2013-2015
Final Report

Salish Sea Nearshore Conservation Project

Prepared for:
Pacific Salmon Foundation
Recreational Fisheries Conservation Partnerships Program
Environment Canada (EcoAction)

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Executive Summary

Land use developments within watersheds have led to a loss of natural estuarine and nearshore marine habitats in British Columbia - the receiving waters of land based activities. Agriculture, forestry, and dredging for commercial and residential development have all contributed to the loss (Durance, 2002). The pressure to modify natural marine features and habitat for the development of commercial facilities and residential units within coastal areas is intensifying. As well, marine activities are directly affecting nearshore habitats. To prepare for the increase in populations on the BC coast and concurrent shoreline developments, it is necessary to identify and quantify nearshore habitats and restore them where possible, and to investigate strategies to restore lost or damaged habitats from historical industrial practices.

This 2013-2015 Final Report is a summary of the accomplishments of a Salish Sea eelgrass project with three components. Inventories, monitoring and restoration of eelgrass (*Zostera marina*) are funded for two years. A list of funders for each component is listed in Appendix B.

The eelgrass inventory is part of a nearshore inventory partially funded by the Islands Trust Fund to improve the conservation and protection of marine habitats within the Islands Trust Area. The islands surveyed included Galiano, Gabriola, Executive Islands, Denman, Hornby, Penders, Lasqueti, Mayne, Saturna, Salt Spring, Thetis, and Valdes Islands in the southern Salish Sea, and Bowen and Gambier Islands, the Thormanbies and Gambier associated islands in Howe Sound. A description of the eelgrass distribution of all the areas mapped from 2012-2014 is included in this report. All the eelgrass maps can be found on the Islands Trust Fund web site: **http://www.islandstrustfund.bc.ca/initiatives/ecosystem-mapping/ecosystem-maps.**

Forty-two potential restoration sites were identified in these sixteen islands within the Islands Trust Area, eighteen eelgrass restored habitat sites were monitored and over 1537 m² of eelgrass habitat was partially restored in the Salish Sea. We addressed eelgrass ecology to 1570 members of the public through three conferences, 35 school programs, 3 college classes, 13 university or college classes/tours, and 104 public presentations. Twenty-four volunteers were involved in the public outreach component of the eelgrass inventories; 165 were involved with eelgrass restoration. Fifty tons of debris was removed from Genoa Bay to augment potential eelgrass restoration. A total of 24 people were paid through this project; over 80% of the funding funneled back into local coastal community economies.

Seventeen partners contributed cash (total $312,730) or in-kind contributions of labour, boats and materials and supplies ($128,277). Two videos were produced documenting restoration methods and “before” and “after” transplant footage. These videos will be used for training and community presentations to increase understanding about this critical habitat for recreational and commercial fisheries.

1 Eelgrass Inventories

The goal of the eelgrass inventory is to support sound decisions that will affect the natural ecological health of the marine nearshores within the Salish Sea. The following is a description of the methodology used for mapping eelgrass and identifying potential restoration sites.

ShoreZone maps of coastal habitats within the Islands Trust Area were created over the past decade. ShoreZone is a mapping and classification system that produces an inventory of geomorphic and biological features of the intertidal and nearshore zones from low altitude aerial images of the coastal environment (Harper 2011). These maps provided the groundwork for identifying suitable physical components for eelgrass on the islands mapped during three years (2012-14).

The presence/absence of *Zostera marina* was determined according to the methodology of Cynthia Durance, R.P. Bio., Precision Identification as described below.

2 Mapping Methodology

The identification and monitoring of the distribution of native eelgrass habitats supplies much needed information for regional planning for conservation purposes. Maps and associated outreach activities may also lead to improvements in land use practices from increased knowledge and awareness about the habitat as well as future restoration as funding opportunities become available. A list of agencies and groups which have requested the eelgrass data is included in the Outcomes section of Part 2 of this Report (pg. 51).

The presence or absence of *Zostera marina* was determined with an underwater towed camera and a boat, except in the Cufra Inlet (Thetis Island), where mapping was done by kayak without a towed camera due to shallow tides. A Trimble Pathfinder ProXR GPS was used, except in the Cufra Inlet where a handheld GPS unit was used.

The methodology is an addendum to Methods *for Map and Monitoring Eelgrass Habitat in British Columbia (Methods)* authored by Precision Identification Biological Consultants and peer reviewed by experts in the field. This addendum was created by the Seagrass Conservation Working Group with input and review by Precision Identification. Average accuracy was 0.814m and was the combined result of the built-in accuracy of the GPS unit, lag time between sighting eelgrass and the unit gathering enough satellite data to create a waypoint, in combination with boat drift.

2.1 Linear Mapping

With the exception of the islands in Metro Vancouver, eelgrass mapping was done using a linear method to determine presence of eelgrass along the shoreline. The resulting representations of eelgrass beds are lines and points (where the eelgrass patch was less than 3m in length).

2.2 Polygon Mapping

With financial assistance from Metro Vancouver, eelgrass beds on Bowen, Bowyer and Passage Islands were mapped using polygons to show their full extent. In addition to the linear mapping described above, underwater camera transects were conducted perpendicular to shore to map shoreward and seaward edges. In some areas, fringing eelgrass and eelgrass patches were too small to map as polygons. In these locations lines and points were used respectively to show eelgrass presence. Fringing eelgrass bands ≤ 5m wide were mapped as lines and patches less than $10m^2$ were mapped as points.
Mapping of polygons according to standard methodology was limited due to safe boat operation in wind, current and tidal movements, as well as navigation around boats and swimmers.

For all the islands, general habitat characteristics outlined in *Methods* are also recorded: Form (flat/fringing), Distribution (continuous/patchy), Percent Cover (<25%, 26-75%, >75%), and Substrate type (sand/mud/pebble/cobble). The state of the tide was recorded as "slack" or "running" in order to indicate the level of confidence in the percent cover estimate. A slack tide yields a higher level of confidence than a running tide, which causes the eelgrass to lie across the ocean floor.

ShoreZone eelgrass bioband mapping and marine charts were used to determine potential locations of eelgrass beds. The majority of the eelgrass beds in the Southern Salish Sea are found between 1 and 3m chart datum. This depth contour was followed and eelgrass presence within this depth range was recorded. If eelgrass was not found in this depth range where bathymetry and substrate characteristics were suitable for eelgrass growth, a perpendicular transect was followed ranging from +1m to -6m which is the typical range of eelgrass in the Salish Sea.

GPS waypoints and the following parameters were recorded at roughly 10m intervals with intervals no longer than 20m: depth, eelgrass presence, distribution, form, sediment types, percent cover, tidal state, presence of broad or tuft algae and visibility.

The terms used to map eelgrass habitats are described below:

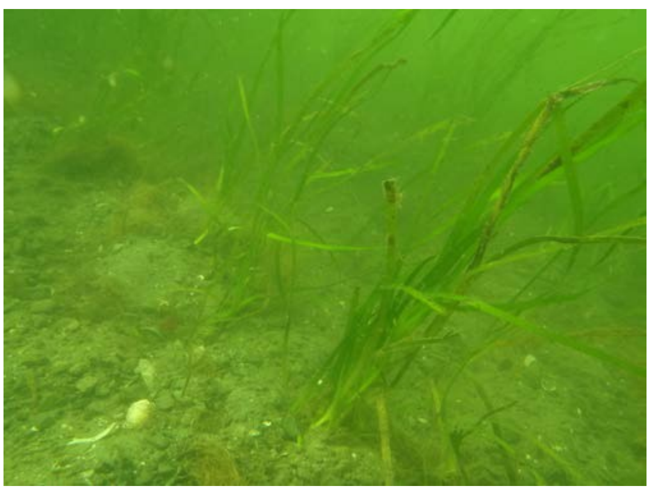
2.3 Distribution

The distribution of eelgrass within the bed is described for this inventory as either patchy or continuous. Patchy beds are those that contain isolated groups or patches of plants. Beds which are not patchy are classified as continuous; a bed that contains bare patches surrounded by eelgrass is classified as continuous. The boundary of a bed is determined by a shoot density of less than 1 shoot per square meter (Durance, 2002).

2.4 Form

There are two basic forms of eelgrass beds in the Pacific Northwest: fringing beds that occur as relatively narrow bands usually on gentle slopes, and more expansive beds that cover large areas such as tidal flats known as "flat" beds (Durance, 2002). Inter-annual variation within a bed is not well known, but appears to be less than ten percent (Dowty et al, 2005). Fringing beds are generally linear. Flat beds are areas of large eelgrass beds in embayments that extend deeper than fringing and more linear beds found along shorelines (Dowty et al. 2005). Distribution is often, but not solely, determined by aspect to dominant winds. Eelgrass distribution across a bathymetric gradient is limited at the upper boundary by the degree of exposure at low tide (desiccation) and by light limitations at the lower boundary.

2.5 Sediment Types



When possible, field observers rated the primary, secondary and tertiary occurrence of substrate types: sand, mud, pebble and cobble. A subtidal environment dominated by cobble might indicate a habitat more suitable for large kelps, which would shade any eelgrass shoots growing between the cobble during the summer months. A predominately sandy / muddy bottom would support continuous eelgrass meadows in most cases, unless other factors are present, such as exposure to strong waves or the interruption of habitat by boat mooring buoys. In some cases substrate characteristics change with increasing depth (e.g. cobble to sandy or mud to cobble).

2.6 Percent of Cover

Percent cover was estimated in broad categories to increase accuracy of observation (<25%, 26- 75%, >75%). The coverage of an eelgrass meadow reflects both the substrate and the flow of water through it. A calm environment with a sandy mud substrate generally supports a dense, continuous eelgrass bed with virtually 100% cover. The cover of eelgrass in areas subjected to strong currents is typically patchy.
Areas with heterogeneous substrate (mixture of fine and coarse) also tend to be patchy (Durance 2002). The percent of cover data collected from this inventory is based on subjective approximations as observed through the lens of an underwater camera. The approximate percent of cover offers important information on the density and productivity of a bed.

2.7 Tidal Fluctuations

It was important to note whether the tide was running or slack at the time of the inventory. Eelgrass shoots will tend to bend towards the substrate during running tides; the accuracy of percent of cover is then very approximate.

2.8 Presence of Other Vegetation

Other types of algae were documented as broad or tuft. Broad algae, such as kelps, sea lettuce and *Sargassum muticum* can blanket the ocean floor and make it difficult to characterize substrate. They can also shade eelgrass in mixed substrates as they anchor to hard surfaces. Tuft algae, such as brown and red algae do not shade eelgrass but indicate presence of hard surfaces for attachment. The presence of kelps, predominately large brown kelps, was noted, as was the presence of other types of smaller algae and *Sargassum muticum*. *Sargassum* is an exotic species of algae that can overshadow eelgrass if the substrate is a mix of sand and cobble. The presence of *Sargassum* was noted especially off the shores of Thetis and North and South Pender Islands (2012 mapping observations).

2.9 Visibility

Visibility was a subjective observation and was rated low, medium and high. The amount of visibility could impact the accuracy of the observations in some instances, namely characterization of substrate. For example, Gambier Island often had low visibility. This can be caused by winds, sediment flows from the lower reaches of watersheds, inputs from nearby streams and tidal/current movements. Low tide periods make for the best visibility.

3 Survey Limitations

The range of accuracy for all the islands surveyed in 2012 was within +/-2.4 metres. Visibility at times was poor, due to tidal influences, sedimentation in the water column from stream outflows, summer plankton blooms and wind. During the last day of mapping Gambier Island in August, 2012 the wind was too high to continue the inventory. The survey team returned to complete the inventory in September 2012. During the 2013 survey of islands within Howe Sound, the winds were often a factor in scheduling the inventories. The average horizontal precision for the GPS unit used for the 2013 and 2014 eelgrass inventories was +/- 0.814

metres.

Shorelines within the Gulf Islands National Park Reserve were not included as part of this survey However, eelgrass that occurs along shorelines within the Gulf Islands National Park Reserve are represented by BC ShoreZone eelgrass biobands on maps included with this report.

Percent of cover of eelgrass shoots is difficult to assess accurately with an underwater camera but was deemed important to characterize. Areas of particular interest (e.g., impact of shoreline modifications, restoration potential) should be surveyed by SCUBA divers. Overall, this inventory is an indication of the presence or absence of eelgrass habitat and does not represent maps of the outer or shoreward edges of each bed, with the exception of Bowen, Passage and Bowyer Islands. Polygons were mapped for these islands where possible in 2013.

4 2012 Inventory Findings

Eelgrass inventories were conducted using ShoreZone inventory maps which include presence of eelgrass where available and the ShoreZone shoreline classification types (available for all islands) as a reference.

The Islands Trust eelgrass inventory is important, particularly on islands such as Gambier and Lasqueti, as the ShoreZone data was based on Orthophoto images alone. Valdes, Cufra Inlet (Thetis Island), Passage and Bowyer Islands were mapped in 2013, but are included in the 2012 inventory, as they are within the Thetis and Gambier Island Local Trust Areas, which were surveyed in 2012. Similarly, the Associated Islands of Lasqueti Island and North Pender Islands were mapped in 2014 and are included here.

4.1 Gambier Island Local Trust Area

Gambier Island was surveyed on August 21st-23rd and September 11th, 2012. This island has rugged shorelines, with steep slopes leading to the subtidal zone. Eelgrass habitat comprises approximately 8.3% of the island's linear subtidal shoreline. The majority of the eelgrass beds are fringing, the significance of which has been described earlier in this report as important to wildlife corridors.

Gambier Island has been highly impacted by historical log storage practices. Eight sites were identified as possible restoration areas starting with small eelgrass test plots (approximately 800 to 1000 shoots). Larger eelgrass restoration might occur if these test plots increase in shoot density and coverage and as funding opportunities arise. In some of these sites, backshore lands have been placed on the real estate market, which may impact future restoration efforts if docks and wharves are permitted as additions to upland development.

Boat mooring buoys and recreational equipment on the water over eelgrass beds as well as derelict log booming cables and booms were observed. There were numerous docks and wharves within eelgrass habitats. Several large shoreline modifications were also noted. These changes to the shore can have long term impacts on nearshore environments, including wave scouring, shading and interruptions to sediment transport. With the presence of active and retired log leases, the island would greatly benefit from an eelgrass restoration strategy plan to increase value for both biological diversity and ecological services.

Bowyer Island was surveyed on October 11-12th, 2013 using the polygon mapping methodology. The west, north and east coasts of Bowyer Island are largely steep and rocky. The south shore is characterized by several coves, varying in substrate. Eelgrass was estimated to extend along 11.4% of the Bowyer Island shoreline, observed only in particular coves along the southern portion of the island. The area of polygons containing eelgrass was observed to total 3690 m^2 and the length of mapped line features was observed to total 70 m. In addition to continuous beds, 4 individual patches of eelgrass were recorded, noted on the map as points.

Eelgrass around Bowyer Island was similar in appearance and percent cover to that surrounding Bowen Island, I.e. patchy and sparse. Percent cover within the polygons was less than 25%.

Docks were located in eelgrass depth in the bay on the central southern shore of Bowyer Island, within zone W2/W1a. Eelgrass beds in that bay were observed to extend as far as the docks. Several chains were located on the ocean floor in zone W2 on the southeast shore of the island, and a large dock is within or adjacent to the eelgrass bed.

Large schools of small fish were frequently observed while circumnavigating Bowyer Island, particularly on the west, north and east coasts. Also observed were large numbers of pile perch (*Rhacochilus vacca*) and rockfish. Harbour seals were observed in several locations.

Passage Island was surveyed on October 5th, 2103 using the polygon methodology. One of the most exposed islands of Howe Sound, this island is a good example of how people and eelgrass tend to occur within similar, sheltered environments. Most of the island is characterized by rocky cliffs, with a few beaches. Eelgrass was observed in sections of the east coast of the island, along 15.7% of the total shoreline of the island. The area of polygons containing eelgrass was observed to total 3718 m^2 and the length of mapped line features was observed to total 40 m. Percent cover within the polygons was less than 25%. Ropes were observed on the sea floor in eelgrass depth in an area of the southeast coast of the island in the presence of patchy eelgrass. In this area was also located a floating dock within eelgrass depth and approximately 12 moorings in the eastern part of the area, where the eelgrass was very sparse and patchy. A floating dock and mooring was located at the south end of the more northerly eelgrass polygon on the east coast of the island.

The islands west of Bowen Island were inventoried between August 4th - 6th, 2013. The linear shoreline extent of eelgrass habitat surrounding the associated islands within the Gambier Island Local Trust Area totals approximately 13.3%.

Most of **Keats Island** contains flat or fringing beds of continuous eelgrass habitat on sandy/mud substrates, especially on the north and west facing shores. Patchy eelgrass beds were observed on the southeast shores, most likely due to exposure to predominant winds.

A high preponderance of single eelgrass patches lie on the southern tip of Keats Island, which may be caused by exposure to southerly winds, but also to the multiple locations of docks, especially on the southwestern shore.

There is potential for eelgrass restoration on the northern end of the island at the eastern point of a log booming area if the log lease is retired in the future. This area has a rocky/cobble foreshore, forested backshore and water park with overwater floats. There are also many docks on the southwestern portion of the island, which may cause fragmentation of eelgrass beds. Where there were low rock/cobble substrates, no eelgrass was present.

