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SURF SMELT AND PACIFIC SAND LANCE POTENTIAL SPAWNING HABITAT MAPPING

James and Sidney Islands, BC

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March 27, 2019

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS I

1 INTRODUCTION AND OBJECTIVES 1

2 ASSESSMENT AREA 2

3 IMPORTANCE OF FORAGE FISH IN THE MARINE ECOSYSTEM 4

4 SURF SMELT AND PACIFIC SAND LANCE SPAWNING HABITAT REQUIREMENTS AND SPAWNING CHARACTERISTICS 4

5 METHODOLOGY 5

5.1 REVIEW OF PREVIOUS ASSESSMENTS 5

5.2 PRE-TYPING ASSESSMENT AREAS 6

5.3 DATA COLLECTION AND FIELD SAMPLING 6

5.4 GPS DATA COLLECTION AND POST-PROCESSING 8

5.5 ANALYSIS OF FIELD DATA AND SAMPLES 9

6 RESULTS 11

6.1 SIDNEY ISLAND 11

6.1.1 GENERAL INTERTIDAL ZONE DESCRIPTION RELATED TO FORAGE FISH SPAWNING HABITAT 11

6.1.2 GENERAL MARINE BACKSHORE ZONE DESCRIPTION RELATED TO FORAGE FISH SPAWNING HABITAT 17

6.1.3 BEACH UNIT GRAIN-SIZE DISTRIBUTION CHARTS 27

6.2 JAMES ISLAND 34

6.2.1 GENERAL INTERTIDAL ZONE DESCRIPTION RELATED TO FORAGE FISH SPAWNING HABITAT 34

6.2.2 GENERAL MARINE BACKSHORE ZONE DESCRIPTION RELATED TO FORAGE FISH SPAWNING HABITAT 40

6.2.3 BEACH UNIT GRAIN-SIZE DISTRIBUTION CHARTS 48

7 DISCUSSION 54

7.1 CURRENT STRESSORS TO FORAGE FISH SPAWNING HABITAT ON JAMES AND SIDNEY ISLANDS 54

7.1.1 HUMAN-RELATED MODIFICATIONS 54

7.1.2 NATURAL BACKSHORE VEGETATION CHARACTERISTICS 55

7.1.3 NATURAL LONG-TERM AND SEASONAL COASTAL MORPHOLOGICAL CHANGES 56

7.2 PROTECTION OF FORAGE FISH SPAWNING HABITAT ON JAMES AND SIDNEY ISLANDS 58

REFERENCES 62

APPENDIX 1 - DATA DICTIONARY AND FIELD DATA A1-1

APPENDIX 2- BEACH UNIT FIELD PHOTOS A2-1

APPENDIX 3 - GPS DATA COLLECTION SPECIFICATIONS A3-1

Acknowledgements

We appreciate the opportunity provided by The Islands Trust Conservancy (Kate Emmings and Wayne Bourque) to complete this assessment. In preparation for the fieldwork, we extend our gratitude to Rachel Wang (WWF – Canada) for the helpful advice. Roy Smitshoek (President - Sidney Island Strata) was an integral part of the pre-fieldwork preparation phase, and we appreciate his local knowledge and assistance in planning the fieldwork logistics for Sidney Island. Similarly, Greg Alexander (James Island caretaker) was instrumental in providing access and logistical assistance for the James Island field assessment. Finally, we extend our thanks to Reg Kirkham (Island Water Taxi) for providing a safe, efficient and reliable service to and from James and Sidney Islands.

SURF SMELT AND PACIFIC SAND LANCE POTENTIAL SPAWNING HABITAT MAPPING

James and Sidney Islands, BC

1 Introduction and Objectives

A partnership between The Islands Trust Conservancy (ITC), Islands Trust (IT) and the BC Marine Conservation and Research Society has been instrumental in the on-going inventory of forage fish spawning habitat in the Salish Sea, with focus on surf smelt (*Hypomesus pretiosus*) and Pacific sand lance (*Ammodytes hexapterus*). These species are a key component of the marine food chain, and populations can be vulnerable to impacts from human activities along the shoreline. The main reasoning for their vulnerability is the fact that both surf smelt and Pacific sand lance spawn in areas that occur at the interface between the upper foreshore and the marine backshore zone, which is a zone of significant human interaction.

Since 2012, twelve islands in the Islands Trust area have been assessed for potential surf smelt (SS) and Pacific sand lance (PSL) spawning habitat: North and South Pender Islands; Thetis Island; Denman Island; Hornby Island; Gambier Island; Keats Island; Bowen Island; Galiano Island; Lasqueti Island; Salt Spring Island; and Valdes Island. The ITC has used these assessments to raise public awareness of forage fish and provides educational material to help decrease potential human-related impacts. Maps showing the locations of potential spawning areas are an integral part of the inventory projects and help to highlight areas that could be susceptible to impacts from adjacent human activities. The mapping information can be used to inform land owners about the value of adjoining marine habitat and to help government agencies (e.g. IT) develop long-term management strategies.

The specific objective of the project was to identify and map potential spawning beaches through identification of potential habitats by way of research and analysis of existing information and by conducting site visits to ground-truth potential spawning beaches on

Sidney and James Islands. This project allowed for the continuation of the inventory of potential SS and PSL spawning habitat on islands located in the Salish Sea. It is important to note that the project did not include confirming SS or PSL spawning activity through the processing of sediment to identify embryos. Instead, qualitative assessments were used to identify and map potential SS and PSL spawning habitat in the field, which were backed up by quantitative sediment grain-size analyses.

In order to ensure that the data collected during the James and Sidney Islands forage fish spawning habitat survey were of maximum value, the results were shared with the World Wildlife Fund (WWF). Sharing and collaborating with the WWF helped to ensure that broader region-wide studies were supported and also allowed for data gaps and further areas of study to be identified.

2 Assessment Area

Sidney and James Islands are located close to the US-Canada border between the Saanich Peninsula to the west and Stuart, San Juan and Orcas Islands to the east (Figure 1). The assessment area was comprised of the entire intertidal zone surrounding James Island and the segment of Sidney Island beyond the National Park Reserve.

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PROJECT: Sidney & James Is. Forage Fish Habitat Assessment

DRAWN BY: Ian Wright

DOSSIER: 18.0329

LOCATION: Southern Gulf Islands BC

CLIENT: Islands Trust Conservancy

MAP DATE: March 21, 2019

N

FIGURE 1: Overview of Study Area

3 Importance of Forage Fish in the Marine Ecosystem

SS and PSL are a component of the Salish Sea beach-spawning "forage fish" population, which also includes Pacific herring (*Clupea pallasi*). These fish form a critical part of the marine ecosystem, linking marine zooplankton production of predatory fish, birds and mammals in the upper food web. The ocean-phase life period of Pacific salmon (especially chinook salmon – *Oncorhynchus tshawytscha* and coho salmon – *Oncorhynchus kisutch*) depends upon forage fish (including SS and PSL). In particular, PSL are known to provide a significant proportion of the marine diet of both chinook salmon and coho salmon (de Graaf 2017).

Considering the current general decline of Pacific salmon stocks throughout the Pacific Northwest, the integrity of forage fish populations is extremely important. In addition, the apparent decline of species such as the Endangered Northeast Pacific southern resident killer whale (*Orcinus orca* pop. 5) that rely significantly upon chinook salmon is also a concern that has links to the general health of the forage fish population.

4 Surf Smelt and Pacific Sand Lance Spawning Habitat Requirements and Spawning Characteristics

One of the most important aspects of SS spawning habitat is the presence of a suitable sediment size mix at an appropriate intertidal level along the shoreline (Penttila 2007). The elevation on the beach that is used by SS for spawning is generally between the upper high tide line and the low high tide line (de Graaf 2017). Confirmed SS spawning has been documented in regions of the beach between 1.5 m and 4.5 m above chart datum, with spawning also documented at the highest level of the maximum high tide (de Graaf 2017).

SS are dependent upon a gravel component in the beach sediment, with the majority of spawning activity having been documented in sediment with particle sizes between 1 mm and 10 mm (Penttila 2001; cited in de Graaf 2017). SS spawning activity occurs in very shallow water during high tides (Penttila 2007). Based on the relative hostility of the SS spawning zone along the upper beach zone, the eggs of SS appear to have adapted to become resilient (at least to a certain extent) to temperature variations, salinity changes and desiccation (Penttila 2007). Throughout their range in the Pacific Northwest, SS are known to spawn year round, with specific winter and summer spawning aggregations (Penttila 2007). The incubation period for eggs is approximately 2 weeks over the summer months and 4 to 8 weeks during the winter time (Penttila 2007).

The spawning habitat used by PSL parallels that of SS spawning habitat, i.e. with regard to beach elevation and sediment type, and eggs of both species have been found in the same beach sediment during the winter months (Penttila 2007). PSL spawning activity can occur at lower elevations on the beach in comparison with SS (Penttila 2007). The typical particle size of PSL spawning substrate is generally a finer-grained sand mix compared to SS, with most spawning activity being documented in sand particles between 0.2 mm – 0.4 mm (Penttila 2007). As with SS, PSL eggs are thought to be resilient to extremes in temperature and salinity (Penttila 2007). Throughout their range in the Pacific Northwest, PSL have been shown to spawn in the fall and early winter months, with eggs incubating for approximately 1 month (Penttila 2007).

Because SS and PSL spawning habitat is in the upper intertidal zone, both species depend upon functioning marine riparian vegetation to reduce erosion/transportation of sediment, reduce surface run-off of potential pollutants and provide shade to incubating eggs. Shade from marine riparian vegetation helps prevent the desiccation of incubating eggs from sunlight and increased temperatures (Penttila 2007). Vegetation also reduces the drying effect of wind, and SS and/or PSL eggs that occur in beaches adjacent to exposed marine riparian areas generally have a higher potential for desiccation from wind (de Graaf 2017). The provision of shade is not as important to the value of PSL spawning habitat, based on the timing of spawning (fall and early winter), and also not as important to winter-spawning SS (Penttila 2007).

The natural supply/transportation of sediment along a beach and clean water are also extremely important to the integrity of SS and PSL spawning habitat (de Graaf 2017). Modifications such as piping storm drainage can lead to the erosion of sediment (both on the beach and in the backshore zone), bank instability and the concentration of pollutants. Larger shoreline modifications may interfere with the along-shore transportation of sediments that create SS and PSL spawning habitat.

5 Methodology

5.1 Review of Previous Assessments

The assessment of potential forage fish spawning habitat on Sidney and James Islands represents a component of a broader-scale project that has been on-going since 2012. As such, there were a number of reports that had been completed (de Graff 2013a, 2013b, 2014a, 2014b, 2014c, 2017a, 2017b, 2017c and 2017d). These reports provide valuable background information on forage fish and associated spawning habitat characteristics. However, the methodology of these studies is proprietary to the author of those reports.

Therefore, the sediment grain-size analyses used to identify potential SS and PSL spawning habitat on Sidney and James Islands differed from the methodology used in the previous (2012-2017) assessments. Previous assessments and studies completed in Washington State (mainly by Penttila) specific to forage fish were also relevant to the Sidney and James Island forage fish habitat assessment. The methodology in this study of James and Sidney Islands is designed to be simple, informative, cost effective and reproducible.

5.2 Pre-Typing Assessment Areas

High-resolution orthophotos provided by Islands Trust were studied to determine the large-scale characteristics of the intertidal areas surrounding both James and Sidney Islands. This preliminary coarse-scale assessment helped to determine the general location of potential forage fish spawning habitat, where areas consisting of unconsolidated sediment such as sand and gravel beaches (potentially suitable) could be separated from areas consisting of rock platforms and/or rock cliffs (unsuitable).

To provide an additional level of background knowledge and help focus the field assessment effort, the Coastal Resource Inventory Mapping System (http://maps.gov.bc.ca/ess/sv/crims/) was accessed to assess the documented composition of intertidal sediments around James and Sidney Islands. This database provided a more detailed framework of the suitability of the intertidal areas for forage fish spawning by helping to distinguish the differences between areas of potentially suitable unconsolidated sediment, i.e. sand and gravel, and areas of unsuitable unconsolidated sediment, i.e. silt. The database also indicated areas that required further verification in the field to confirm the occurrence of pockets of potentially suitable habitat. Such areas included isolated embayments containing unconsolidated sediment (sand and/or gravel), or areas where deposits of sand and/or gravel occurred over an otherwise rocky shoreline.

Previous Sensitive Ecosystem Mapping (SEM) updates completed in 2017 on behalf of IT by Madrone were also reviewed. Specifically, data related to coastal sand ecosystems were reviewed to provide a background and context of the types of ecosystems surrounding both James and Sidney Islands. These mapping updates helped focus the survey effort by further identifying and/or confirming areas of unconsolidated sediment.

