Sensitive Ecosystems Inventory for the Discovery Islands

Mapping Methods

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Acronyms

The following is a list of common acronyms used throughout this document.

CDC	Conservation Data Centre
DIEM	Discovery Islands Ecosystem Mapping
SEI	Sensitive Ecosystems Inventory
TEM	Terrestrial Ecosystem Mapping
FWA	Fresh Water Atlas
LRDW	Lands Resources Data Warehouse
BEC	Biogeoclimatic
CDED	Canadian Digital Elevation Data
DEM	Digital Elevation Model
LSAT	Landsat
TPI	Topographic Position Index
ArcSIE	Arc Soil Inference Engine

1.0 Introduction

The following report describes the methodology used in the mapping of the Sensitive Ecosystems Inventory (SEI) for the Discovery Islands Ecosystem Mapping (DIEM) Project. The classification system is based on Provincial methodologies and previous SEI projects. SEI units were modelled from Terrestrial Ecosystem Mapping (TEM) where it existed, and elsewhere were identified using predictive methods and existing Provincial 1:20,000 base data. The field verification was completed in 2014.

The DIEM project creates ecosystem maps to provide a comprehensive ecological reference that can be used by local communities, Governments, and land managers. The produced mapping is used to better understand the ecology of the area, enlighten discussions about resources and development, and inform resource development decision making. SEI is one of the types of ecosystem mapping being produced for the Discovery Islands area by the DIEM project. The other two types of ecosystem mapping include Enduring Features. "Sensitive Ecosystem Inventory" (SEI) identifies ecosystems which are rare or sensitive to development. "Enduring Features" map biophysical features that provide a big-picture view of what is sustaining the area's ecosystems. Both of these methods are recognized by the Provincial Government as legitimate components in development planning.

This community-based mapping project has been initiated by residents of Read and Cortes Islands. The project has also received encouragement and support from scientists, government, citizens and community organizations. "*We are reaching out to recognize and involve all of the area's small communities and First Nations for whom this is traditional territory. Everyone will benefit from the maps and spatial data produced"* (DIEM project, 2012).

The final project maps are available on Databasin.org as interactive webmaps. The information can be used by individuals and groups for any purpose within the local community, as well as for regional, provincial, and national planning purposes. *"We hope that the DIEM Project will form a base map for continued community mapping in many areas of interest".* So far, the DIEM project has been funded entirely through grants and local fundraising.

The DIEM SEI Project area is made up of the following Discovery Islands: North Quadra, Read, Maurelle, Sonora, Stuart, Raza, East Redonda, West Redonda, and the Rendezvous Islands.

2.0 Mapping Data Sources

Table 1) Data Sources

NAME	SOURCE	DATE ACQUIRED	DATA TYPE	DESCRIPTION
Tem_projects_discovery_islands_ecoast_van_isl.gdb	Conservation Data Centre (Provincial database)	Dec 2011	Polygons	Existing TEM data for the study area; the data was from three different TEM projects: Strathcona TSA Project, the Cortes LU TEM project; and the TFL 47 TEM Project
Discovery_TEM.gdb	Bob Green BA Blackwell & Associates	Oct 2012	Polygons	The DIEM Project hired Bob Green to complete TEM mapping for 3366 ha on Read and Maurelle Islands that are private forest land and Provincial park and therefore no publicly available TEM data existed.
FWASTRMNTWR_line	LRDW	Jan 2012	Lines	Fresh Water Atlas (FWA) 1:20,000 Provincial stream network
FWALKSPL	LRDW	Jan 2012	Polygons	FWA 1:20,000 Provincial lakes
WSA_WB_PLY	LRDW	Jan 2012	Polygons	FWA 1:20,000 Provincial wetlands
BEC_POLY	LRDW	Dec 2011	Polygons	Provincial biogeoclimatic (BEC) zones
VEG_COMP_LYR_R1_Poly.gdb	LRDW	Feb 2013	Polygons	Provincial Forest cover polygons
CDED DEM	Geobase		Raster grid	25m Canadian Digital Elevation Data (CDED) Digital Elevation Model (DEM)

