Mayne Island Shoreline Atlas Report

Prepared by the Mayne Island Conservancy Society
April 2013

Mayne Island Conservancy Society

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Table of Contents

Table of Figures

Table of Tables

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Executive Summary

The Mayne Island Shoreline Atlas (MISA) provides results of a shoreline inventory conducted in 2012 and 2013 by the Mayne Island Conservancy Society (MICS) in a geographic information system (GIS) database. The study area covered 77% of Mayne Island's shorelines for a total of 35 km mapped (**Figure 1**). First Nations Reserves and portions of the Gulf Islands National Park Reserve were not included.

The MICS initiated the project, which was funded by Environment Canada's EcoAction Community Funding Program. Deliverables of the project are a GIS database and maps, which provide information about the ecological nature of Mayne Island's shorelines. The impetus for the inventory arose out of concern for the increasing number of shoreline modifications constructed near the intertidal boundaries of the study area, combined with a lack of information regarding the location of critical habitats.

Two rating systems were created, one calculating the ecological value of Mayne Island shorelines and the other calculating the level of modification to this shoreline. Data was collected by small boat and field technicians recorded shoreline modifications, backshore ecology, erosion, wildlife habitat features, and presence of important species such as forage fish, eelgrass, and kelp in marine riparian areas.

The data within the GIS database will be available to the Mayne Island Local Trust Committee, Island Trust planners, the Islands Trust Fund and other interested parties; providing a large amount of data for reference, additional query and future comparison. The purpose of this data is to provide planners and members of the public with information for science based decision-making, identification of essential biological habitats, and information and stewardship opportunities for the Mayne Island community.

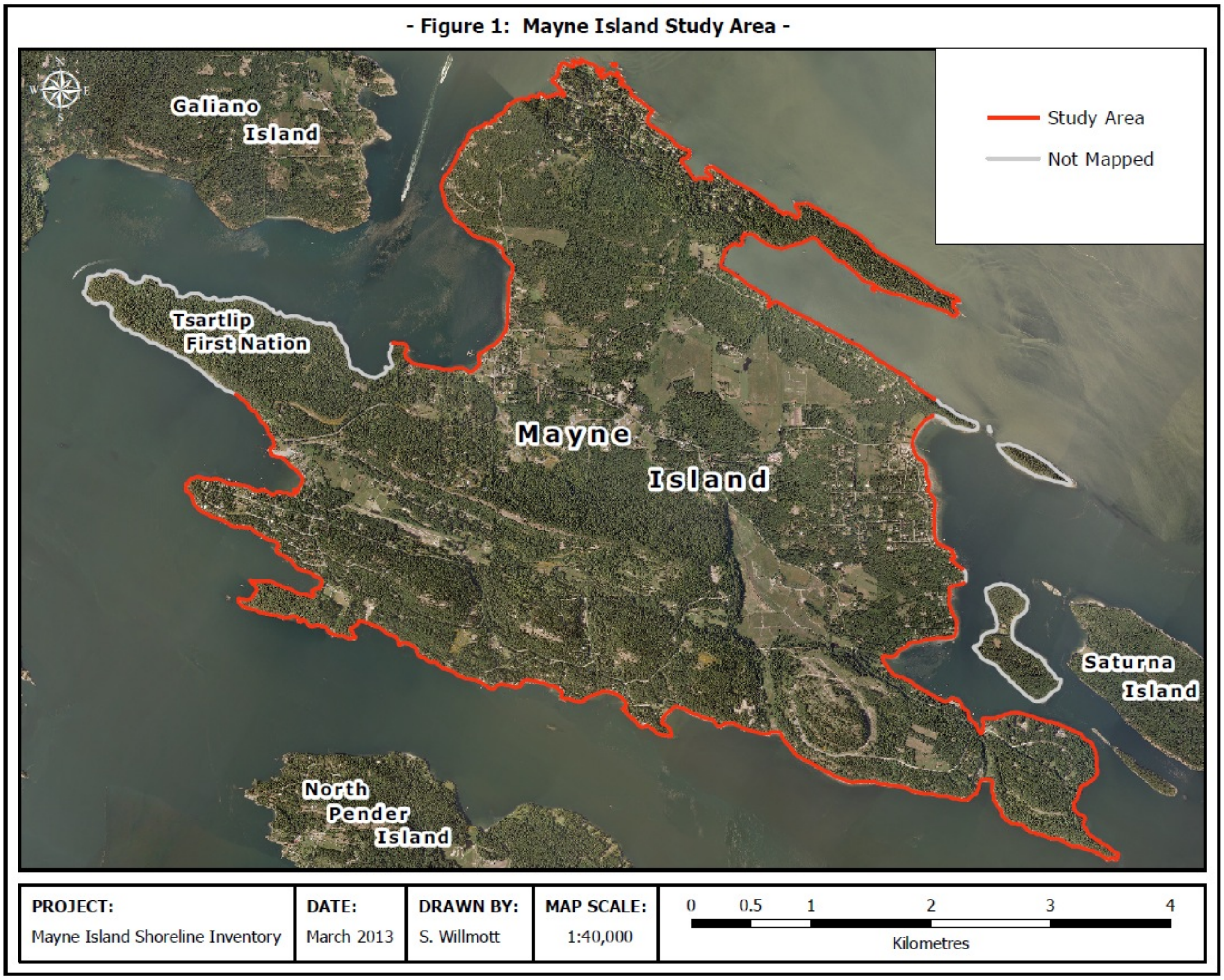

Figure 1: Mayne Island Shoreline Atlas Study Area.

1.0 Introduction

This report summarizes the shoreline inventory of Mayne Island conducted in 2012-2013 by the Mayne Island Conservancy Society (MICS). The MICS works to foster harmony between nature and community on Mayne Island B.C. through increasing public understanding of environmental, ecological, and recreational values of Mayne Island ecosystems. We also strive to provide expert advice to government on the ecosystems of Mayne Island.

The purpose of this shoreline inventory is to document natural and modified shorelines, wildlife habitat, backshore vegetation, and foreshore use. This documentation provides information for science based decision-making by local governments, identification of essential biological habitats, and information and stewardship opportunities for Mayne Island communities.

The extent and condition of Mayne Island's shoreline has been impacted by human development. These impacts have resulted in bank erosion, sediment loss, invasive species encroachment, loss of wildlife habitat, and degradation of the intertidal zone. The functioning habitats that remain enrich the region and are valued by residents and are ecologically vital.

MISA was funded by Environment Canada, with revenue used for supplies to complete the survey and to pay staff salaries. ShoreZone maps and accompanying data were generated by Coastal and Ocean Resources, Inc. and Archipelago Marine Research Ltd. as part of the National Marine Conservation Area Initiative in 2004-5.

1.1 Objectives and Deliverables

The primary objectives of this project were:

- To conduct a 100% ground-truthed shoreline inventory of ecological characteristics and anthropogenic disturbances;
- To survey the study area for key species habitat;
- To provide an overall ecological rating of the shoreline; and
- Increase ability of Island Trust to protect sensitive island ecosystems. Give trustees and planners improved tool for shoreline land use planning.

The final MISA project deliverable is the production of the following:

- GIS layers and associated attribute databases containing all the collected inventory data,
- Maps displaying collected data.

1.2 Using the MISA Information

The MISA database provides data covering 35 km of intertidal and backshore areas on Mayne Island. This systemically collected data and the associated rating classifications can be used to:

- Identify areas to be designated as ecologically sensitive in Official Community Plans and Development Permit Areas;
- Identify areas prioritized for remedial improvements;
- Assess potential impacts of proposed shoreline development;
- Help determine appropriate structures near the shoreline based on ecological values;
- Establish a baseline for monitoring shoreline modifications and changes in the near shore character of Mayne Island; and
- Raise the awareness of ecologically sensitive areas and the values of the marine near shore environment among members of the public, business, government and visitors.

Copies of this report and associated data can be obtained from the Mayne Island Conservancy Society. Please contact us via e-mail, phone or mail at:

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2.0 Background

Staff members from the Islands Trust Fund were consulted to determine priorities for shoreline development planning within their jurisdiction. We did not include First Nations territories in the study because we had not been invited to assess marine environments in those areas. Portions of the Gulf Islands National Park Reserve and Curlew Island were not inventoried due to time and funding constraints.

2.1 Location and Ecological Setting

The study area was located within the Coastal Douglas Fir moist-maritime ecological subzone (CDFmm). This biogeoclimatic subzone extends along the Strait of Georgia from sea level to approximately 150 meters above sea level. Ecosystems throughout the CDFmm are currently listed as critically imperiled in a global context by the B.C. Conservation Data Centre (CDC).[1]

The survey area was 35 kilometers of Mayne Island shoreline, including 15m from the high water mark seaward into the intertidal zone and 15 meters toward the backshore. In total, 77% of Mayne Island's shoreline was surveyed (

Table 1).

Table 1: Mayne Island Shoreline Atlas Shore Units

	Number of Shore Units	Length (km)
Mayne Island Total	254	46.0
Mapped	191	35.4
Not Mapped (Total)	63	10.6
Sections not mapped breakdown:		
First Nations	26	5.2
National Park	14	2.4
Not Captured	23	3.0

[1] B.C. Conservation Data Centre. 2013. BC Species and Ecosystems Explorer. B.C. Minist. of Environ. Victoria, B.C. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Mar 27, 2013).

3.0 Methodology

The Mayne Island Shoreline Atlas (MISA) work was preceded by the Saanich Inlet and Peninsula Shoreline Atlas (SIPAS). ShoreZone spatial data of the study area was obtained from Parks Canada and a Geographic Information System (GIS) specialist was hired to create shoreline unit maps, build a database for data input and analyze collected data.

Field inventories started in the winter of 2012 and finished in February 2013, with one MICS staff and a contractor working together on a boat to collect the following data:

- Shoreline modifications;
- Intertidal and backshore structure and features;
- Wildlife sites, sensitive features and polluting features; and
- Areas of erosion.

The methodology and digital GIS datasets used in the MISA project were informed by previous scientific studies from the following:

Saanich Inlet and Peninsula Atlas of Shorelines[2]

The Saanich Inlet and Peninsula Atlas of Shorelines (SIPAS) provides the results of a shoreline inventory conducted from 2007 to 2009 in a Geographic Information System (GIS) database. A Technical Committee was formed, composed of experts in the field, to develop the methodology. The study area included the shores of Saanich Peninsula north of the Saanich border and Cowichan Valley Regional District from Bamberton Provincial Park to Cherry Point. SIPAS created a GIS database for use by both land use planners and the public.

Mayne Island Conservancy contracted a SIPAS field technician to train staff and assist with data collection.

ShoreZone Mapping for the Southern Strait of Georgia[3]

The Southern Strait of Georgia ShoreZone Mapping Project completed for Parks Canada Agency by Coastal & Oceans Resources Inc. and Archipelago Marine Research Ltd. in 2004-5 provides the groundwork on which the MISA study is based. ShoreZone is a coastal habitat mapping and classification system based on the collection and interpretation of low-altitude, low tide, aerial imagery of the coastal environment.

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2 Seachange Marine Conservation Society. 2010. Saanich Inlet and Peninsula Atlas of Shorelines: Technical Report. Victoria, BC.

3 Coastal and Ocean Resources Inc. (CORI). 2009. "ShoreZone Coastal Habitat Mapping Program Fact Sheet." Jodi N. Harney, John R. Harper, Mary C. Morris, ed. Retrieved May 12, 2009, from http://www.coastalandoceans.com/downloads/ShoreZone_FactSheet_Jan09.pdf

Sensitive Ecosystem Inventory[4]

The Sensitive Ecosystems Inventory (SEI) systematically identifies and maps rare and fragile ecosystems in a given area. The information is derived from aerial photography, supported by selective field checking of the data. SEI mapping methodology is based on original air photo interpretation for SEI polygons, or as an SEI theme based on Terrestrial Ecosystem Mapping (TEM) polygons.