Anthropogenic Impacts include the construction of docks, presence of moored boats in eelgrass beds, removal of native backshore vegetation and recreational use of the nearshore (water park overwater play structures).

Continuous flat eelgrass habitat was observed in the southeast and western shores of **Shelter Island** directly west of Keats Island. No eelgrass was found near **Home Island** south west of Keats Island. **Preston Island** south of Keats Island contains a small continuous eelgrass bed on the southeast shore. The backshore is forested. **Ragged Islets** contain mostly patchy eelgrass beds throughout most of the subtidal areas, except for the west facing side of the islets. Mooring buoys and docks were observed on the eastern shore and a float on the northern side of the islets. Most of the islets are forested and contain rocky substrate. The small islet to the northeast contains a fringing continuous eelgrass bed.

The majority of eelgrass surrounding **Pasley Island** south of Ragged Islets is flat and continuous in sandy/shell hash substrate. Vegetation along the foreshore has been cleared near many residences. Retaining walls, docks and mooring buoy chains interrupt eelgrass continuity along the south and southeastern facing shores. There is potential for eelgrass restoration on the southeastern facing shore almost at the midpoint of the island where there is a gap in an otherwise flat continuous eelgrass bed. On the northeastern shore of Pasley there is a dense eelgrass bed that could serve as a possible harvesting site for restoration of lost or damaged eelgrass habitat.

No eelgrass was noted off of **Worlcombe Island** southeast of Pasley Island.

Mickey Island northeast of Pasley Island is surrounded on its western, southern and northern shores by mostly fringing patchy beds of eelgrass in sandy/shell substrate. Eelgrass is mostly likely limited on the eastern shores by low rock/boulder substrates. The rocky shores are surrounded by natural forests. Minimal anthropogenic impacts were observed.

To the west lies **Hermit Island.** The majority of eelgrass habitat is flat and continuous in sandy/shell hash substrates. Most of the habitat is located on the east facing shoreline, though the foreshore is cobble or low rock. The majority of the backshore is forested. In some areas, dock construction interrupts eelgrass beds. Harlequin ducks were observed within an eelgrass area on the southwestern side of the island.

Little Popham Island south of Hermit Island has mostly continuous flat beds of eelgrass to the southwest and northeast next to rocky shores and forested backshores. It is very likely eelgrass is limited by the subtidal low rock/boulder substrate surrounding the remaining areas of the island. Most of the eelgrass around **Popham Island** lives on the northeastern portion of the island in sandy/shell substrate and consists mostly of continuous and flat beds along steep rocky shores.

Grace Island southwest of Gambier Island contains mostly fringing continuous eelgrass habitats in shell/sand substrates next to steep rocky foreshores and forested backshores. A large school of fish was observed. **Woolridge Island** to the northwest of Gambier Island contains mostly flat continuous beds of eelgrass on its north facing shores. The beds are very robust, with a possible harvesting site on the east shore if restoration is undertaken in this area. There is woody debris noted near a breakwater on the north western facing shore of the island.

The majority of eelgrass habitat surrounding **Anvil Island** northeast of Gambier Island lives on the southeastern shores and is characterized as fringing. Most of the island is classified as cliff or low rock/boulder which is limiting for eelgrass growth. The presence of numerous mooring buoys and retaining walls impact the habitat. One potential restoration site was identified on the eastern shore.

Near the Sunshine Coast, the shorelines of **North Thormanby Island** are composed of sediment accreted from nearby large sandy bluffs, as compared with the shores of **South Thormanby Island**, which are dominated by sea cliffs, low rock boulders and exposure to wind and strong wave forces from the south and northwest. Eelgrass composes 19.6% of the combined linear shorelines of both North and South Thormanby Islands.

Eelgrass distribution on North Thormanby Island reflects this predominately sandy sediment, as most of the eelgrass surveyed was continuous flat habitats completely surrounding the island, broken only by a change in sediment from sand to gravel. Rockfish, perch, seastars and Dungeness crabs were observed in the continuous flat eelgrass habitats.

Fringing continuous beds in **Buccaneer Bay** are the exception to the flat eelgrass habitats on the southwestern side of North Thormanby, where a steep drop off in depth prevents a flat contour for eelgrass growth. The eastern shore of Buccaneer Bay on South Thormanby Island had a paucity of eelgrass, but an abundance of sea urchins was noted.

No eelgrass habitat was noted off of **Surrey Island**. Very small eelgrass patches and two small continuous beds were located on the eastern shores of South Thormanby Island, most likely due to their exposure to high wave energy. No eelgrass was noted on **Bertha** and **Merry Islands** on the south end of South Thormanby Island. The furthest eastern island of the **Trail Islands** group contained patchy continuous eelgrass on its northwestern shoreline and continuous eelgrass flats on northeastern facing shores. An active log booming business operates on the north side of the island. An abundance of fish populations were observed in the waters on the eastern side of this island. Patchy eelgrass was also surveyed on the western-most island on the west side.
Turnagain, Echo and **Tikki Islands** contained very small patches of eelgrass. Within **Secret Cove**, on the northeast side of Turnagain Island log booming debris showed evidence of a former log storage site.

4.2 Lasqueti Island Local Trust Area

Lasqueti Island was surveyed from July 17th to July 19th 2012. This island's shoreline is composed of substrate formed from shallow stony deposits over bedrock. Shallow sandy/muddy benches extend into the subtidal zones. Eelgrass comprises approximately 13.8% of the island's linear intertidal and subtidal shoreline. The majority of the eelgrass habitat is flat, dense and continuous. Most of the backshore lands were naturalized with little development.

Possible impacts that could be occurring would be from boat mooring buoys anchored within eelgrass habitats, grazing by Canada geese, historical damage from log booming practices, hardened shoreline modifications and site locations of some aquaculture enterprises. False Bay could benefit from more detailed eelgrass mapping, as the multiple mooring buoys might be impacting eelgrass habitats.

Lasqueti Associated Islands' eelgrass habitats were surveyed between August 19th and October 8th, 2014. Eelgrass beds cover 16.5% of the shorelines.

Small continuous eelgrass beds were observed in the more protected northern sides of **Higgins** and **Olsen Islands** within False Bay. The backshore was forested with some residences. Backshore was composed of steep rocky cliffs descending to the shore. Most of the eelgrass beds on **Finnerty Island** are on the northeast side between islets in a narrow channel. Shores are characterized as rocky cobble with steep slopes. Oyster catchers were noted feeding within the mussel beds there.

The **Fegan Islands** have dense continuous beds between islets, although there was citing of many boats anchored in areas where substrate would have been suitable for eelgrass growth and none was observed. **Lindbergh Island** in Scottie's Bay contains small continuous flat eelgrass beds on its eastern shores. **Marine Island** to the north contains small continuous and patchy eelgrass on its south facing shores. **Jelina Island's** extensive continuous flat eelgrass beds lie south facing Lasqueti Island and on the southwest shore. One house is constructed on this island.

One small continuous eelgrass bed was located on the western shore of **Jervis Island**. Two small patches less than $10m^2$ were noted on the two islets north west of Jervis. Rocky substrate is most likely the cause of the absence of subtidal eelgrass. Steep drop offs down to the shore characterized **Paul Island** where no eelgrass was observed. On **Jedidiah Island**, designated as a BC Provincial Marine Park, there were small continuous and patchy eelgrass beds observed on the western and eastern rocky shores.

An abundance of green sea urchins were observed off the south side of **Bull Island**, which had eelgrass in patches and small continuous beds on the north side. Green urchins have been observed eating eelgrass in other locations within British Columbia (pers. comm. Cynthia Durance). Eelgrass was absent surrounding **Circle Island** southeast of Jedidiah Island, where green urchin barrens were also noted. No kelps were present, although pelagic cormorants, oyster catchers, gulls and a colony of stellar sea lions were cited.

No eelgrass was noted off of **Bo Ho, Rabbit** or **Sheer Islands,** although eelgrass was expected to be noted on Rabbit Island because of the sandy substrate. The presence of green urchin barrens was noted however. Rocky islets prevented the surveyors from travelling closer to shore on Rabbit Island, so there is a possibility eelgrass was present in shallower waters if sea urchins were absent. Stellar sea lions were hauled out near Sheer islands.
No eelgrass was observed off of **Sangster Island** to the southeast of Lasqueti Island. A sea urchin barren was noted on this island's northeast side.

To the south of Lasqueti Island no eelgrass was noted on **Sea Egg Rocks**. Two small continuous beds were located on the northwest shore of **Jenkins Island**.

Lasqueti and its associated islands may contain the least impacted eelgrass habitat of all the southern Gulf Islands in the Islands Trust Area, as land development and marine activities are at a minimum compared to more populated islands in the southern Salish Sea.

4.3 North Pender Island Local Trust Area

North Pender was inventoried on July 3rd, 4th and 6th 2012. Eelgrass comprises approximately 11.6% of the island's linear intertidal and subtidal shoreline. The majority of the eelgrass beds are flat and continuous. The protected nature of North Pender results in a relatively high proportion of soft substrate in shallower areas.

Impacts include housing developments with accompanying tree and shrub clearings, rip rap and rock wall modifications, some of which were constructed below the high water line, direct raw sewage outfall at Port Washington which would directly affect the water quality for eelgrass productivity, the presence of Canada geese, direct grazers on eelgrass shoots during low tides, and mooring buoys within eelgrass beds. Port Browning might be an appropriate site for eelgrass restoration as the substrate is suitable and there is a small bed on the northeast side.

The **Associated Islands of North Pender Island** were surveyed between June 5th and 17th 2014. Only shorelines outside the Gulf Islands National Park Reserve were mapped; however the maps associated with this report show eelgrass coverage of unmapped shorelines from the ShoreZone mapping. Eelgrass grows on 17.5 % of these islands' shores. Impacts on eelgrass beds include derelict fishing gear, removal of native shoreline vegetation, shading by docks and shoreline modifications. Two potential restoration sites were identified: one off of Knapp Island and one off of Sidney Island.

Extensive eelgrass beds surround the west and east shores of **Knapp Island**. One restoration site was located between two continuous beds on the eastern shore near a constructed breakwater. Rocky substrate limits eelgrass extent on the southeastern shore. ***Pym Island*** to the east has small fringing patchy beds on its west facing shoreline. The western shore of this island has a 70 metre retaining wall in back of beds of fringing patch surf grass (*Phyllospadix* sp.), a plant that is an indicator of high wave energy in the intertidal zone.

The major distribution of ***Coal Island's*** eelgrass lies near its southern shores. In a bay on the northwestern side of the island sheltered by a breakwater lies a continuous flat bed of eelgrass. A large dock and several large boats are situated within eelgrass depth range.

Goudge Island has two small continuous flat beds on its northern shore, characterized by natural vegetation and a forested backshore. South of Canoe Cove is **Kolb Island** where a continuous flat eelgrass bed grows on its western shore. **Fernie Island** has no eelgrass present. **Ker Island** has a continuous flat bed of eelgrass below a backshore of Garry Oaks on its south shore and another small continuous bed on the north shore in front of a rocky shore.

Forrest, **Sheep**, **Domville**, **Brethour**, **Comet** and **Gooch Islands** have small continuous flat eelgrass habitats where suitable substrates allow for their growth. The islands are mostly cobble rocky beaches as indicated by an abundance of kelp beds and rocky slopes. A 50 metre rip rap wall has been erected on the southern shore of Brethour Island below the High Water Mark (HWM). On the northern side of Brethour shoreline modifications such as a rock wall and rip rap were also observed.

Between Sheep Island and Domville Islands a derelict trap was noted. An extensive kelp bed was also noted on the north end of Comet Island. There was no eelgrass habitat observed off of **Ruby Island** to the south east of Domville Island.

Small continuous flat and fringing eelgrass beds were located on the northwest and eastern coasts of **Moresby Island**. Possible impacts to the habitat on the west facing shore are cleared landscaped and agricultural areas close to shore and some dock construction. Most of the shoreline of Moresby is characterized as rock/cobble. Kelp beds were abundant near the east and south shorelines, where some continuous flat beds were located. Most of the backshore in these areas was forested.

James Island was surveyed June 25th, 2014. Because of its eroding sandy bluffs on the northeast end of the island and relative lack of backshore activities, extensive continuous flat eelgrass habitats were located along the west and eastern sides of the island, at times in deeper water
(-5 to -7.6 m). Percent of cover was between 26-75%. On the southwestern shore, a dense kelp bed interrupted the eelgrass survey, but eelgrass seemed to be growing around the kelp. Most likely, since this is a depositional area for the sandy sediment eroding from nearby sandy bluffs, cobbles and boulders are providing anchors for kelp holdfasts amidst an otherwise sandy substrate. An extensive patchy flat eelgrass habitat was located here. High wave energy arriving from the southwest most likely prevents stable sediment for eelgrass growth.

Eelgrass surrounding **Sidney Island** was surveyed June 26-27th, 2014. Continuous and patchy flat eelgrass habitats were located on the west facing shores and south of the Parks Canada National Park boundary on the east side. Percent of cover on the western side ranged from continuous beds of <25% to 75%. The backshore on this side of the island is characterized as steep high sandy bluffs, which create sandy sediment for abundant eelgrass habitat. Anthropogenic backshore activities that would lead to damage of these beds are minimal. Kelp beds were dense on the southwest shore. *Sargassum* was also noted in this area. Eelgrass was growing at depths of - 8.6 metres. Though not directly surveyed, it is worth noting that the shoreline of the northern spit on Sidney Island is shown to have significant eelgrass coverage by the BC ShoreZone eelgrass bioband.

The most southern part of Sidney Island had surfgrass appearing to be growing out of the rock outcroppings. High wave energy might explain the scarcity of eelgrass on this side. Patchy surfgrass was also observed on the south eastern shoreline. Patchy eelgrass beds on the eastern side were less dense (<25%) and growing in shallower depths (-2.5 to -3.6 m). One potential eelgrass restoration site was indicated in this area. Continuous flat eelgrass beds were surveyed on the west side of **Little D'Arcy Island**.

4.4 South Pender Island Local Trust Area

South Pender was surveyed on July 6th 2012. Eelgrass comprises approximately 8.5% of the island's linear intertidal and subtidal shoreline. South Pender has more exposed shoreline therefore less eelgrass is to be expected. Roughly the same proportion of flat and fringing beds are present with slightly more than half of them being continuous.

4.5 Mayne Island Local Trust Area

Mayne Island was surveyed from 2009-2012 using two methodologies on a variety of platforms including: 1) delineation and creation of polygons (with towed underwater camera, on foot, by kayak, by free diver), 2) linear presence/absence (by kayak). Data was converted to presence/absence line format for incorporation into the 2012 Islands Trust Eelgrass Inventory.

Mayne Island is mostly protected except on the Northeast side which is exposed to winds from the Strait of Georgia. Eelgrass comprises approximately 22% of the island's linear intertidal and subtidal shoreline. **Mayne Associated Islands**, **Georgeson** and **Curlew** contain 15.7% and 24.8% respectively.

Evidence from the Mayne Island Conservancy's eelgrass monitoring program and historical anecdotal evidence has shown loss in intertidal eelgrass in **Miners Bay** and two Southeast facing bays on the Southeast side of Mayne. Reasons for loss are unknown, but ongoing monitoring will indicate natural variability in these eelgrass beds. Potential impacts include grazing from Canada geese, anchoring, mooring buoys, trampling by kayakers and damage from boats and propellers. Winter heavy rain events could be introducing increased sediment loads into eelgrass beds, but this would need to be studied.

Gallagher Bay (on Navy Channel) and **Conconi Reef Park** are potential eelgrass restoration sites. They both have large bare areas adjacent to continuous eelgrass beds and have suitable substrate.

4.6 Thetis Island Local Trust Area

Thetis and its associated islands were surveyed July 31st through August 3rd, 2012, except for the inside of Cufra Inlet which was inaccessible because of low tides, and Valdes Island. The Cufra Inlet survey was completed in the summer of 2013. Valdes Island was surveyed July 29th, and 30th, 2013.

Approximately 26.6% of the linear subtidal shoreline on Thetis Island is composed of eelgrass habitat, 72% of which is continuous. Fringing continuous eelgrass beds were observed off the western shore of Thetis where the ShoreZone map indicates a preponderance of low rock and boulder (not a typical shoreline type for eelgrass). **North Cove** is also rich with an abundance of eelgrass, except where it is shaded by overwater structures.

Cufra Inlet contains dense (26-75% cover) flat continuous eelgrass beds. The inside of the inlet was surveyed during the summer of 2013 by local residents using kayaks and hand held GPS units but without the use of an underwater camera, as the water was shallow enough for eelgrass to be observed from the kayaks. Low tides in 2012 prevented an aluminum boat from approaching close to shore during the low tides occurring during the survey. The continuous bed begins on the western shore of Cufra Inlet as a narrow 1 m wide swath on the shoreward side and then widens out. An abundance of drifting sea lettuce (*Ulva* spp.) was observed within this area. Eelgrass became denser seaward in the muddy/shell hatch substrate. The substrate became sandier as the mappers traveled towards the mouth of the channel. Patches of sand dollars were noted as the inlet widens and the eelgrass extends towards the eastern shore. Diatoms were noted growing on the eelgrass blades. At the western edge of the mouth of the inlet eelgrass is patchy and sparse despite its ShoreZone classification of 'cliff'. **Clam Bay** eelgrass was dense and continuous.

