Saanich Inlet and Peninsula Atlas of Shorelines

Technical Report December 2009

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Executive Summary

The Saanich Inlet and Peninsula Atlas of Shorelines (SIPAS) represents the results of a shoreline inventory conducted from 2007 to 2009. The study area includes the eastern and western shores of both Saanich Inlet and Saanich Peninsula. (Figure 1) SIPAS created a Geographic Information Systems (GIS) database for use by both land use planners and the public. 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. Three charitable non-profit stewardship organizations coordinated the project with the support of scientific advisors, funders and other professional partners. The three participating organizations are all community stewardship organizations that are regularly contacted by local municipalities for input regarding shoreline permit applications.

The Southern Strait of Georgia ShoreZone Mapping Project, completed for Parks Canada by Coastal and Oceans Resources, Inc. (CORI) and Archipelago Marine Research Ltd. (Archipelago) in 2004-5 provided the groundwork on which the SIPAS study is based.

Through consultation with local governments, it was found that most land use planners needed a rated shoreline to represent a shore unit's overall ecological value and level of naturalness. To meet this need, two rating systems were created. The first system is a conservation ranking protocol based on Terrestrial Ecosystem Mapping (TEM) and the second system is an overall ecological value ranking based on data collected by SIPAS in the field.

The results of the rating systems applied to the SIPAS data give the following overview of the ecological status of the shores of Saanich Inlet and Peninsula:

Overall Ecological Rating	**%**	**Shore unit Count**	**Total Length (m)**	**Total number of seawalls present**	**Total length modified (m)**	**Average TEM Conservation Rank**
VH – VERY HIGH	1	3	497	4	100 20%	2.1 (Moderate)
H – HIGH	8	29	5569	32	935 17%	2.1 (Moderate)
M – MODERATE	37	126	23994	146	4555 19%	1.9 (Moderate)
L – LOW	34	115	22249	166	8119 36%	1.8 (Moderate)
VL – VERY LOW	20	70	11141	107	5479 49%	1.6 (Low)

Over half of the study area falls into the low or very low overall ecological rating category. Those units are associated with shoreline modifications averaging nearly half their total length. There is an obvious correlation of shoreline modifications greater than 20 % of the shoreline in a unit with significantly degraded shoreline ecology.

1.0 Introduction

This report summarizes a shoreline inventory of the Saanich Inlet and Peninsula conducted in 2007-2009 by SeaChange Marine Conservation Society, in collaboration with the Saanich Inlet Protection Society and Peninsula Streams Society. These three charitable non-profit organizations have worked on the Peninsula over many years to conserve and restore the watersheds that drain into the Saanich Inlet and the eastern shores of the Peninsula.

The purpose of the shoreline inventory is to document natural and modified shorelines, critical wildlife habitat, backshore vegetation and foreshore use. The survey provides:

1. Information for science based decision making for municipal and regional governments;
2. Identification and conservation of critical biological habitats, and
3. Information and stewardship opportunities for Saanich Inlet and Peninsula communities.

In 2006, an informal boat survey by a community volunteer (a geomorphologist) revealed that approximately 30% of the shoreline of the Saanich Peninsula was modified by seawalls, docks and wharves. The Saanich Inlet and Peninsula Atlas of Shorelines (SIPAS) was then initiated by the three conservation organizations named above.

A Technical Committee was formed to advise and guide the SIPAS project. The Committee included two biologists, a geographer, a geomorphologist and a cartographer.

From the onset of the study, there were three particular areas of interest:

1. The amount of human modification to the shoreline and the current and potential ecological impacts of those modifications;
2. The location of subtidal eelgrass because of its high ecological value as habitat; and
3. The location of potential spawning habitat for sand lance and surf smelt.

Over the past 50 years, the natural shorelines of the Saanich Peninsula and Inlet have been heavily influenced by development. The extent and condition of the foreshore and backshore have been directly impacted by anthropogenic disturbances such as seawall modifications, wharves, and residential, commercial and industrial development. These changes have resulted in altered drainage patterns, bank erosion, sediment loss, invasive species, loss of wildlife habitat, degradation of the intertidal zone and overall shoreline hardening. The ecological values that do remain enrich the region and are valued by residents.

SIPAS was preceded and influenced by the Harbours Ecological Inventory and Rating (HEIR) Project as well as the Southern Strait of Georgia ShoreZone Mapping Project. SIPAS staff consulted with the Technical Committee during the initial stages of developing the methodology for the intertidal shoreline surveys. ShoreZone maps of the study area were obtained from Parks Canada. A Geographic Information System (GIS) specialist was hired and set to work creating inventory field data sheets.

Field inventories started on the eastern shores of Saanich Inlet with the support of two Ministry of Environment interns mapping the locations of sub-tidal eelgrass habitat. Field staff then proceeded systematically to inventory each shore unit to delineate:

- shoreline modifications,
- intertidal and backshore features,
- wildlife sites, sensitive features and polluting features, and
- areas showing erosion.

The inventory was completed in the summer of 2009. A total of 11 people were employed and 40 community volunteers participated in the SIPAS project.

Funding for SIPAS was procured from foundations, local, provincial and federal governments and local businesses. Revenue was used to hire staff and for materials and supplies to complete the survey. The 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. The Canadian Hydrographic Service at the Institute of Ocean Sciences helped us accurately align tide heights to the ShoreZone maps. The Institute also supported the *Headwaters to Deepwaters II* Conference in November, 2008, which, in part, highlighted the SIPAS inventory then underway.

1.1 Objectives and Deliverables

The main objectives of this project are:

- To conduct a 100% ground-truthed shoreline inventory of ecological characteristics and anthropogenic disturbances;
- To survey the study area for key life cycle habitat: Sand lance spawning areas and eelgrass habitats
- To provide an overall ecological rating of the shoreline;
- To provide a conservation evaluation ranking for backshore ecological communities using Terrestrial Ecosystem Mapping (TEM) data, and
- To increase public awareness of the ecological, economic and social values of Peninsula shores through informational workshops and stewardship activities.

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

1. A GIS layer and associated attribute database containing all the collected inventory data,
2. An online interactive map atlas to host the GIS layer described above, and
3. A technical and public report

The data provides local governments with a baseline inventory of the physical and biological characteristics of the shoreline so that it can be carefully managed to protect its ecological and physical integrity.

1.2 Using the SIPAS Information

The SIPAS database provides a reliable set of data covering 63 km of intertidal and backshore areas on the Saanich Inlet and Peninsula. This systemically collected data and the associated rating classifications can be used to:

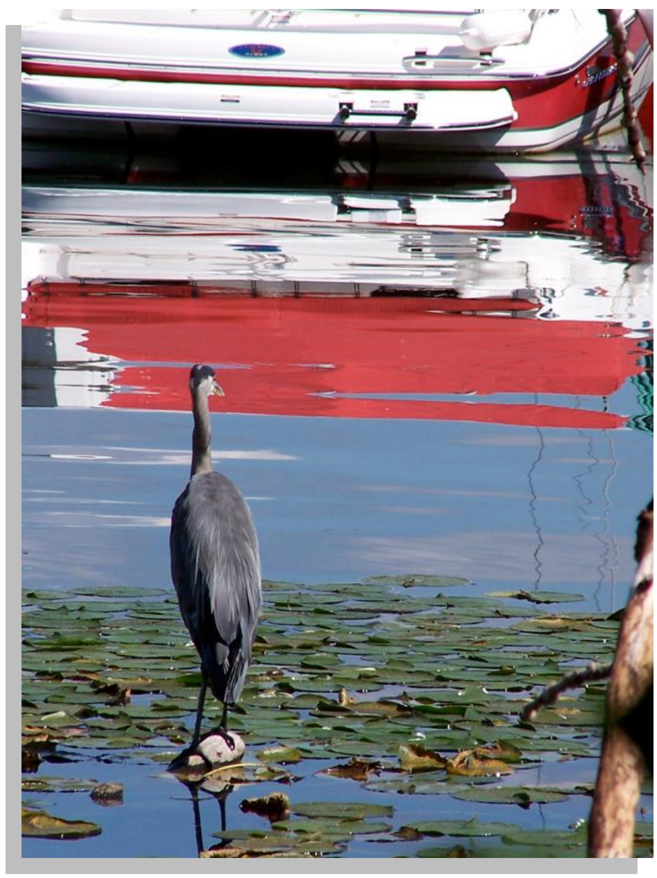
- Identify properties to be designated as ecologically sensitive in Official Community Plans and Development Permit Areas;
- Identify areas prioritized for remedial improvements;
- Assess potential impacts of proposed shoreline development;
- Determine appropriate structures on the waters and nearshore lands based on ecological values;

- Establish a baseline for monitoring shoreline modifications and changes in the nearshore shores of the Saanich Inlet and Peninsula, and
- Raise the awareness of ecologically sensitive areas and the values of the marine nearshore environment among members of the public, business, government and visitors.

Copies of the public and technical SIPAS reports can be obtained by contacting

SeaChange: P.O. Box 75 Brentwood Bay, BC V8M 1R3

Phone: (250) 652-1662 E-mail: seachange@shaw.ca



2.0 Background

Consultations with Local Jurisdictions

Staff from the Planning Departments of North and Central Saanich municipalities and the Cowichan Valley Regional District were consulted to determine priorities for shoreline development planning within their jurisdictions. Highest priority was given to areas of environmental sensitivity, critical marine habitats, and areas of slope failure and erosion.

The objectives of SIPAS align with the 2009-2011 North Saanich Strategy Plan calling for an inventory of sensitive marine and inter-tidal habitats and the identification of those habitats requiring protection. It also fills in some of the information gaps for the North Saanich Marine Task Force, a committee tasked with reviewing permitted uses and restrictions within seven marine zones in North Saanich for economic development purposes. Part of the mandate of the Task Force was to develop and recommend a method to inventory sensitive shoreline areas with respect to beach erosion and marine and foreshore habitats.[1]

Central Saanich recently adopted an application process for shoreline Development Permit Areas (DPAs). The SIPAS inventory will inform planners in both municipalities and the CVRD when they set guidelines for shoreline development within these DPAs.

The CVRD needs to have shoreline inventories at the development scale. Establishment of zones of sensitivity, or some sort of grading system was seen as an important component of the SIPAS study when it was proposed. The CVRD also needed access to information by staff and the public on the importance of marine riparian areas and expressed concerns for the sudden increase in DPAs in the CVRD.

The town of Sidney did not express an interest in participating in the project. We also did not include First Nations territories in the study, as we had not been invited to assess marine environments in those areas. Since then, however, SIPAS staff has been invited to inventory eelgrass habitat (*Zostera marina*) for the Tsawout community.

2.1 Location and Ecological Setting

The study area includes 63 kilometers on the eastern and western shores of Saanich Inlet and Peninsula on Vancouver Island. The survey area included 15 meters on either side of the high water mark (foreshore and backshore) for a total study area of approximately 189 hectares.

[1] North Saanich Marine Task Force Committee. District of North Saanich Marine Task Force Final Report. July 2008. p. 1.

The study area is 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) (Madrone, 2008). The shoreline and backshore areas of the CDFmm have high ecological value with a database search yielding 56 red and blue listed plant and animal species (B.C. C.D.C. 2009)(Appendix 1). A similar search in the ecological communities database reveals 36 ecological communities that are provincially red or blue listed (B.C. C.D.C. 2009) (Appendix B).

3.0 Methodology

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

ShoreZone Mapping for the Southern Strait of Georgia

The Southern Strait of Georgia ShoreZone Mapping Project completed for Parks Canada by Coastal & Oceans Resources Inc. (CORI) and Archipelago Marine Research Ltd. (Archipelago) in 2004-5 provides the groundwork on which the SIPAS study is based. This study was completed according to the methodology outlined in the *BC Biological ShoreZone Mapping System* (RISC, 1995) and the *BC Physical ShoreZone Mapping System* (RISC, 1995). 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. (CORI, 2009)

The Harbours Ecological Inventory and Rating Project

The HARBOURS Ecological Inventory and Rating (HEIR) Project is an inventory and evaluation of the ecological values of the backshore, intertidal and subtidal shore areas of Victoria and Esquimalt Harbours and connected waterways. The project was initiated by the Victoria and Esquimalt Harbours Environmental Action Program (VEHEAP). The results of the HEIR project can be viewed through a web-based interactive map: www.crd.bc.ca/partnerships/veheap/index.htm). The HEIR project was used by SIPAS as a guideline for designing field forms and determining field procedures.

Terrestrial Ecosystem Mapping of the Coastal Douglas-fir Biogeoclimatic Zone

The Coastal Douglas-fir moist maritime (CDFmm) Terrestrial Ecosystem Mapping (TEM) project was completed by Madrone Environmental Services (Madrone) in 2007-8 for the Integrated Land Management Bureau (ILMB). TEM is a standardized set of protocols for bioterrain and ecosystem mapping supported by field data collection and GIS mapping and interpretation (ILMB, 2008). The CDFmm TEM digital data was acquired through the ecological reports catalogue and overlaid onto the shore unit data. The TEM data provided SIPAS with an accurate interpretation of the plant communities existing in the backshore areas of the coastline.

3.1 Data Sources

A large amount of spatial and hard copy data to support the SIPAS project was provided by the Capital Regional District (CRD). The CRD provided the HEIR project documentation, 2005 and 2007 high resolution orthophotography, digital stream data, contours, roads, cadastral data, and an assortment of natural habitat related GIS datasets.

Parks Canada allowed access to all of the spatial data collected for the ShoreZone Mapping Data Summary for the Southern Strait of Georgia project. The Canadian Hydrographic Service (CHS) provided the high and low water mark lines for the extent of the shoreline study area. The Cowichan Valley Regional District (CVRD) provided orthophotography, roads, contours, cadastral and other GIS datasets for the CVRD side of Saanich Inlet.

3.2 Background Research

Background material on the vegetation ecology, land management, sensitive ecosystem inventory, Garry oak communities and previous marine studies were researched. Documents referred to throughout the SIPAs study included:

- Terrestrial Ecosystem Mapping of the CDFmm (Madrone, 2008);
- Sensitive Ecosystem Inventory of East Vancouver Island (Axys, 2005);
- Saanich Inlet Study Synthesis Report Summary (MOE, 1996).

3.3 ShoreZone Data & Shore Units

The SIPAS study is based on the ShoreZone mapping data collected by Parks Canada in 2004/2005. This spatial dataset is a linear representation of the geographic location of the coastline. The dataset was provided in shapefile format with a series of associated tabular data (the database). 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 (Howes, 2001). 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. Shore units described for the Southern Strait of Georgia were applied at a scale of 1:15000 and result in shore unit lengths ranging from 30 m to 20 km with a median of 485 m.