3.1 Data Sources

The Capital Regional District (CRD) provided 2005 and 2009 high-resolution orthophotography, cadastral data, and an assortment of natural habitat related GIS datasets.

The Parks Canada Agency allowed access to the Sensitive Ecosystems Inventory and all of the spatial data collected for the ShoreZone Mapping Data Summary for the Southern Strait of Georgia project.

3.2 ShoreZone Data & Shore Units

The MISA study is based on the ShoreZone[5] mapping data collected by Parks Canada in 2004/2005. This spatial dataset is a linear representation of the geographic location of the coastline. The ShoreZone dataset is made up of shore units. A shore unit is an area consisting of one or more components and processes that are continuous and homogenous along and across the shore within the unit.[6] Shore units are defined by physical form and material (morphology) of the shoreline where unit boundaries identify a change from one physical class to another. For example, a change from a beach to a rocky platform would define a boundary between two shore units.

Each shore unit within the ShoreZone dataset already had a physical unit identification number that represented the primary key for the dataset. The spatial origin of the shore unit dataset is derived from the Terrain Resource Information Management Program (TRIM).

As with SIPAS, it was decided that MISA be built on the shore unit dataset rather than create a new dataset. The primary key is maintained, making it possible for all of the data created out of the MISA study to be linked back to the ShoreZone database. Because the data originates from TRIM, the MISA dataset can overlay seamlessly on other provincial datasets that are TRIM derived.

3.3 Design Field Forms & Maps

The final field form used for data collection was one that had been developed for the SIPAS study. The field form notes shoreline modifications, other anthropogenic modifications such as docks or pilings, intertidal and backshore features, wildlife sites, presence of eelgrass and potential forage fish spawning area, and areas showing erosion. A field form example can be found in Appendix A.

Field maps were printed at a scale of 1:1000 and displayed a 2009 orthophoto image overlaid with shore unit data and legal property lines. The shore units were labeled with the associated physical

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4 Ministry of Environment. 2013. Sensitive Ecosystems Inventories. B.C. Ministry of Environment. Victoria, B.C. Available: http://www.env.gov.bc.ca/sei/ (accessed March 27, 2013).

5 Howes, D.E. 2001. BC Biophysical Shore-Zone Mapping System-A Systematic Approach to Characterize Coastal Habitats in the Pacific Northwest. British Columbia Land Use Coordination Office, Province of British Columbia, Victoria, B.C., p.4.

unit ID so that field crews could reference the unit number on the field form. The entire map was draped with a 50 meter UTM grid so that field crews could reference coordinates as well as predict distances between the ground and map. An example of a field map can be found in Appendix B.

3.4 Field Inventory

Fourteen days were spent in the field, between December 2012-March 2013, with surveyors using the shoreline unit datasheets to record data. Photographs were also taken during the shoreline attribute survey so that specific units can be referred to for reference and planning purposes.

Use of a 14-foot aluminum boat allowed travel close to the shoreline for observation of shoreline attributes. Field surveyors noted GPS coordinates for the beginning and end points for shoreline modifications and potential forage fish spawning habitat from as close as they could reasonably access by boat. The lengths of smaller modifications were estimated visually. Percent cover and lengths for backshore characteristics and features were visually estimated for the area 15m back from the high water mark. The use of field maps and a range finder increased the accuracy of visual estimations.

Shore unit characteristics were recorded using the Rational for BC Shore Types (Table A-2) and Shore Type Classification (Table A-3) from the Southern Strait of Georgia NMCA Summary Report.[7]

3.5 GIS Database Design

Following fieldwork completion, a GIS database was built in which to input the data collected. Using ESRI's ArcGIS software, a MISA geodatabase was created as the top level of data storage. Inside the geodatabase there is a feature dataset named Shore unit (SU) that contains the SU feature class. The SU feature class is a modified copy of the original ShoreZone shapefile data. The SU feature class has been designed to hold all of the information collected on the field form.

To facilitate data entry and ensure data integrity, every attribute field that contained a choice of categories was made into a domain so that only those categories can be chosen from a drop down list.

[7] Southern Strait of Georgia NMCA Summary Report. 2008. Available from Parks Canada.

4.0 Rating Process

In order to make the gathered data user friendly for use by land use planners and the public, a shoreline rating system incorporating field observations was needed to represent a shore unit's overall ecological value and level of modification. To meet this need, two rating systems were created, both using data collected by the Mayne Island Conservancy Society.

The first system identifies the overall ecological value of a shore unit. The second system was created to show the level of modification to the shoreline and incorporates data on the human modification.

4.1 Rating the Shore Units' Ecological Value using the MISA Data

A shoreline rating protocol to represent the overall ecological value of a shore unit was designed by the Mayne Island Shoreline Atlas (MISA) field crew and GIS staff. Two different rating criteria tables were created, one for soft shores (shorelines with a substrate of either only sediment, or rock and sediment) and one for hard shores (shorelines with a substrate of only rock). These categories were created because the initial analysis was resulting in a high percentage of hard shores ranking as either very low or low ecological value, despite the fact that they were unmodified, in pristine condition, and still valuable habitat for a number of shoreline species. This was occurring because the hard shores did not contain habitat for the intertidal and key species for which we were awarding points. Therefore, these shores were getting 0 values for both of these categories, giving them a low overall value. It was felt that showing hard shores as having very low ecological value might be misleading, thus the creation of the dual rating system.

The soft shore rating is based on five shore unit characteristics deemed to have significant ecological worth. The criteria used to rate each shore unit is described in Table 2.

Table 2: Soft Shore Shoreline Rating Criteria

Rating Class	Value Range	Criteria
Intertidal Features	0-5	If a shore unit has any of the five intertidal features (Sand lance spawning habitat, Eelgrass, Fucus, Clams or Oysters) present it receives 1 point for each feature present. A shore unit can be awarded up to 5 points for this rating class.
Habitat Cover	0-10	If a shore unit has any percentage of habitat cover that is Coniferous, Deciduous, Shrub, Bare Ground (e.g. rock), or Wetland habitat class it receives one tenth of the percent value, ie. 50% Coniferous = 5; 20% Deciduous = 2, 30% Wetland = 3; Total =10. Landscaped areas receive 0 because of their non-natural nature.
Wildlife Feature	0-5 (Although there are six possible wildlife features there was never a shore unit that had more than five.)	If a shore unit has any of the six listed wildlife features present (Nesting Area, Rock Ledge, Undercut Shelter, Artificial, Driftwood Pile or Wildlife Tree) it receives 1 point for each feature present. A shore unit can receive up to 5 points for this rating class. If no wildlife features are present the unit receives 0.
Sensitive Ecosystems	0-1	If a shore unit is within 15 meters of an SEI polygon or has a riparian area or Garry oak community present the shore unit receives a value of 1. A shore unit can only receive up to 1 point for this rating class.
Key Species	0-4	If a shore unit has forage fish spawning potential or is adjacent to eelgrass or kelp bed it receives 4 points. A shore unit can only receive up to 4 points for this rating class.
Total:	0-25	A shore unit can receive a highest possible value of 25.

The numerical values resulting from the rating system are further simplified into an overall ecological value summarized in Table 3.

Table 3: Soft Shore Shoreline Ecological Value

Value	Overall Ecological Value	Description
0-5.5	Very Low	Shore unit is significantly altered by land use activities; there is little sign of wildlife activities or marine beach life.
5.6-10.5	Low	Shore unit has been disturbed, little remains of the natural landscape of the unit. Shore unit has potential for some marine and land based wildlife activities.
10.6-15.5	Moderate	Shore unit is in a semi-natural state with some anthropogenic land use activities occurring. Potential for signs of wildlife and marine beach activities at this location. Potential for presence of key life cycle species.
15.6-20.5	High	Shore unit is likely in a natural or almost natural condition, signs of wildlife activity present, and potential for presence of key life cycle species.
20.6-25	Very High	There is presence of key life cycle species in shore unit as well as wildlife activity, marine life and natural vegetation.

The hard shore rating is based on three shore unit characteristics deemed to have significant ecological worth. The criteria used to rate each shore unit are described in Table 4.

Table 4: Hard Shore Shoreline Rating Criteria

Rating Class	Value Range	Criteria
Habitat Cover	0-10	If a shore unit has any percentage of habitat cover of Coniferous, Deciduous, Shrub, Bare Ground (e.g. rock), or Wetland habitat class it receives one tenth of the percent value, ie. 50% Coniferous = 5; 20% Deciduous = 2, 30% Wetland = 3; Total =10. Landscaped areas receive 0 because of their non-natural nature.
Wildlife Feature	0-5 (Although there are six possible wildlife features there was never a unit that had more than five.)	If a shore unit has any of the six listed wildlife features present (Nesting Area, Rock Ledge, Undercut Shelter, Artificial, Driftwood Pile or Wildlife Tree) it receives 1 point for each feature present. A shore unit can receive up to 5 points for this rating class. If no wildlife features are present the unit receives 0.
Sensitive Ecosystems	0-1	If a shore unit is within 15 meters of an SEI polygon or has a riparian area or Garry oak community present the shore unit receives a value of 1. If the shore unit does not have any sensitive feature documented or adjacent, it receives 0. A shore unit can only receive up to 1 point for this rating class.
Total:	0-16	A shore unit can receive a highest possible value of 16.

The numerical values resulting from the hard shore rating system are further simplified into an overall ecological value summarized in Table 5.

Table 5: Hard Shore Shoreline Ecological Value

Value	Overall Ecological Value	Description
0-3	Very Low	Shore unit is significantly altered by land use activities; there is little sign of wildlife activities and no sensitive ecosystem.
3.1-6	Low	Shore unit has been disturbed, little remains of the natural landscape of the unit. There is little sign of wildlife activities and very little in the way of sensitive ecosystems.
6.1-9	Moderate	Shore unit is in a semi-natural state with some anthropogenic land use activities occurring. Potential for signs of wildlife at this location with some sensitive ecosystems nearby.
9.1-12	High	Shore unit is likely in a natural or almost natural condition, potential signs of wildlife activity and sensitive ecosystems.
12-16	Very High	Shore unit is in natural or almost natural condition, there is presence of wildlife activity and sensitive ecosystems.

4.2 Rating the Shore Units' Naturalness using the MISA Data

A rating system (Table 6) that shows the level of modification of the Mayne Island shoreline was developed for MISA so that planners and the public could see which shore units are highly impacted by shoreline development.

Table 6: Level of Modification Rating Criteria

Rating Class	Value Range	Criteria
Seawalls	5	If a shore unit has any of the six seawall features (boat ramp, concrete, landfill, sheet pile, rip rap, wooden) present it receives 5 points.
% length modified	0-10	If a shore unit has any percentage of the total length modified by a seawall it receives one tenth of the percent value, ie. 50% Modified= 5; 20% Modified = 2 If there is no modification it receives 0.
Other Man Made Features	0-8 (Note that although there are six possible other man made features there was never a shore unit that had more than five of the possible six features.)	If a shore unit has any of the six listed other man made features present (Pilings, wharves, floats/docks, access path, stairs, groin) it receives points for each feature present. A shore unit can receive up to 8 points for this rating class. If no other man made features are present the unit receives 0. Wharves, floats/docks and groins all receive 2 points whereas access paths and stairs receive 1. The difference in points received is due to the greater effect that the former have via shading the seafloor vs. the latter.
Polluting Features	0-2	If a shore unit has any of the 4 polluting features (storm outfall, sewer outfall, creosote logs, toxic waste) present it receives 1 point for each polluting feature recorded. If the shore unit does not have any polluting features documented it receives 0.
Total:	0-25	A shore unit can receive a highest possible value of 25.

The numerical values resulting from the level of modification rating system (Table 6) are further simplified into an overall modification value summarized in Table 7.

