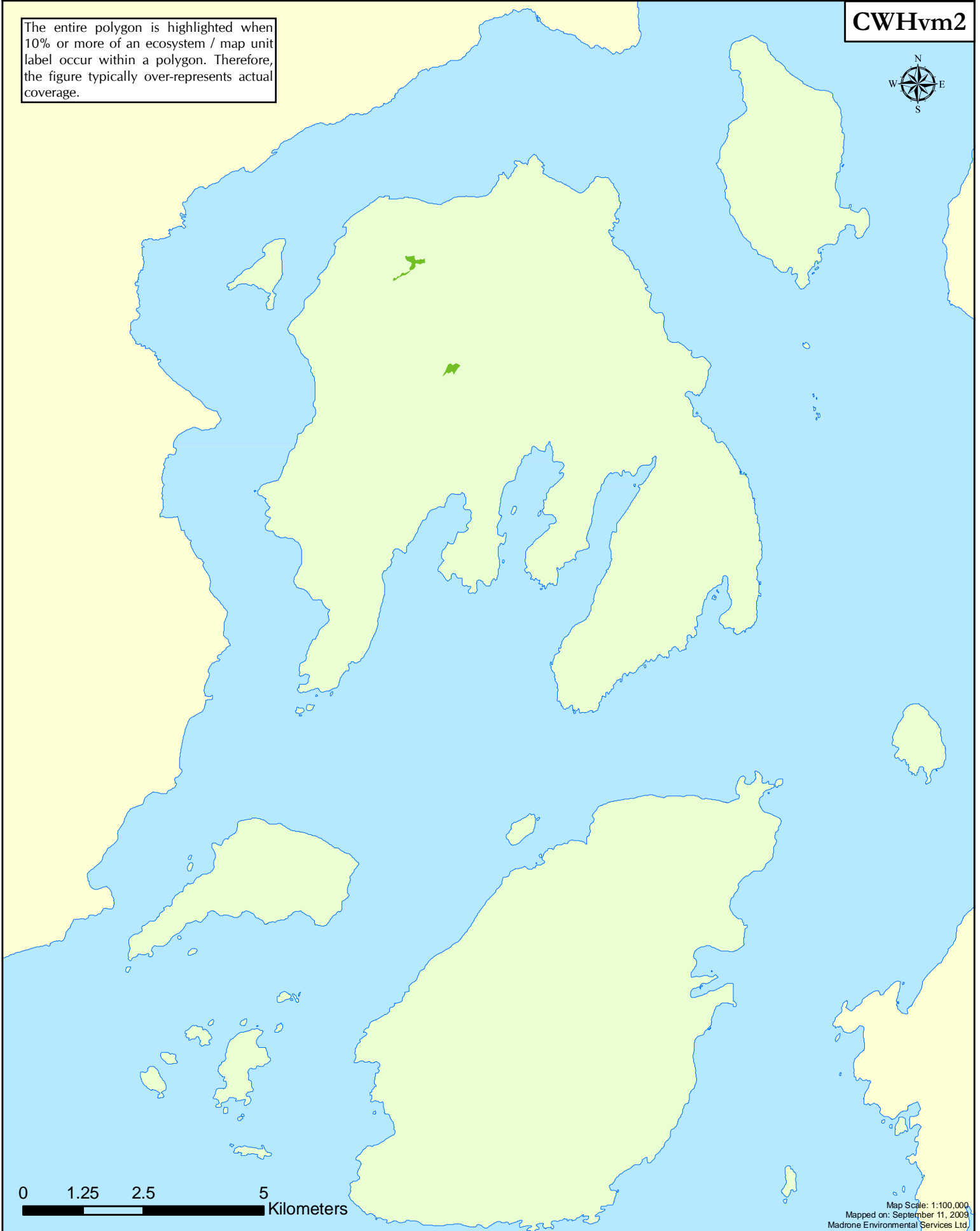
Site modifiers for atypical conditions

TEM Map Code	Site Series Name	CWHvm2 Site Series
HD typic		
HDs cool aspect		

Distribution of Polygons Containing HD Map Units

CWHvm2

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



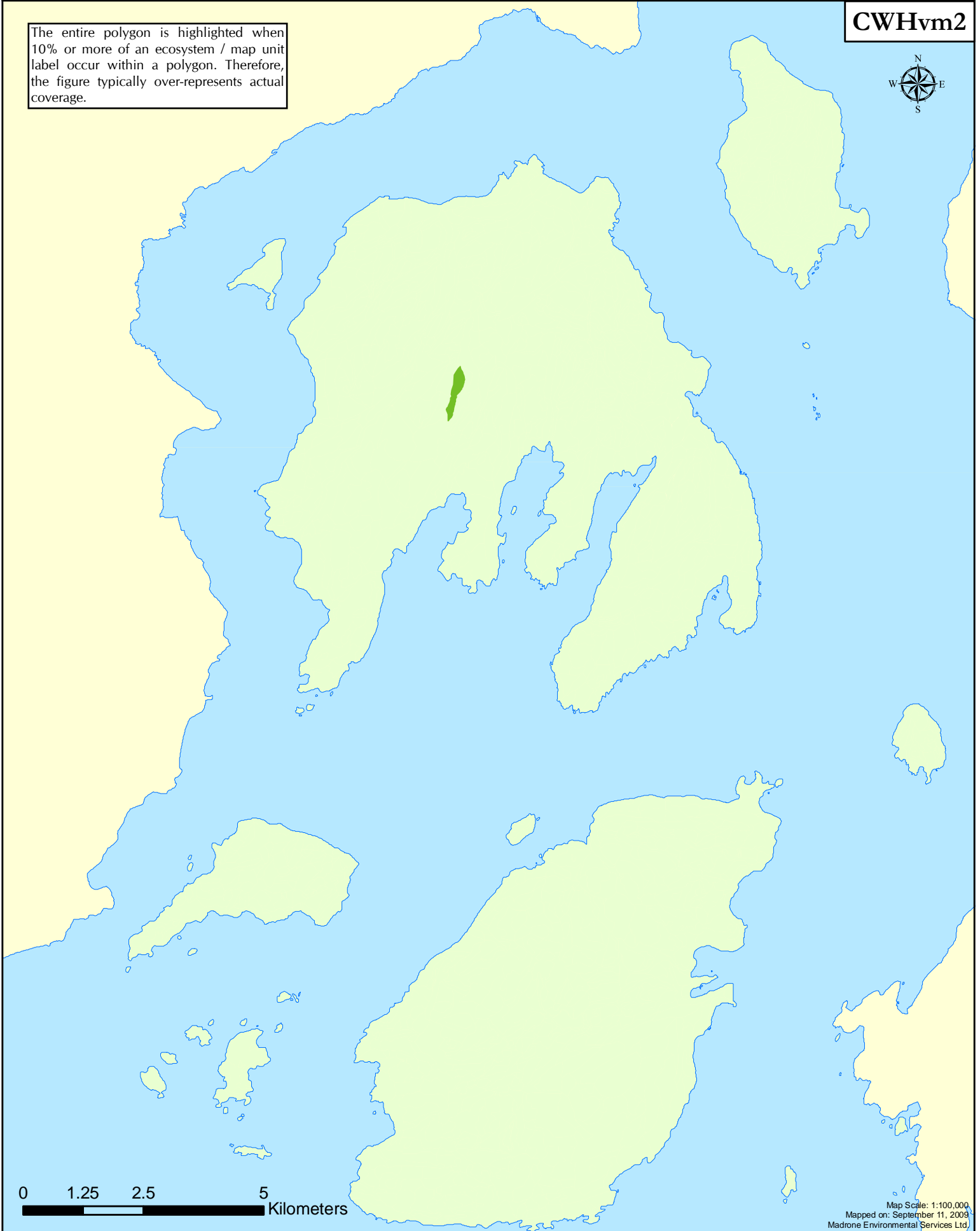
TEM Map Code	Site Series Name	CWHvm2 Site Series	
AS	Grand fir—Western redcedar—Salmonberry	07	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The AS ecosystem was mapped infrequently in the upper elevations of Howe Sound on moisture-receiving toe slopes, and seepage sites. Western redcedar was often associated in the semi-open canopy with constant associates western hemlock, red alder, grand fir and bigleaf maple. Shrubs included dense cover of the dominant species salmonberry and thimbleberry.</p> <p>Assumed modifiers: d, j, m</p>		Elevation (m) Slope (%) Aspect (°) Surficial material Drainage SMR SNR	>650 0-35 variable M, F ^G m 5-6 D-E