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). It was previously available from the Land Use Coordination Office (LUCO) and is now the Integrated Land Management Bureau (ILMB)).

It was decided early in the project to build 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 SIPAS study to be linked back to the ShoreZone database. Because the data originates from TRIM, the SIPAS dataset can overlay seamlessly on other provincial datasets that are TRIM derived.

3.4 Design Field Forms & Maps

Following meetings with the Technical Committee a draft field form was created. The final field form used for data collection was the result of three drafts of field forms tested and revised by SIPAS field crew throughout August and September 2008. 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.

The field form content was largely based on selected attributes that were collected by VEHEAP for the HEIR project. Additional attributes were recommended by John Harper of CORI, Ian Bruce of Peninsula Streams Society and Mary Morris of Archipelago. A field form example can be found in Appendix A.

Final field maps were printed at a scale of 1:1000 and displayed the 2007 orthophoto image overlaid with the shore unit data and legal property lines. The shore units were labeled with the associated physical 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 easily predict distances between the ground and map. An example of a field map can be found in Appendix C.

3.5 Field Inventory

Over 60 days were spent in the field for the shoreline inventory and subtidal eelgrass survey. Once the shore unit data sheets for shoreline attributes were substantially complete, the subtidal eelgrass search was conducted along the same shoreline, but at a depth appropriate to view subtidal eelgrass with an underwater camera on a cable.

The complexity of the shoreline attribute survey forms the basis for the GIS database. The subtidal eelgrass is a single component. Eelgrass mapping was done with an underwater camera attached to a cable and a GPS unit in the boat above. Images of the plants were viewed on a monitor on the boat.

Photographs were taken during the shoreline attribute survey so that municipal staff can view pictures associated with particular shore units for planning purposes. Photos are intended as general overview in the interest of landowners' privacy.

After a few initial days surveying the beaches by walking, land access points became a challenge. Use of a 14 foot aluminum boat allowed travel close to the shoreline for observation of shoreline attributes. Field surveyors noted coordinates for the beginning and end of shoreline modifications from as close as they could reasonably access by boat.

3.6 GIS Database Design

As field work progressed a GIS database was built to store the data collected. Using ESRI's ArcGIS software, a SIPAS geodatabase (GDB) was created as the top level of data storage. Inside the GDB there is a feature dataset named Shore unit 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, 15 domain rules were imparted on the GDB. Every attribute field that contains a choice of categories has been demined so that only those categories can be chosen from a drop down list. A data dictionary outlining the domains created as well as the rest of the attribute fields (85 in total) can be found in Appendix D.

3.7 Data Entry & Quality Assurance

Data was entered from the field forms directly into the SIPAS GDB SU feature class by the GIS Technician. Data fields were ordered in the same arrangement as they were ordered on the field form so that data entry followed the field form through to the end. Most information on the field forms is captured; however, in some cases information was not entered into the database. On the occasion where more than three seawalls occur in a shore unit, a note was entered into the comment section indicating that the user should review the field forms for additional seawall occurrences. Comments throughout the form were summarized at the end in one 250 character comment field. If comments were lengthy there was a notation for the user to review the field form.

Once all of the data had been entered into the GIS, a number of quality assurance (QA) methods were used to highlight errors in data collection and data entry. The QA resulted in a number of minor errors which were found and corrected. Most errors were related to miscalculated percentages and lengths, missing lengths that had to be calculated using GPS coordinates and general data entry typos.

4.0 Rating Process

During early communications with local government land management staff, it was found that most land use planners needed a rated shoreline to represent a shore unit's overall ecological value and level of naturalness. To meet this need, two rating systems were created. The first system is a conservation ranking protocol based on Terrestrial Ecosystem Mapping (summarized in sections 4.1 to 4.4) and the second system is an overall ecological value rating based on an averaging of selected data collected by SIPAS in the field (summarized in sections 4.5 to 4.6).

4.1 Terrestrial Ecological Mapping

Following a series of standardized protocols, Terrestrial Ecological Mapping (TEM) is the stratification of landscape features into biophysical and ecological map units that reflect climate, physiography, surficial material, bedrock geology, soil, vegetation, and disturbance. The landscape is subdivided into polygons representing the terrain, which are further split into ecosystem polygons based on vegetation characteristics (RIC, 1998b). Ecosystem polygons are assigned a coded alphanumeric ecosystem label that describes the plant community (site series), structural stage (forest age), moisture, topography, soil and disturbance. Each ecosystem polygon can have up to three different plant communities described in the polygon label with the content of each delineated by the presence of deciles (percentage). An example label and description of the contents of the label has been provided below:

Example Ecosystem Polygon label: **6RF5M:2RP4M: 2CF2b**

- 60% (**6**) Western red-cedar/Grand Fir (**RF**), Structural Stage 5 (**5**) and is a mixed conifer/broadleaf (**M**) forest
- 20% (**2**) Western red cedar/Indian plum (**RP**), Structural Stage 4 (**4**), and is a mixed conifer/broadleaf (**M**) forest
- 20% (**2**) Cultivated Field (**CF**), Structural Stage 2b (**2b**)

4.2 Conservation Ranking using Terrestrial Ecosystem Mapping

The land use activities that take place in the backshore can directly impact the foreshore. Natural backshore plant communities such as wetlands, estuaries, intact mature forests and Garry oak ecosystems are deemed to have a high conservation ranking and are therefore more sensitive to land development activities than ecosystems that have been previously disturbed by land use activities. Terrestrial ecosystem mapping provides a tool to show the locations of these ecosystems in the backshore. Using the TEM data, a conservation ranking procedure was developed by Helen Reid, Professional Biologist and veteran TEM mapper who was the lead ecosystem mapper on the CDFmm TEM project.

4.3 Intersecting the TEM Data with the Shore Units

In order to rate the shore units, the TEM data had to be incorporated into the shore unit database. To achieve this, a spatial analysis procedure was used that involved intersecting the ecosystem polygons within 200 meters of the shoreline with the adjacent shore units. The intersect procedure splits the shore units with the ecosystem polygons to create a new shore unit dataset that contains the original shore unit database combined with the associated TEM database (Figure 2a,2b).