Table 7: Level of Modification Value

Value	Overall Modification Value	Description
0-5	Very Low	Shore unit is likely in a natural or almost natural condition.
5.1-10	Low	Shore unit is in a semi-natural state with some anthropogenic land use activities occurring.
10.1-15	Moderate	Shore unit is in a semi-natural state with much anthropogenic land use activities occurring.
15.1-20	High	Shore unit has almost no natural state remaining.
20.1-25	Very High	Shore unit is significantly altered by land use activities, no natural state remains.

5.0 Results

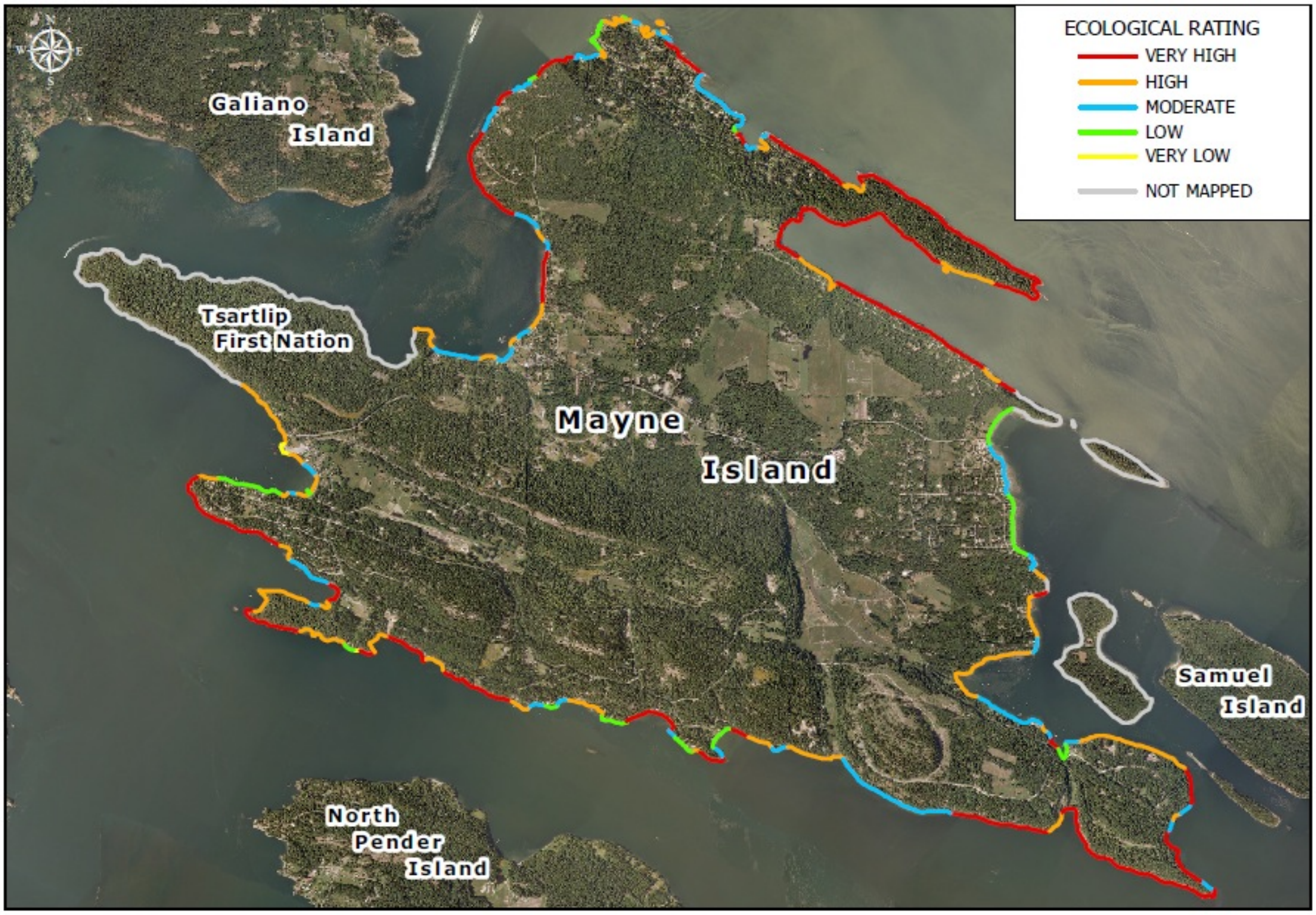
5.1 Ecological Rating

This section includes data showing the ecological value of the shore units, as calculated using the above rating systems (Table 2, Table 4). Both hard shores and soft shores are combined in Table 8, whereas they are separated in Table 9 and Table 10.

Table 8: Ecological Rating of both soft and hard shoreline units.

Shoreline Eco Rank (SER)	Number of Shore Units	Total Length (m)	% Length of Study Area
Very High	68	15,752	45
High	57	9,867	28
Moderate	44	6,540	18
Low	20	3,020	8
Very Low	2	187	1
TOTALS	191	35,366	100

- Figure 2: Overall Ecological Rating -



PROJECT:	DATE:	DRAWN BY:	MAP SCALE:	0 0.5 1 2 3 4
Mayne Island Shoreline Inventory	March 2013	S. Willmott	1:40,000	Kilometres

Figure 2: Ecological Rating of all shoreline units, including soft and hard shores

Table 9: Soft Shores Ecological Rating

Soft Shore ER	Number of Shore Units	Total Length (m)
Very High 20.6 - 25	16	3,549
High 15.6-20.5	46	8,437
Moderate 10.6 – 15.5	36	5,742
Low 5.6 – 10.5	14	2,340
Very Low 0 – 5.5	1	146
TOTALS	113	20,214

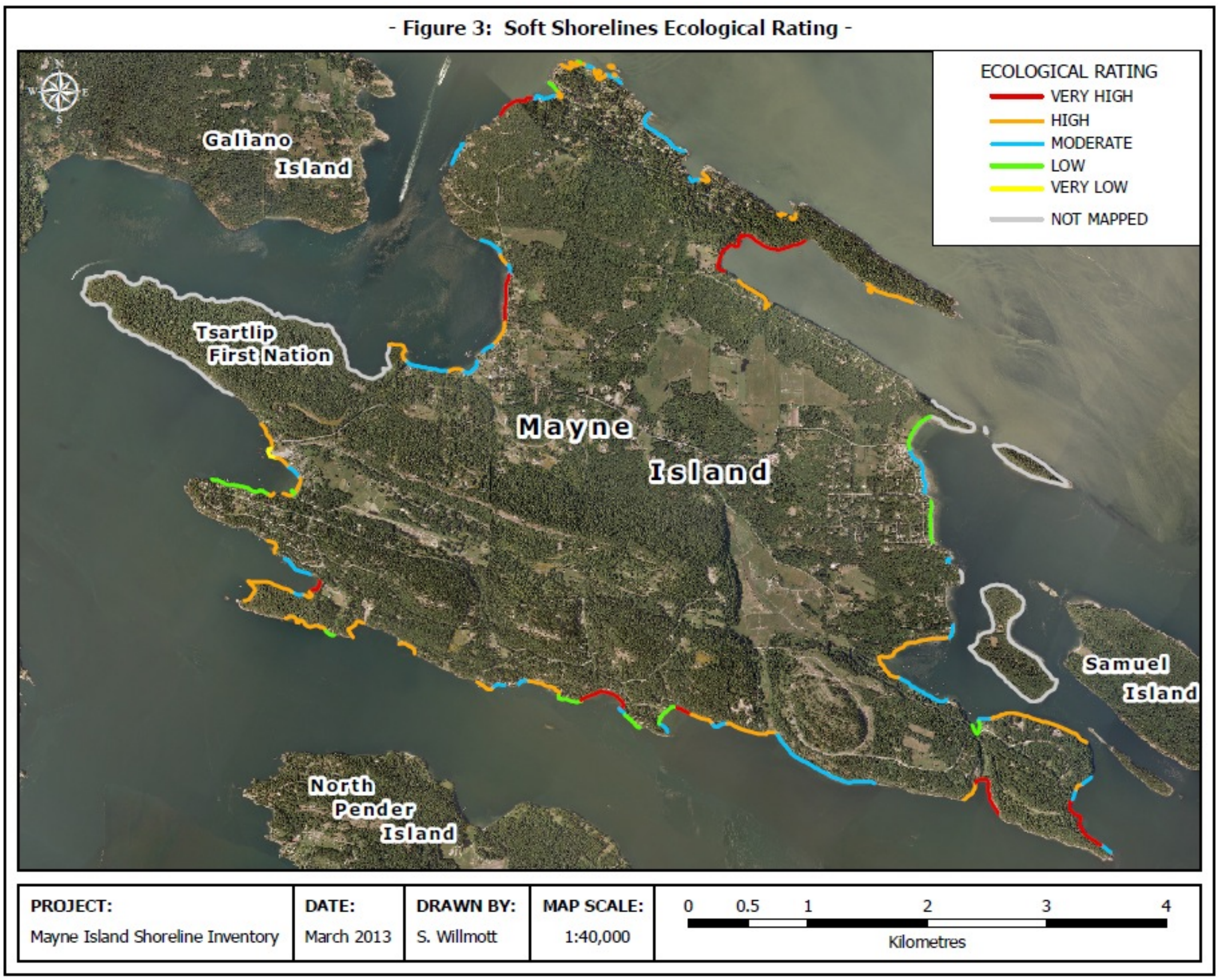


Figure 3: Soft Shores Ecological Rating.

Table 10: Hard Shores Ecological Rating

Hard Shore ER	Number of Shore Units	Total Length (m)
Very High 12 - 16	52	12,203
High 9.1 - 12	11	1,430
Moderate 6.1 - 9	8	798
Low 3.1 - 6	6	680
Very Low 0- 3	1	41
TOTALS	78	15,152