No site modifiers mapped for atypical conditions

Distribution of Polygons Containing AS Map Units

CWHvm2

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

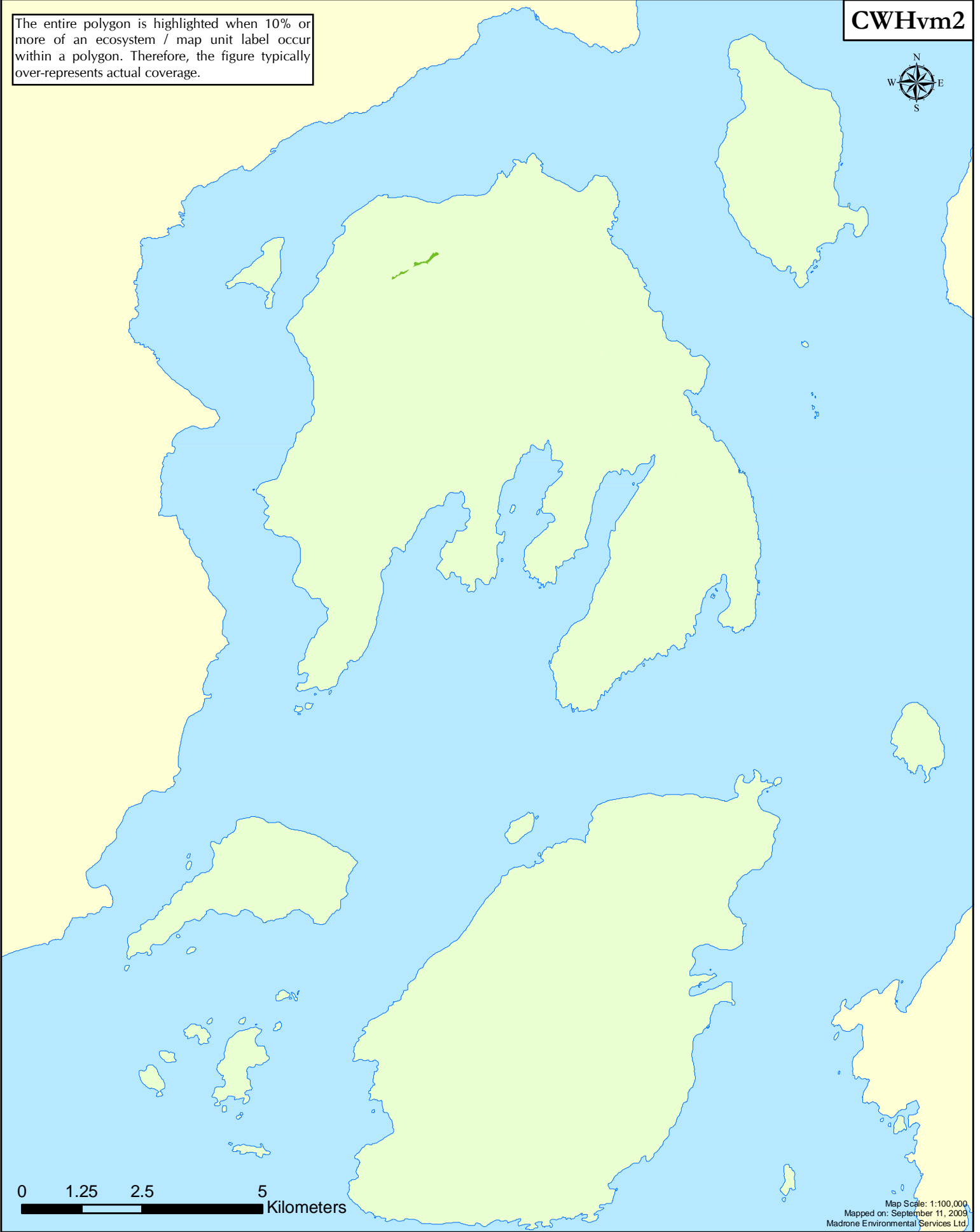
Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd

TEM Map Code	Site Series Name	CWHvm2 Site Series	
YG	Western redcedar-Yellow cedar - Goldthread	09	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The YG unit represents a forested bog ecosystem that is uncommon in the upper elevations of Howe Sound. This ecosystem occurred adjacent to bogs and nutrient-poor sites. Western redcedar and salal are common on these sites with herbs, such as deer fern, bunchberry, and fern-leaved goldthread.</p> <p>Assumed modifiers: d, j, p</p>		Elevation (m) Slope (%) Aspect (°) Surficial material Drainage SMR SNR	>650 <10 n/a Ov, Ob i - p 6 - 7 A - C
No photo available		Plots: N/A	

Distribution of Polygons Containing YG Map Units

CWHvm2


The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers


Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Non-forested Terrestrial Ecosystems in Howe Sound

TEM Map Code	Site Unit	CWHxm1 & CWHdm Site Series	
SC	Cladina – Wallace’s selaginella	00	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The Cladina – Wallace’s selaginella ecosystem is a non-forested ecosystem occurring on shallow to very shallow soils typical of rock outcrops and warm, south facing aspects. Non-vascular flora dominates the unit with species such as <i>Cladina</i> species, hoary and common rock moss, sidewalk moss, and Wallace’s selaginella. Field inspection revealed this community varied to include components of diverse vascular species such as stonecrops, and frequently contained low to moderate cover of introduced grass species on richer sites. The SC unit was often mapped in association with DC and RO units and was typically mapped as structural stage 1b.</p> <p>Dominant species included Wallace’s selaginella and broom moss, while associate species included arbutus, Douglas-fir, blue wildrye, long rock-moss, grey rock-moss, awned haircap moss, juniper haircap moss, early hairgrass, sweet vernalgrass, oceanspray, kinnikinnick, Columbia brome, and curly heron’s-bill moss.</p> <p>Assumed modifiers: j, m, r, v</p>		<p>Elevation (m) All</p> <p>Slope (%) 0-100</p> <p>Aspect (°) 135-285 (varies)</p> <p>Surficial material R (Mx, W^Gx)</p> <p>Drainage x</p> <p>SMR 0-1</p> <p>SNR A-B</p>	
		<p>Plots: H1984, H2010A, I1781A, I1877, I1888, I1905, I1909, JCV02, JCV14, JCV21, JCV44, JCV58, JCV156, JCV158, TTV005, TIV77, TIV79, TIV27</p>	

Site modifiers for atypical conditions

TEM Map Code	Site Association	CWHxm1 & CWHdm Site Series
SC	Cladina—Wallace's selaginella	00
SCh	hummocky	
SCw	warm aspect	
SCK	cool aspect	
SChs	hummocky; shallow soil	