Figure 2a: Shore Unit line shown with Adjacent Ecosystem Polygon

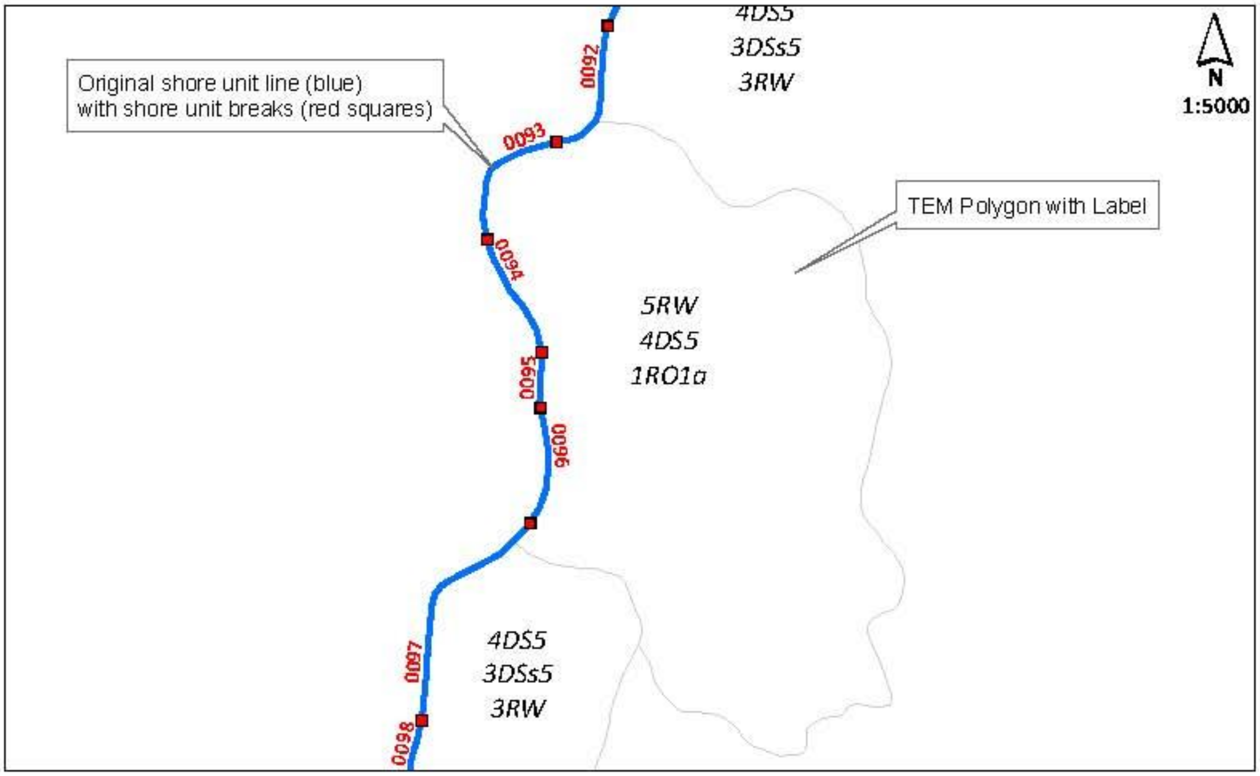
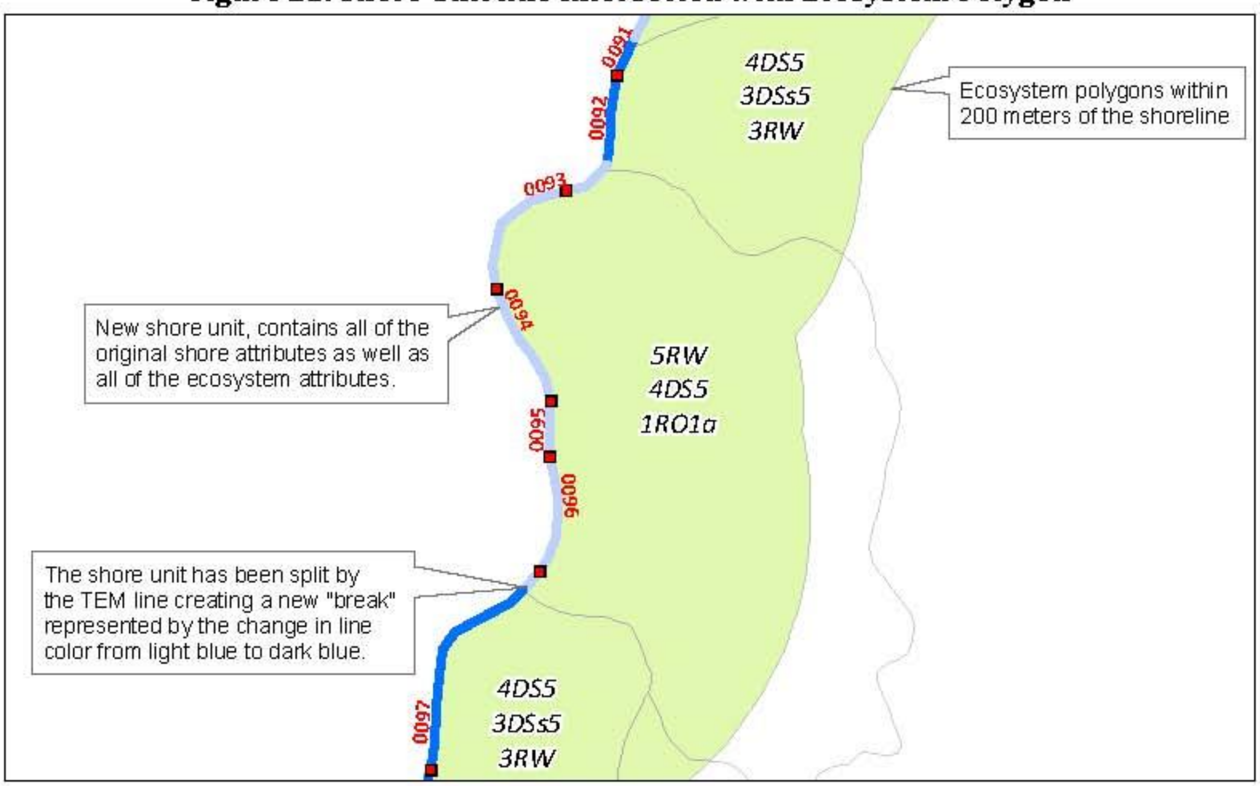


Figure 2b: Shore Unit line Intersected with Ecosystem Polygon



4.4 Ranking the Shore Units using the TEM Attributes

A simplified system of ranking shoreline sensitivities was developed based on the *Conservation Assessment Procedure for Element Occurrences of Ecological Communities (*BC Ministry of Environment, 2007). A low/moderate/high ranking system was created based on the structural stage of the ecosystem polygon and the ecosystem communities present within the polygon (Table 1). Structural stage captures the age and structure of an ecosystem and includes herbaceous sites through to old growth forests (Appendix E). An older forest (structural stages 5-7) is considered to have high ecological value, whereas a non-forested or young forest has a lower value as disturbance has already taken place or is occurring. Natural ecosystem communities were given higher ranks while disturbed ecosystems such as urban areas and agricultural areas were given a lower rank (Appendix F).

Table 1: TEM Features used to Rank Polygons, where a High Rank (3) represents high ecological value and a Low Rank (1) represents low ecological value.

	Conservation Rank		
TEM Feature	**High Rank - 3**	**Moderate Rank - 2**	**Low Rank - 1**
Structural Stage (see Appendix E for a detailed list of structural stage codes and descriptions)	All Forested Ecosystems with Structural Stage >4	All Forested Ecosystems with Structural Stage of 4	All Forested Ecosystems with Structural Stage of 3 or less (recently harvested)
Ecosystem Community (see Appendix F for a detailed list of all ecosystem codes and associated ranks)	Natural Ecosystems Floodplain Ecosystems Herbaceous & woodland Ecosystems Estuary, wetland and marsh ecosystems	Logged or disturbed ecosystems with potential to re-establish as a natural forest	Rural and Urban areas Cultivated Fields Paved/Concrete Surfaces

The determination of conservation rank is based on a formula derived according to the particular features and combinations as shown in Table 1. Each rank (Low, Moderate and High) is assigned a numerical value between one and three; Table 2 shows these values.