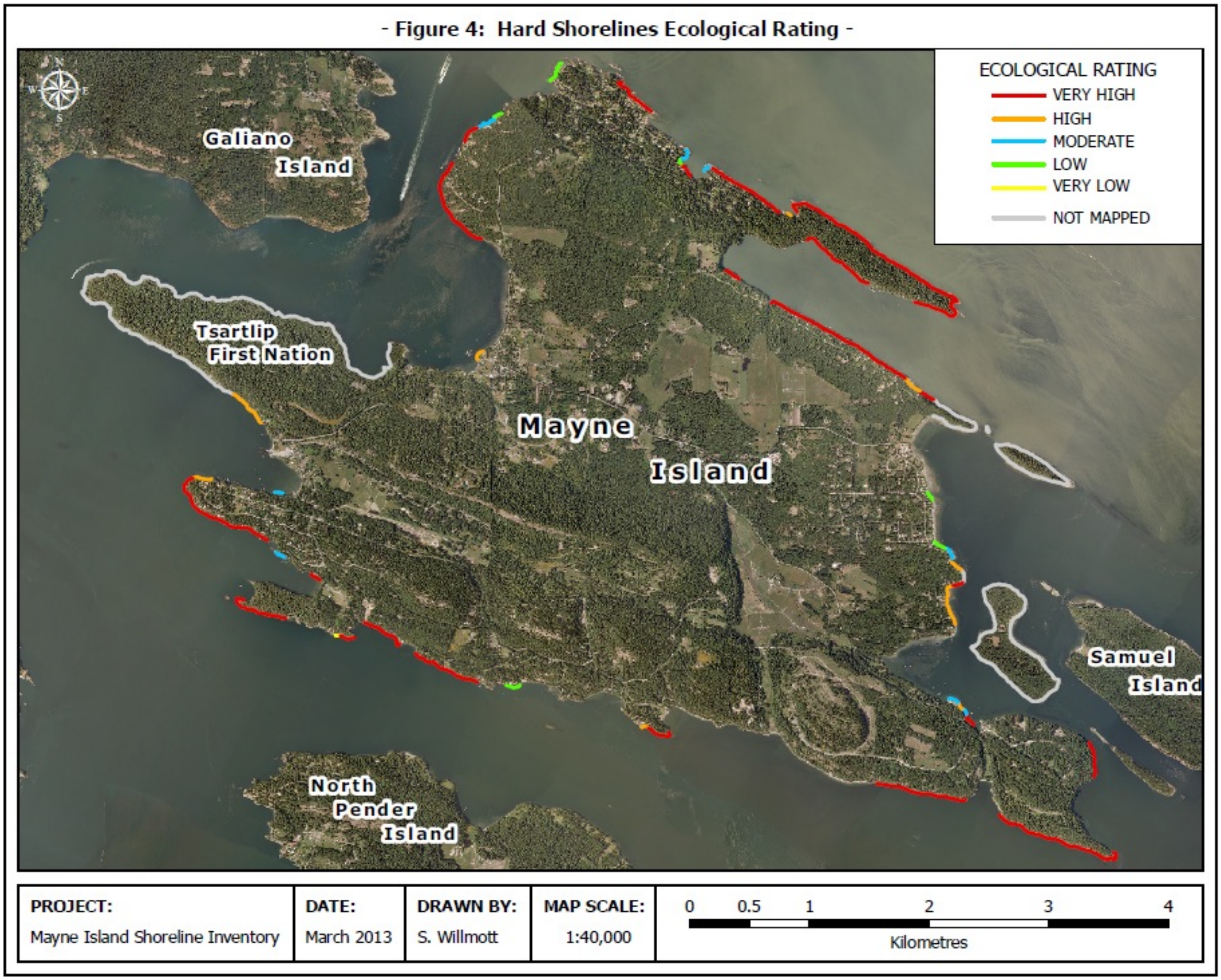


Figure 4: Hard Shores Ecological Rating.

5.2 Shoreline Modifications

5.2a Seawalls

Tables 11-13 provide data on seawalls, as recorded during the MISA survey. A seawall is defined as something put in place by humans (anthropogenic) that prevent the ocean from making contact with the backshore (including boat ramps, concrete, landfill, riprap and wooden walls). Seawalls were noted during the study with GPS points being taken at the beginning and end of the seawall. In cases where seawalls were so short that a GPS start and end point would not be accurate, one point was taken, with the surveyor making note of the seawall's approximate length. Because of the combined variable accuracy of the hand held GPS and taking the points from a boat, the locations of seawalls denoted by a point in the middle of the seawall rather than using a linear representation. Locations of the seawalls are shown in Figure 5.

In total, 167 seawalls were documented, making the study area 6% seawalls or 2.042 kilometers of shoreline. Seventy-eight shore units (41% of the shore units) have at least one seawall, with the maximum number of seawalls within a unit being 7. The seawall bases are built, on average -1.3m below the high water mark. The majority of these seawalls are built on residential land (**Table 12**) and are constructed from either concrete or riprap (**Table 13**).

Table 11: Number of Seawall Occurrences within the Shore Unit

Number of Seawall Occurrences within the Shore Unit	% of Shore Units
0	59%
1	20%
2	8%
3	7%
4 or more	6%

Table 12: Percentage of Seawalls associated with Backshore Land Use Class

Land Use Class	% of Seawalls
Residential	89%
Natural	2%
Commercial	2%
Parking lot	4%
Vacant land	0%
Parkland	2%
Agricultural	1%

Table 13: Types of Seawalls built on Mayne Island

Type of Seawall	% of Seawalls
Concrete (Bulkheads/Blocks)	35%
Riprap (rubble, rock armor)	30%
Rock Masonry	10%
Boat Ramp	8%
Mixed Materials	8%
Wooden	6%
Landfill (soil and rocks)	3%
Sheet Pipe	0%

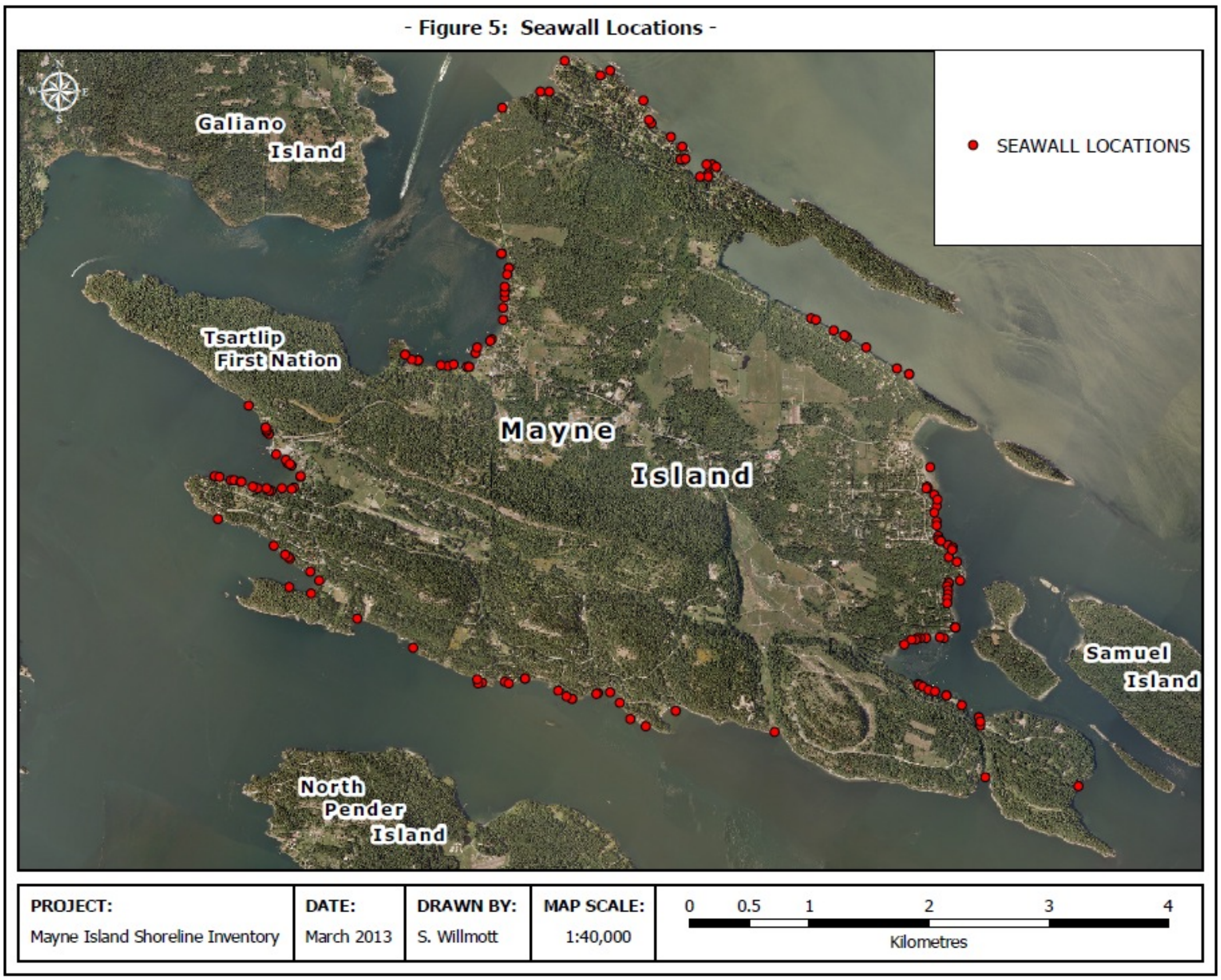


Figure 5: Seawall Occurrences on Mayne Island.

5.2b Other Anthropogenic Modifications

For this study, docks/floats, pilings, groins, access paths, stairs and wharves, were recorded within the category of "other anthropogenic modification." (Note: field data sheets and GIS database denotes anthropogenic as "manmade"). Table 14 and Table 15 provide data on these modifications.

Because docks and floats can cause higher degrees of ecological damage than most other modifications, we endeavored to make note of all docks within the shore units. Overall, 75 docks are built on Mayne Island, with the highest concentrations being in bays where subdivisions have created small lots. Four bays on Mayne Island contain 61 of the 75 docks (Village Bay=22, Dinner Bay=17, Campbell Bay=16, Horton Bay=6).

Figure 6 provides a map showing the overall modification rating of Mayne Island's shoreline that combines seawalls and other anthropogenic modifications.

Table 14: Number of Shore Units with Other Anthropogenic Modifications

Other Anthropogenic Modifications	Number of units that at least 1 of the modification	% of Shore Units
Stairs	56	29%
Pilings	39	20%
Docks/floats	35	18%
Access Paths	10	5%
Groin	1	1%

Table 15: Number of Docks within Shore Units

Number of Docks	Shore units with number of docks	Percentage of shore units*
0	156	82%
1	24	13%
2	6	3%
3 or more	5	3%

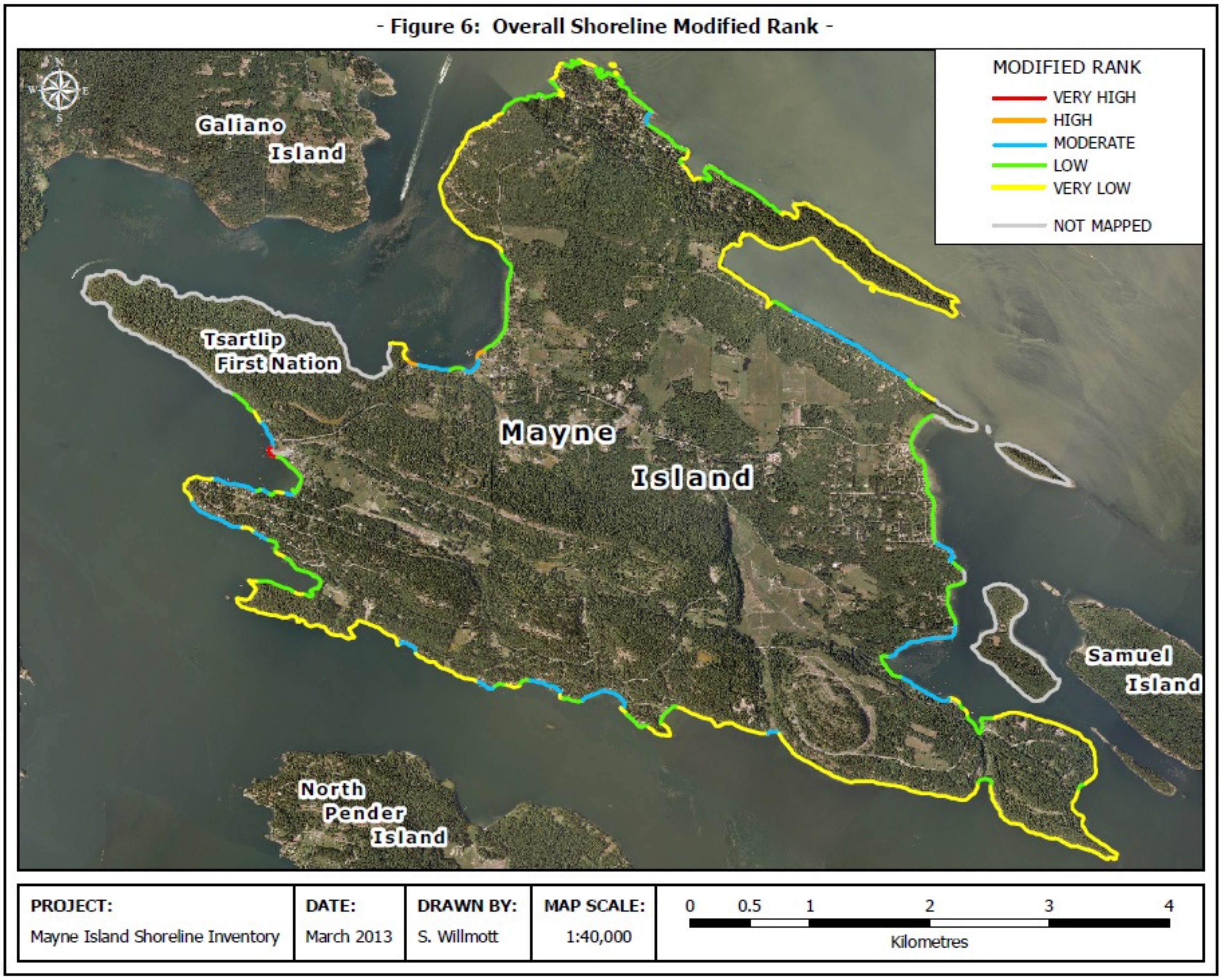


Figure 6: Overall Shoreline Modified Rank.