Tem Map Code	Site Unit	CWHxm1 Site Series	
AM	Arbutus—Hairy manzanita	00	
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>These very xeric Arbutus – Hairy Manzanita sites occurred on coastal bluffs and water-shedding steep slopes directly on bedrock. Canopies were very open (<5%) with arbutus and occasionally shore pine dominant, rarely reaching past structural stage 4 with respect to structural development criteria. The shrub layer was dominated by hairy manzanita, arbutus regeneration, and occasionally Scotch broom. Herbs were typically sparse, but annuals may be evident in the spring, particularly graminoids, but comprising low (<20%) cover. The substrate was typically dominated almost completely by curly heron's-bill moss and, to a lesser extent, and on rock outcrops, foliose lichens.</p> <p>Dominant vegetation included sweet vernalgrass, hairy Manzanita, shore pine, curly heron's-bill moss, hoary rock-moss, Douglas-fir, Alaska oniongrass, grey rock-moss and juniper haircap moss. Associate species included green sorrel and lesser green reindeer. Dominant vegetation included arbutus, curly heron's-bill moss, red-stemmed feathermoss, hairy Manzanita, western hemlock, Douglas-fir, Oregon beaked-moss and salal, with oceanspray as an associate species.</p> <p>Assumed modifiers: j, r, s</p>		<p>Elevation (m) 0-50</p> <p>Slope (%) Variable</p> <p>Aspect (°) 120-250</p> <p>Surficial material R</p> <p>Drainage r</p> <p>SMR 1</p> <p>SNR A</p>	
		<p>Plots: JCV15</p>	

No site modifiers mapped for atypical conditions

Wetland Ecosystems in CWHxm1, dm, and vm2 subzones

TEM Map Code	Site Association	CWHxm1 & CWHdm Site Series	
Wb50	Labrador tea—Bog-laurel—Peat-moss bog		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>The Labrador tea – Bog-laurel – Peat-moss ecosystem is uncommon in Howe Sound. Wb50 sites occur in raised peatlands and closed basins with a stagnant watertable. These sites are characterized by moderate species diversity dominated by low ericaceous species such as Labrador tea, bog-laurel, and sweet gale. Peat-moss species dominate the ground layer with scattered acid-loving herbs. This bog ecosystem occurs on organic veneers of poorly developed peat.</p> <p>Assumed modifiers: N/A</p>		<p>Elevation (m) 150-650</p> <p>Slope (%) 0</p> <p>Aspect (°) 999</p> <p>Surficial material Ov</p> <p>Drainage p-v</p> <p>SMR 7</p> <p>SNR D</p>	
No photo available		Plots: H1997B, H1983D	

No site modifiers mapped for atypical conditions

TEM Map Code	Site Association	CWHxm1 & CWHdm	
Wf50	Narrow-leaved cotton-grass—Peat-moss fen		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Narrow-leaved cotton-grass—Peat moss sites are uncommon in Howe Sound. Wf50 sites are fen ecosystems dominated by cotton-grass and <i>Sphagnum</i> mosses but other species may also be prominent depending specific site conditions. Typically this fen occurs on organic soils which are less than 2 m thick.</p> <p>Assumed modifiers: N/A</p>		Elevation (m) Slope (%) Aspect (°) Surficial material Drainage SMR SNR	All 0 999 Ob, Ov p-v 6-7 C
No photo available		Plots: 11716	

No site modifiers mapped for atypical conditions

TEM Map Code	Site Association	CWHxm1, CWHdm & CWHvm2	
Wf52	Sweet gale—Sitka sedge fen		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Sweet gale—Sitka sedge sites are the most common wetland type in Howe Sound, but occur in a variety of landscape positions that are shallowly flooded during part of the year. Wf52 sites are characterized by low species diversity, dominated by sweet gale, Sitka sedge, and <i>Sphagnum</i> mosses. This fen ecosystem has a closed and dense thicket of sweet gale and hardhack. Sitka sedge dominates the herb layer.</p> <p>Assumed modifiers: N/A</p>		<p>Elevation (m) All</p> <p>Slope (%) 0</p> <p>Aspect (°) 999</p> <p>Surficial material Ob</p> <p>Drainage p-v</p> <p>SMR 6-7</p> <p>SNR C</p>	
No photo available		Plots: H1995, I1993C, I1768, I1993A, I1985, I1988, I1767	

No site modifiers mapped for atypical conditions


TEM Map Code	Site Association	CWHxm1
Wm50	Sitka sedge—Hemlock-parsley marsh	
SITE DESCRIPTION		SITE CHARACTERISTICS
<p>The Sitka sedge – Hemlock-parsley marsh ecosystem is very uncommon in the study area. Sitka sedge is always present with a number of other forb and grass species, depending on the substrate and amount of flowing water. Wm50 sites develop on organic veneers and marine deposits along streams and ponds near coastal waters. From plot data dominant species included common rush, small-flowered forget-me-not and slough sedge, while associate species included common green peat-moss and hardhack.</p> <p>Assumed modifiers: N/A</p>		<p>Elevation (m) <60</p> <p>Slope (%) 0</p> <p>Aspect (°) 999</p> <p>Surficial material W^Gb</p> <p>Drainage p</p> <p>SMR 8</p> <p>SNR C</p>
No photo available		Plots: N/A

No site modifiers mapped for atypical conditions

TEM Map Code	Site Association	CWHxm1														
Em03	Seashore saltgrass															
SITE DESCRIPTION		SITE CHARACTERISTICS														
<p>The Seashore saltgrass ecosystem was found adjacent to mudflat sediments on Gambier Island. Seashore saltgrass communities are often found with Em02 sites. Em03 ecosystems occur on fine-textured, poorly drained tidal sediments in brackish estuaries. The dominant species are seashore saltgrass, glasswort and sea milkwort, with few other species.</p> <p>Assumed modifiers: N/A</p>		<table> <tr> <td>Elevation (m)</td> <td><10</td> </tr> <tr> <td>Slope (%)</td> <td>0</td> </tr> <tr> <td>Aspect (°)</td> <td>999</td> </tr> <tr> <td>Surficial material</td> <td>Ov, Wp</td> </tr> <tr> <td>Drainage</td> <td>p</td> </tr> <tr> <td>SMR</td> <td>7</td> </tr> <tr> <td>SNR</td> <td>B-C</td> </tr> </table>	Elevation (m)	<10	Slope (%)	0	Aspect (°)	999	Surficial material	Ov, Wp	Drainage	p	SMR	7	SNR	B-C
Elevation (m)	<10															
Slope (%)	0															
Aspect (°)	999															
Surficial material	Ov, Wp															
Drainage	p															
SMR	7															
SNR	B-C															
No photo available		Plots: I1785A, I1785B														


No site modifiers mapped for atypical conditions

Anthropogenic and Non-Vegetated/Sparsely Vegetated Map Units of the CWHxm1, CWHdm and CWHvm2


TEM Map Code	Site Unit Name	CWHxm1	
BE	Beach		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Beach units are characterized by sorted sediments reworked by wave action. All beach units were mapped along the ocean edge, beach units were not present along fresh water bodies. This unit is typically void of vegetation and consists of either sand or coarse fragments such as gravels, cobbles and stones, with scattered driftwood, seaweed and various washed up items along the shoreline.</p>		<p>Elevation (m):</p> <p>Slope (%):</p> <p>Aspect (°):</p> <p>Surficial material:</p> <p>Drainage:</p> <p>SMR:</p> <p>SNR:</p>	<p>0-3 m</p> <p>Variable</p> <p>Variable</p> <p>W</p> <p>n/a</p> <p>n/a</p> <p>n/a</p>
		<p>Plots: N/A</p>	

TEM Map Code	Site Unit Name	CWHxm1	
CF	Cultivated Field		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Cultivated fields are non forested, open areas that are subject to agricultural practices including plowing, fertilization, and non native crop production which often results in long-term soil and vegetation changes. Cultivated fields are common throughout Howe Sound on lower elevations. The typical structural stage for cultivated fields is graminoid-dominated (2b). Small islands of forest occur in fields, as do narrow shrub dominated riparian channels and scattered large trees.</p>		Elevation (m): Slope (%): Aspect (°): Surficial material: Drainage: SMR: SNR:	50-150 <15 Variable M, W ^G i - w 2-6 B-D
No photo available	Plots: N/A		

