Nearshore Eelgrass Inventory

Prepared for the Islands Trust and Islands Trust Fund by:

Nikki Wright, BA Executive Director
SeaChange Marine Conservation Society

Leanna Boyer, BSc. MA
Mayne Island Conservancy Society

Galiano Conservancy Association
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1 Introduction

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. To prepare for the increase in populations on the BC coast and concurrent shoreline developments, it is necessary to identify and quantify nearshore habitats to protect and maintain these valuable nearshore environments.

As part of a conservation strategy to protect and conserve critical nearshore areas, the Islands Trust and the Islands Trust Fund initiated an inventory of the presence of native eelgrass (*Zostera marina*) surrounding islands within the Islands Trust Area. The 2012-2014 Nearshore Eelgrass Inventory Report provides background information for future eelgrass inventories and adds value to the Islands Trust Shoreline Mapping Project. The goal is to support sound decisions that will affect the natural ecological health of the marine nearshores within the Islands Trust Area. The Islands Trust and Islands Trust Fund have limited jurisdiction over marine areas; however, they can have an impact on long term development and protection of the shoreline. This report and the mapping information that forms its basis are designed to assist Islands Trust and Islands Trust Fund planners and elected officials to make science-based decisions when planning for nearshore areas.

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 2012-2014. Eelgrass biobands are not shown for First Nations Reserves on the maps.

The presence/absence of *Zostera marina* was determined according to the methodology of Cynthia Durance, R.P. Bio., Precision Identification (Appendix A). A more detailed description of the methods used can be found in Section 6.

2 Importance of Eelgrass

| Seagrasses are rooted aquatic plants that grow in estuaries and along low wave energy shorelines throughout the world. They have important influences on biogeochemical cycling, sediment stability, and food web support (McGlathery et al. 2007; Orth et al., 2006). Seagrasses can form extensive meadows supporting high biodiversity. The global species diversity of |
seagrasses is low (~60 species). Across the globe, however, seagrass meadows cover about 177,000 square kilometers of coastal waters – larger than the combined area of the Maritime Provinces. (Short et al, 2007) British Columbia has about 400 km² of saltmarsh and eelgrass habitats (Campbell 2010).

2.1 Biodiversity

The complex and intricate food webs of an eelgrass (Zostera marina) meadow provide food and shelter for numerous fish and invertebrates. Meadows also serve as a nursery habitat and as a refuge from predation for juvenile fishes (Orth et al., 1984; Bostrom and Bonsdorff 2000; Duarte 2000). The productivity of native seagrasses rivals the world’s richest farmlands and tropical rainforests. From an unstructured muddy/sandy bottom grows a myriad pattern of leaves that supply nutrients to salmonids and other fish, shellfish, waterfowl and about 124 species of faunal invertebrates. The plants offer surface area for over 350 species of macroalgae and 91 species of epiphytic microalgae – the basis of the food web for juvenile salmon in marine waters (Phillips 1994). Often referred to as “salmon highways”, nearshore marine environments containing eelgrass beds (Zostera marina) are home to over 80% of commercially important fish and shellfish species, including all species of salmon, at some point in their life histories (Durance 2002).

2.2 Blue Carbon

Like terrestrial forests, eelgrass habitats capture and store large amounts of carbon but at much more efficient rates - up to ninety times the uptake provided by equivalent areas of forest. This “Blue Carbon” is stored in sediments where it is stable for thousands of years. In B.C., roughly 400 km² of saltmarsh and seagrass meadows sequester as much carbon as B.C.’s portion of the boreal forest, and the equivalent of the emissions of some 200,000 passenger cars (Campbell 2010).

When eelgrass beds are restored, the rate of carbon sequestration appears to be rapid over the first few years and up to 40 years following restoration. The natural transport of eelgrass by currents and wave action to deeper waters in estuaries and the coastal ocean may further sequester more carbon (Thom 2011).

As ocean waters warm as a result of climate change (up to 5 C° during the spring), greater flowering as well as faster growth of eelgrass shoots has been observed. Both of these changes result in greater biomass. Like marshes, much of the eelgrass biomass is under the substrate, indicating that a warming environment may result in greater carbon accumulation rates (Thom 2011).

2.3 Ecosystem Services

Ecosystem services are the benefits provided by the land, air, water and subsurface materials of the earth (Molnar et al 2012). Eelgrai habitats within the lower reaches of the Salish Sea provide
carbon sequestration and storage, habitat refugia and nursery and nutrient cycling benefits to an approximated natural capital cost of $80,929 per hectare per year (Molnar et al., 2012). Within the Islands Trust Area, eelgrass habitats also provide revenue for commercial fisheries, recreational fishery, and revenue from tourism.

Another ecosystem service eelgrass habitats provide is shoreline stability. Established eelgrass beds reduce currents, leading to increased sediment and organic detritus deposition (Durance 2002). Continuous dense eelgrass beds provide a buffer for incoming wave energy. The more the bed is fragmented by physical structures (e.g. boats, wharves, docks and overwater play structures), the less eelgrass beds function as an erosion buffer. Where shorelines are constrained by development or structures to prevent erosion (e.g. rip rap, sea walls), natural coastal features will be squeezed out and maintaining shoreline infrastructure and development will require increasingly expensive engineering measures (Mumford 2007). Pre-emptive planning for these changing conditions is necessary to protect settlement areas and shore features recognized for their natural and ecosystem services.

Protecting and conserving, and in some instances restoring these critical habitats is a recommendation of the Islands Trust Fund’s Regional Conservation Plan. Mapping eelgrass is identified as a priority to meet the goal of conserving marine ecosystems and habitats. As well, accounting for these benefits in economic dollars and cents and factoring them into decision making policies would emphasize the economic, cultural and ecological values of nearshore habitats.

3 Eelgrass Habitat Characteristics

Eelgrass meadows are found in most of the world’s coastal temperate regions except at extremely high latitudes. Physical and chemical factors affecting Zostera marina include temperature, light attenuation, elevation, substratum, wave action, salinity and pH. Worldwide, the plants survive under a wide range of water temperatures, from 0° to greater than 30°C. The optimum temperature for growth lies between 10° - 20° C in most areas (Phillips 1984). Eelgrass grows best within the Salish Sea in salinity ranges of 20 ppt - 32 ppt. Eelgrass can tolerate periods of freshwater inundation on a seasonal or daily basis (Durance 2002).