Table 2: Numerical values assigned to Conservation Rank

Conservation Rank	Numerical value
Low	> 1.00 ≤ 1.65
Moderate	> 1.65 ≤ 2.30
High	> 2.30 ≤ 3.00

The following steps outline the procedure taken in ranking the example ecosystem label: **6RF5M:2RP4M:2CF2b**

Step 1: Calculate Ecosystem/Structural Stage label Rank:

RF5: Forested ecosystem with structural stage 5, therefore gets a HIGH (3) sensitivity rating

RP4M: Forested ecosystem with structural stage 4, therefore gets a MODERATE (2) rating

CF2b: Cultivated field gets a LOW (1) rating

Step 2: Calculate the proportion of the label that contains each ecosystem/structural stage rank

6RF5M = 60% (0.6) of the polygon has a HIGH sensitivity rating

2RP4M = 20% (0.2) of the polygon has a MODERATE rating

2CF2b = 20% (0.2) of the polygon has a LOW sensitivity rating

Step 3: Calculate the overall rating by applying percentages for each portion of the label as follows:

(% of First TEM label * Ecosystem/Structural Stage Rank**)** + (% of Second TEM label * Ecosystem/Structural Stage Rank**)** + (% of Third TEM label * Ecosystem/Structural Stage Rank**)** = **Overall Ecosystem/Structural Stage Rank**

(0.6* 3) + (0.2 * 2) + (0.2 * 1) = Overall Ecosystem/Structural Stage Rank

1.8 + 0.4 + .0.2 = 2.4

The rating of the Ecosystem/ Structural stage feature is calculated to be **2.4.** Note that according to Table 2 this is a HIGH ranking. Using this formula and methodology, the GIS was used to calculate an overall conservation ranking for all shore units based on ecosystems occurring in the backshore. For the results of the conservation ranking see section 5.0.

4.5 Ranking the Shore Units using the SIPAS Data

A shoreline rating protocol to represent the overall ecological value of a shore unit was designed by SIPAS field crew, GIS staff and members of the Technical Committee. The rating is based on five shore unit characteristics that were deemed to have significant ecological worth. The criteria used to rate each shore unit is described in Table 3: Rating Criteria.

Table 3. Rating Criteria

Rating Class	Value Range	Criteria
Intertidal Features	0-5	If a shore unit has any of the five intertidal features (Sand Lance, Eelgrass, Fucus, Clams or Oysters) present in any capacity 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 falls under the Coniferous, Deciduous, Shrub or Wetland habitat class it receives one tenth of the percent value, i.e. 50% Coniferous = 5; 20% Deciduous = 2, 30% Wetland = 3; Total =10. Any other habitat cover present (Landscaped, Bare Ground, Cultivated Field) receives 0.
Wildlife Feature	0-4 *(Note that although there are six possible wildlife features there was never a shore unit that had more than four of the possible six features.)*	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 4 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.
Key Life Cycle Species	0-5	If a shore unit has abundant Sand Lance spawning potential or Eelgrass habitat, it receives an extra 5 points; If a shore unit is within 25m of a documented subtidal eelgrass bed it receives 5 points. A shore unit can only receive up to 5 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 4.

Table 4. Overall 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 shore units in the SIPAS study area have been summarized in Table 5.

Table 5: Overall Ecological Rating Results

Overall Ecological Rating	%	Shore unit Count	Total Length (m)	Total number of seawalls present	Total length modified	Percent of shore unit modified	Average TEM Conservation Rank
VH – VERY HIGH	3	12	2,136	8	190	9 %	2.1 (Moderate)
H – HIGH	12	45	8,946	38	1021	11%	2.1 (Moderate)
M – MODERATE	39	139	27,601	170	5078	18%	1.9 (Moderate)
L – LOW	25	89	16,103	166	8119	50%	1.8 (Moderate)
VL – VERY LOW	21	75	11,802	87	5479	46%	1.6 (Low)
Total	100	360	66,588	469	19,887	30%	

No follow up to sensitivity to development or anthropogenic disturbance. Suggest deleting this table

The following three categories of ratings were applied to each shore unit:

Ecological	Sensitivity to Development	Anthropogenic Disturbance
Habitat Diversity	Soil Stability	Shoreline Hardening
Natural Habitat	Rare Plant Communities	Intertidal Development
Key Life Cycle Areas		

Table 6: Rating Criteria Based on Habitat and Key Life Cycles

Rating	Criteria
Habitat Diversity	
Very High or High	Healthy functioning shorelines evident by presence of native riparian vegetation, shell fish, and mature backshore vegetation. Sensitive ecosystems such as pocket beaches, estuaries, low tide flats, Garry oak forests and mature forests
Moderate	Foreshore and backshore have some form of vegetative structure in place. Beach life is apparent with presence of shellfish and beach vegetation.
Low or Very Low	Very little riparian vegetation exists in foreshore and backshore. Lack of shellfish present, lack of sediment.
Natural Habitat	
High or Very High	Most or all of shore unit is in near natural state
Moderate	About half of the shore unit length has been modified
Low or Very Low	The shore unit is heavily disturbed and modified
Key Life Cycle Areas	
Very High or High	Presence of critical life cycle species or presence of species habitat
Moderate	Area of limited life cycle and associate habitat present
Low or Very Low	Slight or no life cycle value

5.0 Conservation Ranking Results using TEM

The conservation ranking protocol as summarized in Sections 4.4 was applied to all shore units in the study area, resulting in the following findings:

- 13.7km (22%) of the shore units were ranked as HIGH
- 16.0km (25%) of shore units were ranked as MODERATE
- 33.8km (53%) of shore units were ranked as LOW
- The average ranked value was 1.8 (MODERATE)

5.1 Overall Results using SIPAS Data

Following the rating protocol outlined in Section 4.6, the shore units in the SIPAS study area have been summarized in Table 5. It is copied below for easier reference.

Table 5: Overall Ecological Rating Results

Overall Ecological Rating	%	Shore unit Count	Total Length (m)	Total number of seawalls present	Total length modified	Percent of shore unit modified	Average TEM Conservation Rank
VH – VERY HIGH	3	12	2,136	8	190	9 %	2.1 (Moderate)
H – HIGH	12	45	8,946	38	1021	11%	2.1 (Moderate)
M – MODERATE	39	139	27,601	170	5078	18%	1.9 (Moderate)
L – LOW	25	89	16,103	166	8119	50%	1.8 (Moderate)
VL – VERY LOW	21	75	11,802	87	5479	46%	1.6 (Low)
Total	100	360	66,588	469	19,887	30%	

The rating system devised to reflect the overall health of the shore units did not incorporate the amount of modification as a measure of ecological health. So, the association of the amount of seawall modification of the shoreline to the summary of ratings is independent. The correlation is straight forward. The more sea walls there are, the less likely the shore unit is to have oysters, clams, Fucus, eelgrass, sand lance spawning habitat, proximity to sensitive ecosystems, wildlife features or natural marine riparian vegetation.

The units rated very high, high and moderate show a steady progression of increased modification (9 to 18% modified) as each category drops high to moderate. It is not clear if there is a tipping point between 18 and

46% of the shoreline modified that drastically reduces the overall ecological rating. There are many other influences of development that were not measured that accompany a shore unit covered 46 - 50% by seawall. Impervious surfaces such as parking lots, high impact land use and land fill over area that previously was inter-tidal among other things would all contribute to shoreline degradation.

The value of GIS lies in looking at how the various characteristics documented can be assessed in the context of the remainder of the data. The data is being shared with the municipalities or regional districts that took part in SIPAS. It can then be queried according to the question at hand. Following is a summary of each of the shoreline attributes documented in the field.