5.3 Data Collection and Field Sampling

Fieldwork occurred on February 24th, 27th and 28th 2019 - two days were spent on Sidney Island and one day was spent on James Island. The Sidney Island fieldwork (February 24th and 27th) was completed by David Preikshot, PhD., R.P.Bio., Trystan Willmott, B.Sc., A.Sc.T. and Ian Wright, P.Ag., R.B.Tech. The James Island field day (February 28th) was completed by Trystan Willmott and Ian Wright. During the field assessment period, tidal cycles were favourable for assessing intertidal areas and the differences between observed high and low tide elevations were minimal, i.e. < 1 m.

Intertidal areas identified as containing a suitable mix of unconsolidated sediments during the pre-typing exercise were assessed in the field to ground-truth the Coastal Resource Inventory maps and collect specific beach-related data. Areas that had been identified as consisting of unsuitable habitat as part of the pre-field research, i.e. areas of rock and/or silt, were also checked in the field to confirm the absence of potential SS and/or PSL spawning habitat.

Due to the fact that both Sidney and James Islands generally contained long tracts of similar habitat, representative 30 m transects were assessed to be representative of larger integrated beach units. Unless beach conditions (including sediment type, backshore vegetation type, foreshore land use and/or foreshore modification) changed, the observations along a representative 30 m transect were extrapolated to include adjoining beach unit habitat. When beach conditions changed, Beach Unit Breaks (BUBs) were established and new transects were completed to capture the changes in the intertidal and/or backshore zones along each beach unit.

The transects were set parallel to the high tide line at a beach elevation equivalent to where SS and PSL spawning habitat would commonly occur (i.e. between the "high" high water mark and the "low" high water mark). The location of the transect was adjusted depending on the species most likely to occur, because PSL tend to spawn slightly lower down on the beach face compared to SS. Transects were not necessarily conducted at a BUB, or at the mid-point of a beach unit, but were completed at a representative location within the boundaries of the beach unit in areas that represented typical conditions of the overall habitat type.

Data collection at each beach unit transect was completed using a Data Dictionary provided by the ITC (see Appendix 1). The dictionary was pre-loaded onto an I-Pad, to allow for the collection of digital data in the field. Georeferenced maps were also loaded onto an I-Pad to allow for navigation and the preliminary placement of digital observation points during the fieldwork. Following each field day, data forms were checked for errors/inconsistencies, downloaded and then backed up.

Data collected at each of the assessed beach unit transects included information related to: the location of each assessed beach unit; physical beach attributes (e.g. slope and width of the beach); qualitative attributes of potential spawning habitat (e.g. depth of sediment, coverage of sediment, type of sediment, width of potential spawning habitat, potential species use); function of marine backshore vegetation; foreshore modification; backshore modification; foreshore land use; and backshore land use. Appendix 1 contains the full range of data collected at each beach unit. Photographs were also taken to show the characteristics and attributes of the assessed beach units (refer to Appendix 2).

Sediment grain size distribution was analyzed to help confirm the presence/absence of potential SS and/or PSL spawning habitat. Sediment samples were collected at each assessed beach unit transect. A representative 1 litre sample (equating to at least 1kg of dry sediment weight) was collected from a random location along each 30 m transect. The samples were scooped, bagged and labelled, making sure to sample at a depth of between 2.5 cm and 5 cm. This depth is consistent with the depth used for collecting samples to assess for SS and/or PSL embryos (as per methodology established by de Graff).

Confirming actual SS and/or PSL spawning use at any beach unit transects requires more intensive surveys to collect and assess samples for the occurrence of embryos. In the absence of such detailed presence/absence surveys, the range of data collected in conjunction with quantitative sediment analyses provides an alternative, risk-averse method to identify areas that represent suitable SS and/or PSL spawning habitat. That is, our methodology will not exclude any potential spawning habitat but may include some non-optimal spawning habitat.

5.4 GPS Data Collection and Post-Processing

A Trimble GEO 7X differential GPS unit was used to collect data on location and extent of potential forage fish habitat in the assessed intertidal areas. Positions were collected at the start and end of each beach unit, the start and end of each transect, the location of each collected sediment sample, and other points of interest (e.g. notable foreshore structures or active erosion). GPS data were collected in accordance with the specifications established by Islands Trust (refer to Appendix 3). After field assessments were completed, the GPS data were downloaded and post-processed in GPS Pathfinder Office using the closest base station relative to the study area that supported GLONASS post-processing and that produced the best result after testing several of the nearest stations (SOPAC, Albert Head, BC). The post-processed data was then exported to shapefile format and imported into ArcGIS.

Following the post-processing of the collected GPS data, maps were produced (Figures 2 and 4) to indicate the distribution of potential SS and/or PSL spawning habitat on Sidney and James Islands. The total length of potential SS and/or PSL spawning habitat on each island was calculated from the GPS data.

5.5 Analysis of Field Data and Samples

As the main objective of the project was to determine the distribution of potential forage fish spawning habitat, the proportion of sediment particles in the preferred SS (1 – 10 mm diameter) and PSL (0.2 – 0.4 mm diameter) sediment spawning ranges were isolated from the field samples. This was achieved by air-drying the samples for six days and then sieving 1 kg of each sample through a stack of four Tyler Canadian Standard Sieves with available mesh sizes that closely matched the spawning diameter ranges: 0.21 mm; 0.42 mm; 1.0 mm and 9.5 mm. The weight of each collected fraction (including material that was either larger than 9.5 mm, less than 0.21 mm or between 0.42 mm and 1 mm) was then measured and expressed as a percentage of the overall sample weight. This approach of isolating the preferred ranges of potential spawning habitat is similar to the methodology used in an assessment completed by Archipelago Marine Research Ltd. (2014).

While sediment fractions that were larger than 9.5 mm or smaller than 0.21 mm were considered unsuitable, the 0.42 mm to 1 mm fraction in the mid-range between the "ideal" diameter ranges comprises a component of the spawning substrate that could be used by both species. This mid-range would be more likely to be used if there was also a suitable pebble component for SS and/or a suitable component of medium sand for PSL. With regard to confirming potential habitat for SS and/or PSL, however, the mid-range fraction was not included as a definitive indicator. It should be noted that the mid-range fraction is still important in that it helps to show the proportion of particle sizes that "overlap" the general spawning sediment ranges for both species.

A SUB-SET OF DRY SAMPLES AFTER SIX DAYS OF AIR DRYING PRIOR TO THE GRAIN SIZE SIEVING ANALYSIS.

STACK OF SIEVES (9.5 MM, 1.0 MM, 0.42 MM AND 0.21 MM) AND SHAKER MACHINE USED FOR THE GRAIN SIZE ANALYSIS.

Bar charts were produced (refer to Section 6.1.3) to indicate whether the preferred spawning sediment ranges for SS and/or PSL were present at each of the areas that were qualitatively assessed and mapped as potential spawning habitat in the field. In addition to confirming the presence of potential spawning habitat, the quantitative (sieve) analysis of the sediment samples provided a measure of the spawning habitat quality (per species) of each of the assessed beach units. The quantitative sediment analysis also allowed for the confirmation of those beach units where both PSL and SS could potentially spawn by indicating the occurrence and amount of the preferred spawning sediment for each species.

Field data collected and recorded in the Data Dictionary were also reviewed to help indicate the relative value of each assessed beach unit where potential forage fish spawning habitat was identified. In particular, the degree of human encroachment and quality of marine backshore vegetation were assessed to provide an indication of the current integrity of forage fish spawning habitat and identify any immediate threats.

6 Results

6.1 Sidney Island

6.1.1 General Intertidal Zone Description Related to Forage Fish Spawning Habitat

During the assessment of Sidney Island, 31 beach units were identified, with 7.6 km of potential forage fish spawning habitat (including both SS and/or PSL). Figure 2 shows the distribution of potential SS and/or PSL spawning habitat on Sidney Island. This apparent abundance of potential spawning habitat is related to the general morphology of the intertidal zones around the island and the predominance of suitably-sized unconsolidated sediment as opposed to bedrock and/or coarse sediments.

The majority of the western shoreline of Sidney Island (beach units 1 – 9) is comprised of a predominantly sand beach (known collectively as Sandy Beach and Crabtrap Beach), which becomes interrupted by bedrock, boulders and cobbles along the western side of Sallas Point. Pocket beaches (mainly consisting of gravel and/or cobble) occur along the western and southern shorelines of Sallas Point (beach units 10 – 15). On the eastern side of Sallas Point, suitably-sized unconsolidated sediment occurs along Jackspring Beach (beach units 16 and 17), which is truncated by bedrock along the western shoreline of Wymond Point. Pocket beaches, generally with gravel and/or cobble substrate (beach units 18 – 24) are interspersed along the western and eastern shores of Wymond Point (Barnacle Beach and Red Snapper Beach being the most prominent).

LOOKING SOUTH ALONG THE SAND BEACH THAT COMPRISES THE MAJORITY OF THE WESTERN SHORELINE OF SIDNEY ISLAND.

LOOKING NORTH ALONG THE WESTERN SIDE OF SALLAS POINT SHOWING PREDOMINANCE OF BOULDERS, BEDROCK AND LARGE COBBLES IN THE INTERTIDAL ZONE.

LOOKING NORTH EAST ALONG JACKSPRING BEACH INDICATING THE OCCURRENCE OF A MIX OF SAND AND GRAVEL IN THE INTERTIDAL ZONE.

LOOKING EAST TOWARDS THE ROCKY SHORELINE COMPRISING THE SOUTHERN SHORE OF WYMOND POINT.

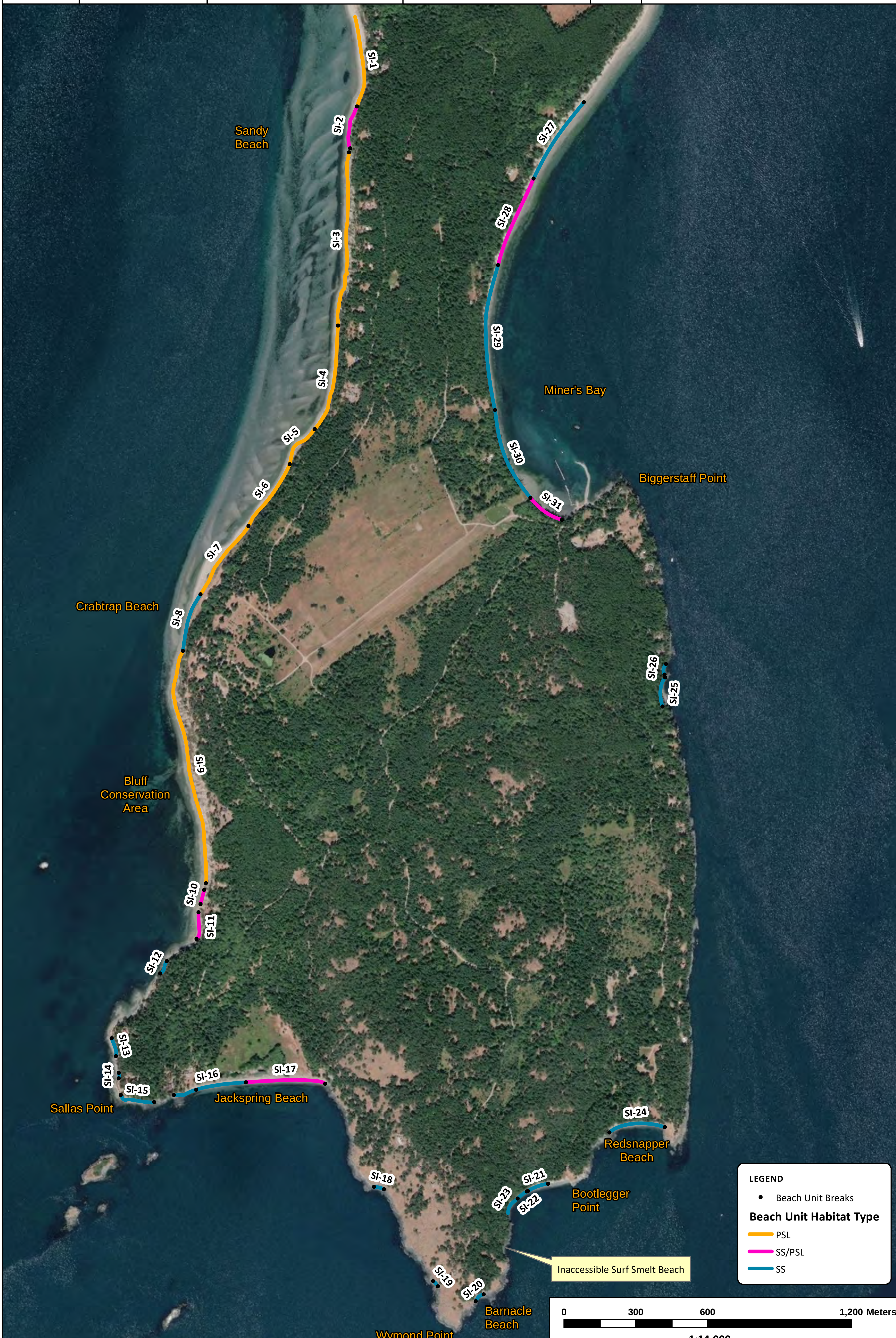
The majority of the eastern shoreline of Sidney Island, to the south of Miner's Bay, is composed of bedrock, with pocket beaches of sand and gravel (e.g. beach units 25 and 26) also occurring. Miner's Bay (beach units 27 – 31) represents a long tract of sand, gravel and cobble beaches. The sediment becomes dominated by silt and very fine sand in the southern segment of Miner's Bay to the immediate west of Biggerstaff Point. This transition in the sediment creates an area of unsuitable spawning habitat in the eastern-most segment of Miner's Bay. The protection from wind and wave activity afforded by Biggerstaff Point allows for the deposition of fine-grained material. The breakwater that has been constructed in this area to allow for the protection of the marina (the main access point for Sidney Island) appears to have encouraged the deposition of silt and fine sand.