TEM Map Code	Site Unit Name	CWHxm1	
GC	Golf Course		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Only one golf course was mapped in Howe Sound. Golf courses are characterized by flat to gently rolling grass-covered throughways and open areas for playing golf. The fairways are typically separated by isolated rows or patches of trees and ponds.</p>		Elevation (m): Slope (%): Aspect (°): Surficial material: Drainage: SMR: SNR:	Variable <15 Variable M, W ^G n/a n/a n/a
No photo available	Plots: N/A		


TEM Map Code	Site Unit Name	CWHxm1 & CWHdm	
GP	Gravel Pit		
SITE DESCRIPTION		SITE CHARACTERISTICS	
Gravel pits are areas of exposed soil through the commercial removal of sand and gravel.		Elevation (m):	Variable
		Slope (%):	Variable
		Aspect (°):	Variable
		Surficial material:	W ^G , F ^G , A
		Drainage:	n/a
		SMR:	n/a
		SNR:	n/a
		Plots: TTV008	


TEM Map Code	Site Unit Name	CWHxm1	
IN	Industrial		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Industrial sites were added as an anthropogenic unit due to the requirement to address sites that were dominated by industrial development namely, pulp and paper, lumber mills, oil/gas refineries and so on. These units are characterized by a high degree of ground disturbance; concrete parking lots, large commercial buildings, work yards and other specialized industry infrastructure.</p>		Elevation (m): Slope (%): Aspect (°): Surficial material: Drainage: SMR: SNR:	Variable Variable Variable n/a n/a n/a n/a
No photo available	Plots: N/A		


TEM Map Code	Site Unit Name	CWHxm1, CWHdm & CWHvm2	
LA	Lake		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>A lake is a naturally occurring body of water, greater than 2 m deep. Several lakes occur within the mapping area such as Grafton, Gambier, Killarney, and Josephine.</p>		<p>Elevation (m):</p> <p>Slope (%):</p> <p>Aspect (°):</p> <p>Surficial material:</p> <p>Drainage:</p> <p>SMR:</p> <p>SNR:</p>	<p>Variable</p> <p>0</p> <p>999</p> <p>n/a</p> <p>n/a</p> <p>n/a</p> <p>n/a</p>
		<p>Plots: N/A</p>	

TEM Map Code	Site Unit Name	CWHxm1	
MU	Mudflat Sediment		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Mudflat sediment is a flat plain-like area dominated by fine textured sediments that often occur in estuaries. These areas were mapped at the interface of salt and fresh water, namely active channel sediment located at the mouth of a creek as they drain into saltwater bays.</p>		Elevation (m):	Variable
		Slope (%):	Variable
		Aspect (°):	Variable
		Surficial material:	n/a
		Drainage:	n/a
		SMR:	n/a
		SNR:	n/a
No photo available		Plots: N/A	

TEM Map Code	Site Unit Name	CWHxm1, CWHdm & CWHvm2	
OW	Shallow Open Water		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Shallow open water is a wetland class composed of permanent, shallow (less than 2 m at midsummer levels), standing water that has less than 10% surface cover of emergent vegetation (plants rooted in the bottom). Open water with more than 10% surface cover of emergent vegetation are classified as marsh wetlands.</p>		Elevation (m): Slope (%): Aspect (°): Surficial material: Drainage: SMR: SNR:	Variable 0 999 n/a n/a n/a n/a
No photo available		Plots: I1993B, I1986	

TEM Map Code	Site Unit Name	CWHxm1	
RE	Reservoir		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>A reservoir is an artificial basin created by the impoundment of water behind a human-made structure such as a dam, berm, dyke, or wall.</p>		<p>Elevation (m):</p> <p>Slope (%):</p> <p>Aspect (°):</p> <p>Surficial material:</p> <p>Drainage:</p> <p>SMR:</p> <p>SNR:</p>	<p>Variable</p> <p>0</p> <p>999</p> <p>n/a</p> <p>n/a</p> <p>n/a</p> <p>n/a</p>
		<p>Plots: SM7</p>	

TEM Map Code	Site Unit Name	CWHxm1, CWHdm & CWHvm2	
RO	Rock Outcrop		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Rock outcrops are bedrock outcroppings with little soil development and sparse vegetation cover. Rock outcrops can be steep such as the one in the photo below or gentle such as those found along ridges. Often rock outcrops are associated with dry O2 sites and SC units. Most importantly SEI units classified as coastal bluffs were mapped as rock outcrops with O2 and SC sites intermixed. These coastal rock outcrops begin at the waters edge and extend to the upper elevations of the study area.</p>		<p>Elevation (m): Slope (%): Aspect (°): Surficial material: Drainage: SMR: SNR:</p>	<p>Variable Variable Variable R x-r n/a n/a</p>
		<p>Plots: JCV61, JCV79, JCV109, JCV112, JCV120, JCV129, JCV155, JCV160, JCV164, SM22, SM23, SM24, TIV19, TIV69, TTV002, TTV004, TTV006</p>	

TEM Map Code	Site Unit Name	CWHxm1, CWHdm & CWHvm2	
RW	Rural		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Rural areas are characterized by areas that have residences and other human development scattered and intermingled with forests, range, farm land, cultivated fields or native vegetation. Rural areas are very common in the lower elevations of Howe Sound and often form the dominant polygon component. Minor components include cultivated fields, zonal forests and shrubby riparian creek draws.</p>		<p>Elevation (m):</p> <p>Slope (%):</p> <p>Aspect (°):</p> <p>Surficial material:</p> <p>Drainage:</p> <p>SMR:</p> <p>SNR:</p>	<p>Variable</p> <p>Variable</p> <p>Variable</p> <p>n/a</p> <p>n/a</p> <p>n/a</p> <p>n/a</p>
		<p>Plots: JCV122, JCV146, JCV161, TTV003, TTV007</p>	

TEM Map Code	Site Unit Name	CWHxm1	
RZ	Road Surface		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Road surfaces are not typically large enough to be mapped in Howe Sound. Defined as areas cleared and compacted for the use of vehicles.</p>		Elevation (m): Slope (%): Aspect (°): Surficial material: Drainage: SMR: SNR:	Variable Variable Variable n/a n/a n/a n/a
No photo available		Plots: N/A	

TEM Map Code	Site Unit Name	CWHxm1	
UR	Urban		
SITE DESCRIPTION		SITE CHARACTERISTICS	
<p>Urban units are not common in Howe Sound where the landform is man-modified and drainage is no longer applicable. Urban areas were mapped in town centers such as Snug Cove and Cates Hill on Bowen Island.</p>		Elevation (m):	Variable
		Slope (%):	Variable
		Aspect (°):	Variable
		Surficial material:	n/a
		Drainage:	n/a
		SMR:	n/a
		SNR:	n/a
No photo available		Plots: N/A	