Telegraph Harbour on Thetis Island had a preponderance of algae (*Ulva* spp.), *Sargassum muticum* and filamentous algae growth. Visibility was poor. Upland and shoreline development (rip rap, retaining walls and cement ramps) with accompanying vegetation clearing most probably has led to higher sedimentation in the nearshore waters.

Understory kelps were observed at most sites, although no fish or crab species were present at the time of the survey in the majority of the survey area. Possible impacts from boat moorings within eelgrass beds (e.g. **Ruxton Island** had <15 boats moored off shore in one small area), recreational overwater play structures, shoreline modifications and nutrient run-off could be impacting nearshore habitats. Where there was suitable substrate for eelgrass as indicated by the ShoreZone data, eelgrass was present, with the exception of the narrow channel between Thetis and Penelakut Islands. However a long-time resident remembers eelgrass presence there approximately 40-50 years ago. Islets and small islands are important refugia for wildlife and often are less impacted than the surrounding larger islands.

A short description of the smaller islands and islets associated with Thetis Island is included below.

Percentages of eelgrass for each associated islet are:

Island	Eelgrass % Cover
Ruxton	11.6%
Pylades	0%
Bute	50.3%
Dunsmuir Islands (2)	34.7%
Hudson	30.9%
Reid	3.9%
Dayman & Scott Islands	39.6%
Valdes	12.7%

Hudson Island west of Thetis is rich with continuous fringing beds of eelgrass (26-75% cover) on both its eastern and western subtidal areas. **Dayman Island** has just under approximately 25% coverage of patchy eelgrass habitat mostly on its eastern facing side. **Reid Island** to the east has dense patches of fringing eelgrass on its northeast facing shore.

Ruxton Island to the north of Thetis has flat, continuous (less than 25% cover) eelgrass beds within sheltered sites on the western facing area; an abundance of nudibranchs was observed on eelgrass blades. The eastern shore, with the exceptions of some sites with fringing patchy beds, is too deep for eelgrass growth.

Whaleboat Island to the east of Thetis had too steep a drop off to be suitable for shallow eelgrass habitats. **Tree Island** contained 100% cover of understory kelps, which is an indication of a dominance of cobble/pebble substrate. As well, the subtidal area is too deep for eelgrass production.

Bute Island off of Ladysmith Harbour contained dense continuous beds because it is surrounded by a shallow bay with sandy substrate. There is a potential eelgrass restoration site on the northeast side of **Dunsmuir Island**, as it is composed of clean sandy substrate in a protected site. The narrow channel between Dunsmuir Island and Ladysmith Harbour contains continuous dense flat eelgrass beds.

Valdes Island was surveyed between July 29th and 30th, 2013. Eelgrass coves 12.69 % of its linear subtidal shores. The majority of the habitat is flat and continuous, with most of the locations cited on the northeastern and southwestern shorelines. Although the majority of the shorelines on the western portion of Valdes are ShoreZone classified as low rock/boulder or cliff, the presence of flat continuous beds with bare patches was noted on the north and south western shores. Three potential restoration sites were identified; one on the central western side of the island, the second site on the northern tip of the island containing a small degraded eelgrass bed adjacent to the BC Parks dock, and the third is located on the southwestern shore which might have been historically impacted by log storage. The substrate at this site is suitable for a transplant; however *Ulva* spp. is present, which might be an indication of a high level of nutrient inputs.

The location of mooring buoys in eelgrass habitats with fifty-one buoys observed within beds and the interruption of eelgrass continuity by the construction of docks are the major anthropogenic impacts affecting eelgrass habitats on Valdes. The majority of the shoreline is naturally vegetated.

5 2013 Inventory Results

The islands mapped in 2013 for eelgrass (*Zostera marina*) within the Islands Trust Area Islands include:

- Galiano Island Local Trust Area
- Gabriola Island Local Trust Area,
- Denman Island Local Trust Area,
- Hornby Island Local Trust Area,
- Winchelsea - Ballenas (Executive Islands) Local Trust Area,
- Valdes Island and Cufra Inlet in the Thetis Island Local Trust Area (Findings included in Section 4.6 above)
- Bowen Island Municipality
- Gambier Island Local Trust Area Associated Island in the Howe Sound (excluding the islands off of the Sunshine Coast- findings included in Section 4.1 above).

5.1 Galiano Island Local Trust Area

Galiano Island and its associated islands were inventoried over seven days between June 26th and November 25th, 2013. Approximately 16.7 % of the linear subtidal shoreline of Galiano Island is eelgrass habitat.

ShoreZone maps indicate that most of the southwestern and northeastern shorelines of Galiano Island are not suitable substrates (coastal bluffs and low rock/boulder respectively), except where there are sheltered embayments. However there are notable exceptions over the north, south west, south and eastern areas of the entire island.

The eelgrass distribution on Galiano is 88% continuous; 12% patchy. The placement of mooring buoys (at least 14 were noted within eelgrass beds, especially on the southwestern shores of the island), private docks (at least 12) and log storage have damaging effects on the habitat's continuity and function as a wildlife corridor. The construction of retaining walls (rip rap, rock and wooden) and the removal of backshore vegetation (at least 10 sites were observed) are obstacles for eelgrass to flourish i n certain sites.

Most of the backshore on Galiano Island remains naturalized, with notable exceptions where trees and understory vegetation surrounding residences are removed and where shores are modified with retaining walls. Exotic invasive plants include English ivy, St John's Wort and gorse. Heavy epiphytic algae growth on eelgrass blades were noted within **Montague Harbour**, a possible indication of a high level of non-point source pollution. Another site for pollution is the public dock in **Whaler Bay** where boats are worked upon. Best management practices are recommended for boat sewage disposal and using tarps for collection of boat paint chips at each location.

There is the potential for eelgrass restoration within Whaler Bay, as the channel in front of the public dock contains a narrow band of eelgrass that could be expanded shoreward if log leases were retired in the future. In November, bufflehead and Barrow's Goldeneye as well as schooling forage fish were observed. Patchy eelgrass beds were noted off the eastern shores of Galiano Island. This area is ShoreZone classified as low rock/boulder. Four mooring buoys were located with these beds.

The eelgrass habitats covering the associated islands of Galiano comprise approximately 19.98% of the islands' linear shorelines. **Parker Island** has extensive eelgrass on its northeastern shores (96% continuous). The construction of docks and the placement of mooring buoys within eelgrass beds, however, may be impacting the habitat. Most of the eelgrass surrounding **Gossip Island** lives on the island's east facing shores is continuous (95%); however docks (7 were noted within the eelgrass beds) interrupt their form and function. Mooring buoys (3 observed) are situated within the existing beds on the south-western facing shores also disrupt the connectivity of eelgrass habitats.

No eelgrass was observed on **Ballingall** and **Lion Islets**, **Wise, Charles**, **Sphinx** or **Julia Islands**.

5.2 Gabriola Island Local Trust Area

Gabriola Island and associated islands were surveyed between July 8th and 21st, 2013. Gabriola Island's linear shores are comprised of 24.8 % eelgrass, with 89% continuous distribution. Two potential eelgrass restoration sites were identified on this island. The first is on the southwestern shore facing **Mudge Island** near an active log booming site. When the log lease is retired at this site, a small eelgrass transplant (100-500 shoots) could indicate whether the area is suitable for a larger transplant. The second site is on the northeast tip of Gabriola Island where a small existing bed could be expanded.

Wildlife in some areas abound, including Canada geese, an abundance of fish species, Great Blue Herons (22 at the southern channel entrance between Gabriola and Mudge Islands), sand dollars and Bald Eagles. Beaches that have suitable substrate for sand lance and surf smelt spawning were also noted. Healthy eelgrass beds near the **Malaspina Galleries** in Gabriola Sands Provincial Park are not surrounded by mooring buoys and docks and are thriving in in 4-5 metres water depth, although the area also contains rocky substrates.

Possibly the biggest impacts to marine wildlife habitats on Gabriola and its associated islands are the locations of floats and mooring buoys (in one embayment on the northwestern shore of Gabriola, over 12 floats – moorings and/or crab traps – and 14 buoys were observed in a continuous eelgrass bed); construction of retaining walls (nine riprap or rock walls identified); and, the removal of native backshore vegetation (13 sites). Numerous moorings are located in an otherwise robust eelgrass bed in **Degnen Bay**.

The eelgrass coverage for the Gabriola associated islands' linear shorelines totals 19.98%. Near the eastern shore of **DeCourcey Island** south of a marine park there are many docks and boats. Poor water quality was noted, and there are no washroom facilities at this location. No marine life was observed growing on the seafloor. North of the marine park there is a potential restoration site facing a steep rock ramp foreshore and a steep grassy conifer backshore near a former log booming site.

Snake Island has the potential for eelgrass restoration on its southern tip where there is a protected area with suitable subtidal sandy mud substrate, although this location may be too close to active boating. Seal pups and oyster catchers were cited near a large mussel bed.

There was no eelgrass habitat observed on **Hudson Rocks**. Marine life there included seal pups hauled out, bird habitats, cormorants and oyster catchers. The shell hash substrate off of **Five Finger Island** was noted to be situated too deep for eelgrass growth.

Mudge Island also has a potential eelgrass restoration site on its southeastern shore. Kelps are mixed with sandy/muddy/ shell substrate. Most of the backshores are naturally vegetated, with exceptions near residential developments where mooring buoys are situated within eelgrass beds (4 observed). The eelgrass habitat observed on Mudge was a mix of patchy/ continuous and flat/fringing beds on the eastern shores of the island. One bed in particular, located mid- island on the eastern side extended 100 metres shoreward beyond the waypoint, but the water depth was too shallow to delineate the bed.

Eelgrass on **Link Island** is characterized as flat continuous beds on its eastern shores. On the south shore of Link Island there are multiple docks (4) and mooring buoys (6).

Continuous fringing beds lie next to the northwest shores of **Breakwater Island**. Near **Saturnina Island** there are fringing continuous beds of eelgrass habitat on the western and northern shores.

Bath Island has a wide rock ramp in front of a windblown forest with a patchy bed with two larger patches surrounded by kelp and *Sargassum muticum* on its northwestern shore, while on its western shore there was a flat continuous bed.

Eelgrass habitat on **Tugboat Island** is characterized as narrow beds tucked between shore and wharf floats on the eastern side of the island and between the Tugboat Island and **Sear Island** to the south, which has flat continuous beds on its western shores. Continuous flat beds lie at the entrance to a marina on **Vance Island**. A rock/boulder shoreline with a, private dwelling with floating dock and several moorings are near flat continuous eelgrass habitat on **Acorn Island**.

5.3 Denman Island Local Trust Area

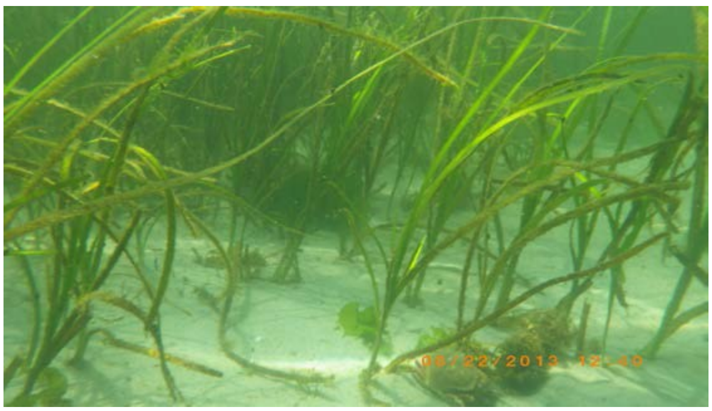
Denman Island and its associated islands were surveyed on several boat expeditions between August 20th and September 15th, 2013. In the Denman Island Local Trust Area 33.24% of the linear shore contains eelgrass. In some areas, especially in eastern subtidal areas, patchy eelgrass was observed amongst broad leaf kelps and *Sargassum muticum*, where the substrate is classified as low rock/boulder. A potential restoration site is located on the southwest area of the island near **Metcalf Bay** and is close to a site that could be used for harvesting transplants. The substrate south of this site gradually changes to cobble and gravel. Most of the beds surrounding the island are fringing, most likely due to coarser substrate changes at depth.

Eelgrass habitat is situated on the north eastern shores, classified by ShoreZone as sand/cobble and where numerous overwater structures are located and associated with industrial aquaculture activities. The eelgrass here was predominately patchy; most likely there are more patchy beds both shoreward and seaward of the mapped area. This area is the second most patchy eelgrass habitat observed, second only to areas in Howe Sound.

The majority of the backshore is not heavily impacted by development; most of the residences had either forested or grassy areas between them, with a minimum of landscaping. Abundant species of birds including black legged kittiwakes, surf scoters, marbled murrelets, grebes, harlequin ducks, surf scoters, herring gulls, and other marine wildlife species such as hooded nudibranchs, sand dollars, sand lance juveniles and abundant schooling fish were observed.

Sandy Island north of Denman Island contains continuous (99%) eelgrass habitats although the southern shores are ShoreZone classified as sand/cobble and the northern areas are classified as altered. Sand dollars were observed on both eastern and western sides of the island. **Seal Islets** were surrounded by fringing continuous (81%) eelgrass habitats. Associated with these beds were observed marbled murrelets and rafts of harlequin ducks and surf scoters, kittiwakes, gulls and seals. The backshore consisted of flat shrub, herbaceous and grassy slopes. . No eelgrass habitat was observed near **Chrome Island** due to unsuitable rocky substrates.

5.4 Hornby Island Local Trust Area



Eelgrass beds on Hornby Island were mapped over several days between August 21st and September 12th, 2013. The linear shoreline of the Hornby Island Local Trust Area is composed 31.7 % of eelgrass habitat. Large areas on both the western and northeastern shores of Hornby have continuous (90%) flat beds, although the classification by ShoreZone of these shorelines is low rock/boulder. The small areas of eelgrass found in these otherwise rocky cobble areas are valuable as critical habitat and corridors for marine life.

Most of the backshore is naturalized, even where residential houses are situated. Suitable substrate for spawning sites for forage fish was identified on the north eastern shores. Three potential restoration sites were also noted; one near this area for potential forage fish spawning, the second within a sandy embayment on the eastern shore (if boat anchoring pressures were decreased), and the third near the Hornby Island ferry terminal on the western side of the island (eelgrass was noted just north of the terminal growing in pebbles). There is also an opportunity for a community clean-up of underwater debris near a breakwater and marina on the southern end of the island. On **Toby Island** dozens of seals were hauled out.

5.5 Winchelsea-Ballenas (Executive Islands) Local Trust Area

The islands within the Winchelsea-Ballenas Local Trust Area were surveyed for eelgrass habitat between November 21st and 23rd, 2013**.** The total linear shoreline coverage of the Local Trust Area is 1.4%.

Mistaken Island west of Parksville has two eelgrass sites, one fringing patchy bed and the second within a cove with a dock, both on the southwestern shore. A flat continuous bed lies between the channel separating the **Ballenas Islands**. A continuous bed also lives on the north shore of the south island, punctuated with rock substrate. A school of forage fish, possibly sand lance was observed at the time of the survey in the shallow subtidal zone.

A small flat continuous bed on the west facing shores of the **Ada Islands** also may serve as suitable habitat for forage fish, prey for ancient murrelets, of which one was cited by field staff (unconfirmed). A second eelgrass bed is situated on the western shore of the west Ada Islands. The substrate at this location is primarily sandy with a secondary substrate of bedrock with associated intermixing rockweed and detritus. A seal haul out with 61 seals was noted near this site.

A small flat continuous eelgrass bed is located on the northeastern side of **Southey Island**. No eelgrass habitats were observed on **Gerald**, **Yeo**, **Amelia**, **Ruth** or **Winchelsea Islands.**

5.6 Bowen Island Municipality

Bowen Island was surveyed between Aug 6th - 11th and Oct 4th, 5th and 12th, 2013 using the polygon mapping methodology. The island is characterized by a mix of sandy bays and steep shorelines. Large homes are common, with docks constructed both in the bays and on the steep cliffs. Bays, which are areas in which eelgrass is expected to grow, were also the location of waterfront homes and associated docks (both land- based and floating), moorings and anchored boats.

Eelgrass was estimated to extend along 11.6% of the shoreline of Bowen Island. The area of mapped eelgrass polygons was observed to total 41,917 m^2 and the length of mapped line features was observed to total 958 meters. Percent cover was low, however, and in addition to continuous beds, 84 individual patches of eelgrass were recorded and noted on the map as points. Eelgrass was observed within bays and straight sections of coastline on the southwest, northwest, northeast tip, east (Mannion Bay and north) and southeast coasts.

Around much of the island eelgrass was characterized by frequent individual patches, with each patch often consisting of very few shoots. Patches on the west coast were observed in areas that, from the shoreline or ShoreZone analyses, would not have been predicted, as the plants occurred seemingly opportunistically in patches of soft substrate located amid boulders and other coarser substrate.
Percent cover even in continuous beds was consistently far less than 25% and noticeably sparser than other islands within the Islands Trust areas also surveyed during the 2013 mapping season.