Multipath Wetness Index			Raster grid	Multipath Wetness Index made from 25m CDED data using System for Automated Geoscientific Analysis (SAGA). CDED data was filtered 3 times, 3x3, 3x3, and a 5x5 filter.
Protection Index			Raster grid	Protection Index made from 25m CDED data using SAGA. DEM was filtered once with a 3x3 filter.
Topographic Position Index (TPI)			Raster grid	50m neighbourhood Topographic Position Index (TPI) made from 25m CDED data SAGA. DEM was filtered once with a 3x3 filter.
Slope			Raster grid	Percent slope made from 25m CDED data. DEM was filtered once with a 3x3 filter.
LSAT red band imagery	Geobase		Raster grid	Landsat imagery, red band. Resampled from 30m to 25m.

3.0 Mapping Methods

3.1 SEI Modelled From TEM Mapping

For the part of the study area that had existing TEM mapping, SEI classes and subclasses were mapped by modelling them from the TEM data. This part of the study area includes Northern Quadra Island, Maurelle Island, Read Island, Sonora Island, Raza Island, and the parts of the Redonda Islands that are not Provincial Park.

The following SEI classes and subclasses were modelled from TEM:

Sparsely Vegetated (SV); Fresh Water (FW); Herbaceous (HB); Riparian gulley (RI:gu); Riparian fringe (RI:ff); Woodland (WD); Wetland swamp (WN:sp); Wetland bog (WN:bg); and Wetland fen (WN:fn).

The BEC and Site Series groupings that comprise each class/subclass are included in the Appendx. These groupings were developed by Carmen Cadrin of the Conservation Data Centre.

Old forest (OF) was mapped using the 1:20,000 Provincial Vegetation Resource Inventory forest cover data. Forest stands of 250+ years old were selected as potential OF, and then manually edited over Google earth to delete recently harvested portions, and also edited based on local knowledge. Both the projected age class 1 and 2 fields were used to identify potential OF polygons from the forest cover data.

Very old forest (VOF) was identified using a stand age break of 400+ years. There are only 2 polygons of VOF in the Discovery Islands study area; one in the Provincial Park on the South end of Read Island, and one on the Southern part of East Redonda Island. Together the 2 polygons make up a total of 10.3Ha.

Mature forest (MF) and maturing second growth (MS) were mapped as an Other Important Ecosystems. Forest polygons of 80-250 years were selected for MF and edited similarly to the OF polygons; and forest polygons of 60-80 years old were selected and edited for MS. These two Other Important Ecosystem classes are identified in the polygon comment field of the SEI dataset.

The Karst (KA) SEI class was added from data produced by VIU Geology professor Tim Stokes who conducts geology field schools on North Quadra island. He produced a map that delineated areas of karst on North Quadra that he felt contained enough karst to be vulnerable to development activities such as forestry. This map was used to identify KA polygons within the SEI dataset.

3.2 SEI Predicted Using the Predictive Modelling Software ArcSIE

The part of the study area that had no existing TEM mapping had herbaceous, woodland, and cliff SEI classes predicted using the predictive modelling software ArcSIE. This part of the study area includes Stuart Island, the Rendezvous Islands, and the parts of the Redonda Islands that are Provincial Park.