Distribution of Polygons Containing Non-Forested Map Units

CWHxm1

Non-Forested Map Units

AM SC

Sparsely Vegetated Map Units

BE OW

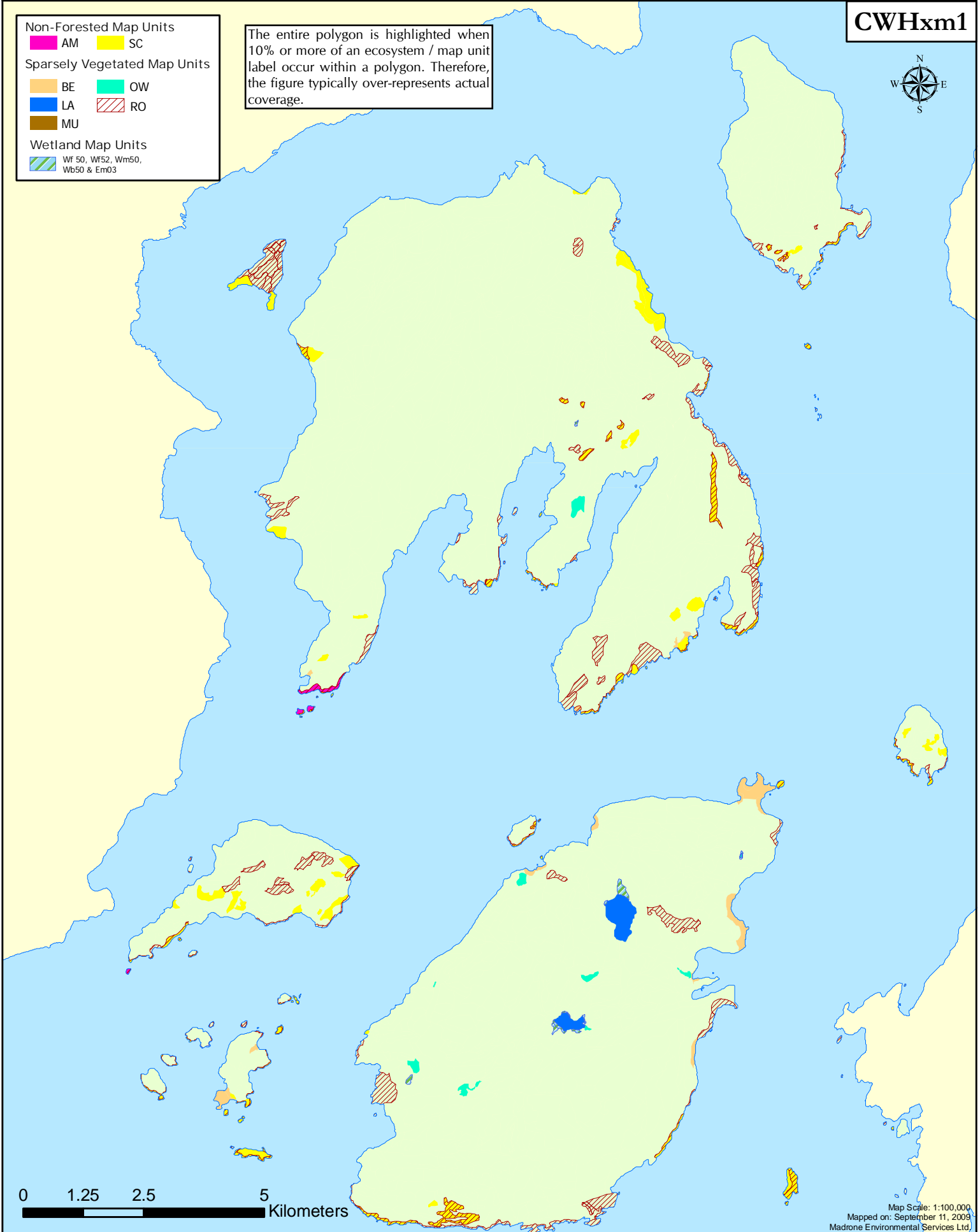
LA RO

MU

Wetland Map Units

Wf 50, Wf52, Wm50,
Wb50 & Em03

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

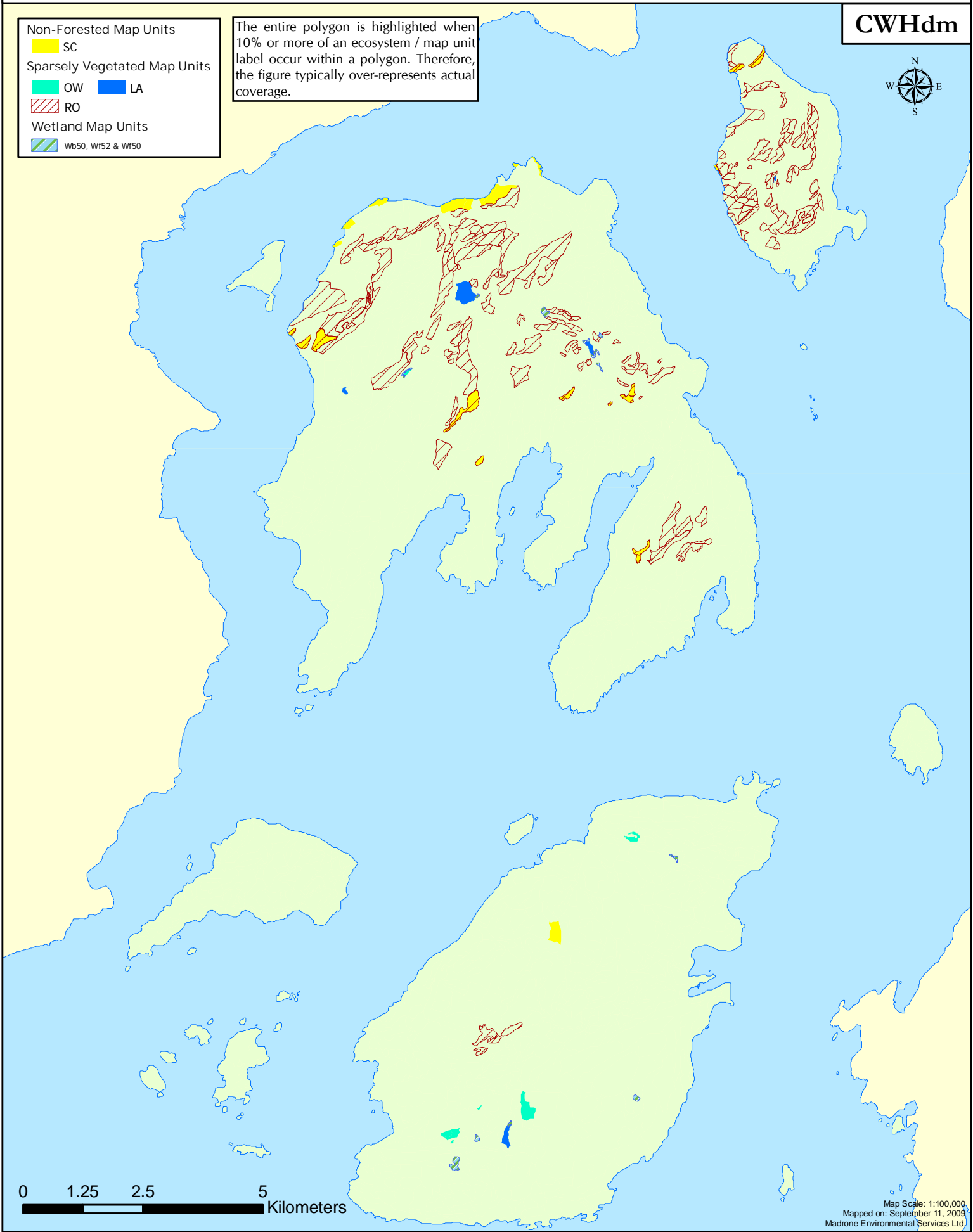
Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Polygons Containing Non-Forested Map Units

CWHdm

- Non-Forested Map Units
 - SC
- Sparsely Vegetated Map Units
 - OW
 - LA
 - RO
- Wetland Map Units
 - Wb50, Wf52 & Wf50

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

Map Scale: 1:100,000
Mapped on: September 11, 2009
Madrone Environmental Services Ltd.