LOOKING NORTH EAST ALONG THE SOUTHEASTERN SHORELINE OF SIDNEY ISLAND NEAR BOOTLEGGER POINT SHOWING PREDOMINANCE OF BEDROCK EXTENDING INTO THE INTERTIDAL AREA.

LOOKING NORTH ALONG THE EXTENSIVE SAND, GRAVEL AND COBBLE BEACH THAT OCCURS ALONG THE MAJORITY OF THE SHORELINE OF MINER'S BAY.

LOOKING NORTH WEST OVER MINER'S BAY TOWARDS THE BREAKWATER AND MARINA. NOTE PREDOMINANCE OF SILT IN THE INTERTIDAL ZONE.

PROJECT:	DRAWN BY:	DOSSIER:	FIGURE 2:
Sidney & James Is. Forage Fish Habitat Assessment	Ian Wright	18.0329	Sidney Island
LOCATION: Sidney Island BC	CLIENT: Islands Trust Conservancy	MAP DATE: March 26, 2019	SS & PSL Potential Spawning Habitat Distribution



6.1.2 General Marine Backshore Zone Description Related to Forage Fish Spawning Habitat

The majority of the marine backshore zone on Sidney Island (considering a 30 m zone inland of the high tide line) is currently unaffected by human-related activities. Private Lots lie adjacent to the high tide line, but the majority of the properties remain in an undeveloped state. Those properties that have been developed generally do not encroach into the marine backshore zone. Development features and activities such as retaining structures, boat ramps, buildings, armouring and vegetation removal are very uncommon. This benefits the current integrity of potential forage fish spawning habitat, as it removes the potential for negative impacts that are usually associated with development along the interface between spawning habitat and private land.

Despite the general lack of development along the foreshore and adjacent backshore zone, some impacted areas were noted. These areas consisted of: an access ramp (with associated rip-rap) in beach unit 15; beach access stairways in beach units 2, 4, 12, 26 and 29; stormwater outflow pipes discharging onto the beach in beach units 4 and 24; rip-rap armouring and historical vegetation clearance in beach unit 24; and a caravan (in association with an area historically cleared of treed vegetation) in beach unit 8. When considering the length of each beach unit, the modified areas generally represented minimal, isolated intrusions. In particular, the small footprints of the beach access stairways in addition to the construction methodology (sympathetic to surrounding vegetation) meant that the overall function of the backshore zone remained generally unaffected by these features. Many of the stairways were unusable based on naturally unstable slope conditions.

LOOKING EAST TOWARDS THE ACCESS RAMP AND RIP-RAP ENCROACHING INTO THE BACKSHORE ZONE AND FORESHORE AREA – BEACH UNIT 15.

LOOKING EAST TOWARDS A BEACH ACCESS STAIRWAY LOCATED IN BEACH UNIT 2. NOTE MINIMAL FOOTPRINT AND LOW IMPACTS TO SURROUNDING VEGETATION.

LOOKING EAST TOWARDS A WOODEN RETAINING STRUCTURE FORMING PART OF A BEACH ACCESS TRAIL IN BEACH UNIT 4. NOTE MINIMAL FOOTPRINT AND RETENTION OF VEGETATION.

LOOKING NORTH EAST TOWARDS THE MINIMAL FOOTPRINT OF A BEACH ACCESS STAIRWAY LOCATED IN BEACH UNIT 12.

MINIMAL BEACH ACCESS STAIRWAY ASSOCIATED WITH BEACH UNIT 26.

LOOKING WEST TOWARDS A BEACH ACCESS STAIRWAY LOCATED IN BEACH UNIT 29. THIS FEATURE IS CURRENTLY UNUSABLE, BASED ON THE INSTABILITY OF THE SLOPE.

ABOVE AND BELOW: STORMWATER OUTFLOW PIPES PLACED THROUGH THE MARINE BACKSHORE ZONE AND DISCHARGING ONTO THE BEACH – BEACH UNIT 4.

The rock armouring along the foreshore/backshore interface in beach unit 24 represents one of the more significant encroachment features. Despite the occurrence of the rip-rap retaining structure, sediment movement along the beach appears to be unaffected (no scour was noted along the base of the wall). Construction of the wall likely resulted in the removal of backshore vegetation, but mature trees are still interspersed in the area upslope of the structure.

LOOKING WEST TOWARDS THE RIP-RAP RETAINING WALL LOCATED IN BEACH UNIT 24.

STORMWATER OUTFALL PIPE FLOWING OUT OVER THE RIP-RAP RETAINING WALL LOCATED IN BEACH UNIT 24.

LOOKING EAST TOWARDS THE CARAVAN LOCATED IN BEACH UNIT 8.

As noted previously, construction of the breakwater and marina (the main access to and from Sidney Island) has likely caused an increase in fine sediment coverage in the southern-most segment of Miner's Bay. This has likely affected the distribution of potential forage fish spawning habitat. The degree of sediment-type changes is difficult to quantify, as it is likely that protection from Biggerstaff Point naturally favoured the deposition of fine grained material in this part of Miner's Bay. Rip-rap associated with the breakwater extends along part of the immediate backshore zone, along with the breakwater access road, but these impacts are not associated with any adjacent forage fish spawning habitat.

With regard to the biological function of backshore vegetation in the provision of shade over potential forage fish spawning habitat and providing bank stability, natural morphological processes on Sidney Island are limiting factors. Steep, unstable sand bluffs extend from the upper high tide line along much of the coastline. These bluffs are sparsely vegetated with pioneer species such as Scotch broom (*Cytisus scoparius*) – an invasive species. As a result, there is minimal shading over the adjacent intertidal zone. Generally, treed vegetation growing beyond the tops of the bluffs is too far removed from the beaches to be of any shade value.

It is important to note that while the sand bluffs may limit the establishment of vegetation, the bluffs are supplying much of the sediment that nourishes the beaches that represent potential forage fish spawning habitat. These bluffs are fragile and naturally sensitive to disturbance, and any modifications to the foreshore and/or backshore zone could interrupt the supply and movement of sediment. The bluffs that occur along parts of the western shoreline of Sidney Island and the bluffs adjacent to Miner's Bay have been mapped as Sensitive Ecosystems (Madrone 2017). Other Sensitive Ecosystems that occur in the assessed areas consist of dunes and beaches (Figure 3).

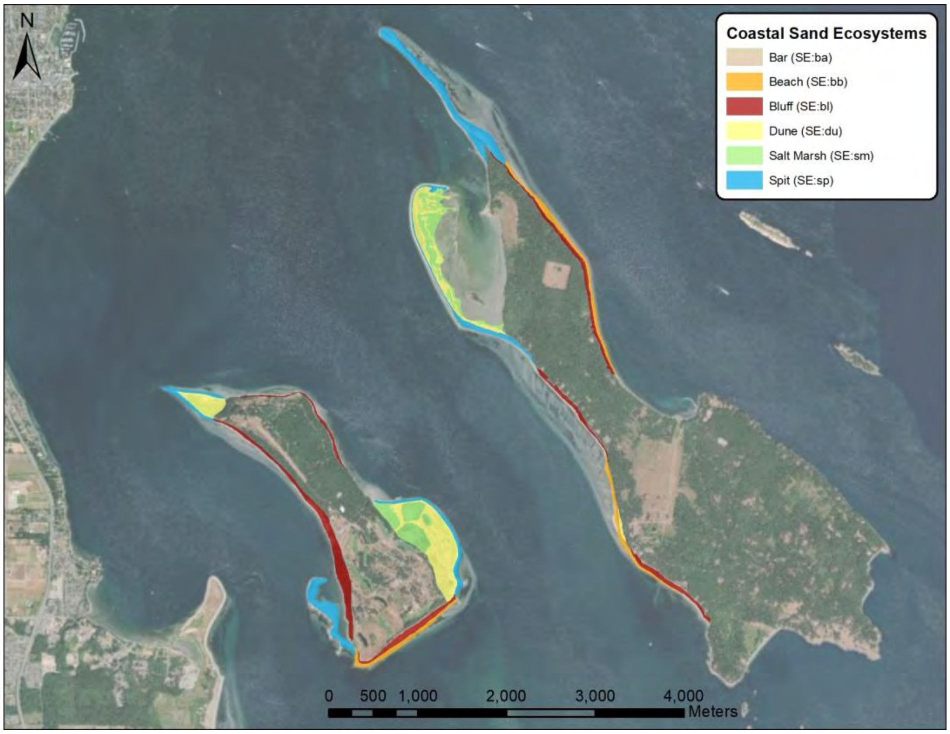


FIGURE 3. DISTRIBUTION OF SENSITIVE ECOSYSTEMS (COASTAL SAND ECOSYSTEMS) ON JAMES AND SIDNEY ISLANDS.

Naturally dry, sparsely vegetated areas with shallow soils over bedrock that occur inland from the high tide line along extended areas of Sidney Island also offer minimal biological function to adjacent potential forage fish spawning habitat.

EXAMPLE OF STEEP, UNSTABLE SAND BLUFFS EXTENDING ALONG BEACH UNITS 9-12.

EXAMPLE OF STEEP, UNSTABLE SAND BLUFF AND SPARSE BACKSHORE VEGETATION (BEACH UNIT 9).

EXAMPLE OF NATURALLY SPARSE BACKSHORE VEGETATION GROWING ON SHALLOW SOILS OVER BEDROCK – BEACH UNIT 18.

Certain areas of Sidney Island do support valuable backshore vegetation, which currently provides important functions in the form of shading and bank stability (e.g. beach units 25, 26, 30 and 31). These areas are limited in extent in comparison with the preponderance of naturally sparse backshore zones.