PROJECT:	MAP SCALE:	REVISION DATE:	DRAWN BY:	
Saanich Inlet & Peninsula Atlas of Shorelines	1:60,000	June 23, 2009	J.Thomson	0 0.5 1 2 3 Kilometers

5.2 Sand Lance Spawning Habitat

The SIPAS shoreline inventory survey found that a total of 136 shore units were flagged for potential sand lance spawning. In December 2008 and January 2009 during Sand Lance spawning season, seven of the 136 beaches were sampled for potential forage fish spawning areas. Samples taken at the sites found two of the 7 beaches had sand lance eggs. One beach was rich in both eggs and hatched larvae.

5.3 Backshore Land Use

The land use activities occurring in the backshore of each shore unit was recorded and categorized into eight possible land use classes. A summary of the results for each land use class has been provided below:

Table 8: Percentage of Seawalls associated with Backshore Land Use Class

Land Use Class	% of Seawalls
Residential	73%
Natural	8%
Commercial	4%
Parking lot	4%
Industrial	3%
Vacant land	3%
Parkland	3%
Agricultural	2%

5.4 Habitat Class % Cover

A visual calculation of the percent cover of habitat types occurring within 15m of the backshore of each shore unit was documented. The following list provides a summary for each habitat class:

Table 9: Percent Cover Habitat Type in Backshore

Habitat Class	% Cover Habitat Types
Landscaped	36%
Coniferous	29%
Deciduous	17%
Bare Ground	8%
Shrub	8%
Cultivated Field	1%
Wetland	1%

5.5 Erosion

A visual judgment of any bank erosion occurring in the backshore was documented and is summarized in Table 10. [Jane, do you agree with the following definition of erosion? Brian asked for criteria of severe to mild.]

Severe erosion – Bare ground is evident across a significant change in elevation with gullies or undercutting evident.

Moderate erosion – Bare ground is evident across a significant change in elevation or undercutting of a narrower band of elevation is significant.

Mild erosion – Bare ground is evident along a particular elevation, often at the toe of a seawall.

Table 10: Degree of Erosion associated with % of Shore Units

Degree of Erosion	% of Shore Units
Severe	3%
Moderate	11%
Mild	20%
None	66%

5.6 Sensitive Features

Sensitive features are ecosystems defined as fragile or rare. The surveys revealed the following:

- 110 shore units contained Garry oak trees
- 23 indicated the shore unit was adjacent to a riparian area (stream, wetland, estuary)
- 36 shore units (10% of the study area) were located within 100 m of a Sensitive Ecological Inventory polygon[2]

5.7 Wildlife features

Wildlife and Wildlife habitat activities were observed and documented in the field. Six checkboxes were available for areas that provided nesting, feeding, shelter, perching, and breeding. The following list outlines the results of the wildlife survey:

- 108 out of 343 shore units have one wildlife feature (31%)
- 86 out of 343 shore units have at least two wildlife features (25%)
- 37 out of 343 shore units have at least three wildlife features (11%)

In the comments field of the database there is notation of eagle sightings and nests, great blue herons and rookeries, sea lions, kingfishers, mergansers, bufflehead, subtidal wolf eel and otter.

[2] A 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 is based on original air photo interpretation for SEI polygons, or as an SEI theme based on Terrestrial Ecosystem Mapping (TEM) polygons.

5.8 Anthropogenic Modifications

Modified shore units are those units where all or part of the unit has a seawall occurrence. The following list outlines the seawall modifications documented in the study area (Figure 4)

Table 11: # of Seawall Occurrences associated with % of Shore Units

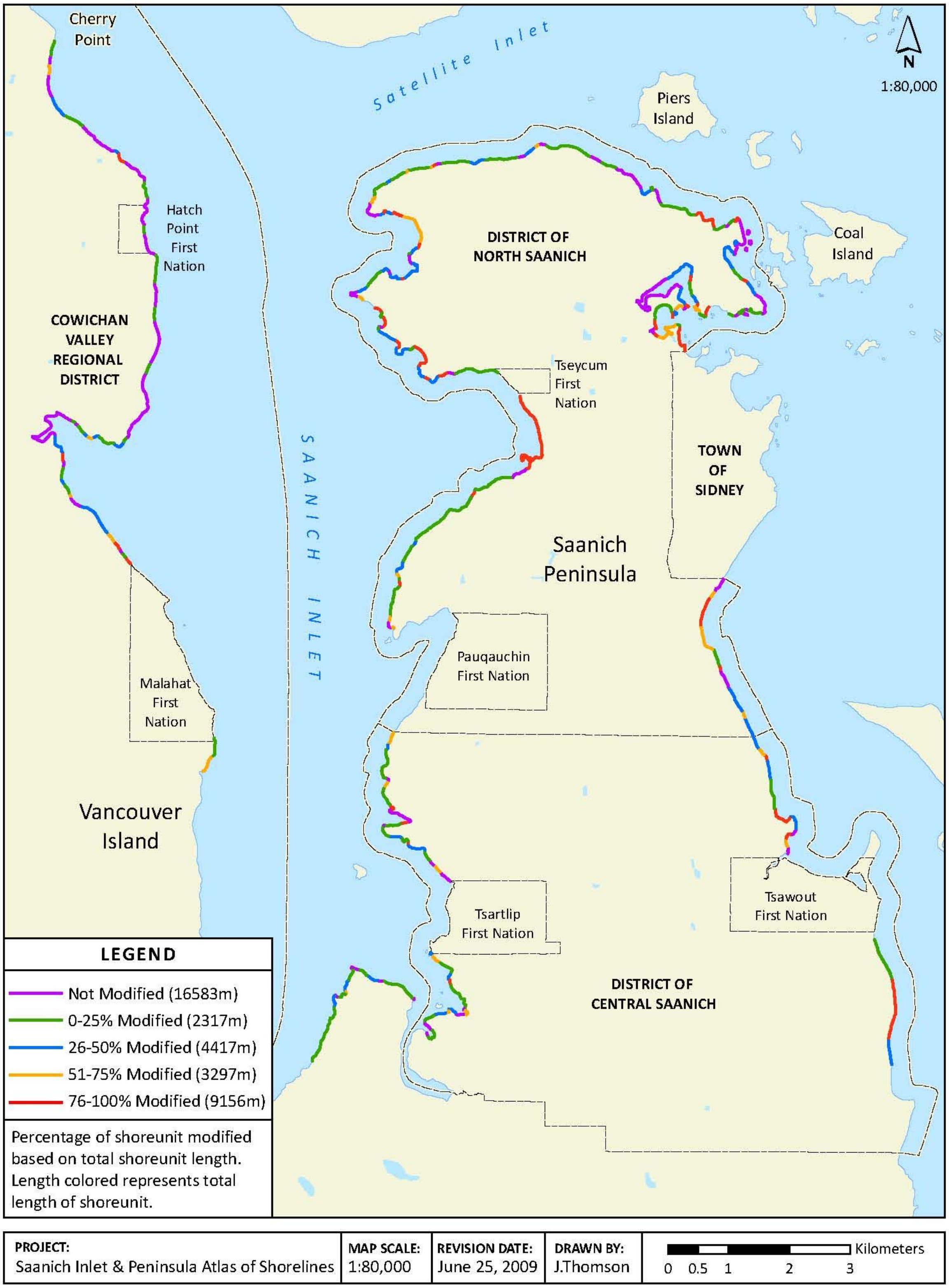
# of Seawall Occurrences	% of Shore Units
0	31%
1	36%
2	18%
3	15%

- 30 % (a total of 19 kilometers of shoreline) of the total study area is modified
- 69% (236 out of 343 shore units) of the total study area has at least one seawall occurrence

It was found that most seawalls are built either right on the high water mark (HWM) or built into the intertidal zone. The following statistics show the results of the HWM survey:

- Seawall modifications are built, on average -2.6m horizontally from the HWM (into the intertidal zone). This result seems surprising. The average is influenced by boat ramps that are generally concrete modifications extending many meters into the intertidal area.
- 314 seawalls) occur right on the HWM or occur in the intertidal zone. This includes the first, second and third seawall within a shore unit. Shore units with 4 or more seawalls did not have the additional seawalls included in this calculation.