Of all the above factors, light availability and elevation may be the most crucial. Light availability seems to be the primary factor limiting depth, distribution, density, and productivity of eelgrass meadows within their salinity and temperature ranges. For example, when the Coal Port was expanded in 1982-1983 in Roberts Bank, the range of both native eelgrass (Z. marina) and introduced eelgrass (Z. japonica) expanded. The construction of causeways across a broad intertidal zone directed the turbid Fraser River water offshore, improving the light regime and initiating higher productivity in the eelgrass beds (Harrison and Dunn 1999).
### 3.1 Wildlife Corridors

Seagrasses are in decline throughout much of the world, with rates of loss accelerating from a median of 0.9% per year before 1940 to 7% per year since 1990 (Waycott et al., 2009). It has been estimated that 18% of coastal marine and nearshore wildlife habitat, including eelgrass habitats, in the Salish Sea has been destroyed (British Columbia/Washington Marine Science Panel 1994). A large percentage of this decline is attributed to human impacts, including filling of shallow waters, dredging, and eutrophication (Short and Wyllie-Echeverria 1996).

Often referred to as “salmon highways”, nearshore marine environments containing Z. marina beds are home to more than 80% of commercially important fish and shellfish species, including all species of salmon, at some point in their life histories (Durance 2002). Zostera marina beds are highways for Chinook, Coho, Pink, Chum, and Sockeye salmonid stocks (Thompson 1994). Great Blue Herons have been observed to feed in eelgrass beds within 3 km of their nesting colonies. Other important bird species using these habitats include Brant geese, Rhinoceros Auklets, cormorants and Western Grebes.

E.O. Wilson proposed the importance of habitat corridors in the 1960s (MacArthur and Wilson 1967). Habitat reduction and fragmentation at a variety of spatial scales has been widely acknowledged as a primary cause of the decline of many species worldwide (Thompson 1994). Habitat fragmentation generally leads to smaller and more isolated animal populations. Smaller populations are more vulnerable to local extinction. To reduce the isolation of habitat fragments, many conservation biologists have recommended maintaining landscape "connectivity" - preserving habitat for movement of species between remaining fragments (BC/Washington Marine Science Panel 1994).

Many nearshore environments on the islands inventoried in 2012 and 2013 indicated continuous fringing eelgrass beds. These beds are the connectivity for salmon and other marine wildlife for shelter, food and refugia. Although they may contain less biomass than continuous flat beds of eelgrass plants, they serve an important function and should be protected.

### 4 Impacts from Human Activities

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.
4.1 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).

4.2 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.
4.3 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).

4.4 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).

4.5 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).

4.6 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.

5 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).

6 Mapping Methodology

Identifying and monitoring the distribution of native eelgrass habitats supplies much needed information for regional planning. Maps and associated outreach activities may also lead to improvements in land use practices from increased knowledge and awareness about the habitat. Locating areas suitable for eelgrass restoration will lead to rehabilitation of eelgrass meadows as funding opportunities become available.

The eelgrass inventory for this project entailed determining the presence or absence of Zostera marina 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. GPS hand held units were used to record waypoints at approximately 10 m intervals in 2012. Accuracy of the GPS readings was on average +/-2.4 metres. In 2013, a Trimble Pathfinder ProXR GPS was used, except in the Cufra Inlet where a handheld GPS unit was used. A detailed description of the methods used to map eelgrass habitats can be found in Appendix A.

The terms used to map eelgrass habitats are described below.

6.1 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).

6.2 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.

6.3 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 sand or mud to cobble).

6.4 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 does give important information on the density and productivity of a bed.

6.5 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.

6.6 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.
6.7 Visibility

Visibility was a subjective observation and was rated low, medium and high. The amount of visibility could impact in some instances the accuracy of the observations, 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.

7 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.

8 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.

8.1 Gambier Island Local Trust Area

Gambier Island was surveyed on August 21\textsuperscript{st}-23\textsuperscript{rd} and September 11\textsuperscript{th}, 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 11-12\textsuperscript{th}, 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 11.35\% 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\textsuperscript{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 (\textit{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 m² 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.

8.2 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 10m² 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.

### 8.3 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. Eelgrass grows on 17.5% of these islands’ shores, excluding areas within the National Park Reserve. The maps associated with this report show BC Shorezone eelgrass bioband coverage for shorelines within the Gulf Islands National Park Reserve. 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**.

### 8.4 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.

### 8.5 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.

8.6 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 are described below.

Percentages of eelgrass for each associated islet are:

<table>
<thead>
<tr>
<th>Island</th>
<th>Eelgrass % Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruxton</td>
<td>11.6%</td>
</tr>
<tr>
<td>Pylades</td>
<td>0%</td>
</tr>
<tr>
<td>Bute</td>
<td>50.3%</td>
</tr>
<tr>
<td>Dunsmuir Islands (2)</td>
<td>34.7%</td>
</tr>
<tr>
<td>Hudson</td>
<td>30.9%</td>
</tr>
<tr>
<td>Reid</td>
<td>3.9%</td>
</tr>
<tr>
<td>Dayman &amp; Scott Islands</td>
<td>39.6%</td>
</tr>
<tr>
<td>Valdes</td>
<td>12.7%</td>
</tr>
</tbody>
</table>

**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 covers 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.

### 9 2013 Inventory Findings

Areas mapped in 2013 for eelgrass (*Zostera marina*) within the Islands Trust Area include:
- Denman Island Local Trust Area,
- Hornby Island Local Trust Area,
- Winchelsea - Ballenas (Executive Islands) Local Trust Area,
- Gabriola Island Local Trust Area,
- Galiano Island Local Trust Area,
- Valdes Island and Cufra Inlet in the Thetis Island Local Trust Area (Findings included in Section 8.6 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 8.1 above)

The characteristics and locations of eelgrass habitats for each island are described below in order of the beginning dates eelgrass inventories occurred. Note that Valdes and Cufra Inlet are described in Section 8 above as they are in the Thetis Island Local Trust Area. Similarly the Gambier Island Local Trust Area Associated islands are also described in Section 8 as they are in the Gambier Local Trust Area. Both Thetis and Gambier Islands were mapped in 2012.

9.1 Galiano Island Local Trust Area
Galiano 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 in 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**.

### 9.2 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 **DeCourcy 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**.

### 9.3 Denman Island Local Trust Area

Denman Island and its associated islands were inventoried 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.

### 9.4 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 31.70 % 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.

### 9.5 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.

9.6 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 m² 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.

10 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.

10.1 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 10m² 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 (<10m²) 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 m² 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.

10.2 Saturna Island Local Trust Area

Eelgrass surrounding Saturna Island was surveyed between July 2\textsuperscript{nd} and 29\textsuperscript{th}, 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.

11 Threats to Eelgrass Habitats

The impacts from human activities have been described previously (Section 4.0). Other field observations are described below.

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 was noted within Telegraph Harbour on Thetis Island and Montague Harbour on Galiano Island. This could be an indication of excessive nutrients, causing an abundance of algae growth on the blades and blocking light, nutrients and gas exchange (Mumford 2007).

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.