5.3 Backshore Land Use

The land use activities occurring in the backshore of each shore unit were recorded and categorized into seven possible land use classes. A summary of the results for each land use class has been provided below. Please note that during surveys, “parking lot” referred to any area that had been paved, which included roads that were within 15m of the high water mark. Also, likely due to addition errors, 208m of shoreline are not represented within the table’s calculations. The land use classes reflect what was visible from a boat near the shoreline, what was visible on orthophotos (which were overlaid with property lines) and knowledge of the surveyors in regards to parkland and commercial uses.

Table 16: Backshore Land Use

Land Use Class	% of Shoreline
Residential	60%
Natural	33%
Parkland	3.1%
Parking lot	2%
Commercial	1.6%
Agricultural	0.7%
Vacant land	0.1%

5.4 Habitat Class % Cover

A calculation of the percent cover of habitat types occurring within 15m of the backshore of each shore unit was completed based on field observations. Table 17 provides a summary for each habitat class.

Table 17: Percent Cover Habitat Type in Backshore

Habitat Class	% Cover Habitat Types
Coniferous	39%
Bare Ground	29%
Landscaped	15%
Shrub	15%
Deciduous	2%
Wetland	0.001%

5.5 Erosion

A visual judgment of any bank erosion occurring in the backshore was documented and is summarized in Table 18.

Severe erosion – Undercutting or sloughing soil is evident across a significant change in elevation.

Moderate erosion – Undercutting or sloughing soil is evident across a change in elevation; may be due to natural causes.

Mild erosion – Undercutting or sloughing soil within same elevation; may be due to natural causes.

Table 18: Degree of Erosion associated with % of Shore Units

Degree of Erosion	% of Shore Units	% of Seawall Occurrences
Severe	2%	2%
Moderate	7%	11%
Mild	8%	16%
None	83%	71%

6.0 Sensitive Features

Sensitive features are ecosystems defined as fragile or rare. The surveys revealed that 46 shore units (24%) contain Garry oak trees and 8 shore units (4%) are adjacent to a riparian area (stream or wetland). Additionally, 140 shore units (64%) were located within 15m of a Sensitive Ecosystem Inventory polygon (see Appendix C

6.1 Wildlife Features

Wildlife and Wildlife habitat activities were observed and documented in the field, including areas that provided features for nesting, feeding, shelter, perching, and breeding. The following table (**Table 19: Wildlife Features** outlines the results of the wildlife survey.

Table 19: Wildlife Features

Number of Wildlife Features	Number of Shore Units	% of Shore Units
1	31	16%
2	59	31%
3	43	23%
4+	31	16%

7.0 Ecological Values

The presence of four key species or their habitat was recorded during the survey. These four species are: eelgrass (*Zostera marina*), bull kelp (*Nereocystis luetkeana*), Pacific sand lance (*Ammodytes* americanus) and surf smelt (*Hypomesus pretiosus*); the latter two collectively known as forage fish. These species are considered key species because they can serve as shelter, food and spawning for other major species at key points in their cycle of life.

7.1 Forage Fish

During the Mayne Island Shoreline Atlas (MISA) survey, 35 of 191 shore units were identified as having potential forage fish spawning sites. Previously, the Mayne Island Conservancy Society (MICS), surveyed beaches over three field seasons for the presence of Pacific sand lance eggs from winter 2009 to winter 2011; and 2 field seasons for surf smelt during the same period and during summer 2010 and 2011. The methodology used to survey beaches and search for eggs was established by Pam Thuringer M.Sc., R.P.Bio. of Archipelago Marine Research Ltd. **Figure 7** displays sites identified as potential spawning areas during the MISA study and also sites that had previously been surveyed for forage fish eggs.

Forage fish spawning habitat (sandy/gravel beaches and underwater vegetation including eelgrass beds) for Pacific herring, surf smelt and Pacific sand lance are essential for reproduction of these species. Because other species including fish, birds and marine mammals forage on these smaller fish, they have come to be known for the service they provide.

Sand lance eggs attach to sand particles from November through mid-February. Surf smelt lay their eggs on coarse sand and pea gravel on the higher reaches of the intertidal area year round[8]. Over-hanging vegetation in marine riparian areas provide shade for the eggs during the warm summer months.[9] The limited extent of their spawning sites makes them vulnerable to shoreline development and construction activities.

Primary threats to forage fish spawning sites consist of the combined impacts that reduce eelgrass habitat or the proper composition of beach sand for spawning. Silt can both shade eelgrass and suffocate forage fish eggs. Shoreline modification leads to shoreline hardening over time as sand is removed and hydrographic conditions are altered[10]. Shoreline hardening affects sand lance and surf smelt habitat as the sand is washed away and eelgrass substrate is altered. Pollution run-off can be toxic as well as decrease water clarity. Overwater structures may shade eelgrass or alter hydrographic conditions. Altered hydrographic conditions may affect sediment transport of beach sand.

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[8] Penttila, D. 2007. Marine forage Fishes in Puget Sound. Puget Sound Nearshore Partnership Report N. 2007-03. Seattle District, U.S. Army Corps of Engineers, Seattle, WA.

[9] Penttila, D. 2002. Effects of shading upland vegetation on egg survival for summer-spawning surf smelt on upper intertidal beaches in Puget Sound. In Puget Sound Research-2001 Conference Proceedings, Puget Sound Water Quality Action Team, Olympia, Washington. 9 p.

[10] Thom, R.M., D.K. Shreffler and K. Macdonald. 1994. Shoreline armoring effects on coastal ecology and biological resources in Puget Sound, Washington. Coastal ErosionMgmt. Studies, Vol 7. Shoreland and Coastal Zone Mgmt. Program, Washington Department of Ecology, Olympia,Washington. 95 p.

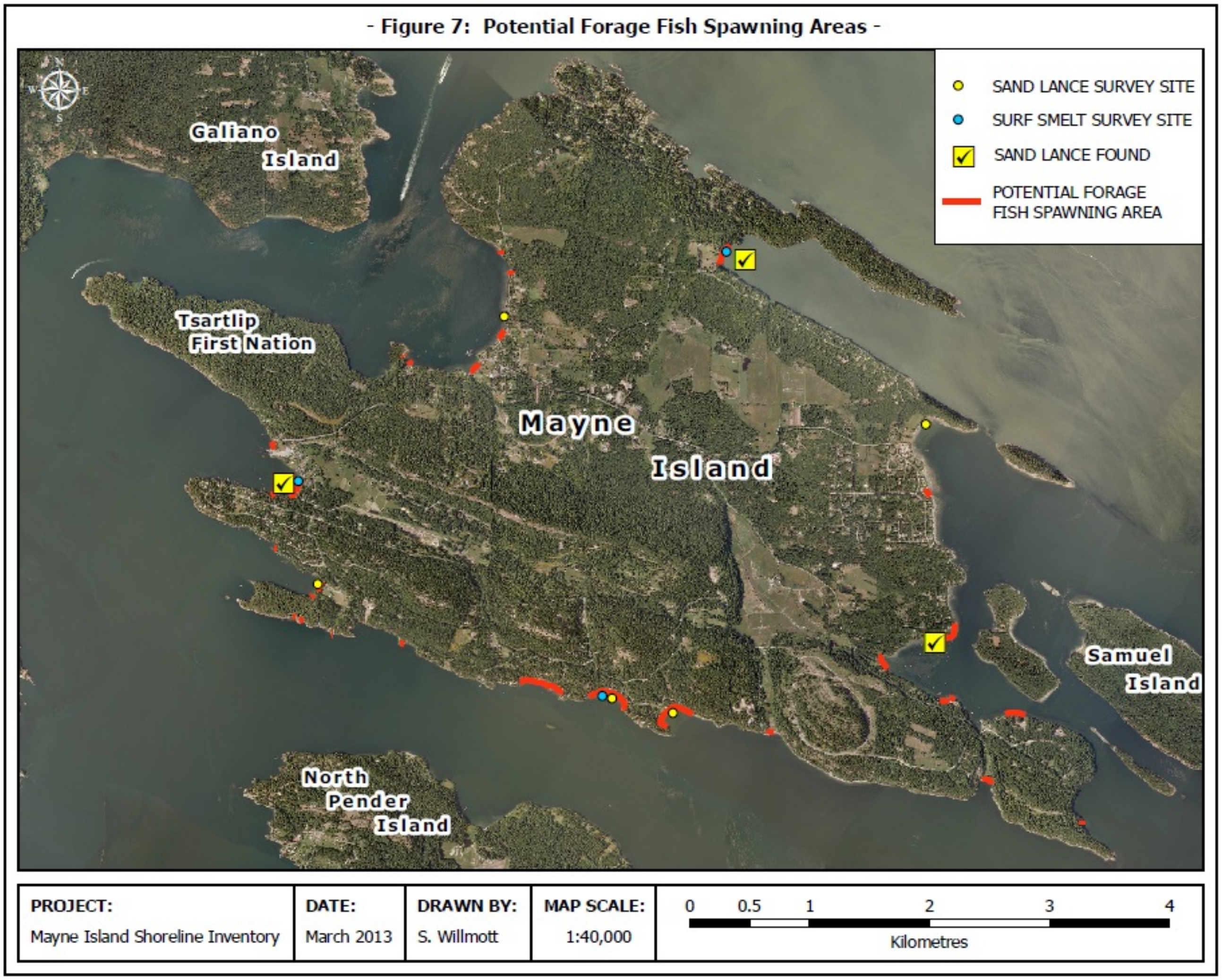

Figure 7: Potential Forage Fish Spawning Areas.

7.2 Eelgrass (*Zostera marina*)

MICS has completed surveys for eelgrass from 2008 to the present, during which 71 of 191 shore units have been identified as having eelgrass beds. Beds were surveyed by boat with underwater camera, by foot on shore, by kayak and by freedivers. A peer reviewed, scientifically established methodology was used.[11]

The complex and intricate food webs of an eelgrass meadow rival the world's richest farmlands and tropical rainforests.[12] From an unstructured muddy/sandy bottom grow a myriad of shoots that supply shelter and nutrients to salmonids and other fish, shellfish, waterfowl and invertebrates. The leaves offer habitat for over 350 species of macro algae and 91 species of epiphytic microalgae – the basis of the food web for juvenile salmon in marine waters. [13]

Eelgrass beds function as refugia, providing respite for salmon from strong ocean currents and predators, and as nutrient rich nurseries for young marine organisms. Across the globe, seagrass meadows cover approximately 177,000 square kilometers of coastal waters[14] – larger than the combined area of the Maritime Provinces. They provide refuge for juvenile Chinook, Coho, Pink, Chum, and Sockeye salmon. The salmon use these critical marine environments for food, shelter and metabolic growth.

Great Blue Herons have been observed to feed in eelgrass beds and other important bird species using these habitats include Rhinoceros Auklets, Cormorants, and Western Grebes.