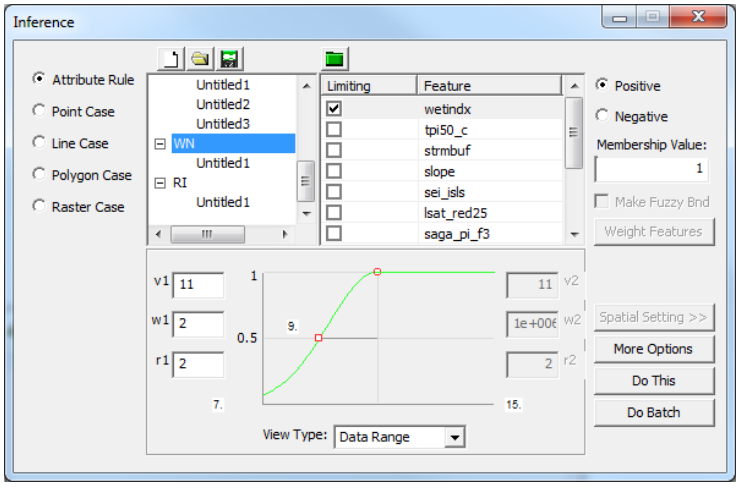
ArcSIE is an inference engine software developed by Dr. Zun Shi of The Dartmouth College. It is designed for predicting soil types and soil attributes, but can be applied to other phenomenon, including ecosystems. The software is an add-on to ArcGIS that uses fuzzy membership mathematics to assign likelihood values to raster grid cells that indicate the likelihood that a particular phenomenon will exist there. It uses raster inputs that characterize the landscape (such as elevation, slope, wetness index, vegetation cover, etc) and rule curves that tell the software what values of these predictors the phenomenon requires in order to exist (refer to figure 1).

This method worked reasonably well for the dry SEI classes because the predictions were restricted to polygons that were manually digitized over Google Earth to roughly delineated cliffs, bare rock outcrops, and sparsely treed rock outcrops. This prevented recently harvested, and other non-applicable barren lands, from being predicted as herbaceous, cliff, or woodland SEI classes.

Fresh Water Atlas streams buffered by 20m, and FWA lakes buffered by 30m were used as the riparian class, and FWA wetlands were used as the wetland class.

The polygons in this mapping contain one SEI class each, as compared to the multi-component polygons of TEM mapping, with the exception that a polygon can be OF and WD or OF and RI. SEI subclasses are not included. Old Forest SEI units were mapped using Vegetation Resource Inventory forest cover data, as described in section 3.1, modelling SEI units from TEM.