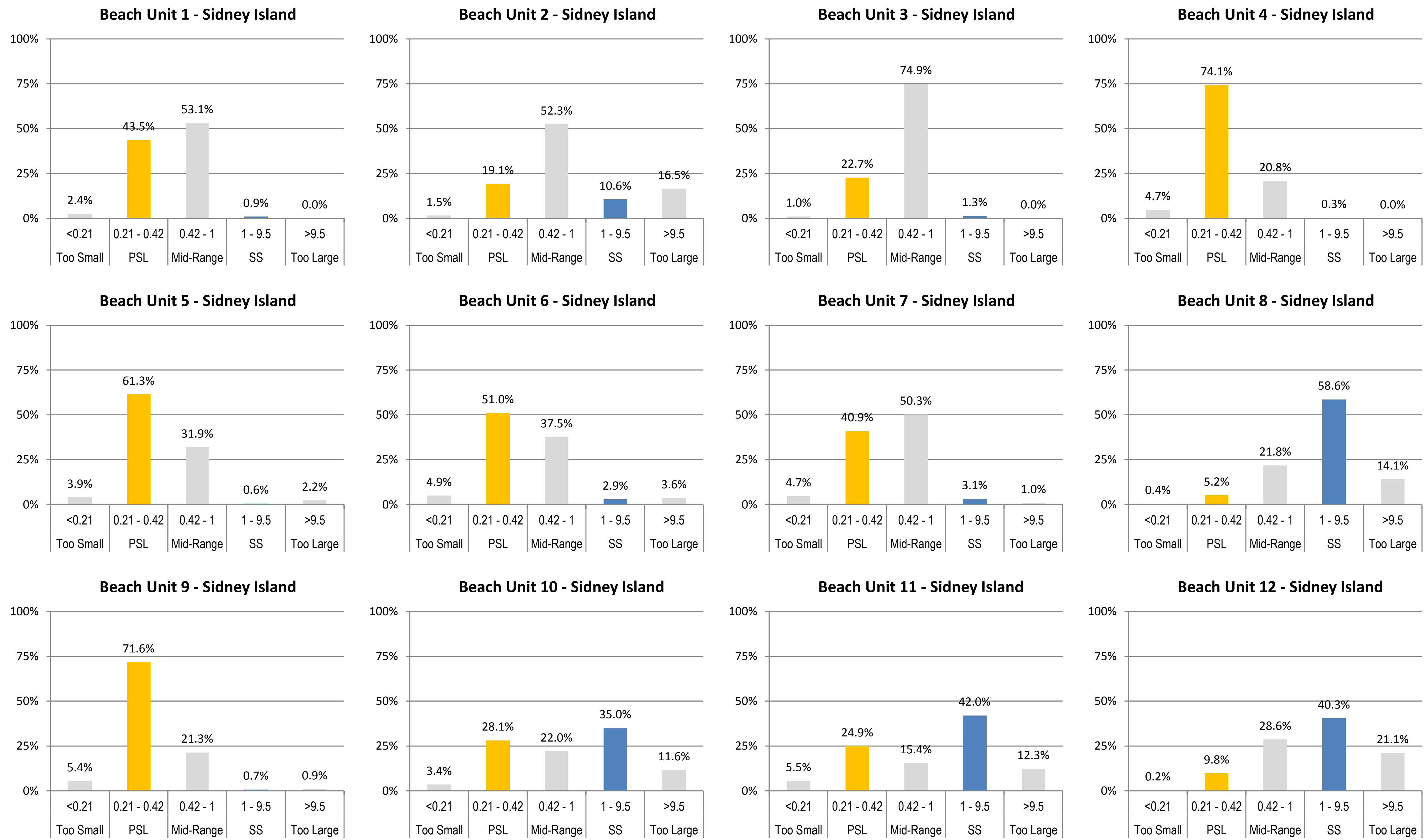
EXAMPLE OF FUNCTIONING OVERHANGING BACKSHORE VEGETATION – BEACH UNIT 25.

EXAMPLE OF FUNCTIONING OVERHANGING BACKSHORE VEGETATION – BEACH UNIT 31.

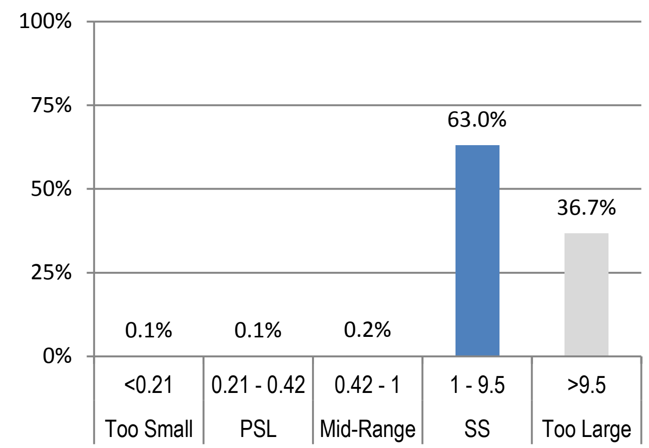
6.1.3 Beach Unit Grain-size Distribution Charts

The following charts show the relative proportions of the preferred SS and/or PSL particle size spawning ranges for each beach unit on Sidney Island. The beach units have also been summarized and labelled as representing potential spawning habitat for SS, PSL or both species.

Sidney Island Beach Unit Grain Size Distribution Results



Beach unit 13 - Sidney Island



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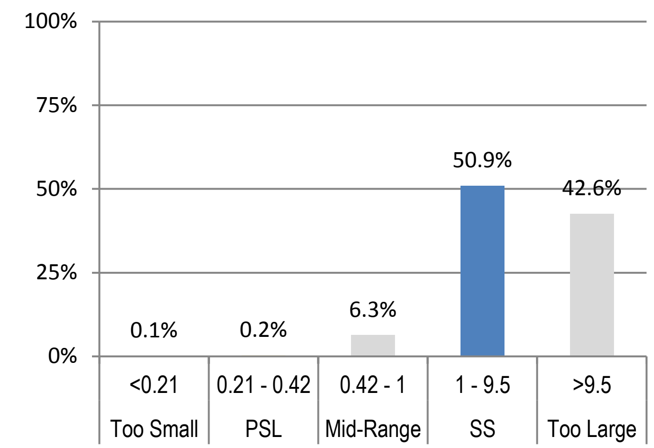

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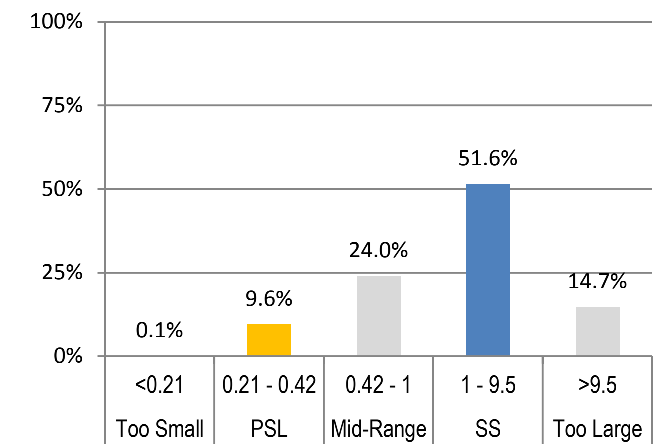

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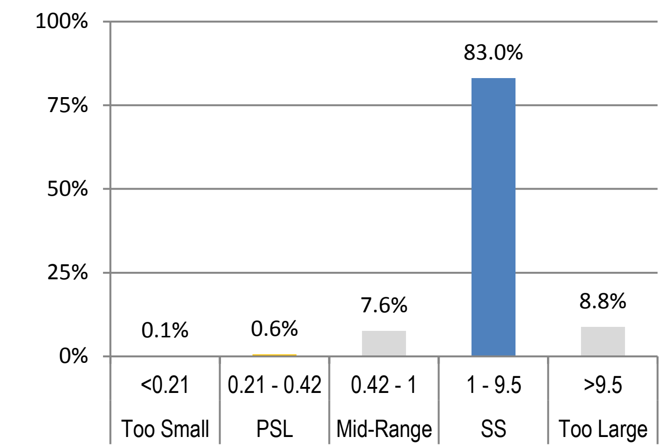

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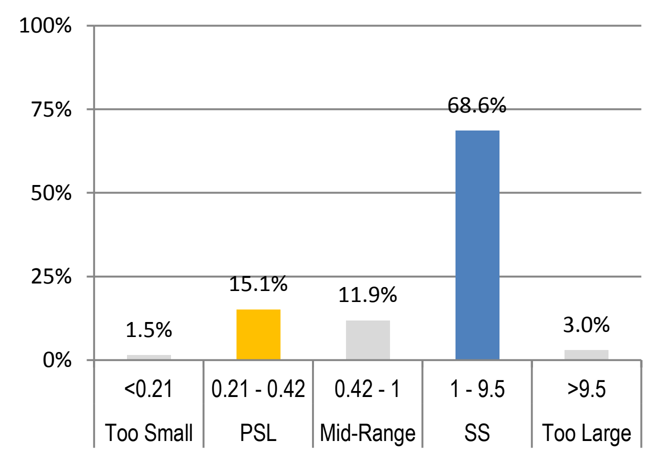

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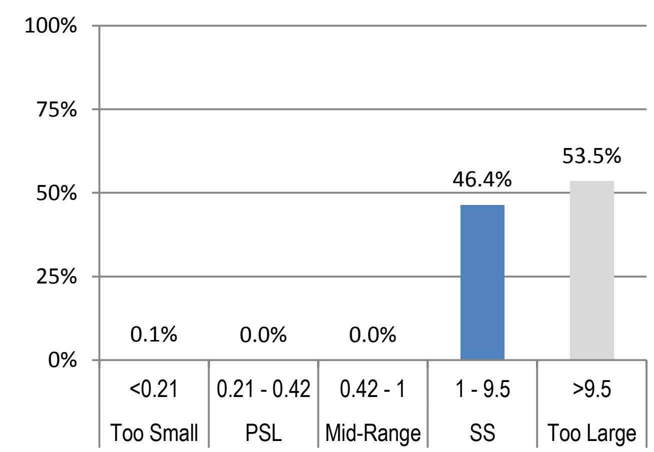

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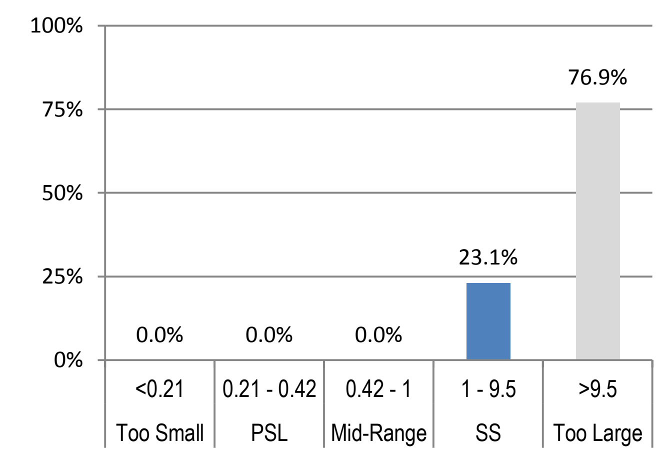

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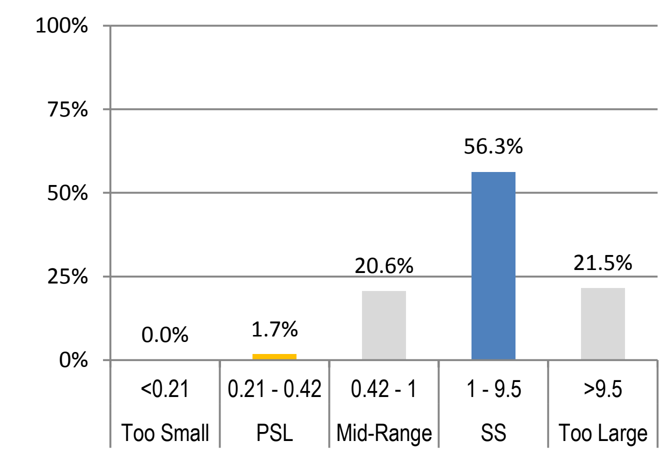

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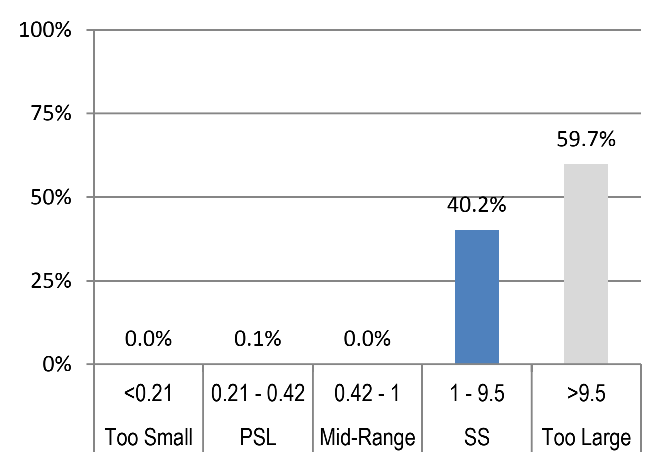

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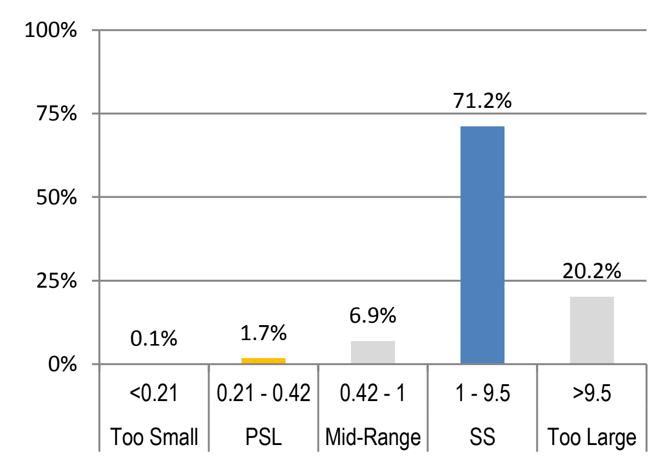