Distribution of Map Units Containing Non-Forested, Wetland & Anthropogenic Map Units

CWHvm2



Non-Forested Units

LA RO

OW

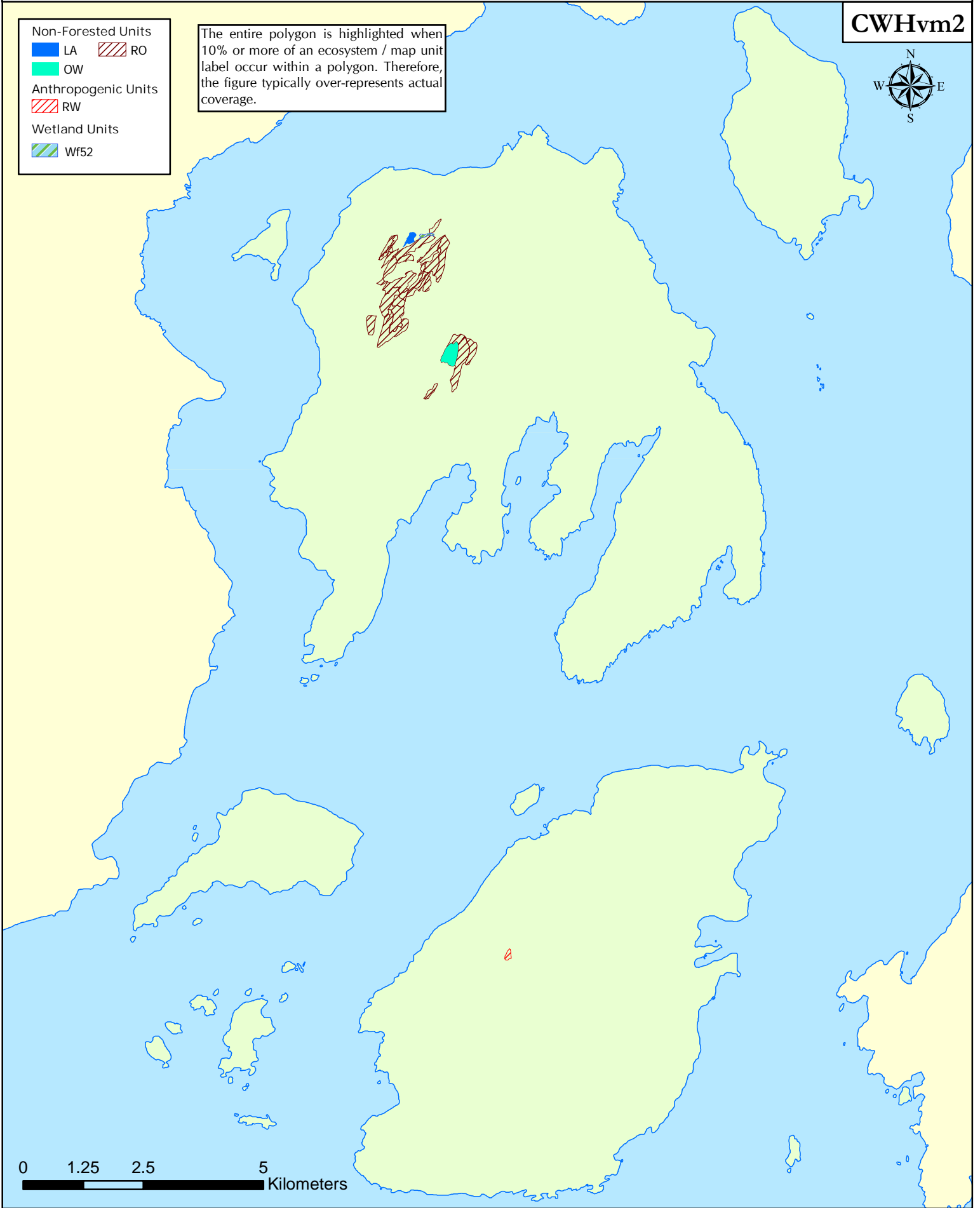
Anthropogenic Units

RW

Wetland Units

Wf52

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers

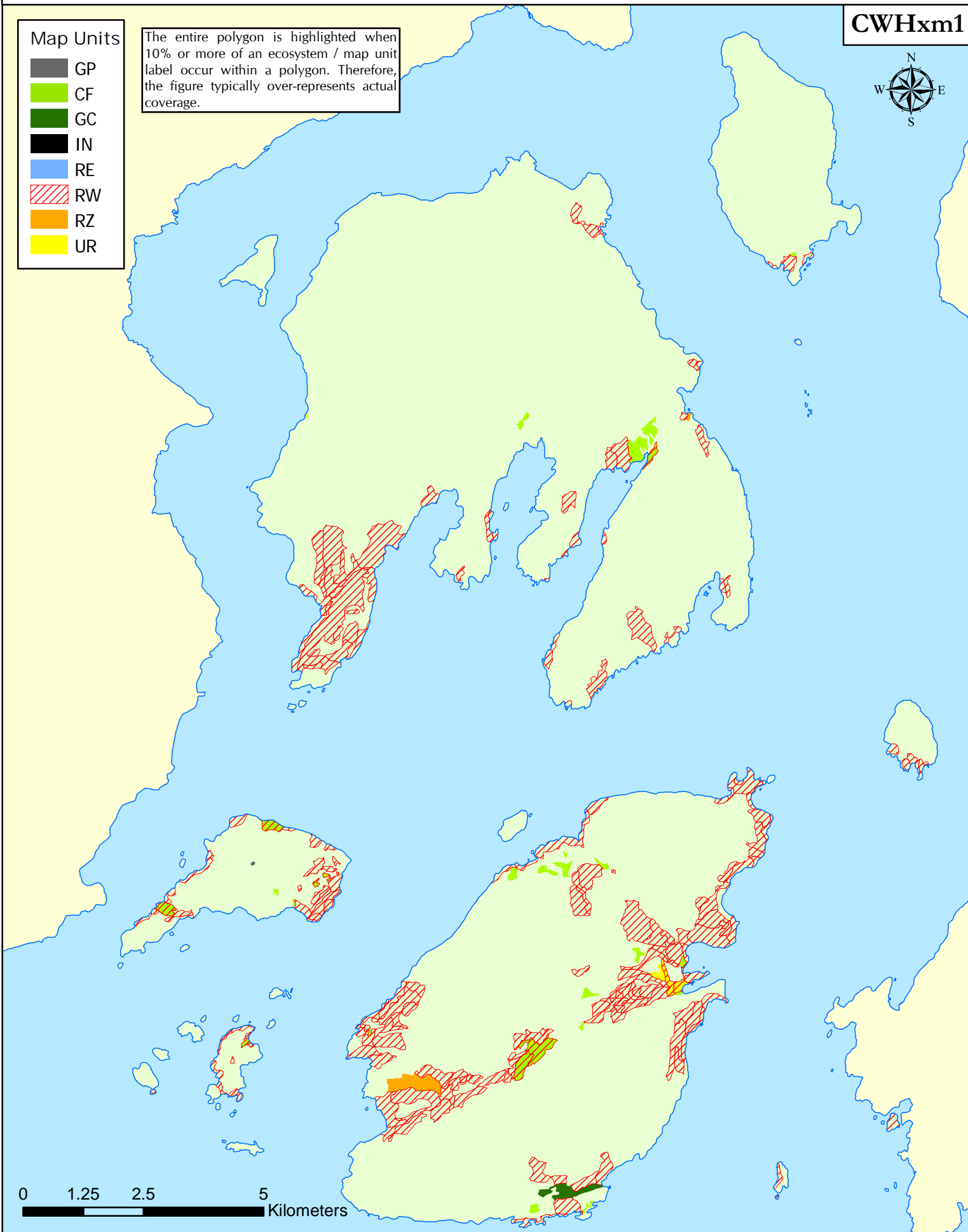
Distribution of Map Units Containing Anthropogenic Map Units