Figure 1) ArcSIE Software Interface



4.0 Results

Figure 2) Mapping Results

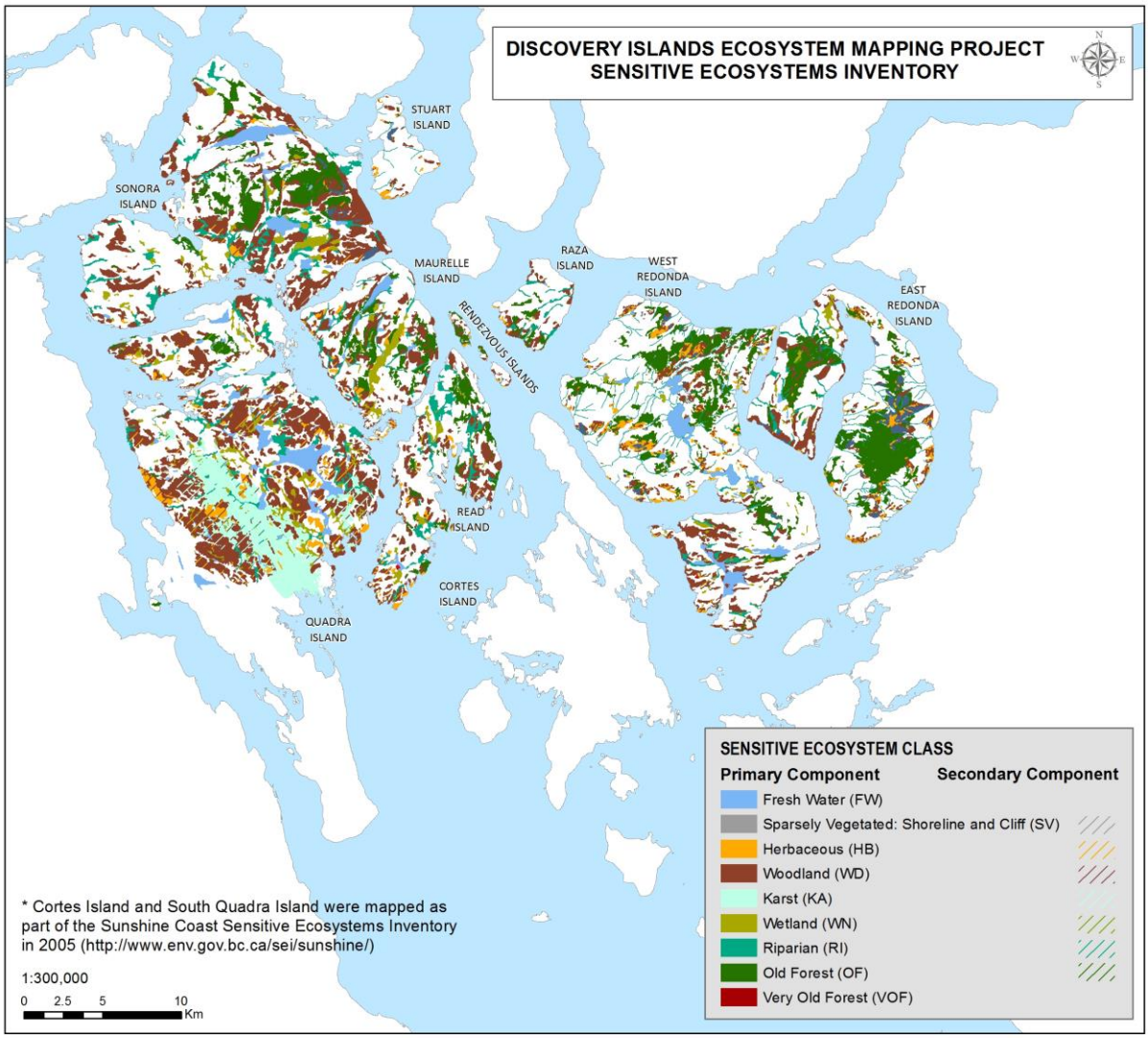


Table 2) Hectares of SEI Class by Island

	Mapped SEI Class (HA)									
	CL	**FW**	**HB**	**KA**	**OF**	**RI**	**VOF**	**WD**	**WN**	**Grand Total**
East Redonda	385.1	26.7	279.7	0.0	2021.5	534.5	0.0	805.5	79.2	4132.3
Maurelle	8.3	193.7	83.1	0.0	445.4	193.9	0.0	498.6	157.7	1580.8
Middle Rendezvous	0.0	0.0	1.5	0.0	13.8	0.0	0.0	8.2	0.0	23.5
North Rendezvous	0.0	0.0	8.8	0.0	58.5	0.0	0.0	52.2	0.0	119.6
Quadra	0.0	987.8	766.7	2386.4	94.9	474.1	0.0	2909.7	523.9	8143.5
Raza	5.1	3.6	15.4	0.0	135.2	86.4	0.0	102.4	3.2	351.4
Read	6.9	33.6	149.6	0.0	383.2	234.1	0.6	552.6	120.4	1481.0
Sonora	117.7	636.4	127.8	0.0	1164.5	502.6	0.0	1624.3	228.3	4401.6
South Rendezvous	0.0	0.0	4.5	0.0		1.9	0.0	20.0	0.0	26.4
Stuart	26.1	3.7	59.8	0.0	5.0	48.9	0.0	92.3	0.8	236.5
West Redonda	138.7	847.0	601.3	0.0	1893.1	661.3	0.5	1507.9	136.2	5786.1
Grand Total	**687.9**	**2732.5**	**2098.3**	**2386.4**	**6215.2**	**2737.7**	**1.0**	**8173.7**	**1249.8**	**26282.6**