12 Opportunities for Eelgrass Restoration

A total of forty-two sites were identified as potential eelgrass transplant areas during the inventories that occurred between 2012-2014. These sites are shown on the maps produced by this project. When funding is available, these sites can be further investigated. The history of eelgrass transplants and their success in British Columbia to date is described below.

12.1 History of Eelgrass Restoration

In the Pacific Northwest, the history of success for *Zostera marina* transplanting projects was dismal prior to 1985. Initially transplant techniques 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 (Durance 2001).

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, Borde, Williams, Southard, Blanto and Woodruff 2001). Factors that led to a higher success rate include the correct selection of physical attributes for the restoration 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. The criteria for success included shoot density and area re-vegetated (Durance 2001).

### 12.2 Criteria for Successful Restoration

In British Columbia, the criterion for transplant success is based upon the mean shoot density being equal or greater than the area of adjacent natural beds and the area coverage. Projects are thus considered successful if the habitat that was created provided habitat equal in eelgrass productivity (shoot density) to that which it was designed to replace (Durance 2001).

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 are necessary for successful transplants. Several restoration transplants have occurred in Squamish, the Sunshine Coast, Campbell River, Cowichan Bay and Saanich Inlet. Most of the locations have been impacted by historical log storage practices. The majority of these transplants are considered successful based on monitoring of shoot densities and area coverage post-transplant. They were completed under the supervision of a scientific advisor with community volunteer support and a Workers Compensation Board (WCB) certified team, with funds collected by environmental conservation groups.

### 13 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 work of the Islands Trust and Islands Trust Fund.

### 13.1 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.

### 13.2 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 that are 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.

### 13.3 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 and other organizations to establish best practices for anchorages and mooring buoy sites and encourage active monitoring of the usage of those sites.

### 14 Conclusion

Changes from increased human population, more frequent and intense storms and changes in sea levels and pH of the oceans emphasize the need to monitor eelgrass habitat and protect it with sound science-based policies and regulations.

Eelgrass meadows function as natural marine sanctuaries, as indicators of nearshore ecological health, and as sequesters of atmospheric carbon. As well, these valuable habitats are important sources of nutrients for local and off-shore marine and nearshore systems. The conservation, protection, monitoring and restoration of native eelgrass within the Islands Trust Area is and will continue to be a long term smart investment in the social, cultural and biological vitality of the islands.
15 References


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Each line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data table.

Eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted in July 2012 using a towed underwater camera and Garmin GPS.

Map Produced by: Galliano Conservancy Association
Map Date: December 6th, 2012
Orthophoto Date: 2013
Map Scale: 1:11,000
Map Projection: UTM Zone 10, NAD83
Map 1b: Eelgrass Presence
North Pender Island Local Trust Area
Associated Islands - North

The eelgrass inventory was
completed by SeaChange
Marine Conservation Society
under contract by Islands Trust
Fund and the Islands Trust.
The inventory was conducted
from June to September, 2014
using a towed underwater
camera and Trimble Pathfinder
Pro XR GPS.

Produced by:
Galiano Conservancy
Map Date: Nov. 28th, 2014
Orthophoto Date: 2013
Scale: 1 : 15,000
Projection:
UTM Zone10N, NAD83

Each line segment is labeled with its unique
ID number. This number corresponds with
the ID column in the associated data table.

Potential site for restoration
- Eelgrass Patch: < 10m2
- Eelgrass Bed: Flat, Continuous
- Eelgrass Bed: Flat, Patchy
- Eelgrass Bed: Fringing, Continuous
- Eelgrass Bed: Fringing, Patchy
- Zostera Biobank Units (BC Shorezone)
- Gulf Islands National Park Reserve Boundary

0 1 2 Kilometers
Map 1c: Eelgrass Presence
North Pender Island Local Trust Area
Associated Islands - South

Potential site for restoration
- Eelgrass Patch: < 10m2
- Eelgrass Bed: Flat, Continuous
- Eelgrass Bed: Flat, Patchy
- Eelgrass Bed: Fringing, Continuous
- Eelgrass Bed: Fringing, Patchy
- Zostera Bioband Units (BC Shorezone)
- Gulf Islands National Park Reserve Boundary

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted from June to September, 2014 using a towed underwater camera and Trimble Pathfinder Pro XR GPS.

Produced by:
Gallopi Conservancy
Map Date: Nov 28th, 2014
Orthophoto Date: 2013
Scale: 1 : 15,000
Projection:
UTM Zone10N, NAD83

Each line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data table.
MAP 3b: Eelgrass Presence Gambier Local Trust Area, Howe Sound Associated Islands

For Bowyer and Passage Islands: Eelgrass patches < 5m wide are represented by lines. Patches > 5m wide are mapped as polygons.

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted from July to November, 2013 using a towed underwater camera and Trimble Pathfinder Pro XR GPS.

Each polygon and line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data table.

Produced by: Galiano Conservancy Assoc.
Map Date: December 12th, 2013
Orthophoto Date: 2011
Scale: 1:12,000
Map Projection: UTM Zone 10N, NAD83
Map 3c: Eelgrass Presence
Gambier Local Trust Area Associated Islands
Sunshine Coast Area

- Eelgrass Patch: < 10m²
- Eelgrass Bed: Flat, Continuous
- Eelgrass Bed: Flat, Patchy
- Eelgrass Bed: Fringing, Continuous
- Eelgrass Bed: Fringing, Patchy

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted from June to September, 2014 using a towed underwater camera and Trimble Pathfinder Pro XR GPS.

Produced by: Galliano Conservancy
Map Date: Nov, 28th, 2014
Orthophoto Date: 2011
Scale: 1:15,000
Projection: UTM Zone10N, NAD83

Inset: Trail Islands
MAP 4a: Eelgrass Presence Thetis Island Local Trust Area, excluding Valdes Island

Eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by the Islands Trust and the Islands Trust Fund. The inventory was conducted in July 2012 using towed underwater camera and Garmin GPS, with the exception of Cufra Inlet, which was completed in 2013 by community volunteers.

Map Produced by: Galliano Conservancy Association
Map Date: December 12, 2013  Orthophoto Date: 2011
Map Scale: 1 : 11,000  Inset Maps Scale: 1 : 10,000
Reference Map Scale: 1 : 73,000
Map Projection: UTM Zone 19, NAD83
MAP 4b: Eelgrass Presence Valdes Island

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. This inventory was conducted from July to November, 2013 using a towed underwater camera and Trimble Pathfinder Pro XR GPS.

Produced by: Galloso Conservancy Assoc.
Map Date: December 12th, 2013
Orthophoto Date: 2011 Scale: 1:15,000
Map Projection: UTM Zone 10N, NAD83

Each line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data table.
Map 5b: Eelgrass Presence
Lasqueti Local Trust Area - West

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory of Lasqueti associated islands was conducted from June to September, 2014 using a towed underwater camera and Trimble Pathfinder Pro XR GPS. Inventory of Lasqueti Island was conducted in July 2012 using a Garmin GPS.