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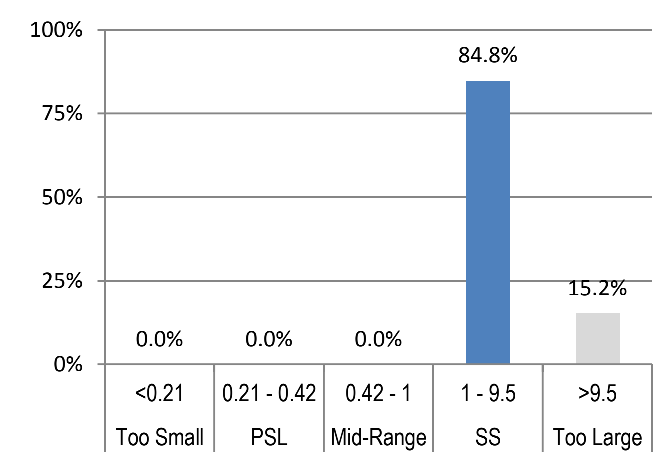

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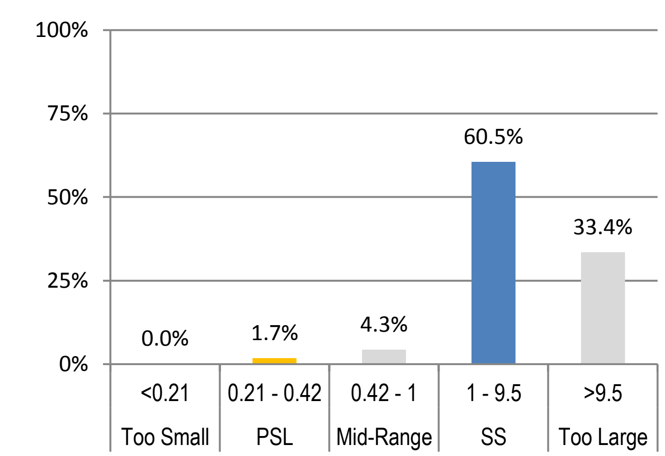

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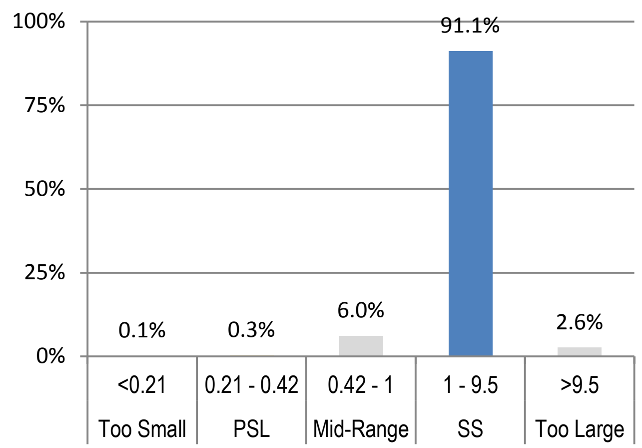

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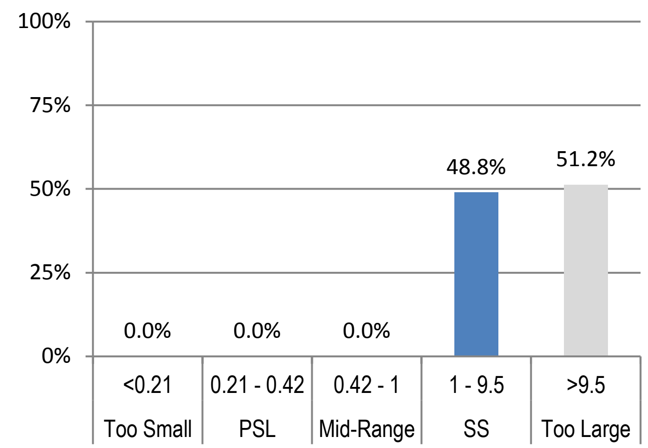

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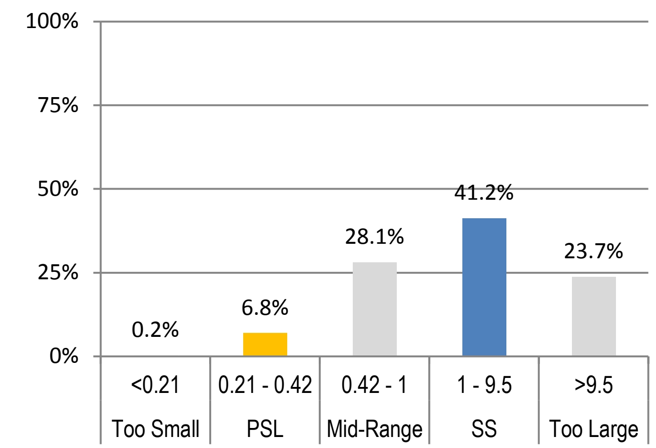

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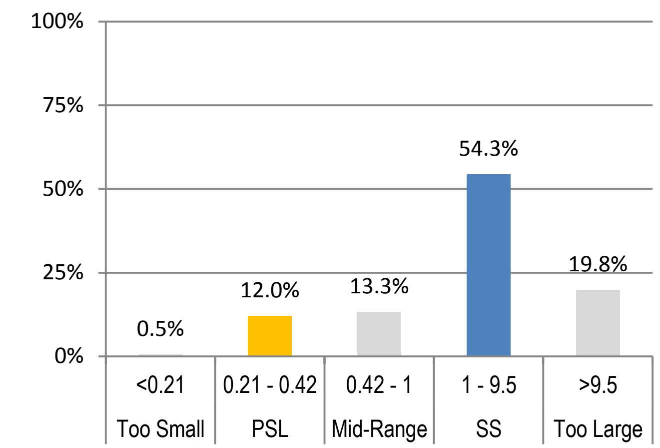

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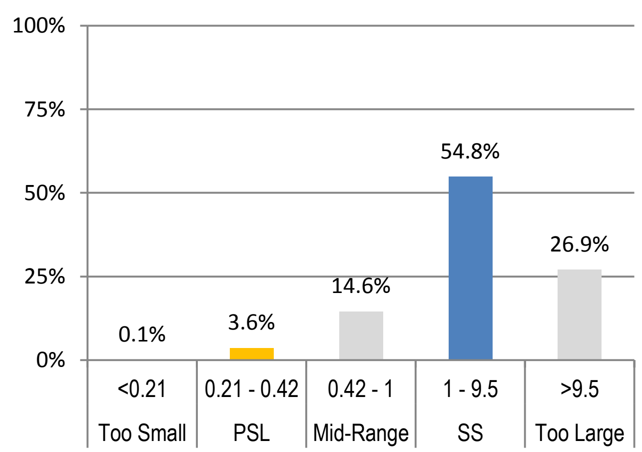

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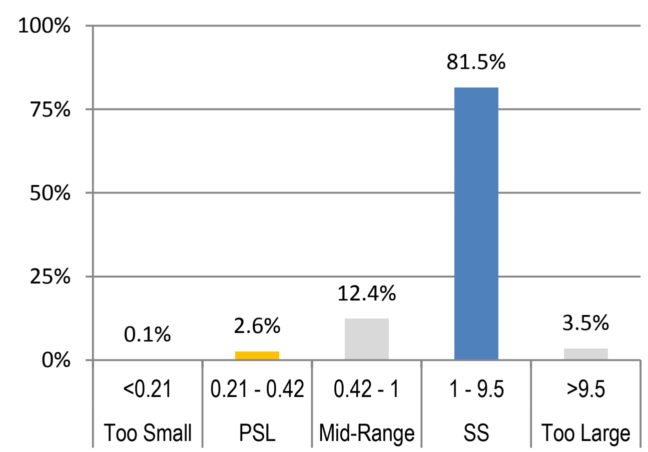

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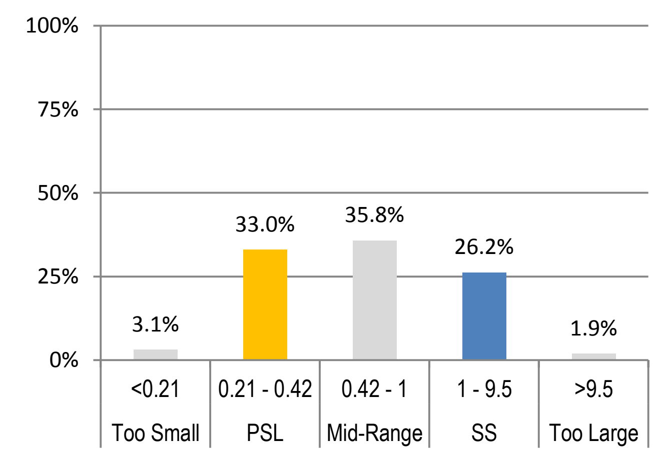
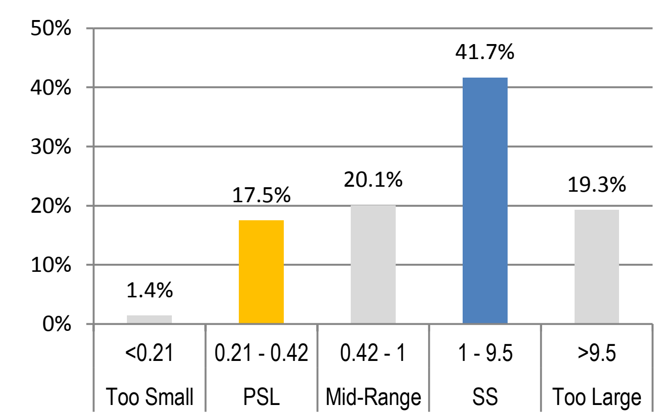
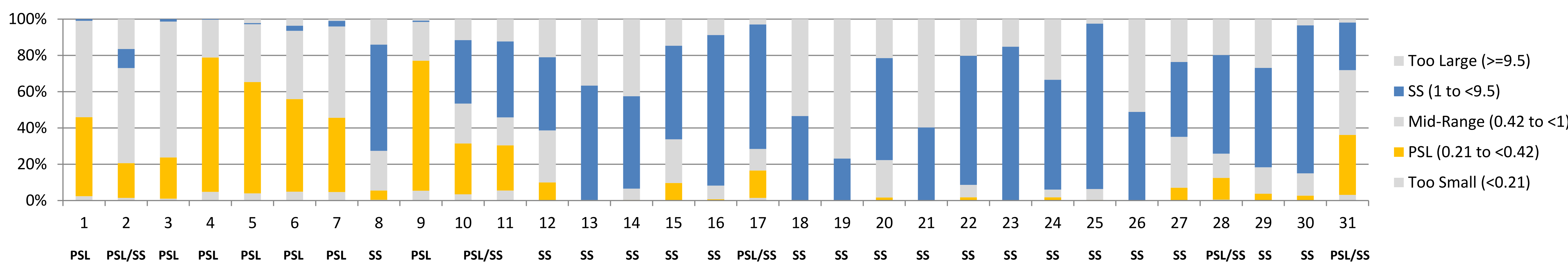


Sidney Island - Overall Beach Unit Grain Size Composition



Sidney Island Beach Units - Potential Species Use Based on Grain Size Distribution



The grain size analysis of samples collected on Sidney Island showed that 18 beach units (8, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29 and 30) contained sediments that were more suited to SS spawning due to the relative proportions of material in the 1 mm to 9.5 mm diameter range. Seven beach units (1, 3, 4, 5, 6, 7 and 9) were shown to be more suited to PSL (these beaches contained an abundance of sand particles in the 0.21 mm to 0.42 mm range and a distinct lack of particles beyond the preferred range). Six beach units (2, 10, 11, 17, 28 and 31) contained potential spawning habitat for both species due to the relative abundance of both sediment particle ranges, including a general abundance of a medium sand base in the 0.42 mm to 1 mm diameter range. In terms of total extent of potential spawning habitat, approximately 3 km consisted of habitat best suited to SS, about 3.4 km was more suited to PSL and approximately 1.2 km was suited to PSL and/or SS.