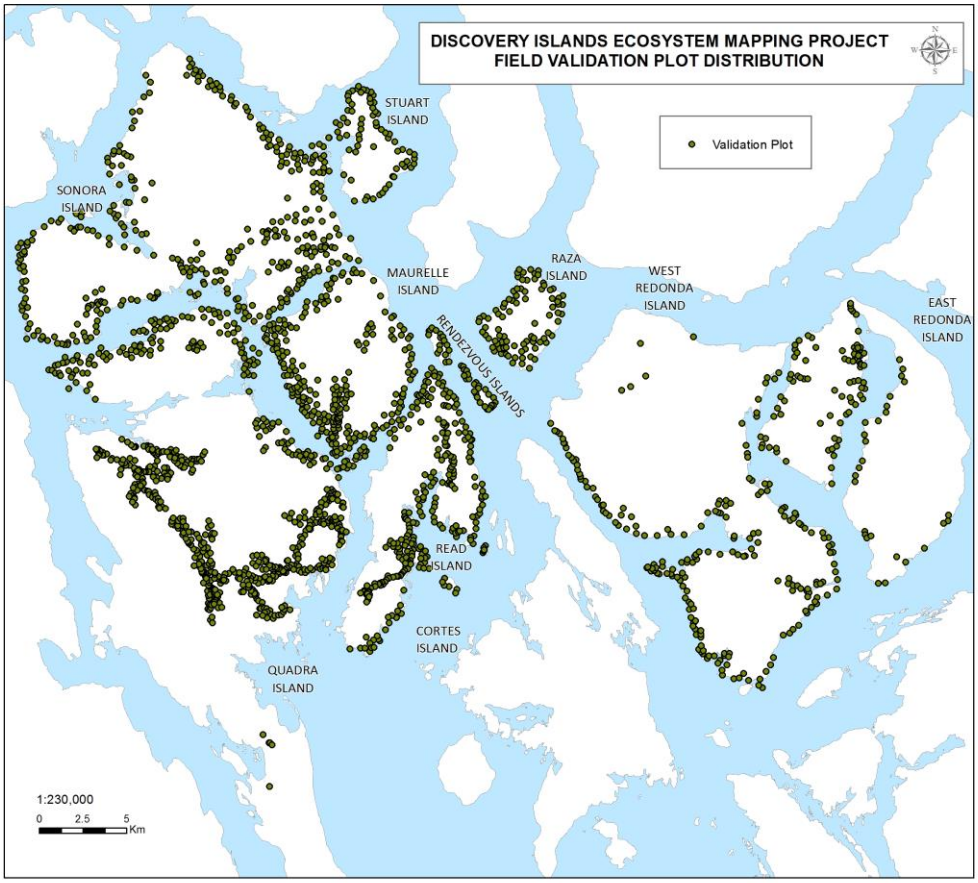
5.0 Validation Accuracy

A field validation program was conducted in the spring of 2014 by Ryan Durrand (RPBio Taara Consulting), and local Sonora Islander Cam Erikson. They collected over 2000 validation points; most were visual identification of SEI class collected within a short walk of the shoreline or road (refer to figure 3). The full report is referenced at the end of this document.

Of the 2000+ plot points, 712 were of the SEI classes captured in the mapping; the others were either Mature Forest (MF), or Young Forest points collected to validate the absence of an SEI class. Of the 712 SEI class points, 438 agreed with either the first or second SEI class component of the polygon they fell within (accurate 62% of the time). Of these 712, 165 did not fall within an SEI polygon at all. This could be a mapping scale issue. Of the 547 SEI class points that fell within SEI polygons, 438 agreed with the polygon mapping; this indicates that 80% of the time, the SEI class that has been mapped is there in the field.

Disagreements between field plot data and SEI polygon mapping appears to do mostly with the spatial resolution of the TEM polygons used to model the units (1:20,000 TEM polygons are a coarser scale than that which the field data was collected). For example it occurred often that a FW field plot fell on the edge of polygon mapped as WN, indicating that the TEM mapping rolled the pond up in a wetland class. There were many small wetlands captured by the field data that were not captured by TEM, particularly within the Karst area. There were also some OF field plots that were not captured by the forest cover data used to map the forested SEI units.