Produced by: Gallano Conservancy
Map Date: Nov 28th, 2014
Orthophoto Date: 2011
Scale: 1 : 15,000
Projection: UTM Zone10N, NAD83
Rotation: 10 degrees W of N
MAP 7: Eelgrass Presence Mayne Island

- Potential Restoration Site
- Eelgrass Present: Flat, Continuous
- Eelgrass Present: Flat, Patchy
- Eelgrass Present: Fringing, Continuous
- Eelgrass Present: Fringing, Patchy

Eelgrass inventory was completed by Mayne Island Conservancy Society (2008-2012). Eelgrass dataset was created by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust.

Each line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data table.
MAP 8: Eelgrass Presence Ballenas - Winchelsea (Executive Islands) Local Trust Area

Eelgrass Bed: Flat, Continuous
Eelgrass Bed: Flat, Patchy
Eelgrass Bed: Fringing, Continuous
Eelgrass Bed: Fringing, Patchy

Each line segment is labeled with its unique ID number. The number corresponds with the ID column in the associated data table.

The eelgrass inventory was conducted by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted from July to November 2013 using a towed underwater camera and Tripod Pathfinder Pro XIX GPS.

Produced by: Gallo Conservancy Association
Map Date: December 12th, 2013
Orthophoto Date: 2011
Scale: 1:12,000
Map Projection: UTM Zone 10N, NAD83
MAP 9a: Eelgrass Presence Bowen Island North and Bowyer Island

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted from July to November, 2013 using a towed underwater camera and Trimble Pathfinder Pro XR GPS.

Each polygon and line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data tables.

Produced by: Galatea Constancy Assoc.
Map Date: December 12th, 2013
Orthophoto Date: 2011
Scale: 1:10,000
Map Projection: UTM Zone 10N, NAD83
MAP 12b: Eelgrass Presence Galiano Island Local Trust Area - North

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted from July to November, 2013 using a towed underwater camera and Trimble Pathfinder Pro XR GPS.

Produced by: Galiano Conservancy Assoc.
Map Date: December 12th, 2013
Ortho Photo Date: 2011
Scale: 1:15,000
Map Projection: UTM Zone 10N, NAD83

Each line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data table.
Map 13a: Eelgrass Presence
Salt Spring Island Local Trust Area - South

Potential site for restoration
- Eelgrass Patch: < 10m²
- Eelgrass Bed: Flat, Continuous
- Eelgrass Bed: Flat, Patchy
- Eelgrass Bed: Fringing, Continuous
- Eelgrass Bed: Fringing, Patchy

Gulf Islands National Park Reserve Boundary

Each line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data table.

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted from June to September, 2014 using a towed underwater camera and Trimble Pathfinder Pro XR GPS.

Produced by: Gallano Conservancy
Map Date: November 25th, 2014
Orthophoto Date: 2013
Scale: 1:20,000
Projection: UTM Zone 10N, NAD83
Map 13b: Eelgrass Presence
Salt Spring Island Local Trust Area - North

- Potential site for restoration
- Eelgrass Patch: < 10m²
- Eelgrass Bed: Flat, Continuous
- Eelgrass Bed: Flat, Patchy
- Eelgrass Bed: Fringing, Continuous
- Eelgrass Bed: Fringing, Patchy
- Gulf Islands National Park Reserve Boundary

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted from June to September, 2014 using a towed underwater camera and Trimble Pathfinder Pro XR GPS.

Produced by: Galiano Conservancy
Map Date: November 25th, 2014
Orthophoto Date: 2013
Scale: 1:20,000
Projection: UTM Zone10N, NAD83

Each line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data table.
Map 14: Eelgrass Presence
Saturna Local Trust Area

- Potential site for restoration
- Eelgrass Patch: < 10m²
- Eelgrass Bed: Flat, Continuous
- Eelgrass Bed: Flat, Patchy
- Eelgrass Bed: Fringing, Continuous
- Eelgrass Bed: Fringing, Patchy
- Zostera Bioband Units (BC Shorezone)
- Gulf Islands National Park Reserve Boundary

The eelgrass inventory was completed by SeaChange Marine Conservation Society under contract by Islands Trust Fund and the Islands Trust. The inventory was conducted from June to September, 2014 using a towed underwater camera and Trimble Pathfinder Pro XR GPS.

Produced by: Gallano Conservancy
Map Date: Nov. 28th, 2014
Orthophoto Date: 2013
Scale: 1:16,000
Projection: UTM Zone10N, NAD83

Each line segment is labeled with its unique ID number. This number corresponds with the ID column in the associated data table.
Appendix A: Mapping Methodology 2012 – 2014

2012 Methodology for *Zostera marina* Presence and Absence Mapping With a Towed Underwater Camera

The following methodology for eelgrass mapping (*Zostera marina*) was used to determine the location (presence/absence) of eelgrass habitats for Thetis, North and South Pender, Mayne, Lasqueti and Gambier Islands in 2012 under contract with the Islands Trust Fund.

The methodology reported here is an addendum to “Methods for Mapping 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.

The purpose of presence and absence mapping methodology is to determine the linear extent of eelgrass along the coastline. This is achieved by deploying an underwater camera that is towed by a boat and recording the geographic location of eelgrass beds using a hand held GPS. The resulting representation of eelgrass beds are lines.

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/boulder). 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 lay across the ocean floor.

Eelgrass ShoreZone 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 include habitat between 1 and 3 m chart datum. This depth contour was followed and eelgrass presence within this depth range was recorded. If eelgrass ass 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: depth, eelgrass presence, form, distribution, substrate, percent cover, tide state, presence of broad or tuft algae, visibility.

Where marine charts indicated suitable conditions (a shallow bathymetric relief) for eelgrass but eelgrass was not present; waypoints and substrate type were recorded at 20m intervals. Where marine charts indicated unsuitable conditions for eelgrass (steep bathymetric relief), only waypoints were recorded to indicate mapping coverage.
2013 Methodology for *Zostera marina* Presence Mapping with a Towed Underwater Camera

For the 2013 contract, the following methodology for eelgrass mapping (*Zostera marina*) was used to determine the location (presence) of eelgrass habitats for the Gabriola Island Local Trust Area, the Galiano Island Local Trust Area, Valdes Island, Winchelsea-Ballenas (Executive Islands) Local Trust Area, Cufra Inlet (Thetis Island) and the Gambier Associated Islands found within Howe Sound (excluding the Thormanbies and other islands off of the Sunshine Coast).