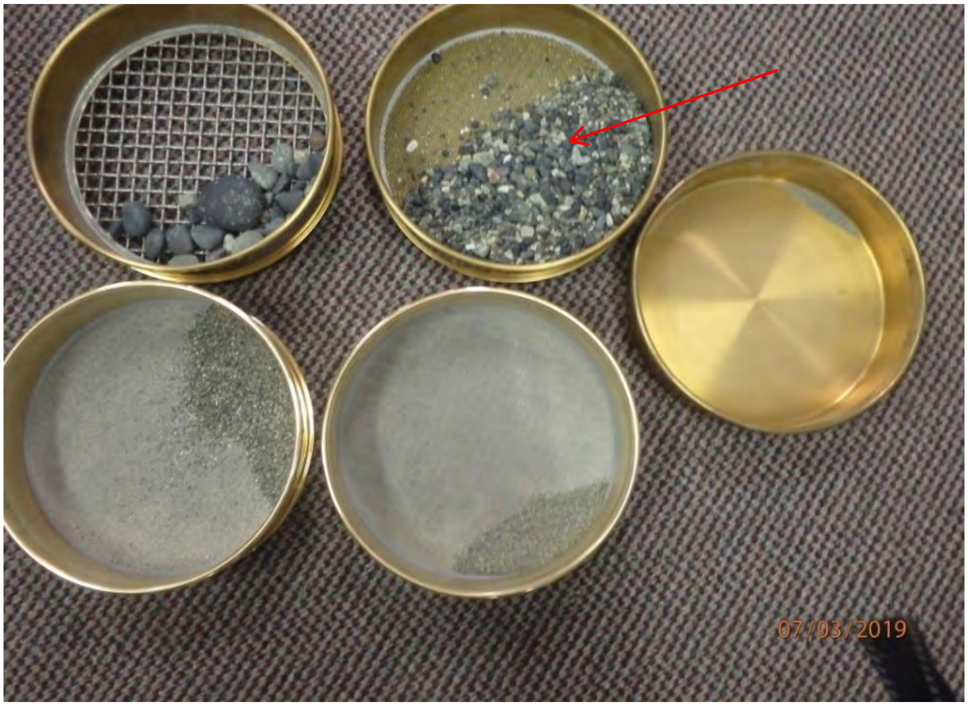
The analysis matched with the qualitative assessment of potential spawning habitat in the field, as there were no field-identified potential spawning beaches that were disqualified. The sieving exercise also indicated very small proportions of fine-grained material, i.e. fine sand and silt.

Considering the analysis of the collective beach units, 17.5 % of the sediment sampled represented the 0.21 mm – 0.42 mm (PSL) range, 41.7 % represented the 1 mm to 9.5 mm (SS) range, 19.3 % of the sediment sampled was considered to be too large (> 9.5 mm), 1.4 % of the sediment was considered to be too small (< 0.21 mm) and 20.1 % represented sediment that fell in the mid-range sand base (0.42 mm – 1 mm). Despite the apparent abundance of sediment and individual beach units in the potential SS sediment particle range, potential PSL spawning habitat covered a larger area in the field, mainly due to the extensive lengths of the sand beach units along the western shoreline of Sidney Island.

EXAMPLE OF SEDIMENT FROM A BEACH UNIT WITH POTENTIAL PSL SPAWNING HABITAT – BEACH UNIT 4 – SIDNEY ISLAND.

RETAINED FRACTIONS OF SEDIMENT FROM A SAMPLE TAKEN FROM BEACH UNIT 4 (SIDNEY ISLAND). NOTE ABUNDANCE OF SEDIMENT IN THE 0.21 – 0.42 MM FRACTION (HIGHLIGHTED), INDICATING POTENTIAL PSL SPAWNING HABITAT.

EXAMPLE OF SEDIMENT FROM A BEACH UNIT WITH POTENTIAL SS SPAWNING HABITAT – BEACH UNIT 22 – SIDNEY ISLAND.



RETAINED FRACTIONS OF SEDIMENT FROM A SAMPLE TAKEN FROM BEACH UNIT 22 (SIDNEY ISLAND). NOTE ABUNDANCE OF SEDIMENT IN THE 1.0 – 9.5 MM FRACTION (HIGHLIGHTED), INDICATING POTENTIAL SS SPAWNING HABITAT.

During the assessment, one beach could not be accessed because of steep cliffs. This pocket beach was located on the eastern side of Wymond Point (see Figure 2 for precise location). The beach was assumed to be a potential SS spawning beach due to the general size of the sediment.

LOOKING DOWN ON THE INACCESSIBLE POCKET BEACH LOCATED ON THE EASTERN SIDE OF WYMOND POINT. NOTE PREDOMINANCE OF GRAVEL AND COBBLE, INDICATING A POTENTIAL SS SPAWNING BEACH.

6.2 James Island

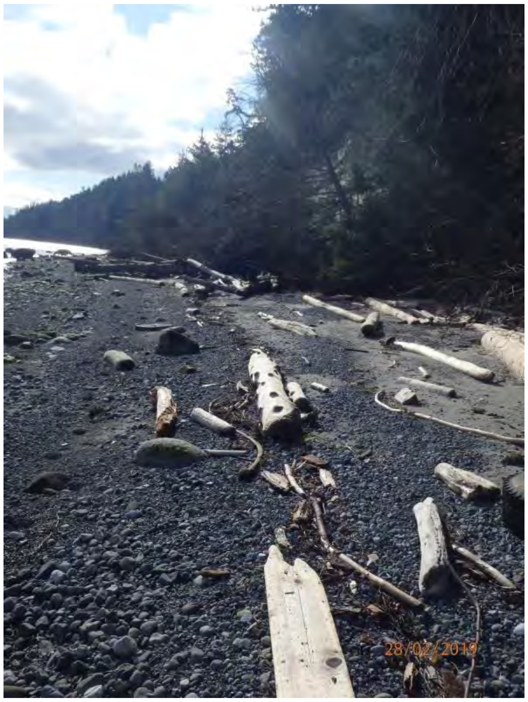
6.2.1 General Intertidal Zone Description Related to Forage Fish Spawning Habitat

Nineteen beach units were mapped during the assessment of James Island, which resulted in the identification of 11.0 km of potential SS and/or PSL spawning habitat (Figure 4). As with Sidney Island, potential forage fish (SS and/or PSL) spawning habitat does not appear to be limited on James Island. As shown by Figure 4, the majority of the shoreline is potential spawning habitat, reflecting the general morphology of the intertidal zones and predominant coastal processes. Despite the fact that the coastline of James Island is smaller than Sidney Island, it supports more potential spawning habitat.

The southern shoreline of James Island is characterized by a predominantly sand/gravel beach (beach units 1-4), which grades into consistent sand along beach unit 5 (part of the southeastern shoreline of the island). Gravel and cobble become mixed with the sand along beach unit 6, which extends along part of the eastern shoreline. Sand again dominates the substrate type along beach unit 7 before grading into a segment of gravel and cobble through beach unit 8. Sand (with components of gravel and cobble) prevails through beach units 9 – 14 along the northern and western shorelines. Beach units 9 and 10 are part of a sand spit that extends to the northwest of James Island. A segment of gravel and cobble (with sand) occurs along beach unit 15, before transitioning back to predominantly sand in beach unit 16.

LOOKING EAST ALONG THE EXTENSIVE SAND/GRAVEL BEACH THAT EXTENDS ALONG THE SOUTHERN SHORELINE OF JAMES ISLAND.

LOOKING NORTH WEST ALONG THE SAND BEACHES COMPRISING PART OF THE SOUTHEASTERN SHORELINE OF JAMES ISLAND.



LOOKING SOUTH ALONG THE GRAVEL/COBBLE BEACH EXTENDING ALONG PART OF THE EASTERN SHORELINE OF JAMES ISLAND.

LOOKING SOUTH ALONG THE PREDOMINANTLY SAND BEACHES THAT EXTEND ALONG THE WESTERN SHORELINE OF JAMES ISLAND.

A sand spit occurs along the southwestern shoreline of James Island. This feature has created a sheltered lagoon, with corresponding sediments of fine sand and silt that are unsuitable for SS or PSL spawning. A marina serviced by an access road running along the spine of the sand spit occurs inside the sheltered lagoon. Potential forage fish spawning habitat consisting mainly of sand (mostly suited to PSL) occurs along beach units 17 and 18 along the eastern shore and northern tip of the sand spit. Along the more exposed western shoreline of the spit, gravel and cobbles become mixed with the sand in beach unit 19 (suited to both PSL and SS).

LOOKING NORTH EAST OVER THE SHELTERED LAGOON FROM THE EASTERN SIDE OF THE SAND SPIT CONNECTED TO THE SOUTHWESTERN SHORELINE OF JAMES ISLAND.

PREDOMINANCE OF SILT IN THE SHELTERED LAGOON ON JAMES ISLAND.

LOOKING EAST OVER THE LAGOON TOWARDS THE MARINA THAT REPRESENTS THE MAIN ACCESS POINT FOR JAMES ISLAND.

LOOKING WEST OVER THE NORTHERN TIP OF THE SAND SPIT THAT IS CONNECTED TO THE SOUTHWESTERN SHORELINE OF JAMES ISLAND.

MADRONE environmental services ltd	PROJECT: Sidney & James Is. Forage Fish Habitat Assessment	DRAWN BY: Ian Wright	DOSSIER: 18.0329	FIGURE 4 : James Island SS & PSL Potential Spawning Habitat Distribution
	LOCATION: James Island BC	CLIENT: Islands Trust Conservancy	MAP DATE: March 26, 2019	

6.2.2 General Marine Backshore Zone Description Related to Forage Fish Spawning Habitat

The majority of the backshore zone adjacent to the shoreline of James Island is undeveloped. Vegetation clearance and/or modification has occurred, however, as part of a golf course development. Fairways, greens and golf course access trails/roads occur in the immediate backshore zone adjacent to beach units 4 and 5 along the southeastern shoreline of the island. As a result, functioning backshore vegetation is lacking in this area.

Development in the backshore zone has also occurred in and around the sand spit that connects to the southwestern shoreline of James Island. A residence, parking area and gravel access road extend through the backshore zone on the sand spit, and rip-rap protects the exposed western side of the road running along the spine of the sand spit. This road connects to the marina that is located in the lagoon located on the eastern side of the sand spit. The rip-rap armouring along the edge of the road may have altered the natural distribution of sediment along beach unit 19 by increasing scour and encouraging the erosion of sand and deposition of gravel and cobble.

Historical encroachment into the backshore and foreshore zones occurs in beach unit 16 in the form of an old landing area built up in the intertidal area. This landing area is associated with rip-rap armouring along the seaward side. This feature represents part of war-time infrastructure when explosives and ammunitions were stored and produced on James Island. A steep stairway leads up the bank from the landing site. To the North of the landing area (at the end of beach unit 15), the brick remains of a war time structure occur in the backshore and foreshore zones. The bricks and metals from the structure cover the beach producing a short break in the occurrence of potential forage fish spawning habitat.

An old wooden pier that supports buildings and a boat landing area is in the backshore and foreshore zones in beach unit 5. Rip-rap protects the seaward edge of the pier access and a gravel road extends from the pier inland.

Only one stormwater outfall pipe was noted during the assessment. A small-diameter plastic pipe discharges water over the edge of a steep sand bluff in beach unit 11. It appears that this pipe drains an airstrip located further inland.

LOOKING WEST TOWARDS THE BACKSHORE ZONE ADJACENT TO BEACH UNIT 5 (GOLF COURSE LOCATED BEYOND). NOTE LACK OF FUNCTIONING BACKSHORE VEGETATION.

LOOKING EAST TOWARDS THE RESIDENCE LOCATED IN THE BACKSHORE ZONE ADJACENT TO BEACH UNIT 19.

LOOKING NORTH ALONG THE ACCESS ROAD RUNNING ALONG THE SPINE OF THE SAND SPIT (BEACH UNIT 19 IS LOCATED TO THE WEST). NOTE RIP-RAP THAT PROTECTS THE EXPOSED WESTERN SIDE OF THE ROAD.

LOOKING SOUTHEAST ALONG BEACH UNIT 19 SHOWING THE RIP-RAP ARMOURING ALONG THE WESTERN SIDE OF THE ACCESS ROAD SHOWN IN THE PREVIOUS PHOTO.

LOOKING SOUTH OVER THE LANDING AREA LOCATED IN BEACH UNIT 16.

LOOKING NORTH TOWARDS THE RIP-RAP ARMOURING EXTENDING OUT INTO THE FORESHORE AREA ALONG THE EDGE OF THE LANDING SITE IN BEACH UNIT 16.

LOOKING SOUTH OVER THE BRICK AND METAL REMAINS OF A WAR TIME STRUCTURE THAT COVER THE NATIVE BEACH SEDIMENT CLOSE TO THE END OF BEACH UNIT 15.

LOOKING EAST TOWARDS THE PIER LOCATED IN BEACH UNIT 5.

DRAINAGE OUTFALL PIPE LOCATED IN THE BACKSHORE ZONE ADJACENT TO BEACH UNIT 11.

Unstable sand bluffs comprise a significant proportion of the backshore zones along the shoreline of James Island. These bluffs provide a significant input of potential forage fish spawning sediment to the adjacent intertidal zones. The sparsely vegetated bluffs reduce the biological function of backshore vegetation for potential spawning habitat in terms of shading and bank stabilization. The bluffs and other coastal sand ecosystems, such as the sand spit adjacent to the southwestern shoreline, are fragile ecosystems that are susceptible to human-related disturbance. Foreshore and backshore modifications have the potential to negatively alter the natural function of these ecosystems in terms of changing the dynamics of sediment supply and movement.