Figure 3) Field Validation Plot Distribution



6.0 Appendices

Appendix A) TEM Unit SEI Classification

TEM Unit (BEC Label; Mapcode; Site Series; modifiers)	SEI Class	SEI Modifier	Secondary SEI Class	Comment	CMC comment
CWHmm1 RC 12 hu sh	WN	sp		sp if in TEM project Cortes LU	
CWHmm1 AF 05 rv	RI	gu			Legend modifier defined as sites with steep slopes bordering streams
CWHmm1 AS 07 rv	RI	gu			Legend modifier defined as sites with steep slopes bordering streams
CWHxm2 DC 02 hs	CL				
CWHxm2 DC 02 sl	WD		HB		
CWHxm2 DC 02 ss	CL				
CWHxm2 DS 03 rv	RI	gu			Legend modifier defined as sites with steep slopes bordering streams
CWHxm1 ES w g	CL				
CWHxm2 HK 01 fa	RI??	ff??			This site series often mapped as Riparian:fluvial fringe on Cortes and the fan could be a fluvial fan (e.g. mouth of river/stream) but could also be colluvial
CWHxm2 RC 12 hu	WN	sp		sp if in TEM project Cortes LU	
CWHmm1 RC 12 sh	WN	sp		sp if in TEM project Cortes LU	
CWHxm2 RC 12 sh	WN	sp		sp if in TEM project Cortes LU	
CWHxm2 RF 07 fa	RI??	ff??			This site series often mapped as Riparian:fluvial fringe on Cortes and the fan could be a fluvial fan (e.g. mouth of river/stream) but could also be colluvial
CWHxm2 RF 07 gu	RI??	gu??			This site series rarely mapped as Riparian gullies on Cortes
CWHxm2 RF 07 rv	RI	gu			Legend modifier defined as sites with steep slopes bordering streams
CWHxm2 RS 05 fa	RI??	ff??			This site series often mapped as Riparian:fluvial fringe on Cortes and the fan could be a fluvial fan (e.g. mouth of river/stream) but could also be colluvial
CWHxm2 RS 05 rv	RI	gu			Legend modifier defined as sites with steep slopes bordering streams
CWHxm1 CS 15 j	WN	sp			W. Mackenzie considers this is probably the only true swamp of the fluctuating site series units.
CWHxm1 DC 02 h	WD		HB		
CWHxm1 DC 02 j	WD		HB		
CWHxm1 DC 02 k	WD		HB		
CWHxm1 DC 02 q	CL				
CWHxm1 DC 02 v	WD		HB		
CWHxm1 DC 02 w	WD		HB		
CWHxm1 DC 02 z	CL				
CWHvm1 LC 02 k	WD		HB		
CWHvm1 LC 02 q	CL				
CWHvm1 LC 02 w	WD		HB		
CWHmm1 LS 11 j	WN	bg			
CWHxm1 LS 11 j	WN	bg			
MHmm1 MM 02 q	CL				
MHmm1 MM 02 w	WD		HB		
MHmm1 MM 02 z	CL				
CWHxm1 RB 13 j	WN	sp			W.Mackenzie doesn't consider these true swamps, but we mapped them as swamps in the coastal SEI projects, primarily because of importance of water

					in the Georgia Depression
CWHxm1 RC 12 j	WN	sp		sp if in TEM project Cortes LU	
CWHxm1 RC 12 p	WN	sp		sp if in TEM project Cortes LU	
CWHxm1 RF 07 g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHmm1 RO hs	CL				
CWHmm1 RO ss	CL				
CWHxm1 RO 00 h	HB				
CWHxm1 RO 00 j	HB				
CWHxm1 RO 00 k	HB				
CWHxm1 RO 00 q	CL				
CWHxm1 RO 00 w	HB				
CWHvm1 RO 00 z	CL				
CWHxm1 RO 00 z	CL				
MHmm1 RO 00 z	CL				
CWHxm2 CS 15 j	WN	sp			W. Mackenzie considers this is probably the only true swamp of the fluctuating site series units.
CWHxm2 DC 02 g	WD		HB		
CWHxm2 DC 02 h	WD		HB		
CWHxm2 DC 02 j	WD		HB		
CWHxm2 DC 02 k	WD		HB		
CWHxm2 DC 02 q	CL				
CWHxm2 DC 02 v	WD		HB		
CWHxm2 DC 02 w	WD		HB		
CWHxm2 DC 02 z	CL				
CWHvm2 LC 02 q	CL				
CWHvm2 LC 02 w	WD		HB		
CWHxm2 LS 11 j	WN	bg			
CWHxm2 LS 11 k	WN	bg			
CWHxm2 RC 12 j	WN	sp		sp if in TEM project Cortes LU	
CWHxm2 RC 12 p	WN	sp		sp if in TEM project Cortes LU	
CWHxm2 RC 12 w	WN	sp		sp if in TEM project Cortes LU	
CWHxm2 RF 07 c					
CWHxm2 RF 07 gu	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHxm2 RF 07 j					
CWHxm2 RF 07 k					
CWHxm2 RF 07 w					
CWHmm2 RO hs	CL				
CWHxm2 RO hs	CL				
CWHxm2 RO sl	HB				
CWHxm2 RO ss	CL				
CWHxm2 RO 00 j	HB				
CWHxm2 RO 00 k	HB				