The methodology reported here is an addendum to “Methods for Mapping 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. For 2013 mapping Islands Trust Global Positioning System Specifications (Schedule G to the contract) were adopted except for Cufra Inlet on Thetis Island where a hand held GPS was used to be consistent with 2012 mapping. 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.

**Linear Mapping**

With the exception of the islands in Metro Vancouver, the Islands Trust eelgrass mapping was done using a linear method to determine presence of eelgrass along the shoreline. This linear eelgrass mapping is achieved by towing an underwater camera using a boat, except for the mapping done in Cufra Inlet in 2013, where the water was shallow enough to observe eelgrass from kayaks, and by concurrently recording the geographic location of eelgrass beds using a GPS. The resulting representations of eelgrass beds are lines and points (where the eelgrass patch was less than 3m in length).

**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 10m² 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, form, distribution, substrate, percent cover, tide state, presence of broad or tuft algae, visibility.

The following section was removed from the methodology for 2013: Where marine charts indicated suitable conditions (a shallow bathymetric relief) for eelgrass but eelgrass was not present, waypoints and substrate type were recorded at 20 metre intervals. Where marine charts indicated unsuitable conditions for eelgrass (steep bathymetric relief), only waypoints were recorded to indicate mapping coverage.
Appendix B: Maps of Shoreline Units
Shoreline Units & Zostera Bioband Units
-- Pender Islands --

Produced By: Galiano Conservancy Association
Data Source: Provincial Shorezone Database
Map Date: June 2012
Projection: UTM Zone 10 NAD83
Eelgrass Mapping Summary
Thormanby & Assoc. Islands NW

Eelgrass Bed - 2012 Islands Trust Inventory
Eelgrass Bed - Local Community Mapping
IT_shoreline_units
Zostera Bioband

Map Prepared by: Galiano Conservancy Association
Map Date: August 2014
Projection: UTM Zone 10N NAD 83
Scale: 1 : 40,000

² 0 260 520 1,040 Meters
Shoreline Units &
Zostera Bioband Units

-- Thetis Island Trust Area --

Produced By: Galiano Conservancy Association
Data Source: Provincial Shorezone Database
Map Date: June 2012
Projection: UTM Zone 10 NAD83

Map: Shoreline Units & Zostera Bioband Units

Legend:
- Zostera Bioband Units

- SHORELINE_UNITS
  - Red: Estuary
  - Dark Red: Sand / Cobble
  - Yellow: Low Rock / Boulder
  - Black: Altered
  - Purple: Cliff
  - Blue: Coastal Banks or Bluffs

Scale: 1:55,000
Shoreline Units & Zostera Bioband Units
-- Valdez Island --

Produced By: Galiano Conservancy Association
Data Source: Provincial Shorezone Database
Map Date: June 2013
Projection: UTM Zone 10 NAD83
Eelgrass Mapping Summary
-- Lasqueti & Associated Islands --
Eelgrass Bed - 2012 Islands Trust Inventory
Eelgrass Bed - Local Community Mapping
IT_shoreline_units
Zostera Bioband
Map Prepared by: Galiano Conservancy Association
Map Date: August 2014
Projection: UTM Zone 10N NAD 83
Scale: 1 : 65,000

Map 0 425 850 1,700 Meters
Shoreline Units & Zostera Bioband Units -- Executive Islands --

Produced By: Galiano Conservancy Association
Data Source: Provincial Shorezone Database
Map Date: June 2013
Projection: UTM Zone 10 NAD83

Zostera Bioband Units

SHORELINE_UNITS
- Estuary
- Sand / Cobble
- Low Rock / Boulder
- Altered
- Cliff
- Coastal Banks or Bluffs

1:46,362
Shoreline Units & Zostera Bioband Units
-- Bowen Island --

Produced By: Galiano Conservancy Association
Data Source: Provincial Shorezone Database
Map Date: June 2013
Projection: UTM Zone 10 NAD83

Zostera Bioband Units

SHORELINE_UNITS
- Estuary
- Sand / Cobble
- Low Rock / Boulder
- Altered
- Cliff
- Coastal Banks or Bluffs

1:70,000
Shoreline Units & Zostera Bioband Units -- Denman Island --

Produced By: Galiano Conservancy Association
Data Source: Provincial Shorezone Database
Map Date: June 2013
Projection: UTM Zone 10 NAD83

Zostera Bioband Units

SHORELINE_UNITS
- Red: Estuary
- Red: Sand / Cobble
- Yellow: Low Rock / Boulder
- Black: Altered
- Purple: Cliff
- Blue: Coastal Banks or Bluffs

1:70,000
Eelgrass Mapping Summary
-- Salt Spring Island --

- Eelgrass Bed - Local Community Mapping
- IT_shoreline_units
- Zostera Bioband

Map Prepared by: Galiano Conservancy Association
Map Date: April 2014
Projection: UTM Zone 10N NAD 83
Scale: 1 : 40,000
Map Prepared by: Galiano Conservancy Association
Map Date: April 2014
Projection: UTM Zone 10N NAD 83
Scale: 1 : 40,000

Map Legend:
- Eelgrass Bed - Local Community Mapping
- IT_shoreline_units
- Zostera Bioband

Metres

Scale: 1:40,000
Appendix C:  Summary of Overwater Structures
The following information was taken from two sources. A Green Shores document summarizes possible effects of docks.\(^1\) A White Paper published in 2001\(^2\) for the Washington State Transportation Commission in Puget Sound is more detailed. The page numbers at the end of paragraphs indicate the page on which the information was found in the original document.

Information collated by Nikki Wright, Executive Director

SeaChange Marine Conservation Society


Summary of Possible Effects of Docks


**What Can Happen (p. 65)**

The installation of docks can affect the coastal biophysical environment in a variety of ways:

- **Shading**: Shading caused by the dock can affect the vigor of intertidal and subtidal plant communities, such as marsh plants, eelgrass and kelp beds. These impacts may be chronic (reduced productivity) or acute (wiping out plant communities, leaving the area barren).
- **Disruption of shore drift patterns**: This can result in updrift beach formation and downdrift shoreline erosion.
- **Shore damage**: Removal of shore plants and disturbance of soils where docks are attached to land can increase erosion and sedimentation of the intertidal and adjacent subtidal areas.
- **Bottom habitat**: Installation of footings, pilings and other structures permanently alienates benthic habitat. Dredging to create sufficient depth next to the dock can also disrupt or destroy bottom habitat.
- **Operational pollution**: Poor refueling and dock maintenance practices, bilge releases and accidental spills from boats and docks can release contaminants into the nearby waters. (p. 65)
Overview of Ecological and Habitat Issues


Estuarine and shallow marine nearshore habitats provide passage for fish and fish larvae, ocean water and human transportation, as well as areas for settlement of marine shellfish and other marine life. These sites are important sources of prey resource production, refugia, and spawning areas for Pacific salmon, groundfish, and forage fish, such as herring, sand lance and surf smelt. Overwater constructed structures can pose alterations to key factors that control prey production and spawning. Light, wave energy and substrate regimes determine the habitat characteristics that support these critical functions (p. 1).