Globally, eelgrass has been used as an indicator of water quality.[15] Often, a bed will change in size dependent on light availability. Water quality is affected by land practices and water uses. If, for example, a large scale development occurs on shore near an eelgrass bed, the bed may decrease in size because the water quality is compromised by increased pollution; hardening of the shoreline by shoreline modification can change the substrate and energy intensity, and increased boat traffic or over-water structures can fragment the bed.

Because eelgrass is a plant, the amount of light reaching the bed matters. Shading created by structures, increased sediment or plankton blooms associated with increased nutrients from land can kill eelgrass meadows, decrease its density, or limit the suitable growing area to shallower depths.

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[11] Precision Identification. 2002. Methods for Mapping and Monitoring Eelgrass Habitat in British Columbia. Available online: http://cmnbc.ca/atlas_gallery/eelgrass-bed-mapping.

[12] Zieman, J.C. and R.G. Wetzel. 1980. Productivity in seagrasses: methods and rates. In R.C. Phillips and C.P. McRoy (eds.), Handbook of Seagrass Biology. Garland STPM, New York, pp. 87_116.

[13] Belthuis, D.A.. 1991. Distribution of habitats and summer standing crop of seagrass and macroalgae in Padilla Bay, Washington. In: Padilla Bay National Estuarine Research Reserve Technical Report 2. Washington State Dept. of Ecology. 35p.

[14] Waycott M, et al. 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. Proceedings of the National Academy of Sciences 106: 12377–12381.

[15] Sewell, A.T., J.G. Norris, S. Wyllie-Echeverria, and J. Skalski. 2001. Eelgrass Monitoring in Puget Sound: Overview of the Submerged Vegetation Monitoring Project. Washington State Department of Natural Resources.

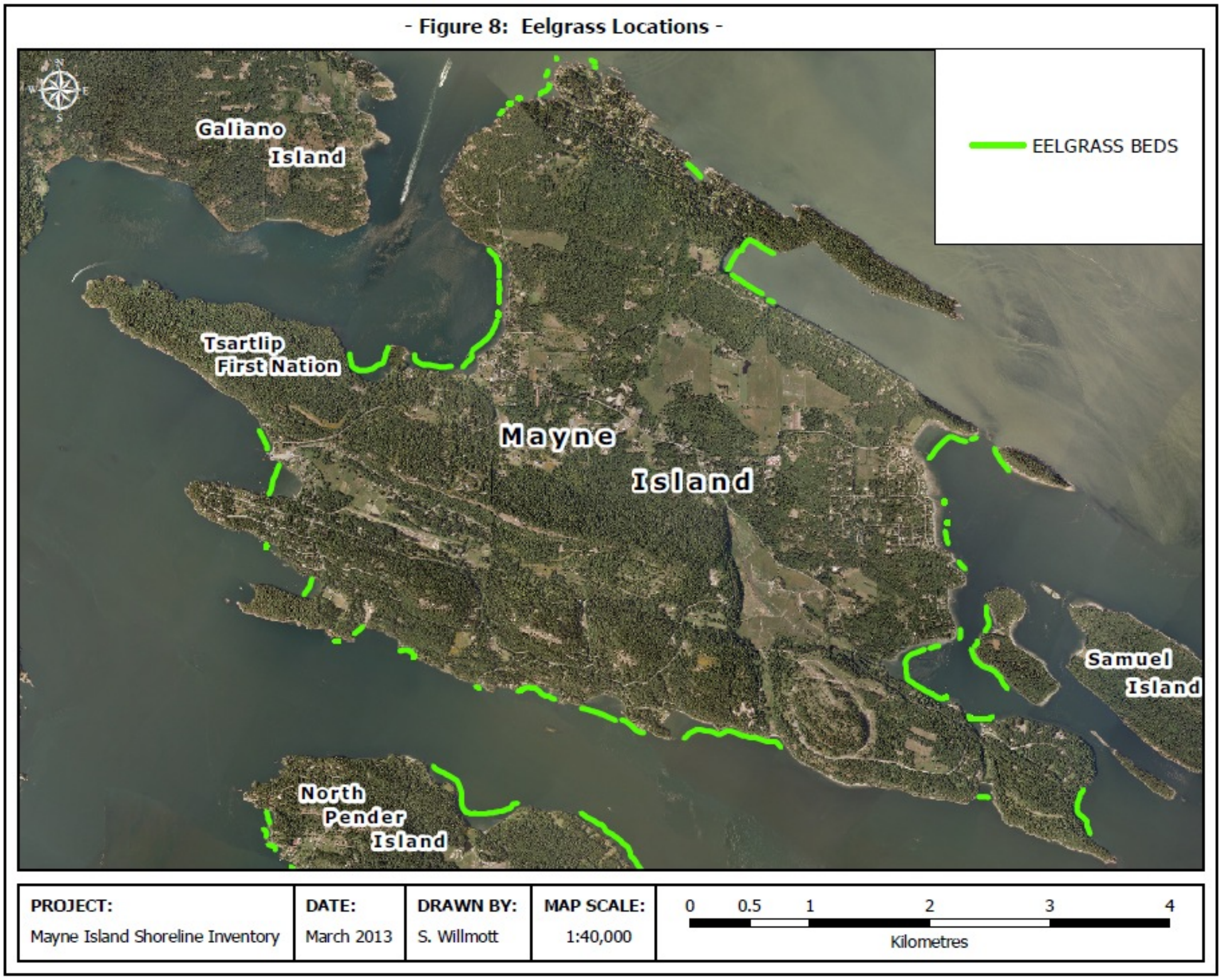

Figure 8: Eelgrass Locations on Mayne Island.

7.3 Bull Kelp (*Nereocystis luetkeana*)

MICS has completed surveys for bull kelp from 2010 to the present, during which 86 of 191 shore units have been identified as having kelp beds. The Mayne Island Conservancy Society created the methodology used, with advice from experts in the field.[16] Surveys are conducted by kayak during peak kelp growth (August-September).

Canopy-forming kelps play an important role in many nearshore marine ecosystems. They form extensive forests below the water's surface, providing ideal habitat that supports populations of fish, invertebrates, marine mammals and marine birds.[17] They also are a key source of carbon in coastal food webs, forming a base of carbon for secondary production.[18] Bull kelp (*Nereocystis luetkeana)* ranges from Alaska to California, forming distinct beds as well as mixed beds.

A wide range of natural and anthropogenic factors affect kelp forests. Sea urchin grazing can dramatically reduce the extent of beds, an impact that is moderated by sea otter predation on urchins.[18] Rises in ocean temperature can also decimate kelp beds, which raises cause for concern about the impact of sea surface temperatures associated with climate change. It has been shown that, while kelps can adjust metabolic processes in order to acclimatize to temperature changes, increased temperature negatively affects the resilience of kelp beds to additional stressors, such as storm disturbances.[19] Anthropogenic impacts on kelp forests include runoff from coastal development, which can reduce water quality by introducing toxins and reducing light penetration.[20] Boating activity can impact kelp forests by physically damaging plants with propellers.

Mapping and monitoring of canopy-forming kelps is an important step towards understanding natural and anthropogenic fluctuations in the aerial extent and overall health of beds. Bull kelp, is an annual kelp, growing anew each year from spores, and thus may lose or take-hold of a given area from one year to the next.

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[16] Mayne Island Conservancy Society. 2010. Guidelines and Methods for Mapping and Monitoring Kelp Forest Habitat in British Columbia. Available online:

[17] Berry, Helen, Amy Sewell, and Bob Van Wagenen. 2001. Temporal Trends in the Areal Extent of Canopy-Forming Kelp Beds Along the Strait of Juan De Fuca and Washington's Outer Coast. Puget Sound Research.

[18] Duggins, David O. 1908. Kelp Beds and Sea Otters: An Experimental Approach. Ecology. 61.3: 447-53.

[19] Wernberg, Thomas, et al. 2010. Decreasing Resilience of Kelp Beds Along a Latitudinal Temperature Gradient: Potential Implications for a Warmer Future. Ecology Letters. 13.6:685-94.

[20] Steneck RS, Graham MH, Bourque BJ, Corbett D, Erlandson JM, Estes JA & Tegner MJ. 2002. Kelp forest ecosystems: biodiversity, stability, resilience and future. Environ Conserv 29:436-59.

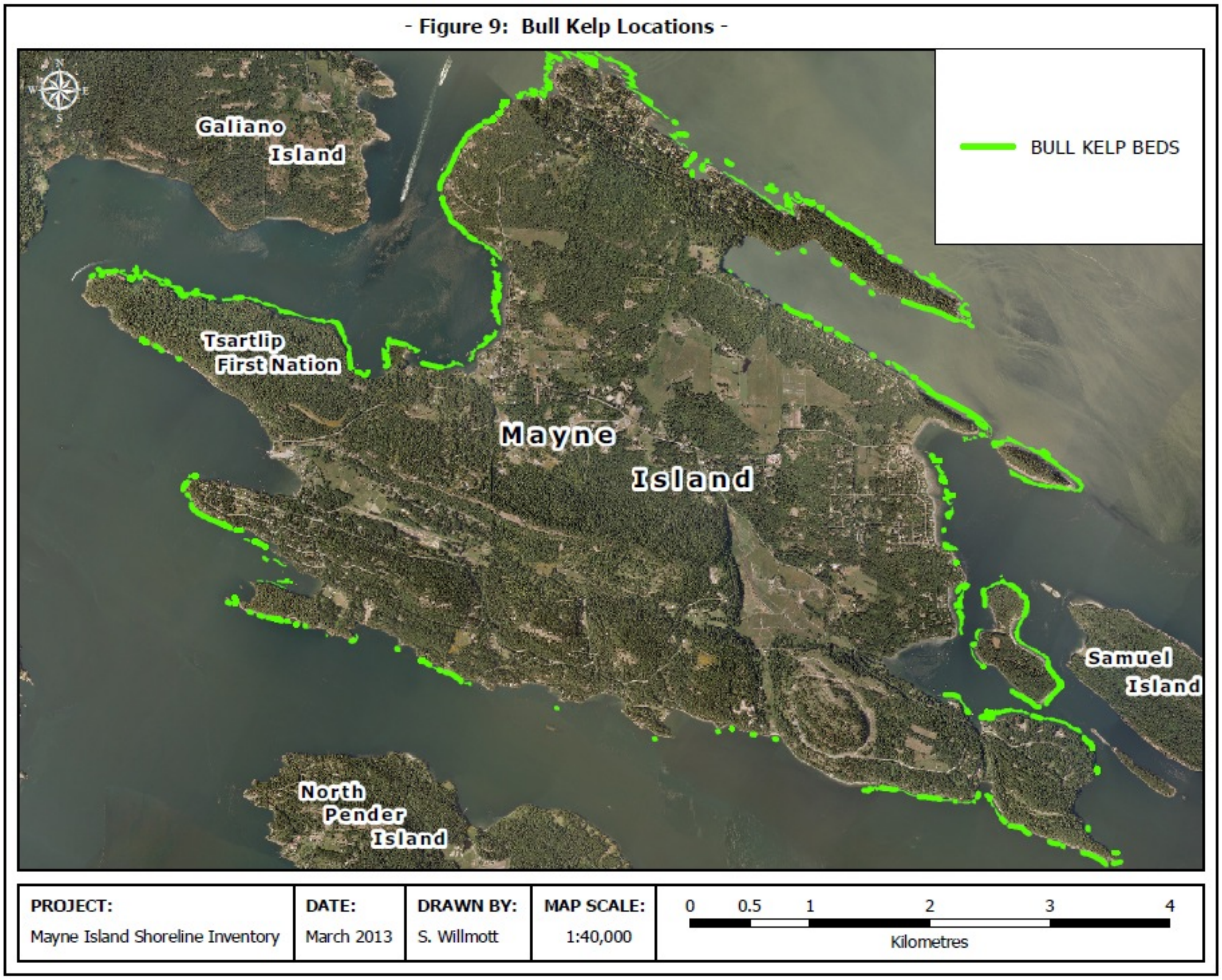

Figure 9: Bull Kelp Locations on Mayne Island.