CWHvm2 RO 00 q	CL				
CWHxm2 RO 00 q	CL				
CWHxm2 RO 00 w	HB				
CWHvm2 RO 00 z	CL				
CWHxm2 RO 00 z	CL				
CWHmm1 RO	HB				
CWHxm2 RM	WD				
CWHxm2 TS	WN	bg			
CWHdm DC 02 c w	WD		HB		
CWHdm DC 02 c z	CL				
CWHdm DC 02 h v	WD		HB		
CWHxm1 DC 02 h v	WD		HB		
CWHxm2 DC 02 h v	WD		HB		
CWHdm DC 02 k v	WD		HB		
CWHxm1 DC 02 k v	WD		HB		
CWHxm2 DC 02 k v	WD		HB		
CWHdm DC 02 q v	CL				
CWHdm DC 02 v w	WD		HB		
CWHxm1 DC 02 v w	WD		HB		
CWHxm2 DC 02 v w	WD		HB		
CWHdm DC 02 v z	WD		HB		
CWHxm1 DC 02 v z	WD		HB		
CWHxm2 DC 02 v z	WD		HB		
CWHxm2 DC 02 w g	WD		HB		
CWHxm2 HD 06 w s					
CWHdm CS 15	WN	sp			W. Mackenzie considers this is probably the only true swamp of the fluctuating site series units.
CWHdm DC 02	WD		HB		
CWHdm HL 00	WN	fn			
CWHdm LS 11	WN	bg			
CWHdm OW 00	WN	sw?			shallow water wetland, floating aquatic vegetation (Brasenia, Nuphar, Potamogeton,etc) see also SC SEI, Cortes polygons
CWHdm PD 00					
CWHdm RC 12	WN	sp		sp if in TEM project Cortes LU	
CWHvm1 LC 02 g k	WD		HB		
CWHvm1 LC 02 k v	WD		HB		
CWHvm1 LC 02 v w	WD		HB		
CWHvm1 LC 02 v z	WD		HB		
CWHvm2 LC 02 v z	WD		HB		
CWHdm AB 01 k					
CWHdm DC 02 h	WD		HB		
CWHdm DC 02 k	WD		HB		
CWHdm DC 02 w	WD		HB		
CWHdm RF 07 g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHdm RO 00 q	CL				
CWHdm RO 00 w	HB				
CWHdm RO 00 z	CL				
CWHxm1 ES w	CL				
CWHxm1 HG j	WN	fn			
CWHmm1 RO j	HB				