Overwater structures are typically located in intertidal areas from above the area submerged by the mean higher high tides and out to 15 meters below the area exposed by the mean lower low tide. The primary physical processes controlling habitat attributes (i.e. plant and animal assemblages) and functions are depth (elevation) substrate type, wave energy, and light and water quality. These are the most important factors influencing the development and distribution of nearshore habitats (p. 33).

Conceptual model used by authors to define overwater structure impacts to nearshore habitat (p. 33).
Overwater structures and associated activities can impact the ecological functions of habitat through the alteration of habitat controlling factors (light regime, wave energy regime, and substrate and water quality). These alterations can, in turn, interfere with habitat processes supporting the key ecological functions of spawning, rearing and refugia. Whether any of these impacts occur and to what degree they occur at any one site depend upon the nature of site-specific habitat controlling factors and the type, characteristic, and use patterns of a given overwater structure located at a specific site (p. 34).

In addition to impacts associated with overwater constructed structures, activities associated with docks can also pose risks to the quality and quantity of habitat through prop scour, groundings, contaminant introduction to the marine environment and structural interferences with shallow nearshore habitats with the placement of ramps and haul-outs in nearshore areas.
## Habitat Impact Mechanisms (p. 34)

<table>
<thead>
<tr>
<th>Habitat Controlling Factors</th>
<th>Overwater Structures &amp; Activities</th>
<th>Habitat Impact Mechanisms</th>
<th>Habitat Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Regime</td>
<td>• Docks</td>
<td>• Reduced light levels</td>
<td>• Limited plant growth &amp; recruitment</td>
</tr>
<tr>
<td></td>
<td>• Floats</td>
<td></td>
<td>• Altered animal behavior and assemblages</td>
</tr>
<tr>
<td></td>
<td>• Pilings</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Moored vessels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wave Energy Regime</td>
<td>• Floats</td>
<td>• Altered wave patterns</td>
<td>• Altered plant and animal assemblages</td>
</tr>
<tr>
<td></td>
<td>• Breakwaters</td>
<td></td>
<td>• Altered substrate type</td>
</tr>
<tr>
<td></td>
<td>• Prop wash</td>
<td></td>
<td>• Altered sediment transport &amp; distribution</td>
</tr>
<tr>
<td></td>
<td>• Marina</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substrate</td>
<td>• Prop &amp; anchor scour</td>
<td>• Altered substrate characteristics</td>
<td>• Altered sediment transport &amp; distribution</td>
</tr>
<tr>
<td></td>
<td>• Pilings, breakwaters &amp; floats</td>
<td></td>
<td>• Altered substrate type</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Altered plant &amp; animal assemblages</td>
</tr>
<tr>
<td>Water Quality</td>
<td>• Discharges</td>
<td>• Increased exotics, toxi...</td>
<td>• Altered plant &amp; animal assemblages</td>
</tr>
<tr>
<td></td>
<td>• Boat &amp; upland run-off</td>
<td>• Limited growth &amp; recruitment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Exotic species replacement of natives</td>
<td></td>
</tr>
</tbody>
</table>
Overwater Structure Effects on Light Regime

Effects on Underwater Vegetation

Without proper precautions, docks, piers, and pilings can cast shade upon the underwater water environment thereby limiting light availability for plant photosynthesis. Distributions of invertebrates, fishes, and plants have been found to be severely limited in under-dock environments when compared to adjacent vegetated habitat in the Pacific Northwest not shaded by overwater structures (p. 38).

Each dock defines a shade footprint specific to its structural specifications. Dock height, width, construction materials, and the dock’s orientation to the arc of the sun are primary factors in determining the shade footprint that a given dock casts over the submerged substrates. Researchers found underwater light availability and eelgrass bed quality under docks to be primarily dependent upon dock height, followed in importance by dock width and dock orientation to the arc of the sun. Light is the most important variable affecting canopy structure (i.e. shoot density and height) and eelgrass bed quality. To the degree that a shade footprint limits plant photosynthesis, it decreases the extent and quality of habitat that support a wide variety of fish and shellfish populations. Construction of even partially shading types of structures, floating or on pilings, could be expected to largely eliminate existing eelgrass and other macroflora with little chance for replacement plant growth (p. 39).

Effects on Fish

Overwater structures can create sharp underwater light contrasts by casting shade in ambient daylight conditions. They can also produce sharp underwater light contrasts by casting artificial light in ambient nighttime conditions. Changes to ambient underwater light environments pose a risk of altering fish migration behavior and increasing mortality risks. Findings have demonstrated that fish responses to piers are ambiguous with some individuals passing under the dock, some pausing and going around the dock, schools breaking up upon encountering docks, and some pausing and eventually going under the dock (p. 43).

Light is considered to be the primary factor limiting the survival and distribution of eelgrass. Given the strong association of important fish prey resources with eelgrass, limitations in the extent of eelgrass pose a potential risk of reduced prey resources. Prey resource limitations likely impact migration patterns and the survival of many juvenile fish species. For smaller fish less than 50 mm in length, residence times along particular shorelines are thought to be a function of prey abundance. Research in the Hood Canal demonstrated that outmigrating juvenile chum fry (30-45 mm) feed extensively upon small, densely distributed harpacticoid
copepods selecting for the largest copepods available. As the fish grew in size, their diet content became composed more of larger epibenthos and pelagic crustaceans. Consistent with other studies, the highest densities of harpacticoid copepods occurred in magnitudes 4-5 times higher in eelgrass stands than in sand habitat without eelgrass. Similarly, the largest abundance of first post-larval stage crabs of 0+ age are found in eelgrass beds (p. 45).

Impacts on Wave Energy

Wave energy and water transport alterations imposed by docks, bulkheads, breakwaters, ramps and associated activities alter the size, distribution, and abundance of substrate and detrital materials required to maintain the nearshore detrital-based food web. Alteration of sediment transport patterns can present potential barriers to the natural processes that build spits and beaches and provide substrates required for plant propagation, fish and shellfish settlement and rearing, and forage fish spawning. Although the specific characteristics of the factors at play vary with the geology of each region or subsystem, changing the type and distribution of sediment will likely alter key plant and animal assemblages. Wave and current interactions in shallow water (i.e. depths <1.0m) are particularly important to intertidal flora and fauna (p. 48).