7.4 Marine Riparian Areas

Vegetative zones along the interface between beaches and the backshore are termed marine riparian areas.[21] The shorelines along Mayne Island contain many species including: Douglas-fir, Garry oak, arbutus, alder and associated understory shrub (e.g. ocean spray, salal). These plants, along with large woody debris, play an important ecological role in the health of shorelines. Roots from plants stabilize soils,[22] and large logs can create beach berms and slow down wave energy.[23] Root systems can also slow down water coming from upland areas that have been channelized, and can filter out some of the pollutants associated with upland uses.[24] Shade from tree canopies can shelter surf smelt eggs from summer sun, and provide insects for young salmon during high tide periods.[25]

However, when trees and shrubs are removed to increase visual horizons, create footpaths, or when large logs are removed from the upper intertidal areas; natural erosion control structures decrease. This increases the likelihood of needing to construct costly artificial barriers to decrease the amount of wave energy reaching the backshore. It is in the best interest of both humans and wildlife to understand the effects of such actions on the natural structure and functions of the shore.

For example, when waves hit the concrete surface of a built seawall, the wave's energy is deflected back towards the beach and along the shore, creating erosion over time on the beach and the neighboring banks. Small particles of sand and gravel that provided spawning grounds for surf smelt and sand lance and soils for salt tolerant plants are washed away and larger coarser materials are left behind. Bank stabilization and the need for more seawalls along the shore increase. Ultimately, the dynamics of the entire shore are altered, lessening the types and numbers of wildlife and native plant communities on the shore and in the shallow marine waters.

Many marine riparian areas have been fragmented or destroyed due to shoreline development pressures. Each area destroyed adds to the cumulative loss of erosion control, wildlife habitat, perching structures for eagles and kingfishers, spawning areas for smelt and sand lance, and microhabitats for insects feeding the food web of the intertidal areas. Adding sands and soils to near shore areas by erosion of these riparian zones can change the elevation and seaward profile of a beach, making it even more vulnerable to wave erosion.

[21] Levings CD, Romanuk TN. 2004. Overview of research and thoughts on the marine riparian as fish habitat in British Columbia. In: Lemieux JP, Brennan JS, Farrell M, Levings CD, Myers D, editors. pp. 3–7. Proceedings of the DFO/PSAT sponsored marine riparian experts workshop, Tsawwassen, B.C., February 17–18, 2004. Can Man Rep Fish Aquat Sci. 2680.

[22] Gray, D., and R. Sotir. 1996. Biotechnical and soil bioengineering slope stabilization: A practical guide for erosion control. A Wiley-Interscience Publication, New York, New York. 378 pages.

[23] Brennan, James S., and Hilary Culverwell. 2005. Marine Riparian: An assessment of riparian functions in marine ecosystems. Washington Sea Grant Program.

[24] Phillips I. 1989. Non-point source pollution control effectiveness of riparian forest along a coastal plain river. Journal of Hydrology 110: 221-37.

[25] Penttila, D. 2002. Effects of shading upland vegetation on egg survival for summer-spawning surf smelt on upper intertidal beaches in Puget Sound. In Puget Sound Research-2001 Conference Proceedings, Puget Sound Water Quality Action Team, Olympia, Washington. 9 p.

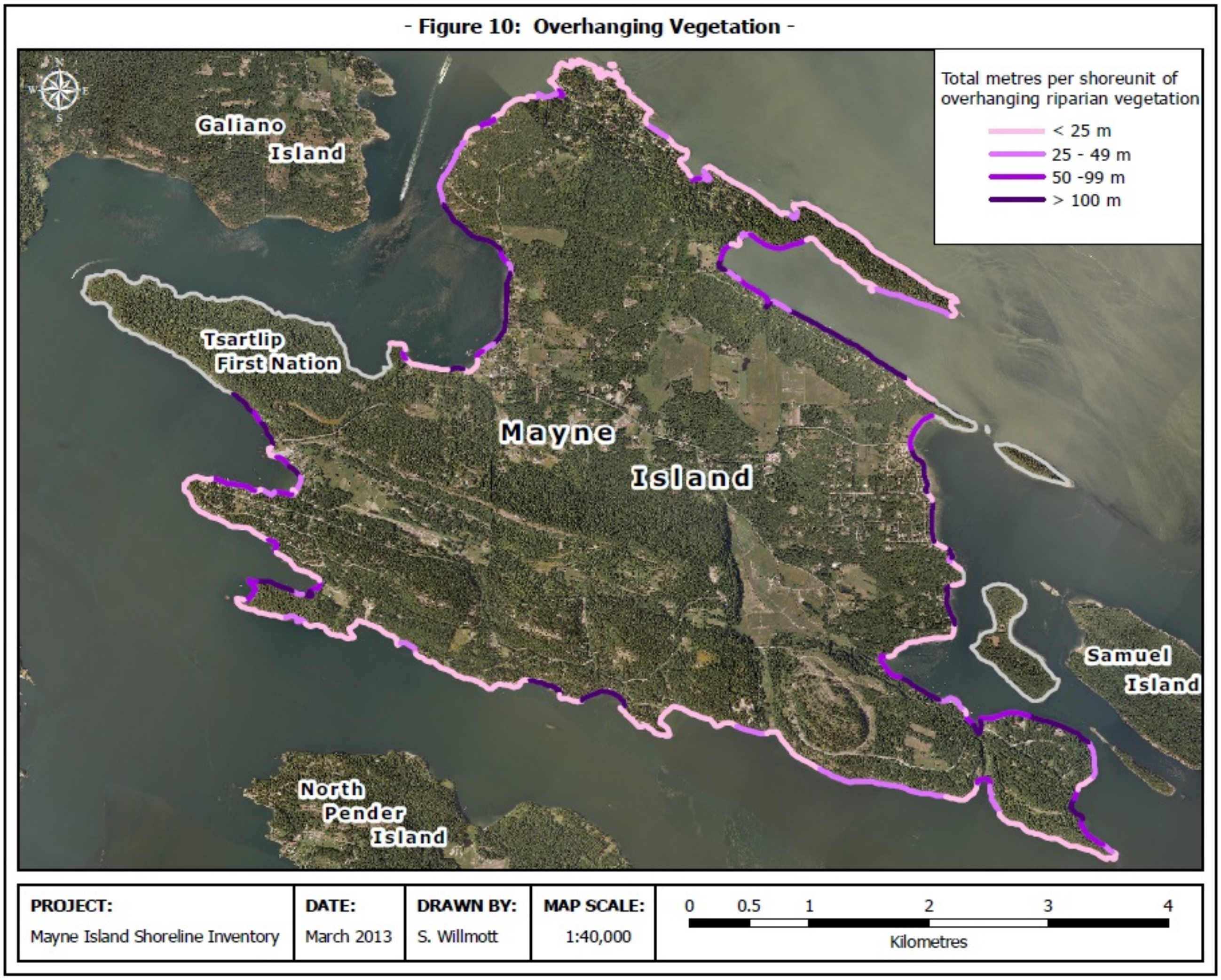

Figure 10: Overhanging Shoreline Vegetation on Mayne Island.

8.0 Conclusion

The objectives and deliverables for this project have been met for 77% of Mayne Island shoreline excluding the Tsartlip Reserve, the Gulf Islands National Park Reserve at Bennett Bay and Curlew Island. Each shore unit in the study area was visited with systematic collection of data. The data was entered into a GIS database that will be made available to the Mayne Island Local Trust Committee (Islands Trust), Islands Trust planners, Islands Trust Fund and other interested agencies.

Mayne Island's shorelines have a relatively low level of modification compared to urban areas. Seawalls comprise 6% of the Mayne Island study area (pop 1,100) compared to 38% in Central Saanich (near Victoria, B.C.; pop 15,900). Because of the low level of modification Mayne's shores have a relatively high ecological rating (45% Very High, 28% High) compared to Central Saanich (0% Very High, 8% High, 44% Moderate).

Maintaining a healthy foreshore in an increasingly urbanized region will be a challenge. In the Trust Area, Mayne Island has the highest percentage (31.3%) of land base converted to human use and the lowest percentage of protected area (4.4%).[26] Given this high level of human use, maintaining the ecological integrity of shoreline and backshore areas is critical. Knowledge regarding the impact of upland development, the importance of riparian buffer zones, and the effects of storm water and shoreline modification has become known in professional communities, but the general public remains frequently uninformed.

The Mayne Island Shoreline Atlas and associated GIS database will help to fill this knowledge gap by providing a tool that can inform both the public and the government in regards to Mayne Island's natural and modified shorelines, critical wildlife habitat, backshore vegetation and foreshore use. It provides information for future comparisons and science-based decision-making by local governments, identification of critical biological habitats, and information and stewardship opportunities for Mayne Island communities.

A recommendation for further shoreline surveys is the inclusion of a measurement of shading created by docks. Shade created by docks and wharves fragment eelgrass and algal communities, which reduces the availability of associated prey for species such as juvenile salmon, marine birds and crabs.

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[26] Islands Trust Fund. 2010. Regional Conservation Plan 2011-2017, 37 p. Available online: http://www.islandstrustfund.bc.ca/media/9359/regional_conservation_plan.pdf

Appendix A: Field Data Form Example

Physical Unit ID #___________

<table>
<tr><td rowspan="2">Date:</td><td rowspan="2">Start UTM:</td><td colspan="2">X:</td><td rowspan="2">End UTM:</td><td colspan="2">X:</td></tr>
<tr><td colspan="2">Y:</td><td colspan="2">Y:</td></tr>
<tr><td>Crew Initials:</td><td colspan="2">Start Time:</td><td colspan="2">End Time:</td><td>Slope:</td><td rowspan="2">Substrate:
☐ Rock
☐ Rock & Sediment
☐ Sediment
☐ Anthropogenic</td></tr>
<tr><td>Obs. Method:
☐ Boat
☐ Ground</td><td colspan="5">Photo #(s):</td></tr>
<tr><td colspan="7">Shore Unit Characteristics/Features</td></tr>
<tr><td colspan="7">Review Parks data; interpret whether the shoreline has changed since 2005 using the provided attributes.
Comment on changes in the space below and reflect updated shoreline on field map</td></tr>
<tr><td colspan="7">[S1] Existing Shore Mapping Comments:</td></tr>
<tr><td colspan="3">[S2] Lowest Overhanging Branch Elev: ________m</td><td colspan="4">[S3] Overhang of Intertidal Zone: __________m</td></tr>
</table>

<table>
<tr><td colspan="3">Intertidal Features</td></tr>
<tr><td>[I1] Sandlance Spawning Pot.
☐ Abundant
☐ Moderate
☐ Scarce
☐ Not Present</td><td>[I2] Fucus
☐ Abundant
☐ Moderate
☐ Scarce
☐ Not Present</td><td>[I3] Eelgrass
☐ Abundant
☐ Moderate
☐ Scarce
☐ Not Present</td></tr>
<tr><td>[I4] Shore Crabs
☐ Abundant
☐ Moderate
☐ Scarce
☐ Not Present</td><td>[I5] Oysters
☐ Abundant
☐ Moderate
☐ Scarce
☐ Not Present</td><td>[I6] Clams
☐ Abundant
☐ Moderate
☐ Scarce
☐ Not Present</td></tr>
</table>

<table>
<tr><td rowspan="2">[I7] Primary Forage Fish Spawning Habitat Occurring within the Unit</td><td rowspan="2">Start UTM:</td><td>X:</td><td rowspan="2">End UTM:</td><td>X:</td></tr>
<tr><td>Y:</td><td>Y:</td></tr>
<tr><td rowspan="2">[I8] Secondary Forage Fish Spawning Habitat Occurring within the Unit</td><td rowspan="2">Start UTM:</td><td>X:</td><td rowspan="2">End UTM:</td><td>X:</td></tr>
<tr><td>Y:</td><td>Y:</td></tr>
</table>