CWHxm1 RO j	HB				
CWHxm1 RO k	HB				
CWHmm1 RO w	HB				
CWHxm1 RO w	HB				
CWHmm1 TS j	WN	bg			
CWHxm1 TS j	WN	bg			
CWHxm2 HG j	WN	fn			
CWHxm2 RH j	WN	sp			
CWHxm2 RM k	WD				
CWHxm2 RM q	WD				
CWHxm2 RM w	WD				
CWHxm2 RM z	WD				
CWHxm2 RO j	HB				
CWHxm2 RO k	HB				
CWHxm2 RO w	HB				
CWHxm2 RO z	CL				
CWHxm2 TS j	WN	bg			
MHmm1 MM 02 g q	CL				
MHmm1 MM 02 g w	WD		HB		
MHmm1 MM 02 v w	WD		HB		
MHmm1 MM 02 v z	WD		HB		
MHmm1 MM 02	WD		HB		
CWHmm1 OW 00	WN	sw?			shallow water wetland, Would need field checking
MHmm1 OW 00	WN???	sw???			unsure about this, likely not with same floating aquatics. Would need field checking
CWHmm1 PD 00					
CWHmm1 RC 12	WN	sp		sp if in TEM project Cortes LU	
CWHmm1 RM 20	WD				
CWHmm1 TS 31	WN	bg			
MHmm1 YS 08	RI				YS is a bog unit in the Strathcona
CWHmm2 RM 20	WD				
CWHmm1 RO sl ta	HB				
CWHxm2 RC 12 j g	WN	sp		sp if in TEM project Cortes LU	
CWHxm2 RC 12 j h	WN	sp		sp if in TEM project Cortes LU	
CWHmm1 RC 12 j s	WN	sp		sp if in TEM project Cortes LU	
CWHxm1 RC 12 j s	WN	sp		sp if in TEM project Cortes LU	
CWHxm2 RC 12 j s	WN	sp		sp if in TEM project Cortes LU	
CWHdm RF 07 c g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHxm2 RF 07 c g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHdm RF 07 c k					
CWHxm2 RF 07 g j	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes

CWHxm2 RF 07 g k	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHdm RF 07 g w	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHxm1 RF 07 j g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHxm2 RF 07 j g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHxm1 RF 07 k g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHxm2 RF 07 k g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHxm1 RF 07 w g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHxm2 RF 07 w g	RI??	gu??			This site series occassionally mapped as Riparian gullies on Cortes
CWHvm2 RO 00 g q	CL				
MHmm1 RO 00 g q	CL				
CWHxm1 RO 00 h j	HB				
CWHvm1 HG 00	WN	fn			
CWHvm1 LC 02	WD		HB		
CWHvm1 OW 00	WN	sw?			shallow water wetland, Would need field checking
CWHvm1 RC 14	WN	sp			We treat as a swamp
CWHvm2 LC 02	WD		HB		
CWHvm2 RC 11	WN	sp			We treat as a swamp
CWHxm1 CS 15	WN	sp			W. Mackenzie considers this is probably the only true swamp of the fluctuating site series units.
CWHxm1 DC 02	WD		HB		
CWHxm1 HG 00	WN	fn			
CWHxm1 HL 00	WN	fn			
CWHxm1 LS 11	WN	bg			
CWHxm1 OW 00	WN	sw?			shallow water wetland, floating aquatic vegetation (Brasenia, Nuphar, Potamogeton,etc) see also SC SEI, Cortes polygons
CWHxm1 RC 12	WN	sp		sp if in TEM project Cortes LU	
CWHxm1 RO 00	HB				
CWHxm1 SW 00	WN	fn			
CWHxm2 DC 02	WD		HB		
CWHxm2 ES 00	CL				
CWHxm2 FS 32	WN	fn			
CWHxm2 HG 00	WN	fn			
CWHxm2 HL 00	WN	fn			
CWHxm2 LS 11	WN	bg			
CWHxm2 OW 00	WN	sw?			shallow water wetland, floating aquatic vegetation (Brasenia, Nuphar, Potamogeton,etc) see also SC SEI, Cortes polygons
CWHxm2 PD 00					
CWHxm2 RB 13	WN	sp			W.Mackenzie doesn't consider these true swamps, but we mapped them as swamps in the coastal SEI projects, primarily because of importance of water in the Georgia Depression
CWHxm2 RC 12	WN	sp		sp if in TEM project Cortes LU	
CWHxm2 RH 25	WN	sp			
CWHxm2 SW 00	WN	fn			
CWHxm2 TS 31	WN	bg			

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