Docks in areas such as in **Tunstall Bay** were located in depths suitable for eelgrass growth. Distances between some points on the polygon mapped in Tunstall Bay are longer than 20 meters as the eelgrass field surveyors needed to navigate around swimmers, docks and moored boats. Large clusters of sunflower stars (*Pycnopodia helianthoides*) were observed in the bay on sandy bottoms that did not contain eelgrass. Docks and moorings were also located in eelgrass depth elsewhere on the west coast of Bowen Island (e.g. the relatively straight shoreline north of Bowen Bay, King Edward Bay, the shoreline north of King Edward Bay and Galbraith Bay).

In some sites such as **Galbraith Bay** and **Columbine Bay**, eelgrass was only observed on one side of the bay despite suitable sandy substrate on the other side. For example, the substrate on the north side of

Galbraith Bay was bare sand. There were several moorings in that bay. Eelgrass in Columbine Bay was sparse and appeared unhealthy; individual clumps were surrounded by bare sand. One hypothesis for this is that eelgrass may be impacted by boat wakes in the area. Boats were moored throughout eelgrass depth in **Cates Bay**.

Multiple beds of continuous eelgrass were identified throughout **Mannion Bay** between zero and more than 5 meter depth relative to chart datum. These beds, however, were not as dense as would be predicted given the soft substrate and sheltered environment. In the northeast side of the bay bare sandy fringing beds are interrupted by the construction of docks.

Mannion Bay is heavily used for boat anchoring, mooring and docking within depths suitable for eelgrass growth. The construction of docks and floats and their associated chains are impediments for eelgrass productivity in this area. Multiple adjacent docks have been constructed within eelgrass depth Ropes and chains from docks, moorings or anchors had dragged on the sea floor, apparent due to the patterns they had created in the sand. The motion of the chains due to waves and currents can damage or uproot eelgrass.

Eelgrass otherwise appeared healthy in Mannion Bay and there are opportunities to restore lost eelgrass habitat if boat anchoring were restricted to a defined area outside of the depth range for eelgrass growth, i.e. if they were limited to 6 m depth or deeper. Schools of fish were observed within the existing sparse eelgrass; therefore, restoring the eelgrass in the area would serve to enhance fish habitat. Although it was not included in the project deliverables, the research team had been requested to look for evidence of litter on the sea floor in this bay; however, only a few cans and the possible remnants of a shopping cart were observed. Some of the moorings and anchored boats appeared derelict. Many crabs were observed on the south side of the bay, but were not identified to species.

No eelgrass was observed in **Snug Cove** including the head of the cove, near Crippen Park beach. Possible reasons include dredging, ferry wakes, eutrophication and boat traffic associated with the marina, and pollution of the substrate due to chipped wood debris. No flora was observed on the sea floor except for encrusting algae. There are restoration opportunities for the nearshore environment by Crippen Park beach if the historical and present impacts from the marina and former log booming site are addressed.

The inner portion of the eastern cove of **Konishi Bay** on the south coast of the island appeared suitable for eelgrass due to the sandy substrate and sheltered cove with a sandy beach. The substrate was bare sand, however. Eelgrass was observed in deeper locations of that bay. Removal of native plants and retaining wall constructions were noted around residences. In another eelgrass location in the southern portion of Seymour Bay/Seymour Landing where an adjacent coastal lot was for sale, coastal vegetation had been cleared and there is already evidence of slope failure both at the top and foot of the slope, despite installation of riprap. Water flow had also been channeled in the area, which could intensify water and sediment flow into the nearshore environment. Slope failure is a possible threat to eelgrass through smothering by eroding sediments. Shoreline hardening also increases wave energy and wave deflection, which can scour shorelines (Lamont 2013).

The area around **Cape Roger Curtis** has been of concern to local residents due to the construction of large docks and potential for damage to submerged habitats. Eelgrass was not observed around the exposed cape, as the observed substrate was steep and rocky. Kelp was observed in the area, however. Chains from the new construction were observed on the ocean floor. Kelp beds are a major feature along the rocky parts of the Bowen Island shoreline. Several schools of small or juvenile fish were also observed around the island.

6 2014 Inventory Findings

Areas mapped in 2014 for eelgrass (*Zostera marina*) within the Islands Trust Area include:

- Salt Spring Island Local Trust Area
- Saturna Island Local Trust Area
- Thormanby Islands and Gambier - Sunshine Coast associated islands (findings included in Section 8.1 above)
- Lasqueti Associated Islands (findings included in Section 8.2 above)
- North Pender Associated Islands (findings included in Section 8.3 above)

The characteristics and locations of eelgrass habitats for Salt Spring Island and Saturna Island local trust areas are described below. Thormanby Islands are described in Section 8.1 above as they are in the Gambier Island Local Trust Area; Lasqueti Associated Islands are included in Section 8.2 as they are part of the Lasqueti Island Local Trust Area; and North Pender Associated Islands are included in 8.3, as they are part of the North Pender Island Local Trust Area.

6.1 Salt Spring Local Trust Area

Eelgrass surrounding Salt Spring and its associated islands was surveyed between April 18th and August 1st, 2014. Approximately 18% of the Island's linear shorelines are eelgrass habitats. The shore composition is mostly low rocky boulder (62%) with softer sediments in pocket beaches on the west facing shorelines. Most of the impacts on eelgrass habitat are heavy boat usage near the shore (boat moorings and anchoring, fuel docks, marinas, sewage discharge and derelict boats, docks and buoys), non-point source pollution and the removal of shoreline riparian native vegetation. Seven potential eelgrass restoration sites were identified.

It is recommended that intertidal mapping by community members be undertaken to update intertidal mapping data collected by the community in 1975 and 1996. It is also suggested that an eelgrass monitoring schedule be developed to measure potential eelgrass habitat impacts of aquaculture activities on the island over time. Improved anchoring methods for mooring buoys would decrease scouring of the seabed.

Compared to maps of intertidal eelgrass beds completed in the past (1975 and 1996), eelgrass beds are greatly reduced in size and spatial extent in **Ganges Harbour**. Flat patchy beds with less than 25% cover (density) were growing near its south western shores. Surveyors identified one potential eelgrass restoration site on this side of the harbour and another site south of the harbour's entrance near a large continuous bed. Major impacts to eelgrass distribution within the harbour include historical log storage, present day non-point pollution and heavy usage by recreational boats.

The north eastern shoreline of the harbour contains small areas of continuous fringing eelgrass beds. No eelgrass was observed growing on **Goat, Deadman** or **Sister Islands**. Ruckle Park to the north of Beaver Pt. contains a naturalized shoreline and is protected as a BC Provincial Park. Densities of eelgrass varied from 25% to 75% in small bays within the Park boundary.

Fulford Harbour contains continuous flat eelgrass habitat on the western shoreline. The density changes into fringing continuous beds to the south of these beds. Five eelgrass patches less than $10m^2$ were noted on the eastern shores. Two potential restoration sites are suggested near two of the eelgrass patches to the south.

Off the shores facing Sansum Narrows eelgrass grows intertidally, some of which lies between aquaculture rafts. Some riparian vegetation had been removed from behind a 30 metre long brick wall. At one site where there is a natural shoreline with a fringing continuous eelgrass bed, an abundance of salmon smolts was noted (May 6, 2014).

Eelgrass in **Burgoyne Bay** is composed of small fringing continuous beds delineated by a sharp drop off into deeper waters on the southern shores of the bay. Closer to the mouth of Burgoyne Bay, known to be used by salmon (pers. comm. Kathy Reimer), there is extensive flat continuous eelgrass. A derelict dock was observed and there was evidence of past log booming activities. Approximately seven boats, including house boats and a sailboat, some of them with small attached docks, were observed.

Over ten harbour seals were noted in the eelgrass beds in the bay. No eelgrass was noted on the northern shore or on the shores of Mt. Maxwell Ecological Reserve, with the exception of a small patch and a small continuous bed to the north of the patch. The sediment on this side of the island is low rocky boulder.

Bader's Beach contains three small but continuous flat eelgrass beds. The continuity of the habitat may be affected by a boat ramp and nearby placement of rip rap, as well as boat moorings. **Booth Inlet** contains extensive continuous flat eelgrass habitat amongst mooring buoys and a gravel boat launch site. It is recommended that a more detailed polygon be created of this habitat to monitor changes over time from aquacultural activities and from the effects of mooring buoys. A potential restoration site was located north of Booth Bay. Many eagles were cited in this area.

Vesuvius Bay also contains extensive continuous flat eelgrass beds, as well as **Duck Bay.** Surrounding the shores of **Idol Island** eelgrass habitat is characterized as patches and fringing and flat continuous beds. Small eelgrass patches (<$10m^2$) to small continuous flat beds were observed from Duck Bay to Stone Cutters Bay. In **Stone Cutters Bay** an increase of continuous flat eelgrass habitat was noted, although there was clearing of backshore native vegetation near residences. At the northern tip of the bay, dense continuous beds extend into the intertidal zone, but the habitat is interrupted by docks and mooring buoys and most likely impacted by the removal of backshore vegetation.

Continuous flat eelgrass habitat continues along the more protected northeastern shore of the island. Along the shores there was a groin, clearing of riparian vegetation by shore residences and docks. There is a gap in the habitat, beginning with a residential site with cleared vegetation from the house to the beach. The gap might be due to a change from shallow sand to cobble. Another gap in otherwise continuous eelgrass occurs further south where again backshore vegetation was cleared.

At the northern and southern outside edges of **Walker's Hook** lie continuous flat eelgrass beds, associated with natural shores and backshores. From the end of the southern bed of Walker's Hook to Nose Pt., small patches, with some fringing continuous beds were surveyed. Dense kelp (*Nereocystis* sp.) obstructed surveyors from traveling closer to shore. Most likely exposure to southwesterly waves and storms limits eelgrass growth in this area.

A derelict buoy was observed in an eelgrass bed on the south side of Walker's Hook. It is providing a subtidal platform for kelp settlement and may be shading out eelgrass beneath it. River otters were observed on the eastern facing shore of Walker's Hook near a small fringing patch of eelgrass.

Intertidal eelgrass habitats along the eastern shores of **Long Harbour** were observed by community mappers in the past. In 2014, four small continuous flat beds were noted in the same areas. On the northwestern shore, sandy substrate where eelgrass should have been present but was absent was noted by the surveyors. Two potential restoration sites were indicated within the harbour. An eelgrass restoration test plot (1200 shoots) was installed during the summer of 2014 near one of these sites. It will be monitored in the spring of 2015 to evaluate whether the transplanted eelgrass site can be expanded. On the western shore two small fringing continuous beds were found. A yacht club outstation and approximately 20 mooring buoys were observed in the harbour.

The eastern shore of **Madrona Bay** contains patchy continuous beds. Some dock construction and boat moorings were present. Gravel beaches line the bay.

The **Associated Islands of Salt Spring** are composed of 14% eelgrass habitat. Four potential eelgrass restoration sites were noted. Impacts included boat anchoring, present day and historical log booming operations, placement of mooring buoys in shallow waters and shoreline modifications resulting in potential hardening of the shore. Note that the Isabella Islets were not surveyed as they are within the Gulf Islands National Park Reserve boundary.

Wallace Island to the northeast of Salt Spring Island contains extensive continuous flat eelgrass habitat on its northwestern shores. However, **Princess Cove** is composed of sandy substrate and was evaluated as a suitable eelgrass restoration site, as well as another site to the south of this area. Boat anchoring may be impacting this area; with improvements in boat mooring practices, eelgrass in Princess Cove, within the Wallace Island Marine Provincial Park, could be restored. Two potential eelgrass restoration sites were located on the western shore of Wallace Island.

One potential eelgrass restoration site was also located off the southeastern shore of **Secretary Island**. A small patch of eelgrass is growing in this area, which may have been used for log storage in the past. Dense intertidal and subtidal eelgrass beds were noted on the southern end of the Secretary Islands. Most likely rocky cobble substrate limits eelgrass growth between otherwise continuous eelgrass. A seal haul out was observed in one of the south west facing bays. The survey of shallow eelgrass habitat in these bays was limited by tide levels and rocky substrate.

Mowgli Island has a small fringing continuous bed on its south and north shores. The southwestern facing shores of **Norway Island** contain continuous and patchy eelgrass habitats amidst rocky outcrops. **Jackscrew Island** has small continuous flat eelgrass beds growing in muddy sandy bottoms of its western shores. Some of the beds are extending into the intertidal zone. **Hall Island** has two continuous eelgrass beds and a patchy bed less than 10 m^2 on its southeastern shore which extends into the intertidal zone. Eelgrass patches are growing within a small cove in the most southern area. The entrance of this site is surrounded by *Nereocystis* sp. and other kelps.

Eelgrass is continuous along the eastern, northern and southern areas of **Shoal Islands**. The northern Shoal Island eelgrass is dense (26 %-> 75% percent cover) and in shallow water (-0.9 to -3.5 m depth). Large schools of fish, harbour seals, gulls, Blue Herons, Canada Geese and eagles were observed here. One buoy was observed within the bed. There was also a logging operation noted on a large tidal flat site in this area. On the farthest northern section of this area, there was an abundance of logs and woody debris on shore, indicators of a highly impacted shoreline. Eelgrass distribution changes in this site from continuous to patchy or absent.

The southern, east facing beds of the Shoal Islands were dense (26%-75% cover) continuous flat habitats. A pulp mill and associated activities have impacted the southern area of these beds, such as the placement of a modified shoreline composed of rip rap. A white slime was observed on eelgrass blades in this area. However, it is recommended that the eelgrass beds surrounding Shoal Islands be protected as they illustrate a rich biodiversity within the Salish Sea, even though industrial activities are operating nearby (log booms to the north and a pulp mill in the south).

All eelgrass surrounding **Prevost Island** was surveyed, except for beds occurring within the boundary of the Gulf Islands National Park Reserve (Parks Canada). The majority of eelgrass habitats were situated on the southwestern shores and most were characterized as either fringing or flat continuous beds, some of which extended into the intertidal zone. One restoration site was indicated on the southeastern bay. One small continuous flat bed was observed on the central east side of the island. Most likely rocky substrate limits extensive eelgrass growth. Most of the backshore was naturally vegetated.

Piers Island eelgrass habitat is composed of extensive continuous bands on the south and eastern shorelines. Docks, boat moorings and their associated chains, and seawalls may be causing some of the habitat to be interrupted or less dense than if these structures were not present. In many places eelgrass was located behind docks closer to shore, which might indicate the locations of these docks may be shading otherwise continuous beds.

6.2 Saturna Island Local Trust Area

Eelgrass surrounding Saturna Island was surveyed between July 2nd and 29th, 2014 and is present on 19.5% of its shores, excluding the shores within the Parks Canada's Gulf Islands National Park Reserve. Fifty-seven percent of Saturna Island's shoreline is composed of rocky boulder and 32% sea cliffs.

Most of the eelgrass located within the Islands Trust Area on Saturna Island was located on the east side, where it is protected from the north westerly winds and waves by Mayne Island. The majority of shoreline on the south end of the island is under the protection and jurisdiction of Parks Canada's Gulf Islands National Park Reserve and was not included in this eelgrass inventory. Eelgrass on the southwest and southeast of the Parks Canada boundary was distributed in patchy and continuous flats. Impacts on eelgrass beds include mooring buoys, docks and shoreline developments that remove native plant vegetation from the marine riparian areas. One potential restoration site was located.

Within **Boot Cove** on the west side of Saturna Island, eelgrass was expected to be observed, as it is a very sheltered site with sandy substrate. However, the area is very heavily used with the construction of docks, placement of multiple mooring buoys and attached boats, floats and ramps throughout the cove. Eelgrass is present but is not dense and absent in many areas where it should be growing. There is potential at this site for restoration in cooperation with local residents. The eelgrass between **Trevor Islet** and Saturna Island was growing in shallow waters

(-1.3m). The surveyors were not able to access the site to map, but it was evident the entire area is eelgrass. Canada geese were observed swimming in the bed.

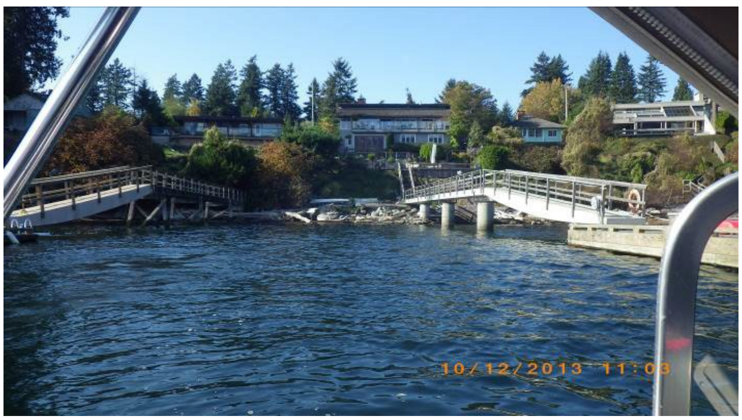
Eelgrass on the south shores of **Lyall Harbour** is mostly continuous flat beds with boulder shores and forested backshores. Towards the east of the harbour there is evidence of a former log booming site with three dolphins (upright log poles) in the site as well as a constructed breakwater and a grouping of wooden floats. Eelgrass is patchy at this location. Approximately one half of the backshore at the end of the harbour is landscaped (i.e. natural native vegetation has been removed). The north side of the harbour contains continuous beds extending into the intertidal zone. The backshore here is forested with rocky boulder shores. At some shore sites the eelgrass becomes dense (26%-75%).