Dock pilings have also been found to alter adjacent substrates with increased shell hash deposition from piling communities and changes to substrate bathymetry. Similarly, dock uses and construction activities are known to limit underwater light and redistribute sediments through prop scouring, vessel shading, and pile driving. These changes in substrate type can change the nature of the flora and fauna native to a given site. In the case of pilings, native dominant communities typically associated with sand, gravel, mud, sand, and seagrass substrates are replaced by those communities associated with shell hash substrates (p. 49).

Cumulative Effects

Given the apparent increasing demand for overwater structures, structural design to allow maximum light transmission and to mitigate energy and substrate changes is required to protect the ecosystems marine fishes rely upon. Given what is known concerning overwater structure impacts in marine and estuarine ecosystems, we conclude that multiple placements of overwater structures in marine waters can pose substantive risks of significant changes to the immediate and surrounding marine and estuarine ecosystems. These risks require the assessment of existing cumulative light limitation effects and wave energy and substrate effects to the shoreline environment. These risks require assessment at the drift cell before considering the addition of new structures (p. 91).
Appendix D: 2012 - 2014 Islands Trust Area Eelgrass Inventory Meta Data

1. File Identification Information:

- 2012-2014 Islands Trust Eelgrass Inventory.dbf
- 2012-2014 Islands Trust Eelgrass Inventory.prj
- 2012-2014 Islands Trust Eelgrass Inventory.sbn
- 2012-2014 Islands Trust Eelgrass Inventory.sbx
- 2012-2014 Islands Trust Eelgrass Inventory.shp
- 2012-2014 Islands Trust Eelgrass Inventory.shx
- 2012-2014 Islands Trust Eelgrass Inventory Points.dbf
- 2012-2014 Islands Trust Eelgrass Inventory Points.prj
- 2012-2014 Islands Trust Eelgrass Inventory Points.sbn
- 2012-2014 Islands Trust Eelgrass Inventory Points.sbx
- 2012-2014 Islands Trust Eelgrass Inventory Points.shp
- 2012-2014 Islands Trust Eelgrass Inventory Points.shx
- 2012-2014 Islands Trust Eelgrass Inventory Polygons.dbf
- 2012-2014 Islands Trust Eelgrass Inventory Polygons.prj
- 2012-2014 Islands Trust Eelgrass Inventory Polygons.sbn
- 2012-2014 Islands Trust Eelgrass Inventory Polygons.sbx
- 2012-2014 Islands Trust Eelgrass Inventory Polygons.shp
- 2012-2014 Islands Trust Eelgrass Inventory Polygons.shx

2. Standard: GPS survey was conducted in accordance with “Methods for Mapping and Monitoring Eelgrass Habitat in British Columbia (MMEHBC)” and the addendum included below as Appendix A. GPS data (2013/2014) was collected in accordance with 'Ammended Schedule G: GLOBAL POSITIONING SYSTEM SPECIFICATIONS' included below as Appendix B.


5. Accuracy: GPS data was exported to ESRI shape file format and brought into an ArcMap project. GPS line segments were interpreted and edited to improve accuracy in accordance with MMEHBC standards. The following tables summarize reported GPS accuracy:

**2012 Data:**

<table>
<thead>
<tr>
<th>Worst Horizontal Precision Reading (m)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gambier Island</td>
<td>12</td>
</tr>
<tr>
<td>Lasqueti Island</td>
<td>2</td>
</tr>
<tr>
<td>Thetis Island</td>
<td>7</td>
</tr>
<tr>
<td>North Pender Island</td>
<td>2</td>
</tr>
<tr>
<td>South Pender Island</td>
<td>2</td>
</tr>
</tbody>
</table>
### Average Horizontal Precision Reading (m)

<table>
<thead>
<tr>
<th>Location</th>
<th>Reading (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gambier Island</td>
<td>3</td>
</tr>
<tr>
<td>Lasqueti Island</td>
<td>2</td>
</tr>
<tr>
<td>Thetis Island</td>
<td>3</td>
</tr>
<tr>
<td>North Pender</td>
<td>2</td>
</tr>
<tr>
<td>South Pender</td>
<td>2</td>
</tr>
</tbody>
</table>

#### 2013 & 2014 Data:

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2014</th>
<th>2013/14 Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Point Features</td>
<td>11,754</td>
<td>9,032</td>
<td>20,786</td>
</tr>
<tr>
<td>Best Reported</td>
<td>0.3 m</td>
<td>0.3 m</td>
<td>0.3 m</td>
</tr>
<tr>
<td>Worst Reported</td>
<td>69.3 m</td>
<td>75.6 m</td>
<td>75.6 m</td>
</tr>
<tr>
<td>Average</td>
<td>0.814 m</td>
<td>0.615 m</td>
<td>0.728 m</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.812 m</td>
<td>1.644 m</td>
<td>1.739 m</td>
</tr>
<tr>
<td>% Point Features</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>91.44%</td>
<td>97.00%</td>
<td>93.85%</td>
</tr>
<tr>
<td></td>
<td>97.04%</td>
<td>99.06%*</td>
<td>97.91%</td>
</tr>
<tr>
<td>% Point Features</td>
<td>99.62%</td>
<td>99.62%</td>
<td>99.62%</td>
</tr>
<tr>
<td></td>
<td>99%</td>
<td>99.98%</td>
<td>99.99%</td>
</tr>
</tbody>
</table>

*All point features with reported horizontal precision over 5.0m were duly noted and assessed on a case by case basis for their utility as guides for interpretation of line / polygon / point placement.*

6. Geographic Extent: Islands Trust Area
   - West Bounding Coordinate: 365551
   - East Bounding Coordinate: 496460
   - North Bounding Coordinate: 5499562
   - South Bounding Coordinate: 5379453

   **Areas Exempted From Inventory:**
   1. Shoreline areas within the Gulf Islands National Park Reserve
   2. Shoreline areas directly adjacent to First Nations Reserves

7. Contact Information
   - Keith Erickson
   - Galiano Conservancy Association
   - RR#1 Sturdies Bay Road
   - Galiano Island, BC V0N 1P0
   - Canada