CWHxm1

Map Units

- GP
- CF
- GC
- IN
- RE
- RW
- RZ
- UR

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



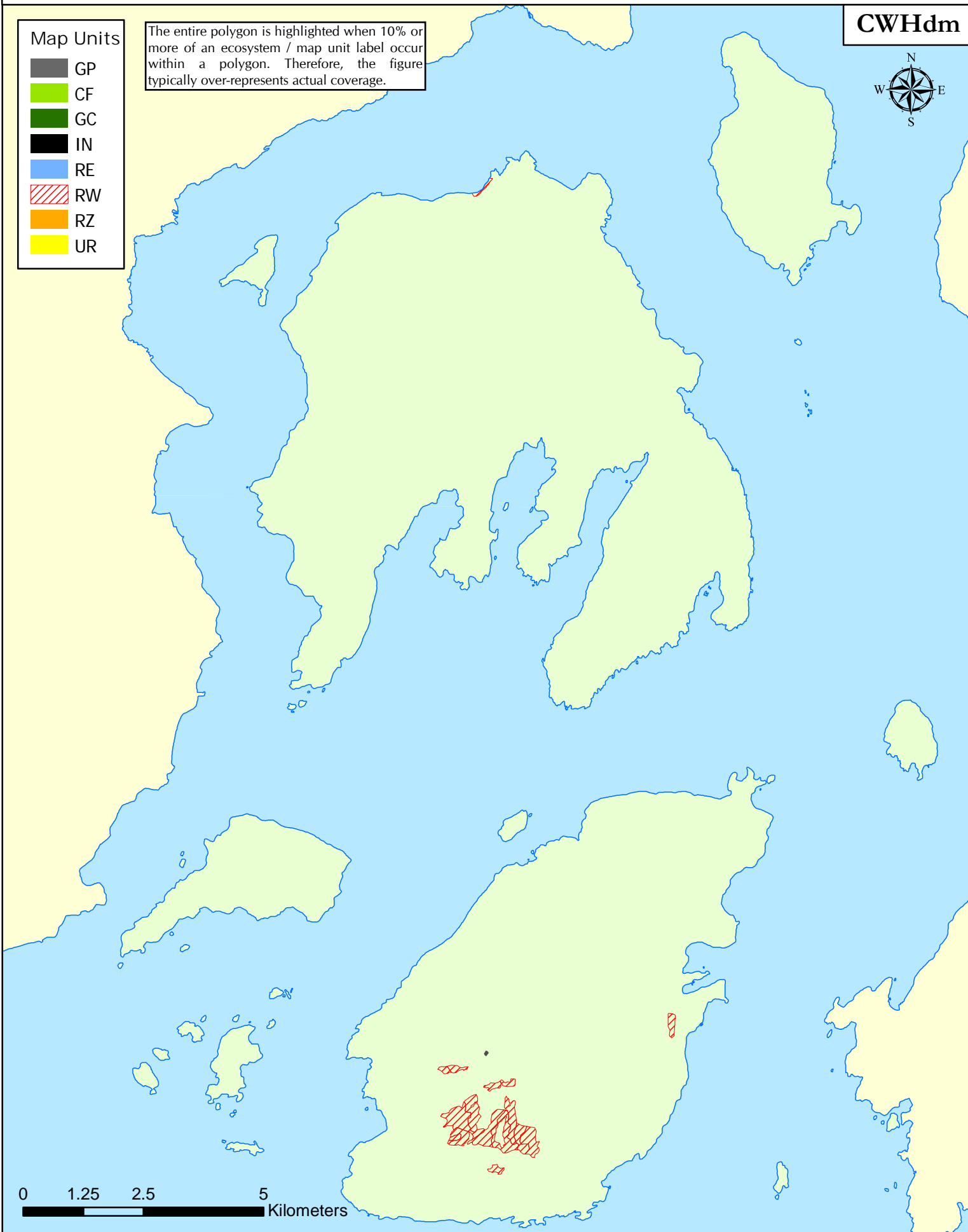
Distribution of Map Units Containing Anthropogenic Map Units

CWHdm

Map Units

- GP
- CF
- GC
- IN
- RE
- RW
- RZ
- UR

The entire polygon is highlighted when 10% or more of an ecosystem / map unit label occur within a polygon. Therefore, the figure typically over-represents actual coverage.



0 1.25 2.5 5 Kilometers



APPENDIX VII

Vascular Plant Species Observed During Field Assessments in the Howe Sound Study Area

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

<i>Abies grandis</i>	grand fir
<i>Acer circinatum</i>	vine maple
<i>Acer glabrum</i>	Douglas maple
<i>Acer macrophyllum</i>	bigleaf maple
<i>Achillea millefolium</i>	yarrow
<i>Adenocaulon bicolor</i>	pathfinder
<i>Adiantum</i> sp.	maiden-hair
<i>Agrostis</i> sp.	bentgrass
<i>Aira praecox</i>	early hairgrass
<i>Allium cernuum</i>	nodding onion
<i>Alnus rubra</i>	red alder
<i>Amelanchier alnifolia</i>	saskatoon berry
<i>Anthoxanthum odoratum</i>	sweet vernalgrass
<i>Aquilegia</i> sp.	columbine
<i>Arbutus menziesii</i>	arbutus
<i>Arctostaphylos columbiana</i>	hairy manzanita
<i>Arctostaphylos</i> sp.	
<i>Artemisia</i> sp.	
<i>Aruncus dioicus</i>	goatsbeard
<i>Aspidotis densa</i>	Indian's-dream
<i>Asplenium trichomanes</i>	common spleenwort
<i>Athyrium filix-femina</i>	lady fern
<i>Atrichum selwynii</i>	crane's-bill moss
<i>Blechnum spicant</i>	deer fern
<i>Brasenia schreberi</i>	water shield
<i>Bromus</i> sp.	brome
<i>Calandrinia</i> sp.	purslane
<i>Carex deweyana</i>	Dewey's sedge
<i>Carex obnupta</i>	slough sedge
<i>Carex pauciflora</i>	few-flowered sedge
<i>Carex sitchensis</i>	Sitka sedge
<i>Carex viridula</i>	green sedge
<i>Carex</i> sp.	sedge
<i>Cerastium</i> sp.	chickweed
<i>Chenopodium album</i>	lamb's-quarters
<i>Chimaphila menziesii</i>	Menzies' pipsissewa

<i>Cicuta douglasii</i>	Douglas' water-hemlock
<i>Circaea alpina</i>	enchanter's nightshade
<i>Cirsium</i> sp.	thistle
<i>Cladina portentosa</i>	maritime reindeer
<i>Cladina rangiferina</i>	grey reindeer
<i>Cladina</i> sp.	reindeer lichens
<i>Cladonia cornuta</i> ssp. <i>cornuta</i>	common bighorn
<i>Cladonia parasitica</i>	fence-rail thatch
<i>Cladonia uncialis</i>	thorn clad
<i>Cladonia</i> sp.	clad lichens
<i>Claopodium</i> sp.	
<i>Claytonia sibirica</i>	Siberian miner's-lettuce
<i>Conocephalum conicum</i>	snake liverwort
<i>Corallorhiza maculata</i>	spotted coralroot
<i>Corallorhiza</i> sp.	coralroot
<i>Cornus canadensis</i>	bunchberry
<i>Cotula coronopifolia</i>	brass buttons
<i>Cytisus scoparius</i>	Scotch broom
<i>Danthonia</i> sp.	oatgrass
<i>Dicentra</i> sp.	
<i>Dicranum scoparium</i>	broom moss
<i>Dicranum</i> sp.	heron's bill moss
<i>Digitalis purpurea</i>	common foxglove
<i>Distichlis spicata</i>	seashore saltgrass
<i>Drosera rotundifolia</i>	round-leaved sundew
<i>Dryopteris expansa</i>	spiny wood fern
<i>Dulichium arundinaceum</i>	three-way sedge
<i>Elymus</i> sp.	wildrye
<i>Epilobium ciliatum</i>	purple-leaved willowherb
<i>Equisetum arvense</i>	common horsetail
<i>Equisetum</i> sp.	horsetail
<i>Eriophorum chamissonis</i>	Chamisso's cotton-grass
<i>Eurhynchium oreganum</i>	Oregon beaked moss
<i>Festuca occidentalis</i>	western fescue
<i>Festuca rubra</i>	red fescue
<i>Festuca</i> sp.	fescue
<i>Fissidens</i> sp.	pocket-moss
<i>Fragaria</i> sp.	strawberry
<i>Galium aparine</i>	cleavers