The southwestern entrance to **Winter Cove** is composed of fringing continuous eelgrass with *Nereocystis* sp. kelp growing in deeper waters. The shores are predominately rocky with very small sandy beaches. The majority of the backshore in the bay is treed, with some rip rap placed on shore.

Eelgrass habitats off the southwestern shores of **Samuel Island** are continuous and flat. Canada geese were observed on shore. Except for a small continuous bed mid-island, there was no eelgrass noted on the northeastern shore. Most likely exposure to northwesterly winds and waves prevent its growth. Natural shorelines and backshores characterize this island.

7 Threats to Eelgrass Habitats

The majority of the earth's population now lives within 10% of land defined as "coastal". One of the results of this increased pressure on coastal shorelines has been the destruction of approximately 215,000,000 acres of estuarine habitat worldwide (BC/Washington Marine Science Panel 1994. With the population of the Georgia Basin/Puget Sound forecasted to exceed nine million people by 2020, nearshore critical habitat loss is likely to increase.



The following is a description of some of the major impacts human coastal settlements have on eelgrass habitats and their functions.

7.1 Removal and Burial

Dredging and filling associated with the construction of harbors and ports have been the major cause of the decline in eelgrass beds (Levings and Thom 1994). The plants themselves are removed and then the physical, chemical and biological composition of the system is altered. Sediments raised by dredging can also bury plants growing nearby and alter eelgrass density by affecting water clarity. The reduction in plant density can further increase silt load because it reduces the capacity of eelgrass beds to trap sediments. It can also increase the erosion of bottom sediments because of the reduced root mass available to hold sediments together. The ultimate result is the reversal of the entire nutrient-flow mechanics of the ecosystem. Dredging activities include hydraulic clam harvesting, bay scallop raking, oyster harvesting and maintenance dredging of

harbors. Filling in shallow wetland areas with the debris from wood processing (e.g. log dumps and log booms), sediment runoff from agricultural land and logging severely impact eelgrass habitats as well (Phillips 1984).

7.2 Pollution and Changes to Freshwater Input

Since estuaries are extremely vulnerable to changes in salinity and temperature, human activities affecting freshwater flows from streams heavily affect eelgrass meadows. Pristine watersheds surrounding estuaries provide steady supplies of fresh water and clean sediments to seagrass communities in the estuary. The opposite holds true as well: unhealthy watersheds increase the problems for seagrass distribution and productivity. Activities that cause increased nutrient loads in streams and rivers can result in overgrowth of algae that then die and deplete the oxygen from the bottom of poorly flushed bays. Chemical contaminants, such as fertilizers, pesticides and household hazardous wastes, runoff from streets and roads and runoff from industrial activities also add to the toxic composition of muddy bottoms of eelgrass meadows
(BC /Washington Science Panel 1994).

Quiescent waters are more susceptible to chronic contamination than areas with high energy water flows (Harrison and Dunn 1999). In the Salish Sea, more than 540 sq. kilometers of intertidal gravel, sand and mud habitat are closed for shellfish harvesting because of bacterial contamination. More than 730 sq. kilometers of shallow water habitat are unusable for crab and shrimp because of dioxin contamination from pulp mills. More than 32% of classified commercial shellfish growing areas in Puget Sound and Juan de Fuca Strait are either restricted or prohibited for harvesting due to water quality issues (Levings and Thom 1994). The same activities that impact shellfish, crab and shrimp harvesting also impact the health of eelgrass meadows.

Most toxic chemicals that accumulate in sediments in an inland sea such as the Salish Sea reside there for long periods of time unless they are physically removed. There is evidence that the roots of eelgrass take up a significant amount of heavy metals for long periods of time (e.g. lead, cadmium, zinc and chromium), thereby making up a large pool of heavy metals in coastal systems (Lyngby and Brix 1989). The consequences of toxic chemicals may have long term effects on eelgrass consumers, especially waterfowl and marine invertebrates.

7.3 Forestry Activities

Logging may cause scouring of stream channels and thereby increase sedimentation in estuaries, limiting the light available for photosynthesis. Bark chips from log booms smother eelgrass beds and form a blanket on the substrate, which leads to anaerobic sediment devoid of life (BC/Washington Marine Science Panel 1994).

7.4 Oil Spills

Oil spills pose serious threats to eelgrass communities growing in sheltered bays that are poorly flushed. These areas will tend to retain oil for long periods of time, becoming chronically contaminated. If spills happen in late

summer or winter when leaf sloughing is at its peak, mats of drift blades will tend to catch and retain oil for later decomposition in the intertidal zone. Seed production and viability could be affected if a spill occurs in the spring (Beak Consultants 1975).

7.5 Shading by Overwater Structures

Increase in demand for overwater structures in the islands can have deleterious and cumulative impacts on the nearshore system. Shading, disruption of nearshore marine water movement, damage to the shore and subtidal habitat and operational pollution from boats can be some of the impacts (Van der Slagt et al., 2003).

7.6 Effects of Boating

Boat propeller cuts disturb eelgrass beds in shallow waters, both when boats are travelling through shallow areas and when they are approaching the shore to debark passengers, moor or anchor. The impacts from boating activities in eelgrass beds may be affecting waterfowl such as Black Brant, direct grazers on eelgrass. The Brant have been steadily decreasing in the Pacific Northwest since the 1940's (Phillips 1994).

Conserving eelgrass habitats enhances the amount of high quality rearing habitat as well as increases the ecological services for human communities, including erosion control, sediment settling and food production (shellfish and fish). With the population of the Georgia Basin/Puget Sound forecasted to exceed nine million people by 2020, nearshore critical habitat loss is likely to increase.

7.7 Invasives

There seems to be an increase in the abundance and distribution range of the invasive seaweed, *Sargassum muticum* within the Islands Trust Area, although there is at present no research to substantiate this. Although the plant settles and grows on cobble, surrounding eelgrass in sandy/muddy sediment can be shaded out by its overarching canopy. The presence of *Zostera japonica* was noted on Lasqueti and Thetis Islands and other areas within the Islands Trust. This non-native species of eelgrass is not known to compete with *Z. marina*, though it can be found mixed with the native eelgrass in the lower reaches of the intertidal zone.

Though there is some disagreement about the causes of epiphytic algae growth on eelgrass blades, it is thought an abundance of algae growth can be an indication of the presence of excessive nutrients, causing blockage of light for photosynthesis and interfering with the exchange of nutrients and gas (Mumford 2007). An abundance of epiphytes was noted within Telegraph Harbour on Thetis Island and Montague Harbour on Galiano Island.

Canada geese are infamous for their grazing on eelgrass shoots. They were noted in large numbers on Lasqueti, Gabriola, and North Pender and South Pender Islands. Overgrazing of shallow eelgrass beds might be a growing concern as the birds are increasing in range and numbers.

As winter storms intensify, there might be an increase in burial of eelgrass shoots by sand over wash. Monitoring eelgrass habitats over time in selected locations vulnerable to storm events might shed light on the effects of climate changes upon the nearshore environment.

8 Eelgrass and Rising Sea Levels

Sea level rise and increased frequency and intensity of extreme weather are two expected and observed effects of climate change (IPCC, 2007, IPCC 2012). The Intergovernmental Panel on Climate Change warns that on small islands in particular, sea level rise is expected to exacerbate coastal hazards such as storm surges, floods and erosion (IPCC 2007).

Impacts of rising sea level on the coastline of the Salish Sea will be more complicated than the inundation of low-lying areas. The effects will differ significantly between different shoreline features. Inland movement of sea water (Titus and Strange 2008), as well as erosion and re-deposition of sediment will reshape the coastal landscape where there is room for the shoreline to shift and sufficient sediment is available (Mumford 2007). Increasing sea levels are expected to shift the zone in which sunlight is available to eelgrass beds. As a result, eelgrass beds are expected to shift inland unless barriers impede this shift (Titus and Strange 2008).

Further research of additional current or historical activities affecting soft-bottom areas around the islands would help to develop a more complete picture of possible limitations to eelgrass growth. These could include forestry activities, shoreline erosion due to coastal development and exposure to natural waves and boat wakes.

9 Recommendations

Globally, eelgrass has been used as an indicator of water quality (Neckles 1994). Often, a bed will decrease or increase in width and length dependent on light availability. The lower depth distribution of eelgrass is related to overall water clarity. Water quality, including water clarity, 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 from increased sediment or plankton blooms associated with increased nutrients from land, eelgrass meadows adapt to the poor light availability through dieback, decreases in density or width and migration to shallower depths.

The Islands Trust Area is home to more than 25,000 people and is located between the highly populated centres of Vancouver, Victoria and Nanaimo. However, only approximately 12.5 % of the marine environment has some type of protection. Most of this protection is in Rockfish Conservation Areas, with

Provincial and Federal Marine Protected Areas accounting for only 1.53% (Islands Trust Fund Regional Conservation Plan 2011-2015). Sound decisions by local trustees and an educated public are necessary to protect the functions of the nearshore for all who benefit from their healthy ecology.

A set of recommendations is listed below to contribute to the conservation of *Zostera marina* within the Salish Sea.

9.1 Education

1. Educate boaters and coastal residents about the presence and importance of eelgrass beds.

2. Encourage shoreline landowners to replace light-impenetrable docks with materials that allow light penetration.

3. Encourage signage at boat ramps reminding boaters to avoid eelgrass beds in shallow water.

4. Build public awareness about the importance of reducing nutrient inputs in marine riparian areas; encourage protection and restoration of wetlands and the construction of retention ponds to filter land based pollutants; and encourage reduction in the use of fertilizers, pesticides and herbicides.

5. Develop a long term public outreach nearshore marine education strategy that includes new

shoreline property owners.

9.2 Regulatory and Enforcement

1. Limit dock development, particularly in established and potential eelgrass areas (i.e. areas where substrate is suitable for eelgrass growth).

2. Encourage creation of "No anchoring/mooring" zones in suitable eelgrass areas (based on substrate, depth and observed presence of eelgrass); encourage movement of moorings to areas too deep for eelgrass.

3. Limit shoreline development; maintain a coastal riparian zone that will enable inland shift of eelgrass beds as sea levels rise.

4. Create and implement appropriate setbacks for built structures from the nearshore.

5. Limit or reduce overwater structures; increase shared community docks and wharves when possible.

6. Require removal of illegal shoreline modifications; require restoration or removal of aged derelict structures where possible.

9.3 Opportunities for collaboration with other agencies

1. Encourage and undertake as resources allow regularly scheduled monitoring of sensitive or vulnerable shorelines; make monitoring results readily accessible to all.

2. Where boat traffic must go through an eelgrass bed, encourage establishment of marked boat channels so that the least damage is done to the habitat.

3. Create protected marine zones and encourage planned siting for mooring buoys for recreational boats around eelgrass beds.

4. Promote management strategies to mitigate conflicting uses in eelgrass habitat, such as oyster and clam harvesting, boating and anchoring in meadows and near-shore development requiring dredging.

5. Promote restoration of natural hydrology when opportunities arise.

6. Promote restoration of eelgrass habitats where possible.

7. Work with BC Parks staff (Ministry of Environment) and other organizations to establish best practices for anchorages and mooring buoy sites and encourage active monitoring of the usage of those sites.

Part 2

1 2013 Eelgrass Restoration and Monitoring

Monitoring of past transplant sites was completed in August and September of 2013. Based on the results of these surveys, suitable locations were identified for transplants near or within these transplanted areas for the fall of 2013 and spring of 2014. The transplants installed in the fall of 2013 were monitored in February, 2014.

Based on all monitoring data, additional eelgrass shoots were planted in Cowichan Bay (Genoa Bay and a Channel site within the estuary), Stawamus (Squamish), Halfmoon Bay, and Sechelt Inlet. The monitoring results are included in this report. Tod Inlet within Saanich Inlet received over 400 shoots in March, 2014.

In August and September of 2013 and February and March of 2014, a total of 7,775 eelgrass shoots covering over 775.5 m^2 were transplanted in six sites within the southern Salish Sea. A mapping expedition took place in March of 2014 in the Saanich Inlet and south of Cowichan Bay to find additional restoration sites for the 2014-2015 field work.

1.1 2014-5 Restoration and Monitoring

In July 2014 monitoring of areas within Sechelt Inlet determined that three of them (Mt. Richardson, Porpoise Bay and McLean Bay and Lamb Bay) warranted test plots. A survey of several areas in the southern Salish Sea (Salt Spring, Pender, Mayne and Gabriola Islands, Mill Bay, Maple Bay, Genoa Bay and Saanich Inlet) determined that eight sites were suitable for eelgrass transplant test plots. A total area of 762m^2 was transplanted between July and September 2014 at these sites. They were monitored for area extent and density in February and March, 2015. Of all eleven sites, it is deemed nine are indicating they are suitable candidates for more transplants in 2015.

Further surveys for potential transplant sites will be carried out in the spring and summer of 2015, based on the eelgrass inventory of the Islands Trust Areas and on invitations by First Nations. Tsleil-Waututh First Nations in Burrard Inlet and the T'sakis First Nations in Port Hardy have extended invitations for surveys and possible restoration.

1.2 Methodology for Eelgrass Transplants

In the Pacific Northwest, the history of success for *Zostera marina* transplanting projects was dismal prior to 1985. Initially transplant techniques were used that were developed and successful on the Atlantic coast. However, these techniques were not well suited to the Pacific north coast environment and eelgrass. Many of the early transplants were conducted without a thorough understanding of eelgrass physiology and ecology; the donor stock was not always well suited to the area where they were transplanted, and the biophysical conditions of the transplant site were not always appropriate for the species. (pers. comm. Durance)

Since 1985, knowledge and experience from adaptive management practices have resulted in a higher success rate for focused mitigation and enhancement projects along the Pacific coast. (Thom et al 2000) In an assessment of 17 eelgrass transplant projects that were completed between 1985 and 2000 in British Columbia, Cynthia Durance (Precision Identification) rated seven projects as successful, four as failures, and five recently planted projects were deemed most likely successes within several years. Since that time the five recently transplanted sites have been documented as successful. The majority of projects surveyed were motivated by the *No Net Loss* policy of Fisheries and Oceans Canada. The success of one site could not be determined due to an absence of interim monitoring data and the expansion of the surrounding natural eelgrass population. (Durance 2000)

Factors that led to a higher success rate included the correct selection of physical attributes for the compensation area, including elevation, substrate composition and light and current regime. The selection of the most suitable ecotype or genotype increased the likelihood for success and rate of production. (Table 1) The criteria for success included shoot density and area re-vegetated (Durance 2000).

Table 1: Three Ecotypes on the Coast of B.C. Ecotype	**Relative leaf size**	**Leaf width (mm)**	**Depth range (m)**	**Seasonal variation in size**	**Current tolerance**
typica	narrow	2 to 5	primarily intertidal	small variation	low
phillipsi	intermediate	4 to 15	0 to -4	large, plant length reduced in winter	moderate
latifolia	large	12 to 20	-0.5 to -10	minimal variation	strongest

Combined with the selection of the appropriate ecotype for the donor plants, and barring unforeseen stochastic events, the success rate of restoration projects has climbed steadily since 1985. A comprehensive review of thirty- nine eelgrass restoration efforts in the United States by the National Marine Fisheries Service verifies that knowledge about eelgrass ecology has improved. (Hoffman, R. 2000)

The main criteria for successful transplanting is determined by suitable site selection with the appropriate biophysical characteristics (salinity, sediment type, current velocity, light/depth, temperature, and pH), using suitable plant donor stock (ecotype), using an appropriate transplanting technique and handling the donor plants with care. (Durance 2000)

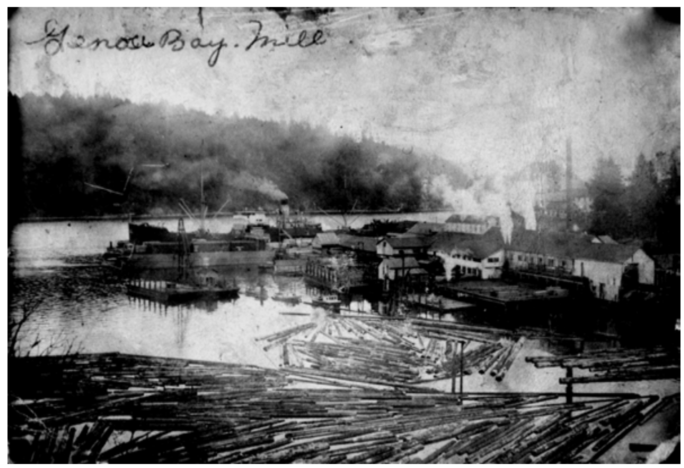
In 2000, Cynthia Durance of Precision Identification created a methodology for mapping eelgrass beds (*Zostera marina*) in British Columbia. Using this protocol, coastal community groups surrounding the Salish Sea (part of the Seagrass Conservation Working Group) started an inventory of these critical habitats for marine wildlife, including all species of juvenile outmigrating salmonid. During the course of these inventories, many communities expressed concern that where there should have been eelgrass, it seemed to be damaged or absent. Ms. Durance had developed a method for transplanting eelgrass that has been used successfully in over 80 sites throughout British Columbia as compensation to achieve No Net Loss. This methodology is used for community based restoration in sites that have been formerly utilized for log storage.