8. Data Projection: UTM, Zone 10, NAD 83
9. Definitions of Attributes in Database Fields:

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ObjectID</td>
<td>Unique number ID for labeling purposes</td>
</tr>
<tr>
<td>ID</td>
<td>Code used to match up records with GPS data</td>
</tr>
<tr>
<td>Trust_Area</td>
<td>Code for Islands Trust Area</td>
</tr>
<tr>
<td>Is_Name</td>
<td>Code for island located in Trust Area</td>
</tr>
<tr>
<td>Presence</td>
<td>Presence (Y) or Absence (N) of eelgrass</td>
</tr>
<tr>
<td>Form</td>
<td>Describes the shape of an eelgrass bed as either flat (FL) or fringe (FR)</td>
</tr>
<tr>
<td>Distrib</td>
<td>Indicates the distribution of eelgrass as either continuous (C) or patchy (P)</td>
</tr>
<tr>
<td>Sub_sand</td>
<td>Indicates proportion of sand substrate as primary (1), secondary (2) or tertiary (3)</td>
</tr>
<tr>
<td>Sub_mud</td>
<td>Indicates proportion of mud substrate as primary (1), secondary (2) or tertiary (3)</td>
</tr>
<tr>
<td>Sub_shell</td>
<td>Indicates proportion of shell substrate as primary (1), secondary (2) or tertiary (3)</td>
</tr>
<tr>
<td>Sub_pebble</td>
<td>Indicates proportion of pebble substrate as primary (1), secondary (2) or tertiary (3)</td>
</tr>
<tr>
<td>Sub_cobble</td>
<td>Indicates proportion of cobble substrate as primary (1), secondary (2) or tertiary (3)</td>
</tr>
<tr>
<td>Cover</td>
<td>Estimate of percent cover of eelgrass; &lt;25% (1), 26-75% (2), &gt;75% (3)</td>
</tr>
<tr>
<td>Tide</td>
<td>Describes whether the tide is running (R) or slack (S). A running tide increases error of percent cover estimate.</td>
</tr>
<tr>
<td>Algae</td>
<td>Describes presence of broad (B) and/or tufty (T) algal species. Presence of broad algae can impair surveyor’s ability to characterize the substrate.</td>
</tr>
<tr>
<td>Visibility</td>
<td>Refers to the ability of the surveyor to see through the water column; high (H), medium (M), low (L). Low visibility can impair surveyor’s ability to characterize substrate and can increase error of percent cover estimate.</td>
</tr>
<tr>
<td>Comments</td>
<td>Comments on backshore and eelgrass limiting factors such as presence of docks, wharves, mooring buoys, anchoring boats, shoreline erosion, point source pollution.</td>
</tr>
<tr>
<td>Length_m / Area</td>
<td>Length of line segment in meters / Area of polygon in square meters</td>
</tr>
<tr>
<td>Map_Class</td>
<td>Categories used for map display (Presence + form + distribution)</td>
</tr>
<tr>
<td>Rest_Pot</td>
<td>Yes – identified as a potential site for ecological restoration</td>
</tr>
<tr>
<td>Survey_Yr</td>
<td>Year that ground inventory was completed</td>
</tr>
</tbody>
</table>

Local Trust Area Codes

BO Bowen
DE Denman
EX Ballenas – Winchelsea (Executive Committee)
GB Gabriola
GL Galiano
GM Gambier
HO Hornby
LA Lasqueti
MA Mayne
NP North Pender
SA Saturna
SP South Pender
SS Salt Spring
TH Thetis
VA Valdes
SCHEDULE G
GLOBAL POSITIONING SYSTEM SPECIFICATIONS

1. General Application

1.01 The target horizontal accuracy is 1 metre. The lowest acceptable horizontal accuracy is 5 metres, at the 95% confidence level. This applies to final map data after averaging (for point features), approximating (for line features), and any editing.

1.02 All GPS receiver systems must be approved for use in stream mapping by Islands Trust GIS staff. Only receiver models which have been tested and proven to be capable of meeting the above accuracy specification in field conditions will be approved.

1.03 At least one person, who is responsible for the quality of the data, must act as a supervisor and have completed GPS-specific training acceptable to Islands Trust GIS staff.

1.04 Field operators must be trained to the satisfaction of the supervisor, including GPS training and other training as required.

2. Field Parameters and Procedures

2.01 All positions fixes must use at least four satellites. No height constraints can be applied.

2.02 The minimum elevation angle to satellites is 15 degrees above the horizon.

2.03 The maximum Dilution of Precision (DoP) is:
- HDOP 5 (preferred in most cases)
- PDOP 8
- GDOP 10
- VDOP 5 (only if elevations are required)

2.04 For standard static point features occupation time must be at least 60 seconds AND there must be at least 30 individual position fixes for each feature. For boat-based, eelgrass surveys, occupation time for static point features must be less than 5 seconds with a target of 1 position fix and never more than 3 position fixes for each feature. Line and polygon features may be interpreted from successive static point features. The majority of the static point features must be no more than 15 metres apart. The maximum distance between successive static point features is 20 metres.

2.05 The maximum distance for point offsets is 25 metres. Directions must be accurate to 2 degrees and distances accurate to 1 metre. If the slope is over 10 percent and over 10 metres long, slope measurements (accurate to 5 percent or 3 degrees) must be made.

2.06 For all line (and polygon) features, all significant deflections and meanders of the feature must be mapped.

2.07 For line (and polygon) features surveyed in dynamic mode, the majority of the individual position fixes must be no more than 2.5 metres apart. The maximum distance between successive position fixes is 10 metres.

2.08 The maximum distance for constant line offsets is 5 metres.

2.09 For line (and area) features surveyed in station-to-station mode, the maximum distance between stations is 10 metres.

2.10 Supplementary traverses (using compass and chain) must begin (Point of Commencement) and end (Point of
Termination) on static GPS point features or on survey control monuments of 1 metre or better accuracy.

2.11 Directions for supplementary traverses must be accurate to 2 degrees and distances accurate to 1 metre. If the slope is greater than 10 percent, slope measurements accurate to 5 percent or 2.5 degrees must be made. The maximum length of an individual traverse leg is 50 metres. There is no limit on the total length of a supplementary traverse.

3. Data Processing and Mapping

3.01 All position fixes must be differentially corrected in real-time or post-processed. If position corrections are used, the same set of satellites must be used at the reference station as at the field receiver.

3.02 Reference stations (real-time or post-processed) must be approved by Islands Trust GIS staff.

3.03 The maximum age of real-time corrections is 20 seconds from the time the observations are made at the reference station to the time the computed corrections are applied at the field receiver.

3.04 All directions from compass observations must be corrected for declination before offset or traverse computations. If applicable, correction for grid convergence must be made.

3.05 Supplemental traverses must close to better than 1 percent (1/100) of the total traverse distance plus 2.5 metres. Traverse misclosures over 2.5 metres total must be adjusted (“balanced”) using the standard compass rule method.

3.06 If true NAD 27 coordinates are required, NAD 83 coordinates must be converted using the Canadian National Transformation, version 2 (NT v2).

3.07 If elevations are required, they must be converted from ellipsoidal to orthometric using the CRD Geoid model HT 2.0.

3.08 If data in any other coordinate system (e.g. ground coordinates) are required, procedures acceptable to Islands Trust GIS staff and the owner of the mapping must be used.

3.09 Any discrepancies between the GPS survey and existing mapping used as base maps must be resolved to the satisfaction of Islands Trust GIS staff and the local agency(s) considered responsible for the mapping.