<i>Galium trifidum</i>	small bedstraw
<i>Galium triflorum</i>	sweet-scented bedstraw
<i>Galium</i> sp.	bedstraw
<i>Gaultheria shallon</i>	salal
<i>Geum macrophyllum</i>	big-leaved avens
<i>Goodyera oblongifolia</i>	rattlesnake-plantain
<i>Grindelia integrifolia</i>	entire-leaved gumweed
<i>Gymnocarpium dryopteris</i>	oak fern
<i>Heuchera micrantha</i>	small-flowered alumroot
<i>Holcus lanatus</i>	common velvet-grass
<i>Holodiscus discolor</i>	oceanspray
<i>Hylocomiastrum</i> sp.	wood-moss
<i>Hylocomium splendens</i>	step moss
<i>Hypericum anagalloides</i>	bog St. John's wort
<i>Ilex aquifolium</i>	English holly
<i>Isoetecium myosuroides</i>	variable moss
<i>Isoetecium</i> sp.	moss
<i>Juncus effuses</i>	common rush
<i>Juncus ensifolius</i>	dagger-leaf rush
<i>Juncus supiniformis</i>	spreading rush
<i>Juniperus communis</i>	common juniper
<i>Kalmia microphylla</i>	western bog-laurel
<i>Lactuca muralis</i>	wall lettuce
<i>Lathyrus</i> sp.	peavine
<i>Ledum groenlandicum</i>	Labrador tea
<i>Leucolepis acanthoneuron</i>	palm tree moss
<i>Leucanthemum arcticum</i>	arctic daisy
<i>Linnaea borealis</i>	twinflower
<i>Listera caurina</i>	northwestern twayblade
<i>Lonicera involucrata</i>	black twinberry
<i>Luzula parviflora</i>	small-flowered woodrush
<i>Lycopodium clavatum</i>	running club-moss
<i>Lycopus uniflorus</i>	northern water-horehound
<i>Lysichiton americanus</i>	skunk cabbage
<i>Madia</i> sp.	tarweed
<i>Mahonia nervosa</i>	dull Oregon-grape
<i>Maianthemum dilatatum</i>	false lily-of-the-valley
<i>Maianthemum stellatum</i>	star-flowered false Solomon's-seal
<i>Malus fusca</i>	Pacific crab apple



<i>Melica subulata</i>	Alaska oniongrass
<i>Melica</i> sp.	oniongrass
<i>Mentha</i> sp.	mint
<i>Menyanthes trifoliata</i>	buckbean
<i>Menziesia ferruginea</i>	false azalea
<i>Mnium spinulosum</i>	red-mouthed leafy moss
<i>Montia parvifolia</i>	small-leaved montia
<i>Myosotis laxa</i>	small-flowered forget-me-not
<i>Myrica gale</i>	sweet gale
<i>Nuphar lutea</i>	yellow pond-lily
<i>Oenanthe sarmentosa</i>	Pacific water-parsley
<i>Oplopanax horridus</i>	devil's club
<i>Osmorhiza berteroi</i>	mountain sweet-cicely
<i>Panicum</i> sp.	witchgrass
<i>Pellia neesiana</i>	shiny liverwort
<i>Peltigera canina</i>	dog pelt
<i>Phalaris arundinacea</i>	reed canarygrass
<i>Phleum pretense</i>	common timothy
<i>Physocarpus capitatus</i>	Pacific ninebark
<i>Picea sitchensis</i>	Sitka spruce
<i>Pinus contorta</i> var <i>contorta</i>	shore pine
<i>Plagiomnium insigne</i>	coastal leafy moss
<i>Plagiothecium undulatum</i>	flat-moss
<i>Plantago maritima</i>	seashore plantain
<i>Plectritis congesta</i>	sea blush
<i>Pleurozium schreberi</i>	red-stemmed feathermoss
<i>Poa paulstris</i>	fowl bluegrass
<i>Poa</i> sp.	bluegrass
<i>Polystichum munitum</i>	sword fern
<i>Polytrichum commune</i>	common haircap moss
<i>Polytrichum juniperinum</i>	juniper haircap moss
<i>Polytrichum</i> sp.	haircap moss
<i>Potamogeton natans</i>	floating-leaved pondweed
<i>Potentilla anserine</i>	common silverweed
<i>Potentilla</i> sp.	
<i>Prunus emarginata</i>	bitter cherry
<i>Prunus virginiana</i>	choke cherry
<i>Pseudotaxiphyllum elegans</i>	small flat-moss
<i>Pseudotsuga menziesii</i>	Douglas-fir



<i>Pteridium aquilinum</i>	bracken fern
<i>Puccinellia nutkaensis</i>	Pacific alkaligrass
<i>Pyrola</i> sp.	wintergreen
<i>Racomitrium canescens</i>	grey rock moss
<i>Racomitrium</i> sp.	rock moss
<i>Ranunculus cymbalaria</i>	shore buttercup
<i>Rhizomnium glabrescens</i>	large leafy moss
<i>Rhynchospora alba</i>	white beak-rush
<i>Rhytidiadelphus loreus</i>	lanky moss
<i>Rhytidiadelphus triquetrus</i>	electrified cat's-tail moss
<i>Rhytidiadelphus</i> sp.	moss
<i>Ribes bracteosum</i>	stink currant
<i>Ribes lacustre</i>	black gooseberry
<i>Ribes</i> sp.	current or gooseberry
<i>Rosa acicularis</i>	prickly rose
<i>Rosa gymnocarpa</i>	baldhip rose
<i>Rubus discolor</i>	Himalayan blackberry
<i>Rubus leucodermis</i>	black raspberry
<i>Rubus parviflorus</i>	thimbleberry
<i>Rubus spectabilis</i>	salmonberry
<i>Rubus ursinus</i>	trailing blackberry
<i>Rubus</i> sp.	
<i>Rumex crispus</i>	curled dock
<i>Salix lucida</i>	Pacific willow
<i>Salix scouleriana</i>	Scouler's willow
<i>Salix</i> sp.	willow
<i>Sambucus racemosa</i>	red elderberry
<i>Saxifraga ferruginea</i>	Alaska saxifrage
<i>Scapania bolanderi</i>	yellow-ladle liverwort
<i>Scirpus microcarpus</i>	small-flowered bulrush
<i>Scirpus</i> sp.	
<i>Scleropodium obtusifolium</i>	blunt-leaved moss
<i>Scleropodium</i> sp.	moss
<i>Selaginella wallacei</i>	Wallace's selaginella
<i>Sparganium angustifolium</i>	narrow-leaved bur-reed
<i>Sparganium</i> sp.	bur-reed
<i>Sphagnum capillifolium</i>	common red peat-moss
<i>Sphagnum fimbriatum</i>	fringed peat-moss
<i>Sphagnum fuscum</i>	common brown peat-moss



<i>Sphagnum squarrosum</i>	shaggy peat-moss
<i>Sphagnum</i> sp.	peat-moss
<i>Spiraea douglasii</i>	hardhack
<i>Spiraea</i> sp.	
<i>Stellaria</i> sp.	starwort
<i>Symphoricarpos albus</i>	common snowberry
<i>Taraxacum</i> sp.	dandelion
<i>Tellima grandiflora</i>	fringe-cup
<i>Thuja plicata</i>	western redcedar
<i>Tiarella trifoliata</i>	three-leaved foamflower
<i>Trientalis europaea</i>	northern starflower
<i>Trientalis latifolia</i>	broad-leaved starflower
<i>Trientalis</i> sp.	starflower
<i>Trisetum canescens</i>	tall trisetum
<i>Trisetum</i> sp.	trisetum
<i>Tsuga heterophylla</i>	western hemlock
<i>Typha latifolia</i>	cat-tail
<i>Urtica dioica</i>	stinging nettle
<i>Vaccinium alaskaense</i>	Alaska blueberry
<i>Vaccinium ovalifolium</i>	oval-leaved blueberry
<i>Vaccinium ovatum</i>	evergreen huckleberry
<i>Vaccinium parvifolium</i>	red huckleberry
<i>Veronica scutellata</i>	marsh speedwell
<i>Viola</i> sp.	violet