- FIGURE 4: Shore Units Modified -



A summary of seawall materials in order of most used to least used is as follows:

Table 12: Seawall Materials

Seawall Materials	% of Seawalls
Mixed materials (concrete rubble, tree stumps, tires, sod)	32%
Riprap (rubble, rock armour)	27%
Rock Masonry (rock and concrete)	16%
Concrete (Bulkheads/Blocks)	13%
Landfill (soil and rocks)	7%
Wooden	3%
Creosote Pilings	1%

6.0 Ecological Values

An important component of the SIPAS study is to identify and document two marine species considered being key life cycle species. Key life cycle species provide important ingredients such as shelter, food and spawning for other major species at key points in their cycle of life. The two species; sand lance and eelgrass have been summarized in the following two sections.

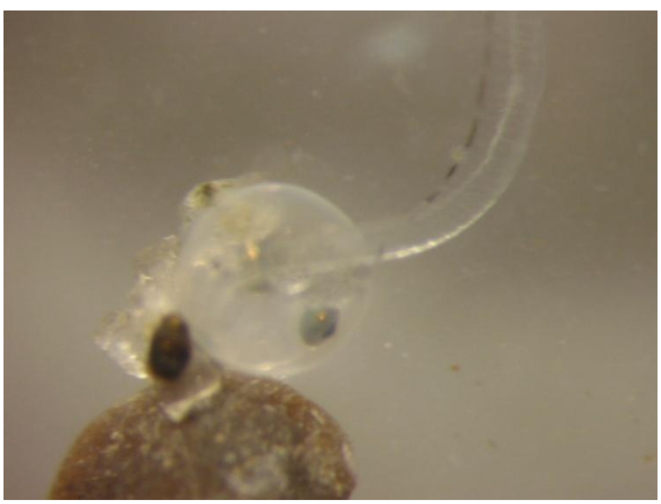
6.1 Sand Lance (*Ammodytes americanus*)

43% of the study area contained potential sand lance and surf smelt spawning area

Forage fish spawning habitat (sandy/gravel beaches and underwater vegetation including eelgrass beds) for Pacific herring, surf smelt and sand lance are essential for reproduction of the fish known as forage fish, so called because they are foraged upon by other fish and bird species.

Sand lance and surf smelt spawn in the intertidal sandy or sandy-gravel beaches. Herring lay their eggs on eelgrass and other marine algae. Forage fish are important prey for the endangered southern resident Orca pods, and other marine mammal populations such as Stellar Sea Lions and Harbour Porpoises. They also provide food for seabirds, such as Rhinoceros Auklet and Marbled Murrelets.

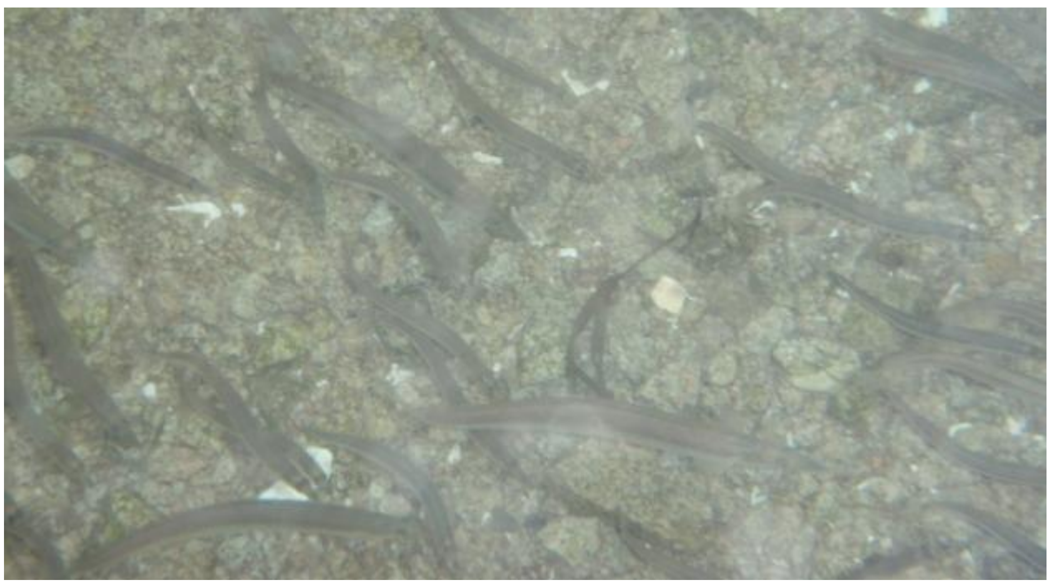
A mating pair of Marbled Murrelets has been observed during the spring over the last few years in the Inlet (H.Graham, pers. comm.). The Murrelets were observed in the vicinity of the location where sand lance were seen swimming in early December and sand lance eggs and larvae were found in January. Sand lance eggs attach to sand particles from November through mid-February. Sand lance provide 35% of juvenile salmon diets, and are particularly significant for the diets of Chinook salmon, with 65% of their diet provided by these fish.



Surf smelt lay their eggs on coarse sand and pea gravel on the higher reaches of the intertidal area year round. Over-hanging vegetation in marine riparian areas provide shade for the eggs during the warm summer months. 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 hardening removes sand and alters hydrographic conditions for eelgrass substrate. Pollution run-off can be toxic as well as silty. Overwater structures may shade eelgrass or alter hydrographic conditions. Altered hydrographic conditions may affect sediment transport of beach sand.

Seven beaches were surveyed over two field seasons for the presence of sand lance eggs from December to January. Presence of eggs was noted in two sites. A survey to visit more of the potential sand lance/ surf smelt spawning sites is underway as of November, 2009. Trained staff with volunteer help collect samples of sand from likely spawning beaches and check for eggs.



Sand lance in Saanich Inlet December 2008

- FIGURE 5: Potential Sand Lance and Surf Smelt Spawning Areas -

PROJECT:	MAP SCALE:	REVISION DATE:	DRAWN BY:	
Saanich Inlet & Peninsula Atlas of Shorelines	1:80,000	June 25, 2009	J.Thomson	0 0.5 1 2 3 Kilometers

6.2 Eelgrass Meadows *(Zostera marina)*

17% of the study area contained eelgrass habitat

The complex and intricate food webs of an eelgrass meadow rival the world's richest farmlands and tropical rainforests. From an unstructured muddy/sandy bottom grow a myriad of shoots that supply shelter and nutrients to salmonids and other fish, shellfish, waterfowl and about 124 species of faunal invertebrates. The leaves offer surface area for over 350 species of macroalgae and 91 species of epiphytic microalgae – the basis of the food web for juvenile salmon in marine waters. [3]

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 about 177,000 square kilometers of coastal waters – larger than the combined area of the Maritime Provinces.