In recognition of the fragility of coastal sand ecosystems and susceptibility to disturbance, the bluffs along the southern, western and north-eastern shorelines are considered Sensitive Ecosystems. The sand spit at the northwestern tip of the island (beach units 9 and 10) and the sand spit connected to the southwestern shoreline of the island (beach units 17 – 19) are also considered Sensitive Ecosystems (refer back to Figure 2). Dune Sensitive Ecosystems lie adjacent to beach units 4, 5, 9 and 10.

LOOKING NORTH TOWARDS AN EXAMPLE OF SPARSELY VEGETATED, UNSTABLE SAND BLUFFS ADJACENT TO BEACH UNIT 14 ON JAMES ISLAND. NOTE BRICKS AND METALS IN THE INTERTIDAL ZONE – REMNANTS OF A WAR TIME STRUCTURE.

LOOKING EAST TOWARDS AN EXAMPLE OF SPARSELY VEGETATED, UNSTABLE SAND BLUFFS ADJACENT TO BEACH UNIT 3 ON JAMES ISLAND.

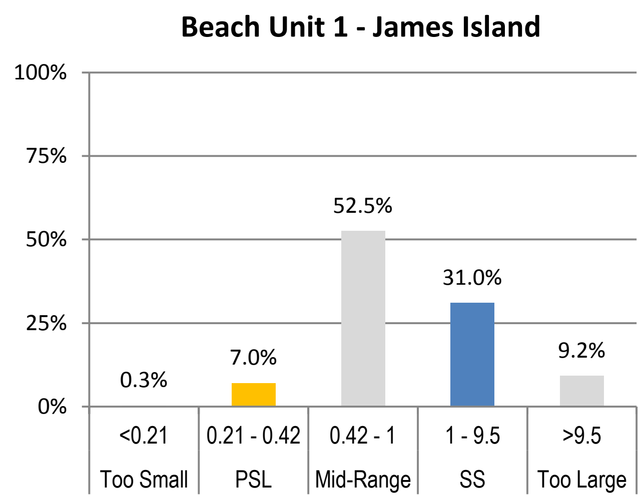
LOOKING NORTH ALONG BEACH UNIT 6 SHOWING AN EXAMPLE OF FUNCTIONING BACKSHORE VEGETATION (PROVIDING SHADE OVER POTENTIAL FORAGE FISH SPAWNING HABITAT).

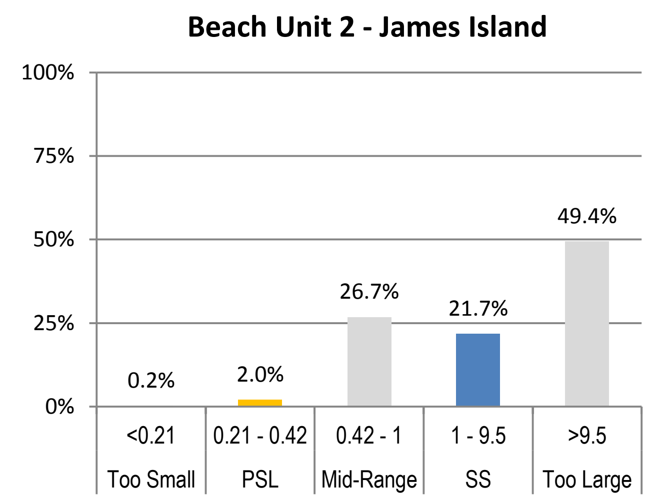
LOOKING NORTH ALONG BEACH UNIT 12 SHOWING AN EXAMPLE OF FUNCTIONING BACKSHORE VEGETATION (PROVIDING SHADE OVER POTENTIAL FORAGE FISH SPAWNING HABITAT).

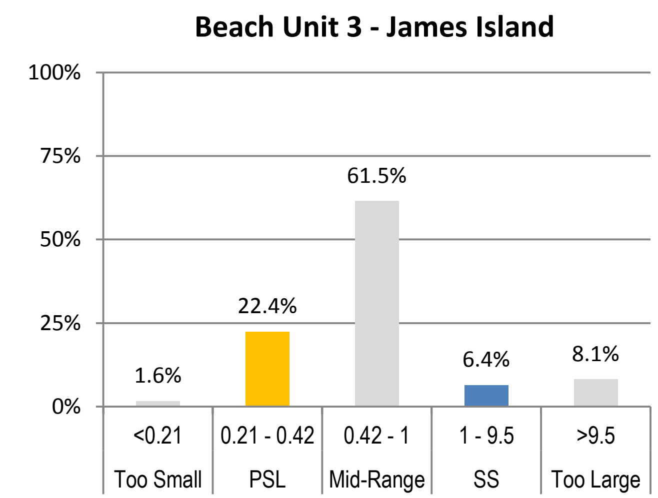
6.2.3 Beach Unit Grain-size Distribution Charts

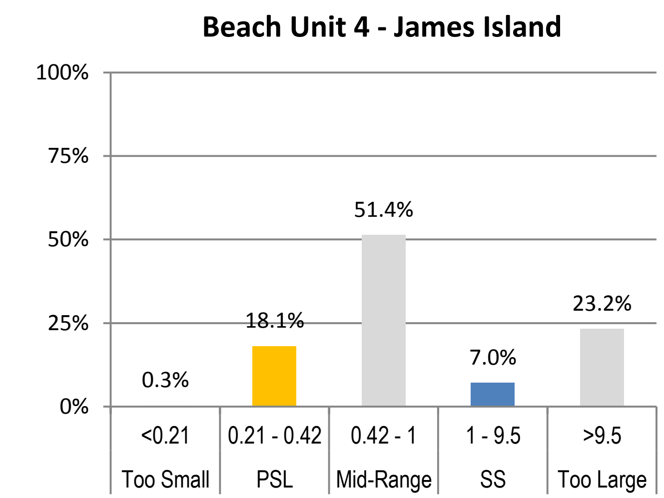
The following charts show the relative proportions of the preferred SS and/or PSL particle size spawning ranges for each beach unit on James Island. The beach units have also been summarized and labelled as representing potential spawning habitat for SS, PSL or both species.

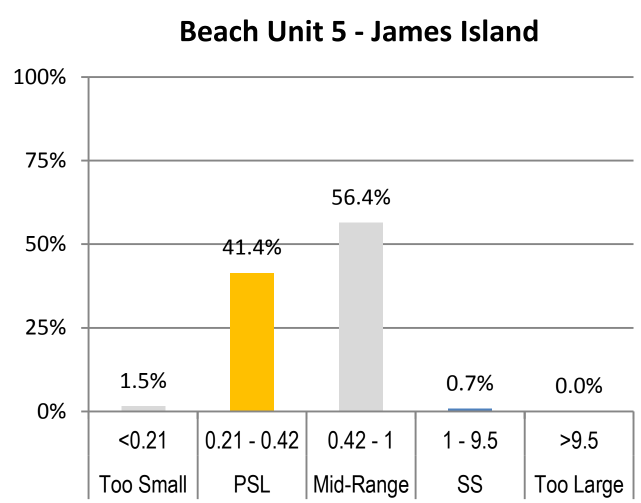
James Island Beach Unit Grain Size Distribution Results