Eelgrass is dependent upon vegetative reproduction; once established, a patch of eelgrass may reclaim a damaged site at a rate of approximately 0.5 metres in all directions annually.

With the support of experienced scientists in estuarine environments and a certified Workers Compensation Board (WCB) SCUBA dive team, community stewardship groups have been trained to accelerate the pace of reclamation for important marine bird, fish, and invertebrate species that utilize these environments for food, protection, and metabolic growth.

Small test plots of 500-1000 shoots are transplanted after an initial assessment is completed to evaluate the suitability of the site. The benefit of setting up these smaller plots in estuaries that have been utilized for log storage is that these highly degraded habitats would benefit most from the establishment of eelgrass that would remediate the poor sediment conditions (low oxygen and high concentrations of sulphides).

Logging activity within the Squamish estuary on the opposite shore of the Stawamus restoration site



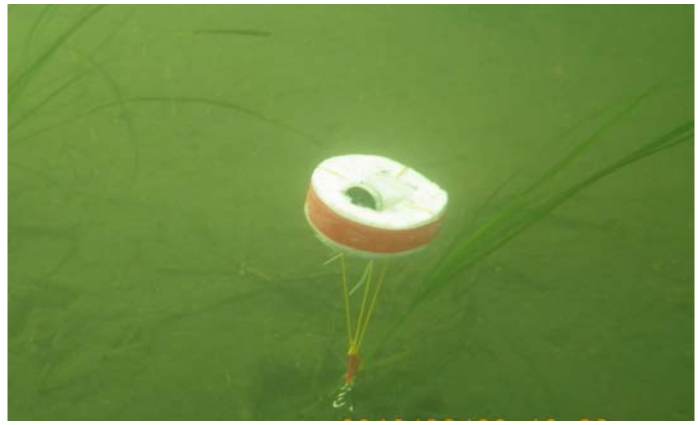
Genoa Bay mill in the past, south of the restoration site within the Cowichan estuary

Log rafts in log storage areas can introduce soluble organic compounds into the water. These leachates increase benthos oxygen uptake, decrease dissolved oxygen, lower pH and increase toxic sulfide compounds (Ascaphus Consulting, 2003). Cynthia Durance has observed over years of monitoring eelgrass transplants that the iron eroding from the ungalvinized steel washers used to anchor eelgrass shoots into the sediment creates favorable conditions for the eelgrass growth (pers. comm.).

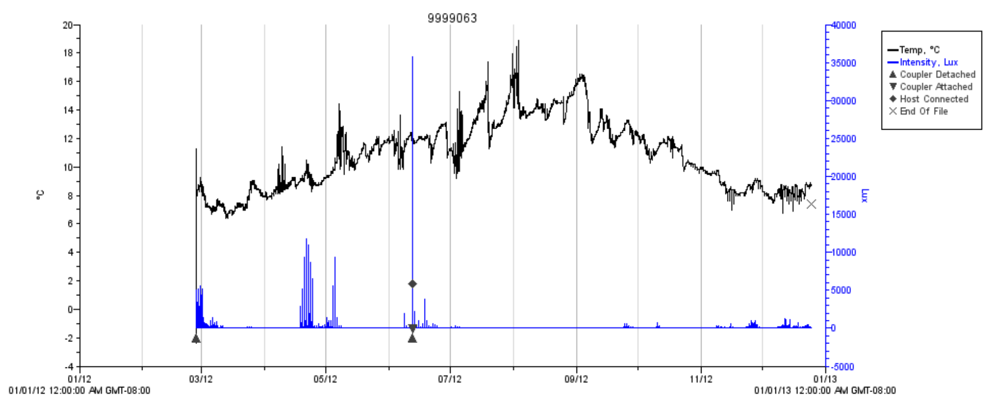
Field observations confirm that the rust from the steel anchors (Fe) chelates with sulphides ($SO4$) in the sediment. Oxygen is released that was bound to the sulphur in the sediment. It was surmised that available iron near the roots of the eelgrass rhizome would encourage growth.

1.3 Water Quality Monitoring

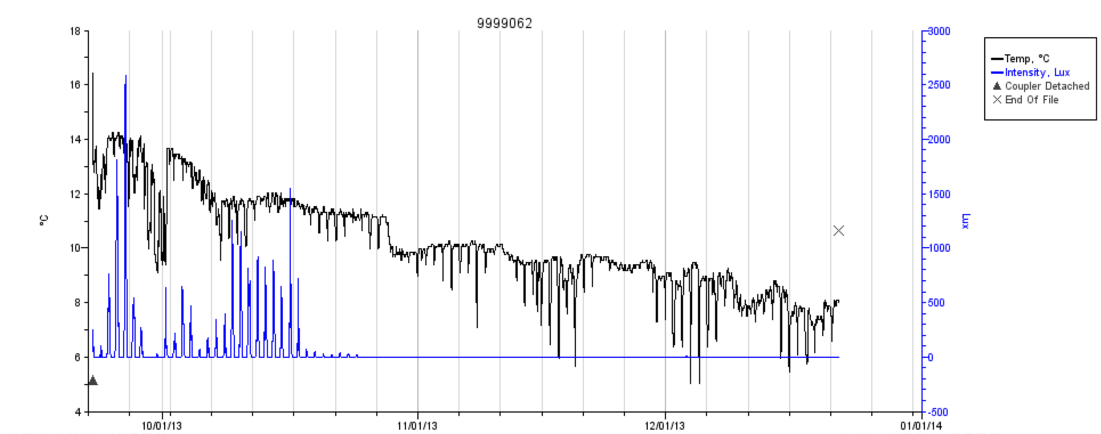
HOBO water monitoring units were installed in six sites: Genoa Bay (installed February 2015), Cattermole Slough, and Stawamus Reserve in the Squamish Estuary, Tillicum Bay in the Sechelt Inlet and Gallagher Bay and Long Harbour in Salt Spring Island. These units monitor water temperatures and light availability over one year. They were installed within the transplanted beds at the same height as the average eelgrass shoot. Information has been downloaded from each unit after six months in the water. Most likely it will take at least two years of monitoring before changes in water temperature and light availability over time can be accurately measured within and between sites. This data is stored with SeaChange and is available upon request.



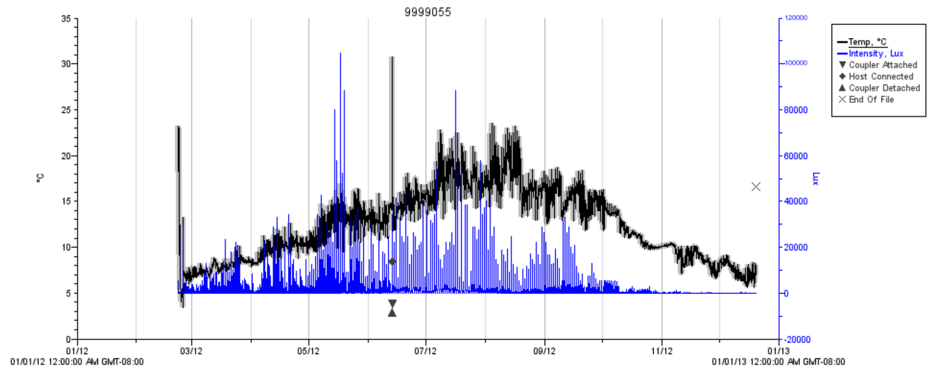
Cattermole Slough, Squamish Estuary



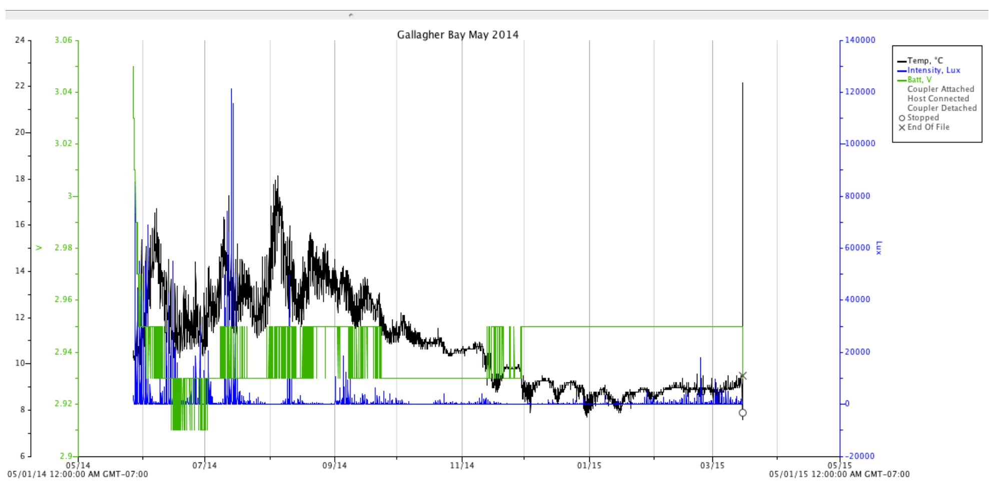
Stawamus Reserve, Squamish Estuary



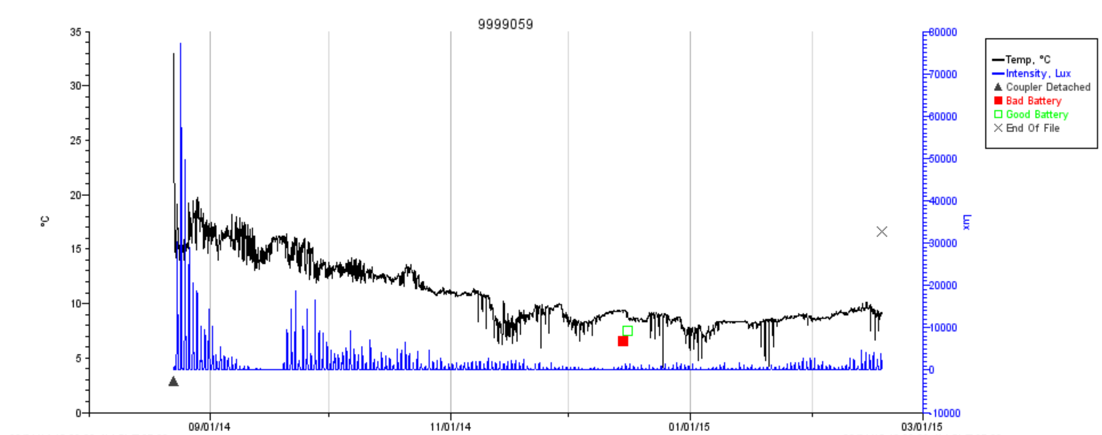
Tillicum Bay, Sechelt Inlet



Gallagher Bay, Salt Spring Island



Long Harbour, Salt Spring Island



1.4 Monitoring Results February 2014

Location	# of samples	Mean Average # shoots/m^2	Shoot Width (mm)	Shoot Length (cm)	Comments	Area Coverage Planted 2013-2014 (m^2)
Cowichan Bay Site 1 Channel Site Site 2: Genoa Bay	Site 1: 10 south : 10 north: 21	5.9 shoots/patch 2.4 shoots/patch 4.8 shoots/patch	4.8 5 5.3	25.8 27.5 32.3	Site 1 appears healthy and growing, although some grazing by geese is evident. No further transplants planned until further monitoring completed. Site 2 does not appear to be healthy – sediment quality may be an issue within the marina near boats, as the area is quite protected from grazing and physical disruption. No further transplants planned. Site 3: Sediment within this site suitable for more shoots. Clean up of underwater and intertidal debris is planned with local community partners.	376.6 m^2
Squamish (Stawamus FN Reserve)	10	8.4 shoots/patch	9.6	68.4	Shoot density and length very similar to those observed during past monitoring surveys. Length of shoots indicates light availability due to high turbidity from snow melt. Area is very stable and protected.	149.7 m^2
Halfmoon Bay	7	10	6.3	61	Sediment is suitable for more transplants. Some disturbance from crabs evident	90 m^2
McLean Bay, Sechelt Inlet	7	9.4	3	52.9	Very productive habitat: Juvenile rockfish, perch, greenlings, flounder, sculpins and other marine life observed during monitoring. Sediment very suitable for	117.5 m^2

					more transplants.	
Tod Inlet, Saanich Inlet	10	3.7/patch	4.7	46.8	Based on this data, an extension of eelgrass was installed east of the monitored site. This site will be monitored regularly, but no new transplants are planned.	41.7 m^2
					Total	**775.5 m^2**

Monitoring results in February indicate only the beginning of spring growth of new shoots, but it was important to monitor changes after 6 months from the transplants to observe any adverse effects on the plants from human or biological activities. The density of the transplants was assessed using a 0.25m^2 quadrat. An average of shoots per patch, width and length of a shoot within a patch was calculated.

Tying anchors onto eelgrass shoots prior to transplant

1.5 February/March 2015 Monitoring Results

Barge Site, Saanich Inlet
15 samples
February 10, 2015
11:48 9’ depth
48˚41.278’ N 123˚32.059’ W

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	11	38	4	57
Maximum	20	72	7	
Average	**15.2**	**57.9**	**5.9**	

Notes:
Marine life observed: Ascidians, snails, juvenile crabs, anemones, ochre stars, shrimp, kelp crabs, and bubble snails
571 eelgrass shoots were transplanted Sept. 24, 2014. Monitored four months after transplant, the shoots remain in distinct alignment but are healthy; 95% survival rate. Plans are to transplant more shoots in 2015 @ 12’ – 16’ depth east of this transplant site. Please see video for visuals.

Mill Bay (Brentwood College site)
18 samples
February 10, 2015
13:15 11’ depth

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	8	30	4	66.4
Maximum	19	69	9	
Average	**12.5**	**52**	**6.4**	

Notes:
Marine life observed: Rock crabs, shrimp, bubble snails, nudibranchs, limpet, juvenile flat fish, and moon snail.

Native eelgrass located in 8-11’ depth. Transplant of 664 shoots Sept. 22, 2014 to fill in gap. Abundance of *Ulva spp*. present. Nine Brentwood College students and two instructors assisted with transplant. When the site was monitored in February, there was evidence eelgrass shoots had been disturbed by juvenile crabs (~10% damage). Where not disturbed, shoots appear healthy and growing. Site will continue to be monitored over the spring to observe growth and further bioturbation from crabs or impacts from other activities. This might be a suitable site to test adaptive management strategy, such as a metal grid (rebar) form to attach eelgrass rhizomes, which might limit crab disturbance.

Maple Bay (Imadedene Cove)
15 samples
February 11, 2015
10:40 13’ depth

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	5	30	4	122.5
Maximum	17	70	7	
Average	**10.2**	**51.6**	**5.7**	

Notes:
Marine life observed: Pipe fish, Leather juvenile stars, snails, shrimp, isopods, nudibranchs, and hermit crabs.

One thousand two hundred and twenty-five shoots were transplanted August 26, 2014 to fill a gap between two native eelgrass beds. While monitoring the site, the depth sounder indicated several schools of fish travelling nearby (species unknown). Some disturbance by crabs was observed, but the native and transplant beds appear very similar (see below). Recommendation is to monitor the site again in late spring and transplant more shoots if monitoring results indicate successful growth and expansion.

Maple Bay native eelgrass bed adjacent to transplant site
6 samples
February 11, 2015

	#/0.25 m^2	Length (cm)	Width (mm)
Minimum	4	23	4
Maximum	12	66	5
Average	**9.2**	**47.3**	**4.5**

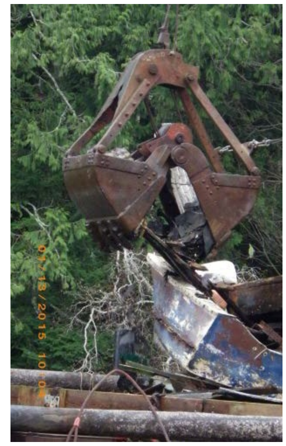
Genoa Bay site
15 samples
February 11, 2014
15:26 7’ depth
N 48˚ 46.023’ N 123˚ 35.916’ W

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	3	32	5	240
Maximum	16	62	8	
Average	**7.3**	**49.4**	**6.1**	

Notes:
Fifty tons of underwater and intertidal debris were removed from this site in January 2015, thanks to funding support from PSF and

the Kruger Foundation. The debris that was removed on the intertidal beach might have covered over suitable sand lance and surf smelt spawning areas, as the sand/gravel mix is suitable sediment.

The removal of underwater vessels as well as metal and lumber debris initiates a community outreach program to encourage boaters not to abandon their vessels and allow them to sink in nearshore sensitive habitats. Maps of already sunken boats will be used in the Cowichan Valley community educational program which will be undertaken in partnership with the Cowichan Community Land Trust (CCLT) and with participants of the Cowichan Round Table.



A total of 2400 eelgrass shoots was installed in this site in 2013 - 14. More eelgrass shoots will be transplanted in Genoa Bay on the northeast side of the estuary in 2015. Monitoring will continue over the next five years.