Intertidal Comments:

Backshore Characteristics/Features

B1 Land Use:	B2 Length:	B3 Habitat:	B4 % Cover:
☐ Residential	______m	☐ Coniferous Forest	______%
☐ Commercial	______m	☐ Deciduous Forest	______%
☐ Agricultural	______m	☐ Shrub	______%
☐ Industrial	______m	☐ Bare Ground	______%
☐ Park	______m	☐ Landscaped	______%
☐ Parking Lot	______m	☐ Wetland	______%
☐ Vacant Open Space	______m		
☐ Natural	______m		

B5 Bank Erosion	B6 If banks are eroding, please describe:
☐ Severe	
☐ Moderate	
☐ Mild	
☐ N/A	

B7 Wildlife Feature:		B8 Sensitive Feature:	Notes:
☐ Nesting Area (whitewash)	☐ Artificial	☐ Garry Oak	
☐ Rock Ledge	☐ Driftwood Pile	☐ Old Growth Forest	
☐ Undercut Shelter/Den	☐ Wildlife Tree	☐ Riparian Area	
☐ Haul Out Area	☐ ______________		

Backshore Comments:

Anthropogenic Modifications

A1 *Primary Seawall Occurring within the Unit*	Start UTM:	X:	End UTM:	X:
		Y:		Y:

Type:	Length:	Condition:	Base Elev. Relative to HWM:	Top Elev. Relative to HWM:	Distance from HWM:
☐ Boat Ramp ☐ Concrete ☐ Landfill ☐ Sheet Pile ☐ RipRap ☐ Wooden ☐ _____________	_______m _______m _______m _______m _______m _______m _______m	☐ New/Good ☐ Moderate ☐ Poor ☐ _____________	_________m	_________m	________ m

A2 *Secondary Seawall Occurring within the Unit*	Start UTM:	X: Y:	End UTM:	X: Y:	

Type:	Length:	Condition:	Base Elev. Relative to HWM:	Top Elev. Relative to HWM:	Distance from HWM:
☐ Boat Ramp ☐ Concrete ☐ Landfill ☐ Sheet Pile ☐ RipRap ☐ Wooden ☐ _____________	_______m _______m _______m _______m _______m _______m _______m	☐ New/Good ☐ Moderate ☐ Poor ☐ _____________	_________m	_________m	________ m

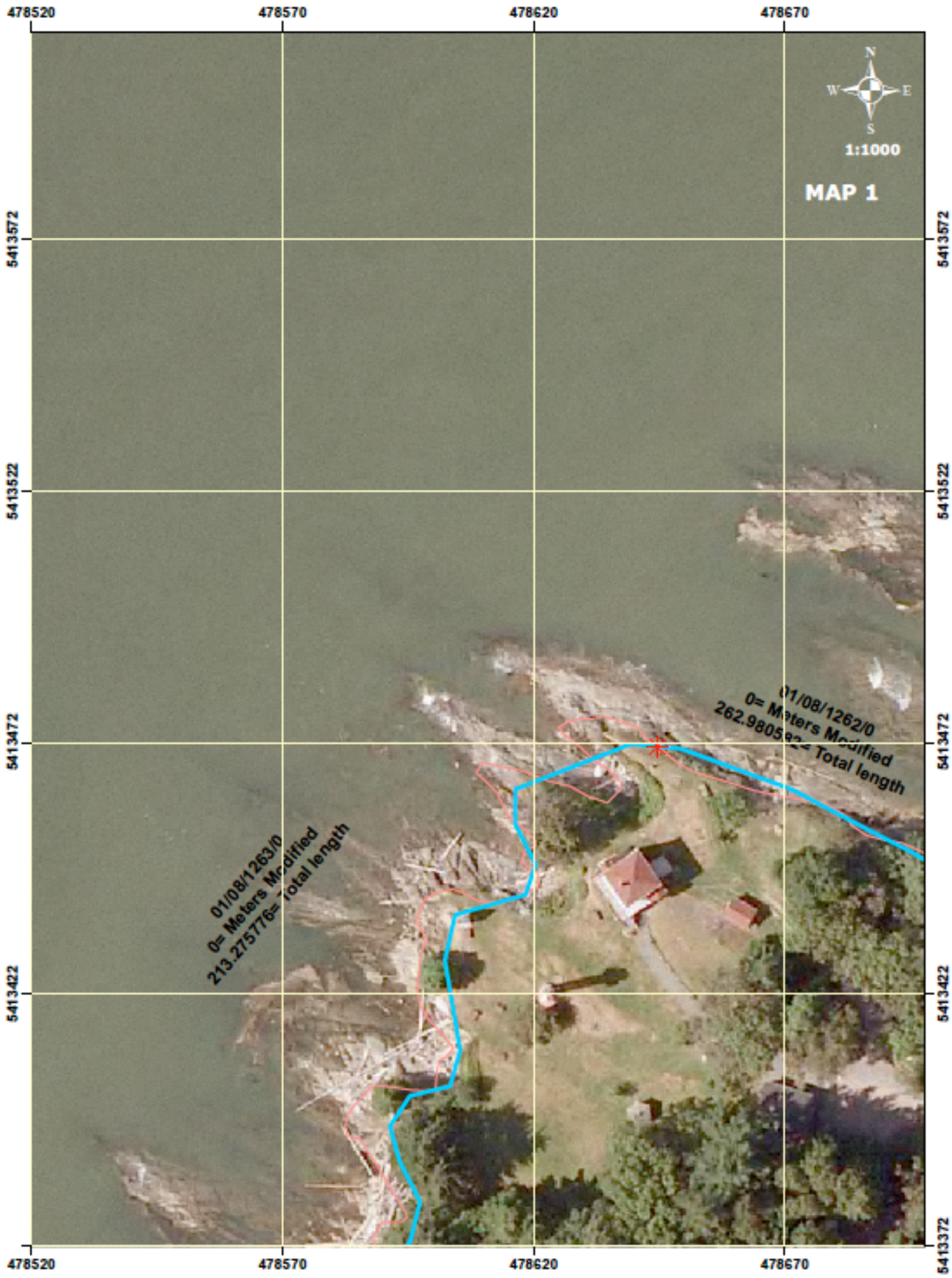
A3 *Tertiary Seawall Occurring within the Unit*	Start UTM:	X: Y:	End UTM:	X: Y:	

Type:	Length:	Condition:	Base Elev. Relative to HWM:	Top Elev. Relative to HWM:	Distance from HWM:
☐ Boat Ramp ☐ Concrete ☐ Landfill ☐ Sheet Pile ☐ RipRap ☐ Wooden ☐ _____________	_______m _______m _______m _______m _______m _______m _______m	☐ New/Good ☐ Moderate ☐ Poor ☐ _____________	_________m	_________m	________ m

A4 Est. Nearest Perm Structure: _____________(m)	A5 Structure Type:
A6 Other Manmade Structures Present: ☐ Pilings ☐ Wharves ☐ Floats/Docks ☐ Access Path ☐ Stairs ☐ Groin	Notes:

A7 Polluting Features Present: ☐ Storm Outfall ☐ Sewer Outfall ☐ Creosote Logs ☐ Toxic Waste ☐ ____________	A8 Restoration Potential:
Overall Shore Unit Comments:	

Appendix B: Field Map Example



Appendix C: Sensitive Ecosystem Inventory Ecosystems

The following ecosystems information is taken from information provided by Province of British Columbia's Ecosystem Branch for Sensitive Ecosystem Inventory performed on East Vancouver Island and the Gulf Islands[27]. Not all sensitive ecosystems are shown, only those that exist on Mayne Island.

Freshwater:
Freshwater Lake (FW:la).
Freshwater Pond (FW:pd).

Mature Forest:
Mature Forest: Conifer dominated (MF:co). Greater than 75% coniferous species.
Mature Forest: Mixed conifer and deciduous (MF: mx). A minimum of 25% cover of either group is included in the total tree cover.

Older Forest:
As a structurally diverse ecosystem, Older Forests support a rich community of wildlife, plant and invertebrate species which were once common to the landscape. They also serve as specialized habitats for species groups and often depend on specific habitat conditions.
Older Forest: Conifer dominated (OF:co). Greater than 75% coniferous species

Riparian:
Riparian ecosystems support a disproportionately high number of vascular plant, moss, amphibian and small mammal species for the area they occupy. Structurally diverse forest features, such as snags, downed logs and a multi-layered/uneven-aged canopy, offer a concentration of varied habitat niches. In addition, their association to rivers and streams, and surrounding coniferous forests create specific microclimates and habitats preferred by certain species.
Riparian: Fringe (RI:ff). Narrow linear communities along open water bodies (rivers, lakes and ponds) where there is no floodplain, irregular flooding

Seasonally Flooded:
Annually flooded cultivated fields or hay fields; important migrating and wintering waterfowl habitat.
Seasonally Flooded (FS)

Sparsely Vegetated:
SV ecosystems provide specialized habitats for a number of rare and specialized species – Sparsely Vegetated ecosystems are rare and contain highly specialized habitats for many species unique to these areas. Some of these species, such as yellow sand-verbena and beach bindweed are rare and only known to occur in these ecosystems.
Sparsely Vegetated: Rock (SV:ro).

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[27] Ministry of Environment. 2013. Sensitive Ecosystems Inventories. B.C. Ministry of Environment. Victoria, B.C. Available: http://www.env.gov.bc.ca/sei/van_gulf/ecosystems.html (accessed March 28, 2013).

Terrestrial Herbaceous:
Terrestrial Herbaceous ecosystems are open wildflower meadows and grassy hilltops, usually interspersed with moss-covered rock outcrops. They typically occur as small openings in forested areas with gentle to moderate slopes not exceeding 30% grades. They are located from outside the salt spray zone near shorelines, to the summits of local hills and mountains within the study area.
Coastal Herbaceous (HB:cs): As **hb** but influenced by proximity to ocean, windswept shoreline and slopes; > 20% vegetation, grasses and herbs, some rock outcrops, moss and lichen communities
Herbaceous (HB:hb). Central concept of the category, non-forested, less than 10% tree cover, generally shallow soils, often with exposed bedrock; predominantly a mix of grasses and forbs, also lichens and mosses

Wetland Ecosystems:
Fen (WN:fn). Underlain by sedge or brown moss peat, fens are closely related to bogs. In addition to rainfall, fens receive mineral and nutrient-enriched water from upslope drainage or groundwater. Thus a broader range of plants, including shrubs and small trees, is able to grow.

Marsh (WN:ms). Marshes are characterized by permanent, seasonal or diurnal flooding of nutrient-rich waters. They include: freshwater marshes which are dominated by rushes, sedges and grasses; saltwater marshes; and estuarine marshes occurring at the mouths of most of the major rivers.

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

Shallow Water (WN:sw). Shallow Water Wetlands are characterized by water less than 2 m in depth in mid-summer, support less than 5% rooted vegetation. They serve as important habitat for waterfowl and support fish, insects and amphibians.

Woodland Ecosystems:
Although fragmented and rare, Woodlands are biologically diverse ecosystems which support a rich assemblage of plants, insects, reptiles & birds. Rare species such as the sharp-tailed snake, Edith's checkerspot butterfly and Nuttall's quillwort, rely on specialized habitat features specific to Woodland ecosystems. This high biodiversity is attributed to: elements of stand structure (open canopy, mixed age classes, snags, seasonal leaf fall, organically enriched upper soil layers); and the proximity and inter-mixing of Woodlands with other ecosystems.
Woodland: Conifer dominated (WD:co). Greater than 75% coniferous species.
Woodland: Broadleaf dominated (WD:bd). Greater than 75% broadleaf species.

Young Forest:
Limited to areas of young forest dispersed among sensitive and other important ecosystems.
Young Forest (YF).