E.O. Wilson first proposed the importance of "wildlife corridors" in the 1980s. Habitat reduction and fragmentation at a variety of spatial scales has been widely acknowledged as a primary cause of the decline of many species worldwide.[4] Habitat fragmentation generally leads to smaller and more isolated animal populations. Smaller populations are more vulnerable to local extinction. To reduce the isolation of habitat fragments, many conservation biologists have recommended maintaining landscape "connectivity" - preserving habitat for movement of species between remaining fragments.[5]

Near-shore marine environments offer that connectivity for juvenile salmon. *Zostera marina* beds provide refuge for Chinook, Coho, Pink, Chum, and Sockeye salmonid stocks, which use these critical marine environments for food, shelter and metabolic growth, some from their juvenile stages to

[3] 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.

[4] Ehrlich, P.R. (1986) The Loss of Diversity in: E.O. Wilson (ed.) *Biodiversity.* Washington D.C. National Academy Press. p 21-27.

[5] Noss, R.F. 1987. Protecting natural areas in fragmented landscapes. *Natural Areas Journal* **7**:2-13.

migrating adult lives. Eighty-percent of commercially important fish populations use eelgrass beds during some part of their life cycle.

Great Blue Herons have been observed to feed in eelgrass beds within 3 km of their nesting colonies. 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. Often, a bed will decrease or increase in width and length 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 in the nearshore is consistently compromised by the increased pollution load, known as non-point source pollution frequently delivered by the storm water system.

When the amount of light reaching the plants is limited by shading created by increased sediment or plankton blooms associated with increased nutrients from land, eelgrass meadows can die, decrease in density or lessen in width, adapting to poor light availability by growing in shallower depths.

In 1995, eelgrass habitats were inventoried for the Saanich Inlet Study, commissioned by the Province of BC, Ministry of Environment, Lands and Parks. [6] The native species, *Zostera marina*, was identified at 67 locations. This data gives a baseline for the 2007-2009 survey. The present extent of eelgrass beds in Saanich Inlet can now be compared to that observed in 1995. A baseline of eelgrass extent can also now be established for the CVRD and eastern shore of the Peninsula.

In addition, eelgrass shoot densities were calculated for three bays in the inlet – Coles Bay, Pat Bay and Deep Cove over two years. Eelgrass shoot densities indicate the level of productivity in a bed. Monitoring these densities over time can add to baseline data to gauge the impacts of non-point pollution or provide warning that specific land developments are affecting the near-shore environment. Monitoring over time by local stewards after impacts have occurred keeps the community informed and can guarantee due diligence is performed.

[6] Copies of the Saanich Inlet Study can be downloaded from: **http://www.env.gov.bc.ca/wat/wq/saanich/siscr.html**


- FIGURE 6: Eelgrass Distribution -
Cherry Point
Satellite Inlet
Piers Island
Hatch Point First Nation
DISTRICT OF NORTH SAANICH
Coal Island
COWICHAN VALLEY REGIONAL DISTRICT
Tseycum First Nation
TOWN OF SIDNEY
SAANICH INLET
Saanich Peninsula
Pauqauchin First Nation
Malahat First Nation
Vancouver Island
Tsawout First Nation
Tsartlip First Nation
DISTRICT OF CENTRAL SAANICH
N
LEGEND
Field Sample Results:
Areas with Subtidal Eelgrass Beds Present
Shoreunits found with Eelgrass Present
PROJECT: Saanich Inlet & Peninsula Atlas of Shorelines
MAP SCALE: 1:80,000
REVISION DATE: June 25, 2009
DRAWN BY: J.Thomson
Kilometers
0 0.5 1 2 3

6.3 Marine Riparian Areas

30 % of the study area contained some form of seawall

Vegetative zones along the interface between beaches and the backshore are termed marine riparian areas. The shorelines along the Inlet and Peninsula can contain maples, alders, Douglas firs, arbutus and associated understory shrub (e.g. ocean spray, salmonberry and Nootka rose) and groundcover species (e.g. pickleweed, gumweed and saltgrass). These plants, along with large woody debris, play an important ecological part in the health of shorelines and properties. Roots from the plants stabilize soils and large logs can create beach berms and slow down wave energy. 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 oil and fuel run-off from roadways, excess fertilizer and herbicide from lawns and chemicals from driveways or failed septic systems. Shade from tree canopies can shelter surf smelt eggs from the summer sun, and provide insects for young salmon during high tide periods.

However, when trees and shrubs are removed to increase visual horizons or to create footpaths, or when large logs are removed from the upper intertidal areas, natural erosion control structures decrease, and the likelihood of constructing costly artificial barriers to decrease the amount of wave energy reaching the backshore increases. 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.

> "The shorelines in the populated regions of B.C. are subject to an ever-increasing number of small-scale developments and human-induced changes. The clearing of a single waterfront property may have little effect on surface rainwater runoff from a coastal bluff to the sea. A groin may disrupt a very small amount of alongshore sediment movement. A seawall hardens and straightens only a small portion of the shore. But, over time, these small insignificant impacts, when combined with each other and those of other shoreline users, can become a large impact…"[7]

[7] Coastal Shore Stewardship Guide. op. cit. p 20.

Hardening shores with seawalls can reduce the amount and diversity of substrate upon which marine plants and organisms colonize, such as sand lance and eelgrass.

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 nearshore 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.


- FIGURE 7: Overhanging Vegetation -
Cherry Point
Satellite Inlet
Piers Island
Hatch Point First Nation
DISTRICT OF NORTH SAANICH
Coal Island
COWICHAN VALLEY REGIONAL DISTRICT
Tseycum First Nation
SAANICH INLET
TOWN OF SIDNEY
Saanich Peninsula
Pauqauchin First Nation
Malahat First Nation
Vancouver Island
Tsawout First Nation
Tsartlip First Nation
DISTRICT OF CENTRAL SAANICH
N
LEGEND
Total meters per shoreunit of overhanging riparian vegetation
25-50m
50-100m
>100m
Total Length of Riparian Overhang Recorded: 12.5km
Average % of overhang based on total shoreunit length: 50%
PROJECT: Saanich Inlet & Peninsula Atlas of Shorelines
MAP SCALE: 1:80,000
REVISION DATE: June 25, 2009
DRAWN BY: J.Thomson
0 0.5 1 2 3 Kilometers

7.0 Conclusion

A shoreline inventory has been substantially completed and the data entered. Once the data was entered gaps were revealed for later inclusion. Two islands have been requested for inclusion by North Saanich. Maps were not available when the field crew was surveying the area since specific islands had not been mentioned for inclusion by the municipality.

A database containing all the data collected to date was included with this Technical Report and submitted to municipal and regional staff. Table 5 summarizes the overall ecological rating and the survey results. Only 9% of the study area representing 32 shore units receives a high or very high overall ecological rating based on the SIPAS data. None of the study area receives a high TEM conservation rank. Fifty-four percent of the area surveyed with very low or low overall ecological rating associated with 60% shoreline modification indicates that there are limits to how much the shore can be modified and still maintain a healthy ecosystem.

The SIPAS data corroborates the Saanich Inlet Study's final conclusion that Saanich Inlet is a threatened but still largely viable ecological system (noted in 1996). SIPAS has provided information to enable all decision makers to better keep the area a largely viable ecological system and support actions to restore it.

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