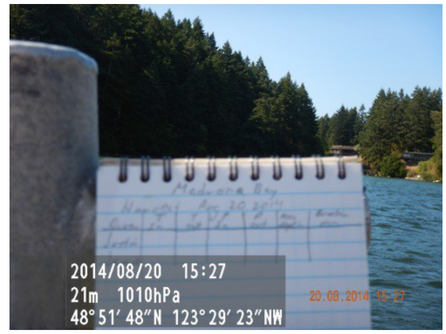
Potential sand lance and surf smelt spawning habitat cleared at Genoa Bay.

North Pender Island site (Bracket Cove)
1 5 samples
February 18, 2015
11:13 7’ depth

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	5	57	6	80
Maximum	19	80	10	
Average	**10.2**	**71.3**	**7.5**	

Notes:
Marine life observed: Sculpins, hermit crabs, needle fish, sole, snails, hooded nudibranchs, shrimp, perch, Buffleheads.
Eight hundred shoots were transplanted August 19th, 2014 at a 9’-11’ depth gradient. Ten community volunteers assisted with tying anchors to the plants. Approximately 75% of the shoots survived. The shoots on the shallow end of the site are doing better than in the deeper end. In the middle of the site, there seems to b e disturbance, possibly from crabs, as anchors without shoots were observed on the surface of the sediment (not buried). Recommendation is to consider planting additional shoots on the southern end of the site – up to 1,000 plants.

Salt Spring Island (Madrona Bay site)
16 samples
February 18, 2015
14:45 12' depth



	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	4	14	4	50
Maximum	23	60	6	
Average	**9.9**	**35.6**	**4.8**	

Notes:
Marine life observed: Shrimp, sole, hermit crabs, hooded nudibranchs

Five hundred shoots were transplanted Aug. 21, 2014. When monitored February 15, 2015, 60% survival rate was observed within the patches. Some disturbance noted from crabs and possibly wave energy from northeasterly winds. Native eelgrass beds at this site have ~50% less density than observed during the summer of 2014. Recommendation is to continue to monitor this site with no new transplants planned for spring 2015.

Salt Spring Island (Long Harbour site)
11 samples
February 18, 2015
15:48 12' depth

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	2	4	3	240
Maximum	10	35	5	
Average	**5**	**24**	**3.7**	

Notes:
A total of 2400 shoots were planted at this site in a protected area between dolphins in Aug. 22, 2014. When monitored on February 18, 2015, 30% survival of all shoots were observed. Data from the Hobo data logger was downloaded (see Section 1.3 above) and the data logger was replaced. Shoots appeared to be re-sprouting after possibly bioturbation by juvenile crabs; an abundance of crabs were noted during the transplant in August. Monitoring will continue during the spring and summer of 2015; if eelgrass recovers, this may be a suitable site for a metal grid-type transplant method to better stabilize the rhizomes and protect them from crab disturbance.

De Courcy Island (east of Gabriola Island)
14 samples
March 17, 2015
11:10 10' depth

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	2	32	5	88.9
Maximum	7	78	9	
Average	**5**	**60.4**	**6.6**	

De Courcy Island
Native eelgrass bed adjacent to transplant site
March 17, 2015
12 samples

	#/0.25 m^2	Length (cm)	Width (mm)
Minimum	9	30	6
Maximum	15	82	8
Average	**11.8**	**57.8**	**6.8**

Notes:
Marine life observed in the transplant site included crabs, pipefish, isopods, nudibranchs, bubble snails and clams.
Eight hundred and eighty-nine shoots were transplanted July 30th, 2014 with the support of community volunteers from Gabriola Island. The transplant bed was sparse, as was the native habitat, perhaps due to strong southeasterly winds during the winter months. A large amount of vegetative detritus was present, as well as an abundance of epiphytes on the eelgrass blades. Recommendation is to monitor the site again in the summer months of 2015 to observe regrowth rates in both the transplant and native beds and to consider further planting in this site.

Spring Beach (Gabriola Island)
14 samples
March 17, 2015
13:09 18'

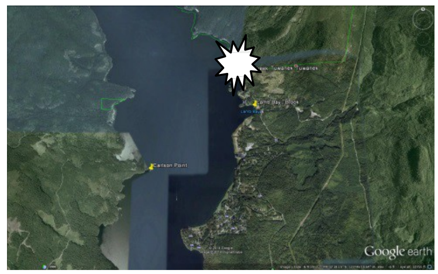
	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	2	56	6	42.5
Maximum	10	93	10	
Average	**5.9**	**73.9**	**7.8**	

Notes:
Marine life observed: Red rock crabs, flounder, kelp crabs, bubble snails, ochre stars, nudibranchs, isopods, multitude of harbour seals and California sea lions at the time of monitoring.

Four hundred and twenty-five shoots were transplanted July 31st, 2014. Monitoring indicates the rhizomes are securely anchored in the substrate. Recommendation is to transplant and continue to fill in the gap between the transplant site and the native bed during the summer of 2015.

Spring Beach native eelgrass bed
10 samples

	#/0.25 m^2	Length (cm)	Width (mm)
Minimum	2	36	5
Maximum	12	57	9
Average	**6.1**	**45.1**	**7.2**



Sechelt Inlet sites

1. Tillicum Bay (transplanted in 2012)

8 samples
March 26, 2015
14' depth
49˚32'29.0" 123˚45'49.6"

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	23	50	3	60
Maximum	53	74	4	
Average	**39.5**	**64.5**	**3.9**	

Notes:
Marine life observed: Kelp, Dungeness and hermit crabs, pipefish, pile perch, snails, sea stars.
Transplant bed demonstrates advantages of monitoring over several years, as this transplant did not show high densities or area extension over the first year. Six hundred shoots were planted in 2012. The transplants are much denser and are spreading since 2013, when first monitored. Recommendation is to consider increasing the bed with more shoots transplanted to the south of the existing test plot in the summer of 2015.

2. Lamb Bay

15 samples
March 26, 2015
12' depth

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	5	23	3	40
Maximum	10	77	9	
Average	**6.9**	**50.4**	**4.7**	

Notes:
Marine life observed: Snails and skeleton shrimp.
70% of the patches have survived from a transplant of 400 shoots in September, 2014. Substrate contains wood fibre. Recommendation is to continue monitoring site.

3. Lamb Bay native eelgrass bed
7 samples

	#/0.25 m^2	Length (cm)	Width (mm)
Minimum	7	42	4
Maximum	23	58	4
Average	**16.1**	**49**	**5**

4. Mt. Richardson
15 samples
March 26, 2015
8' depth
49˚33'03.5" 123˚45'52.6"

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	1	33	3	44
Maximum	13	95	6	
Average	**7.4**	**67.2**	**5.2**	

Notes:
Marine life observed: Kelp, red rock, Dungeness crabs, sea cucumbers, snails, sea stars isopods, and juvenile flat fish. Four hundred forty-four plants installed in September, 2014. Seventy-five percent of patches survived; 5-7' depth is optimal depth range for transplants. On the deeper end the eelgrass seems more gravelly and disturbed, possibly by crabs. Recommendation is to continue monitoring.

Mt. Richardson native eelgrass bed
6 samples

	#/0.25 m^2	Length (cm)	Width (mm)
Minimum	8	34	4
Maximum	21	78	6
Average	**12.2**	**49**	**4.8**

5. Porpoise Bay
15 samples
March 27, 2015
13' depth

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	4	35	3	72
Maximum	25	73	6	
Average	**12.4**	**50.1**	**4.1**	

Notes:
Marine life observed included isopods, moon jellies, sea stars, especially leather stars, flounder, pipe fish, flounder, Dungeness and hermit crabs. Ninety percent of the patches remain of the 719 plants installed in September, 2014. The upper edge (shallow end) is very productive. Recommendation is to consider planting more shoots in the summer of 2015 at this site.

Porpoise Bay native eelgrass bed
15 samples

	#/0.25 m^2	Length (cm)	Width (mm)
Minimum	13	31	4
Maximum	32	68	6
Average	**22.9**	**47.6**	**4.9**

McLean Bay
15 samples
March 27, 2015
12' depth
49˚30'36.8" 123˚45'30.1"

	#/0.25 m^2	Length (cm)	Width (mm)	Area (m^2)
Minimum	11	32	4	118
Maximum	76	105	7	
Average	**33**	**66**	**5.1**	

Notes:
Marine life observed: Sea stars, greenlings, horse, kelp, red rock, hermit, and Dungeness crabs, sculpin, pipefish, sea cumbers. Seven hundred seventy-five shoots were planted in 2013 and another 400 shoots in 2014 to fill in a gap between two natural beds caused by a former transfer station. The transplant is successful as the gap is completely filled in. Please view video for evidence of density and growth. Concern remains for planned housing development on shore. There is communication with the developers and a meeting with them will happen in April, 2015 at which time we will discuss the success of this habitat and present the videos from the beginning of the transplant in 2013 to the monitoring in

2015.

McLean Bay native eelgrass bed
14 samples

	#/0.25 m^2	Length (cm)	Width (mm)
Minimum	22	34	3
Maximum	42	55	6
Average	**28.6**	**43**	**4.3**

The conclusion gained from monitoring the above sites is of the 11 sites transplanted during the spring and summer of 2014, 8 of them show evidence of success and could receive more shoots in 2015.

According to research of transplanted seagrass beds in the United States (Fonseca, 2011), 50% recovery rate can be considered substantial from a natural recovery perspective. The rate of success can be compared to agricultural crops in any given year. Furthermore, monitoring these beds over at least 5 years will offer a perspective over seasonal and annual changes to the ecosystem. Bioturbation from crabs, sediment flows from streams and large river systems and climate changes are a few of the impacts affecting nearshore eelgrass habitats.

Eelgrass restoration is a proven positive alternative to no action at all. However, it is also important to note that it is far less expensive to conserve these critical salmonid habitats than it is to restore them. Thus community participation and education is key to any restoration strategy.

2 Outcomes

The objective of this eelgrass restoration initiative is to address issues related to historical log handling practices that limit the amount of critical habitat accessible for out-migrating salmon species and other marine wildlife that use the nearshore for nourishment, shelter and metabolic growth. Tod Inlet is an exception, as eelgrass habitat was lost due to point source pollution from the flow of leachate from the Hartland Landfill until the early 1990's into the estuary, and the cement factory, now Butchart Gardens, that was in operation until the mid-1950's. Because there is a dearth of research data about the limiting factors of these impacted marine subtidal environments, it is necessary to field test adaptive management strategies and monitor their success over time.

We have accomplished these goals for the two years of this project and surpassed them because of successful on-going community partnerships. The benefits of eelgrass mapping in the Islands Trust Areas have been notable since the beginning of the inventories in 2012. Our partnerships with the Islands Trust and the Islands Trust Fund have strengthened and created new connections with island organizations and Local Trust Committees (LTC).

The Trust Fund reports that as a result of mapping they have responded to data requests from

1) Parks Canada and Canadian Parks and Wilderness Society for use in National Marine Conservation Planning;
2) Ministry of Forest Land and Natural Resource Operations and the Bowen Island Municipality for use in evaluating shoreline infrastructure, such as docks and seawalls;
3) Strait of Georgia Data Centre initiative (through Pacific Salmon Foundation) and the Community Mapping Network to better track marine data in the Salish Sea;
4) Woodfibre LNG through Golder and Associates for use in their Environmental Assessment in Howe Sound; and,
5) Raincoast Conservation Foundation for a study about Ecosystem Services and the Salish Sea.

Islands Trust uses the maps internally to inform responses to referrals regarding dock applications and to evaluate the ecological values of conservation covenant proposals. The Local Trust Committees on Pender, Mayne and Thetis Islands have initiated community outreach (events, brochures) to protect eelgrass and other nearshore ecosystems.

During our mapping expeditions, we observed eelgrass growing in unexpected locations, such as between large boulders in an otherwise very rocky nearshores. This has increased our skill level to collect quality data. With this confidence we have offered our knowledge and services to the District of Oak Bay and the Tsleil-Waututh First Nations in Burrard Inlet. We are seeking new relationships with other First Nations communities concerned with harvesting and conservation issues within their marine nearshore environments.

Community Involvement has strengthened the likelihood of successful transplants. The Cowichan community is a good example. Whenever there is a threat to existing or potential eelgrass habitats, Cowichan residents are quick to respond, as happened when a derelict bridge from Hood Canal was moored off the causeway in the middle of the estuary.

In 2014, 99 volunteers assisted with restoration work; 66 in 2015. With the interest in nearshore habitats increasing through public education and hands-on volunteering with eelgrass mapping and restoration, eelgrass beds are now more in the public eye, and are more likely be considered in plans for land and overwater development.

2.1 Media Coverage

Some of the media coverage for the eelgrass inventories includes:

1) Island Tides Article http://islandtides.com/assets/IslandTides.pdf
2) Coast FM / MyCowichanValleyNow.com: Radio interview and website post http://www.mycowichanvalleynow.com/5669/islands-trust-fund-done-mapping-eelgrass-beds-salish-sea/
3) Thetis Island ESpokes: https://groups.google.com/forum/#!topic/thetis-island-espokes/LZHzhJSaxH4
4) Take 5 Magazine: Monthly magazine requested photos and info about Thetis Island. We'll keep any eye out for coverage
5) Facebook: Over 210 People Reached
6) Twitter clicks
7) Driftwood article

2.2 Discussion

Restoration of nature, by definition, is a complex process. Restoration ecology, a term created by William Jordan III and Keith Wendt is a learning-by-doing approach to understanding ecological principles. Restoration is distinct from mitigation and compensation, as it is the process of bringing back a whole system to a former condition. Jordan defines restoration as "everything we do to a landscape or an ecosystem in an ongoing attempt to compensate for novel influences on an ecosystem in such a way that it can continue to behave or can resume behaving as if they were not present." (Jordan, 2003).

Spatial and temporal extent of the damage from log storage areas is persistent. These impacts include chemical changes in the sediment, smothering by accumulated woody debris and physical alteration and disruption of intertidal and subtidal fish habitat from grounding logs. Such accumulations can physically and chemically alter aquatic systems to the detriment of fish habits, reducing their complexity and often obliterating nearshore vegetation vital for rearing juvenile salmonids. Research has found that site specific factors dictate plant re-colonization rates. There are no consistent eelgrass and algal recovery trends at abandoned sites relative to the amount of time since the last log booming operation. (Pease, 1974)

Restoration near urban and suburban areas presents the following challenges: limited sites available for restoration, limited reference sites, confounding factors, such as poor water quality, chemical contamination, and altered hydrology, fragmented habitat, differing needs for coastal resources (e.g., economic, cultural, social, recreational, environmental) and differing values of local citizens (City of Bellingham 2006).

However, as demonstrated by this restoration project these challenges are often offset by the following benefits:

- the restored habitat provides pockets of habitat where otherwise there would be none
- additional natural landscapes for urban residents (Ehrenfeld 2000)
- a heightened public awareness of coastal ecosystems (Milano 1999)
- educational opportunities
- public involvement in the restoration process of highly visible projects, resulting in

community stewardship

Chinook and coho nearshore habitat is impacted by historical and present land and water activities, but it is hoped that with the growing understanding of its ecological, cultural and economic importance these activities will diminish.

No one data type can stand alone in a monitoring program (Fonseca et al, 1987c, Fonseca 1989a). For some of the small test plots (Squamish), a percentage of the original number of shoots was recorded. In other sites, the actual number of surviving plants was taken and is critical as well. If a planting is small (~500 - 1,000 shoots), all shoots are surveyed for presence or absence (survival survey). The existence of a single shoot indicates its survival because it is associated with a rhizome meristem. Otherwise, subsequent vegetative growth will not occur. This means that if even if a small percentage of the total shoots planted survive; there is likelihood that the transplanted bed will regenerate over time. An example is the Tod Inlet transplant in 2000. Eighteen hundred shoots were planted, with a 23% survival rate after one growing season. That bed in 2014 is now a narrow fringing eelgrass bed, limited by elevation and substrate and protected by buoys. Monitoring of all sites for at least five years after a transplant is crucial, as the rate of change is also affected by seasonal and annual factors.

One hundred sixty-five community volunteers from Squamish, the Sunshine Coast, Cowichan Bay, Mill Bay, Pender, Salt Spring and Gabriola Islands and Victoria participated in the transplants (2013-5). Cowichan, Squamish and Tsartlip First Nations have been strong supporters of the increase of eelgrass habitat within their territories.

Stewardship of these habitats depends upon community support and awareness. Without the commitment and hard work of the Seagrass Conservation Working Group (SCWG) Area Project Coordinators, Dianne Sanford (Sunshine Coast), Edith Tobe (Squamish River Estuary), Leanna Boyer (Mayne Island), Kai Reitzel of Cowichan Bay, Sara Steil of Pender Island, Laura-Jean Kelly on Gabriola Island, Laura Richardson of Brentwood College in Mill Bay and Sarah Verstegen of Brentwood Bay, we would not have achieved success. They supported this work by mapping where eelgrass is and where it should be over large areas, found matching funds, organized community volunteers and helped with logistical issues.

It is hoped that this movement towards recovery of lost marine nearshore habitat is long term, as increasing success depends upon persistence, on-going field observations, applied academic research, community stewardship initiatives, good communications and continued funding. We will continue using adaptive management strategies based on results gleaned from monitoring these sites so that we can accelerate the rate of reclamation for destroyed and damaged critical habitat for all species of salmon and the food webs that support them.

3 Recommendations and Conclusion

1. It is extremely beneficial to continue and establish new partnerships with First Nations, local governments and non-government organizations and academic institutions so that critical marine habitat conservation and restoration can progress sustainably.

2. It is recommended that the monitoring schedule for the eelgrass transplant test plots be continued for all eighteen transplant sites for the next five years to determine the density and area extent of each installation.

3. Monitoring of near-by native eelgrass beds in close proximity to transplant sites should occur to observe the recovery rate (density and area extent) of the transplanted sites. The maximum density of eelgrass within the transplant should eventually mirror that of the adjacent population. However, the mean density in natural eelgrass beds varies between years and seasons. Therefore comparisons between the transplants and the adjacent natural population should be made based on data collected at the same time. (Durance op. cit.). A report by Olesen & Sand-Jensen (1994) suggested that new *Z. marina* beds required a minimum of five years to become established and stable. Transplant failure is generally detected within six months.

4. Continue to install new test plots in areas defined by the results of mapping the Sechelt Inlet in future years, as the inlet is very productive and water quality is good.

5. Combine the results of the Chinook study (2010-2012) in the Squamish River Estuary and Howe Sound to identify key areas where out-migrating Chinook could benefit from restored eelgrass habitats.

6. Continue to survey the southern Salish Sea areas identified as potential eelgrass restoration sites from eelgrass inventories for the Islands Trust Areas. These sites need to be ground-truthed with SCUBA divers and an underwater camera to determine which are suitable to receive test plots.

7. Continue to establish new partnerships through public eelgrass ecology presentations and maintain positive on-going relationships with the Tsleil-Waututh, Cowichan, Sechelt, Saanich and Squamish First Nations communities.

8. Criteria for site selection for eelgrass transplants are critical. A decision making matrix created by a student at the University of Victoria Dept. of Environmental Studies will hopefully make all the factors included in site selection more available to coastal communities' efforts to increase nearshore salmonid habitat. (Please see Appendix D)

10. Experimenting with metal grids for some transplant sites disturbed by juvenile crabs may increase the likelihood of transplants succeeding in areas, such as Long Harbour and Mill Bay. Also we plan to

place sediment traps to monitor sediment flow rates in areas influenced by large river systems (Cowichan and Squamish in particular). Water monitoring with HOBO units continues to be an inexpensive and accessible method to track water temperatures and light availability

Community conservation groups can successfully carry out eelgrass habitat assessments, transplanting and monitoring projects with professional scientific supervision and with authorization from Fisheries and Oceans Canada. The prototype for such activities is the eelgrass mapping project involving 35 community groups. From 2002-2008 well over 1,000 volunteers mapped over 12,000 hectares of eelgrass habitat from Haida Gwaii to Boundary Bay. They are trained in mapping protocols and received stewardship materials beforehand. Some of the mapping data can be viewed on the Community Mapping Network web site: http://www.bc.ca/atlases/atlas.html

This eelgrass network influences the culture of volunteer based environmental conservation organizations by placing them in an active rather than reactive position regarding shoreline development. Many of the thirty-five groups use their maps for locating eelgrass habitat to influence decisions regarding the development and use of the nearshore. Progressing from mapping to restoring damaged or destroyed eelgrass habitats can further strengthen the capacity of grass roots stewardship organizations to affect positive environmental change.

It is proposed that this eelgrass network be utilized to make the next step towards habitat restoration. The groups can assist with restoration by providing labour for shoreline work and assisting with monitoring for restoration projects.

The more work that is accomplished by volunteers, the larger the share of the budget the community would receive for the restoration work. Approximately 80% of all the funding revenue SeaChange has received thus far for this project has funneled into local coastal community economies.

Volunteers have a double incentive in knowing that their time, skills and/or equipment are contributing both to habitat renewal and financial support of a community conservation organization. Volunteer involvement in restoration also increases a community's investment in making sure the restoration site is well stewarded. By making use of the skills and commitment of stewardship groups, more can be accomplished.

For example, the municipality of White Rock funded a transplant project in 2003 for 100 plants. The Friends of Semiahmoo Bay, a local conservation group, augmented the project. They donated their labour on shore, increased the number of plants transplanted and raised awareness of the importance of the habitat in the community. Another eelgrass restoration occurred more recently in the Comox estuary by Project Watershed. This narrative has been repeated over the years within the Salish Sea – indeed it is one of the only ones that give hope that critical nearshore marine habitat can be conserved and increased when appropriate.

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Photographers:

Leanna Boyer, Anu Rao, Dianne Sanford, Jamie Smith, Sarah Verstegen and Nikki Wright Video footage

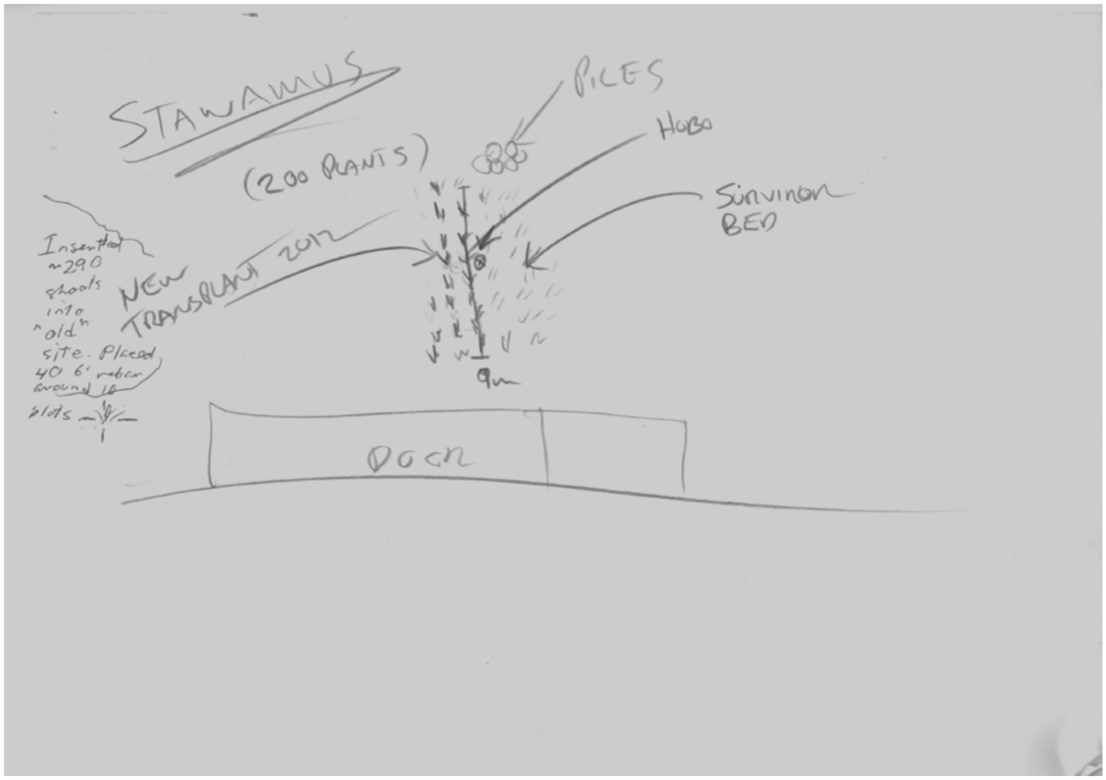
sequences:

Cowichan Bay sites: 0:33-11:57 Stawamus
(Squamish): 11:58-16:57
Halfmoon Bay: 17:07-21:01
Tillicum Bay: 21:02-21:23
McLean Bay: 21:28-27:55
Tod Inlet: 27:56-31:52

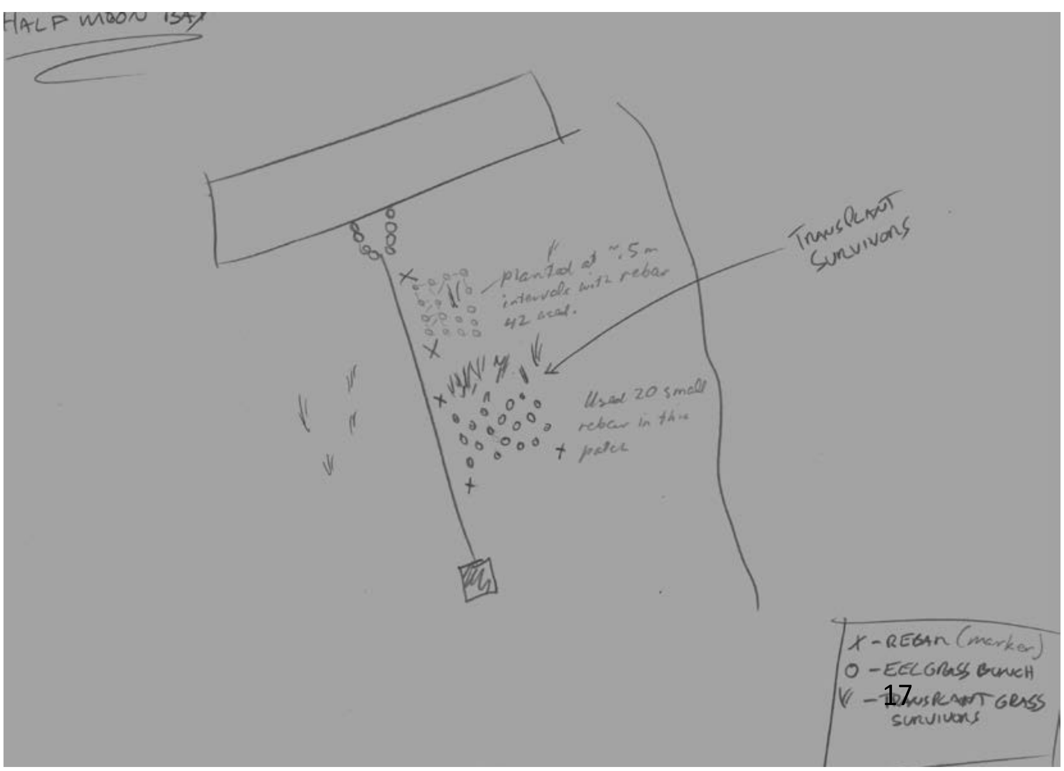
Appendix A Site Sketch Maps

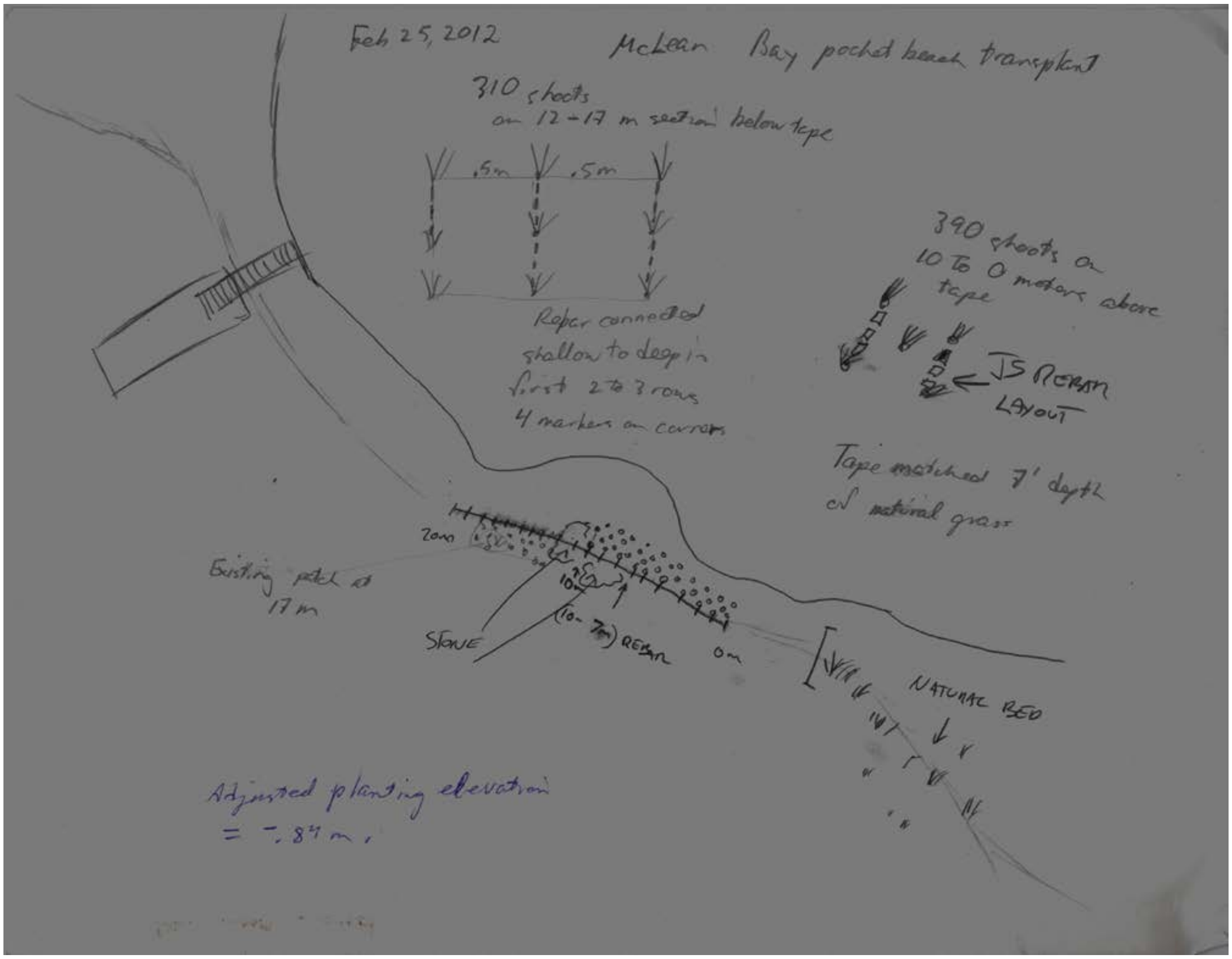
Transplants September 2014

Stawamus (Squamish First Nations Reserve)



Half Moon Bay Sunshine Coast




Feb 25, 2012
McLean Bay pocket beach transplant
310 shoots
on 12 - 17 m section below tape
.5m
.5m
Rebar connected
shallow to deep in
first 2 to 3 rows
4 markers on corners
390 shoots on
10 to 0 meters above
tape
JS REBAR
LAYOUT
Tape matched 7' depth
of natural grass
20m
Existing patch at
17 m
STONE
(10 - 7m) REBAR
0m
NATURAL BED
Adjusted planting elevation
= -.84 m.

Appendix B

2013-2014 Restoration Sites

Half Moon Bay, Sunshine Coast

McLean Bay, Sechelt Inlet

Stawamus First Nations Reserve
Squamish River Estuary

Genoa Bay

Channel transplant site in Cowichan Bay

Donor site for Genoa Bay transplant

Tod Inlet

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Funding support for eelgrass restoration and monitoring: Pacific Salmon Foundation, Environment Canada (EcoAction), Recreational Fisheries Conservation Partnerships Program, West Marine and the Sidney Anglers Association.

Appendix C

Restoration Sites 2014-5

Spring Bay, Gabriola Island

Decourcey Island site, Gabriola Island

Bracket Cove, near Port Browning, North Pender Island

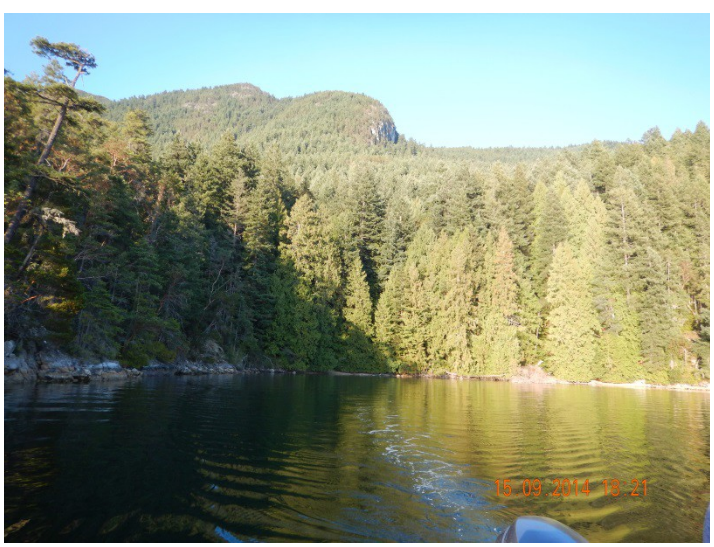
Madrona Bay, Salt Spring Island

Long Harbour, Salt Spring Island

Maple Bay

East Porpoise Bay, Sechelt Inlet

Lamb Bay, Sechelt Inlet



Mt. Richardson Provincial Park, Sechelt Inlet

Brentwood College, Mill Bay

Barge site, Saanich Inlet

Genoa Bay after debris clean-up

Appendix D

Decision Making Matrix for Eelgrass Restoration Site Selection
Anuradha Rao, R.P.Bio, University of Victoria Environmental Studies