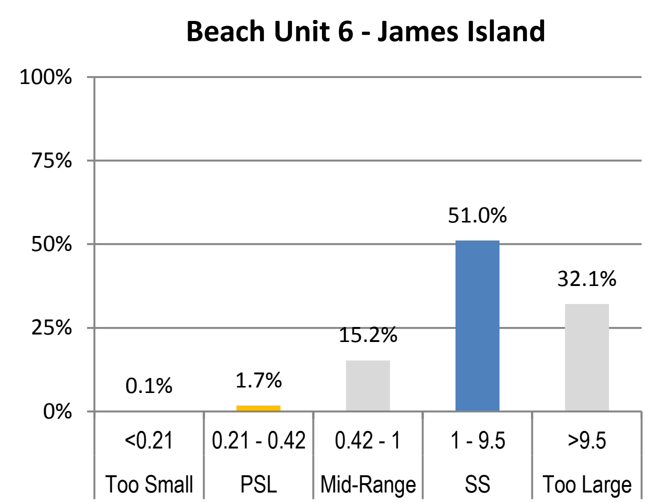


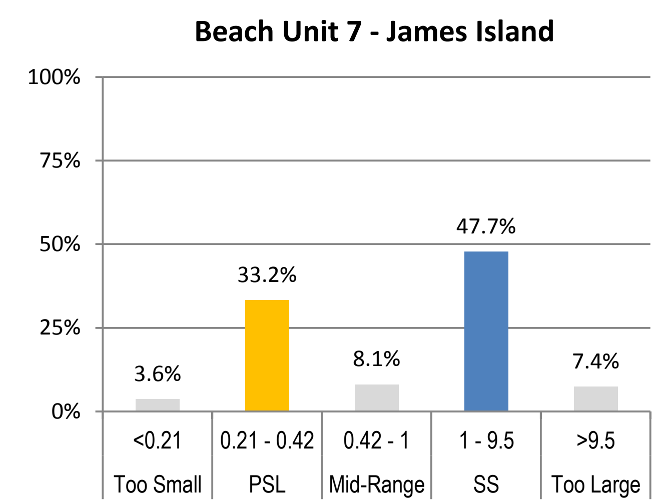


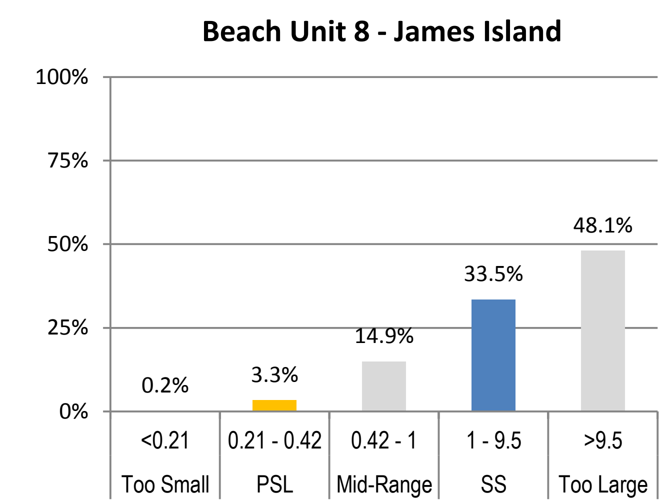


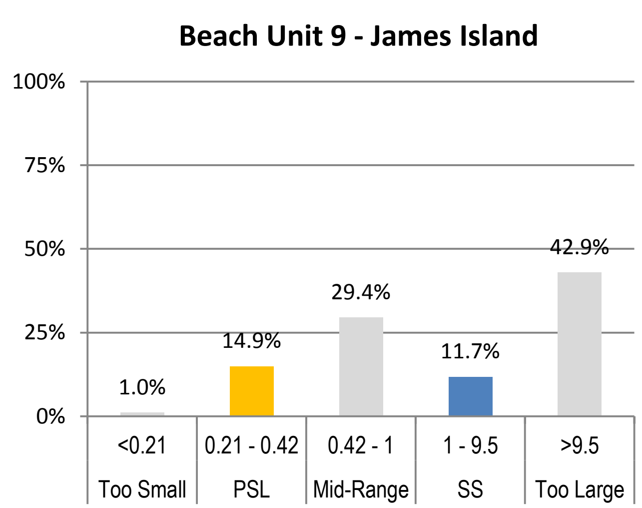


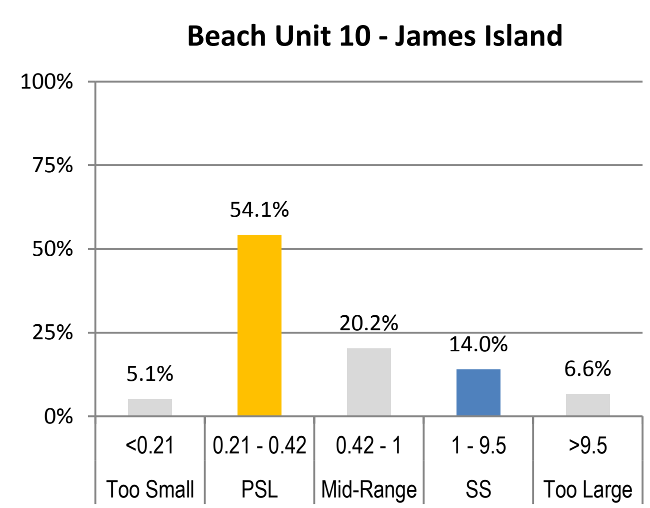


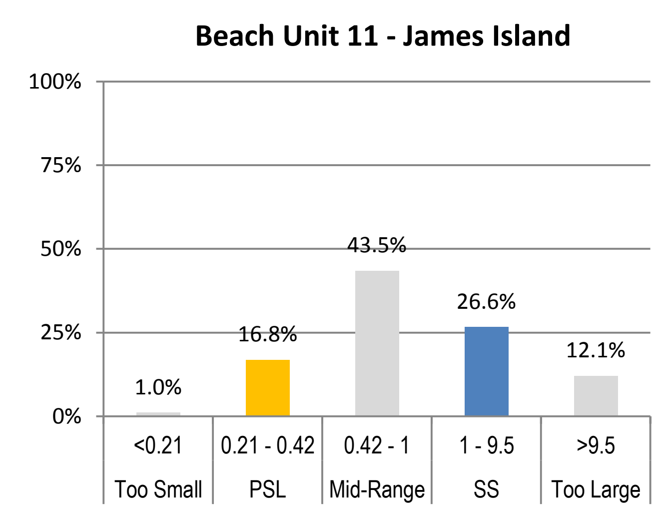


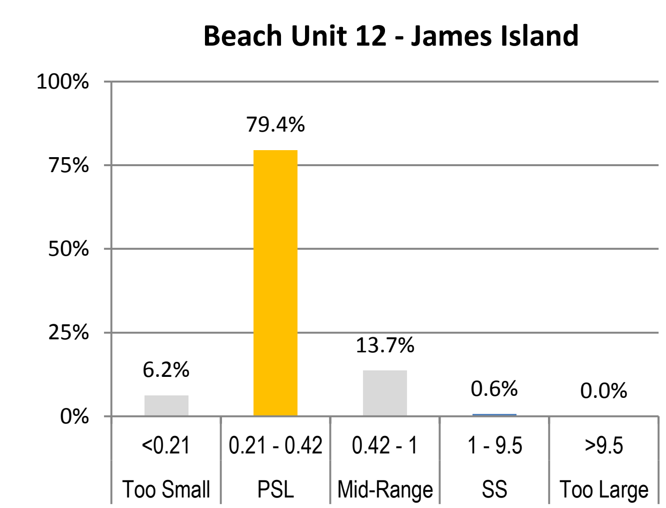




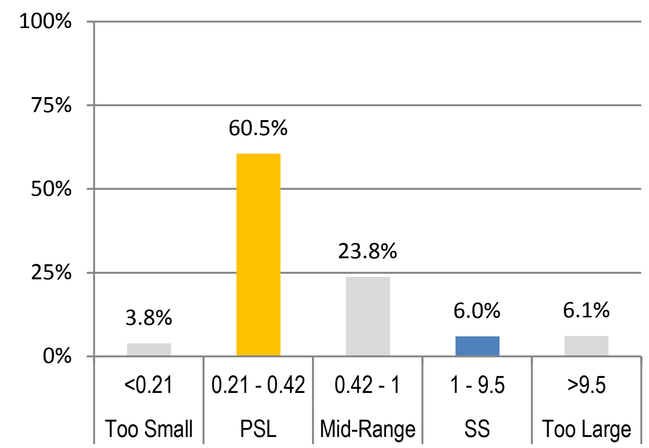




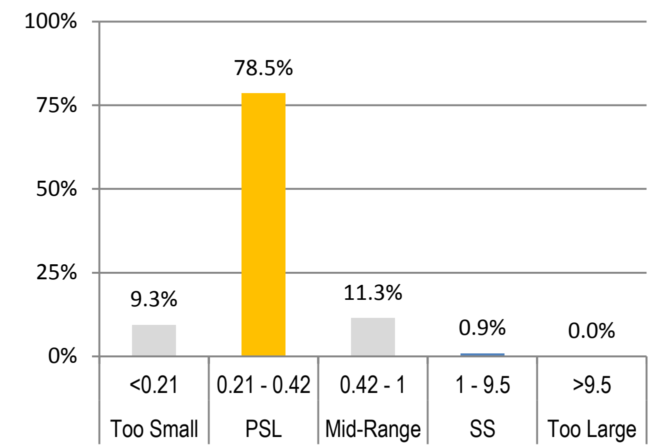




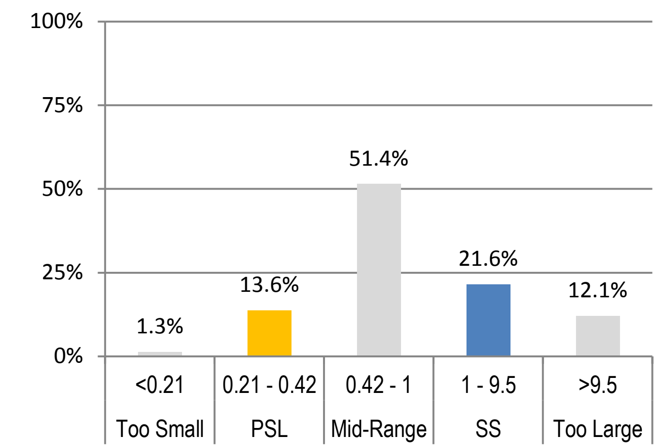
Beach Unit 13 - James Island



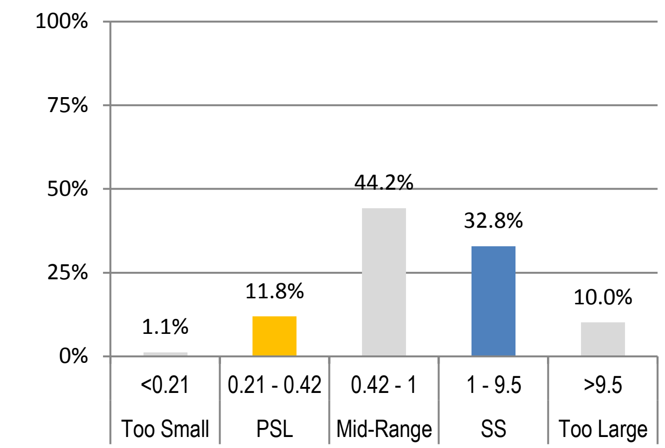
Beach Unit 14 - James Island



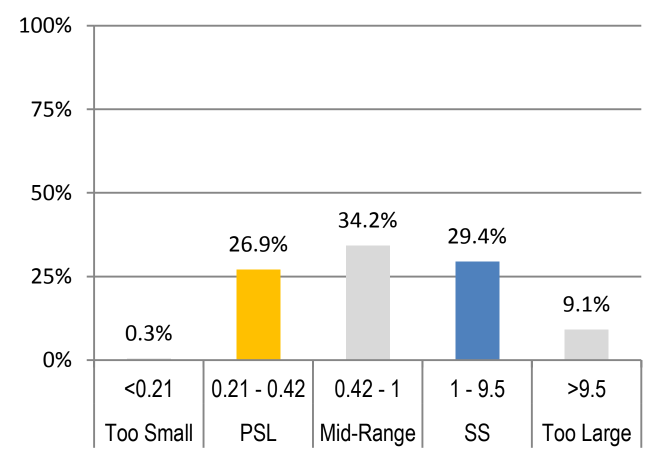
Beach Unit 15 - James Island



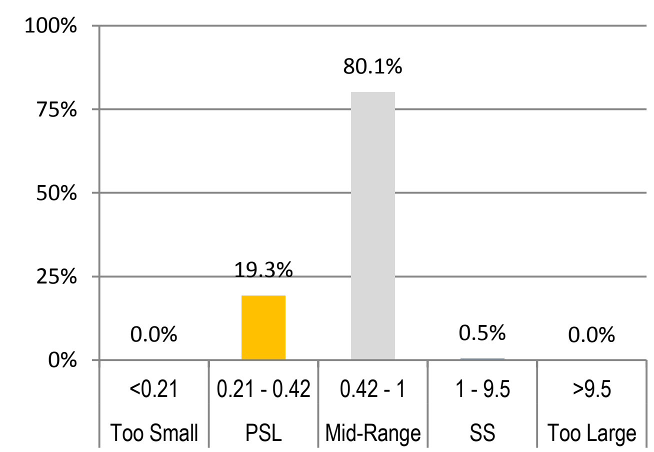
Beach Unit 16 - James Island



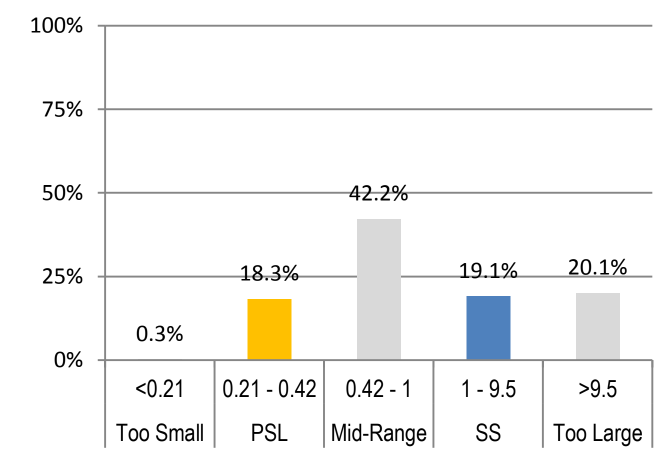
Beach Unit 17 - James Island



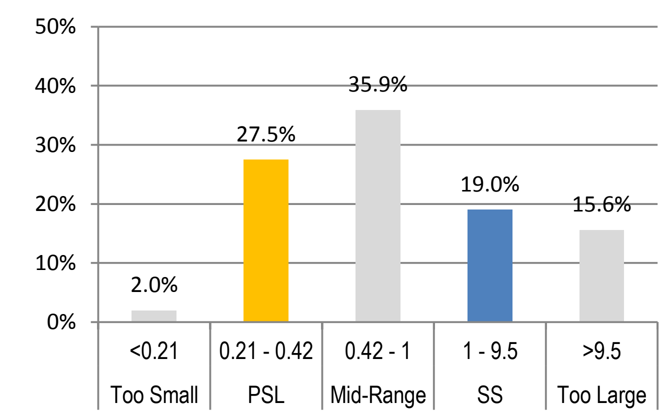
BeachUnit 18 - James Island



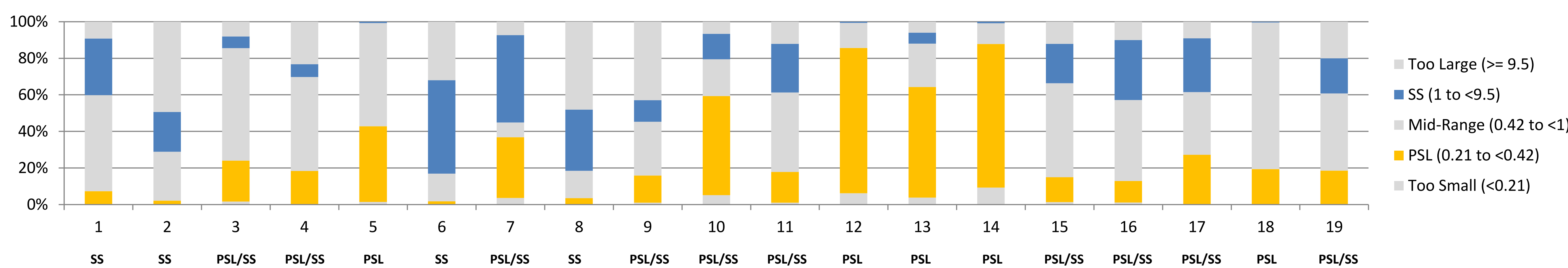
Beach Unit 19 - James Island



James Island - Overall Beach Unit Grain Size Composition



James Island Beach Units - Potential Species Use Based on Grain Size Distribution



Following the grain size analysis for the samples collected on James Island, 4 beach units (1, 2, 6 and 8) were considered to contain sediments that were more suited to SS spawning due to the proportions of material in the 1 mm to 9.5 mm diameter range. Five beach units were shown to be more suited to PSL spawning (5, 12, 13, 14 and 18). These beaches contained an abundance of sand particles in the preferred 0.21 mm to 0.42 mm range and a distinct lack of particles beyond the preferred range. Ten beach units (3, 4, 7, 9, 10, 11, 15, 16, 17 and 19) were shown to contain potential spawning habitat for SS and/or PSL, due to the relative abundance of both sediment particle ranges, including a general abundance of medium sand base in the 0.42 mm to 1 mm diameter range. In terms of the length of potential spawning habitat, approximately 2.5 km was best suited to SS, about 2.4 km was representative of potential PSL spawning habitat and approximately 6 km was suited to SS and/or PSL.

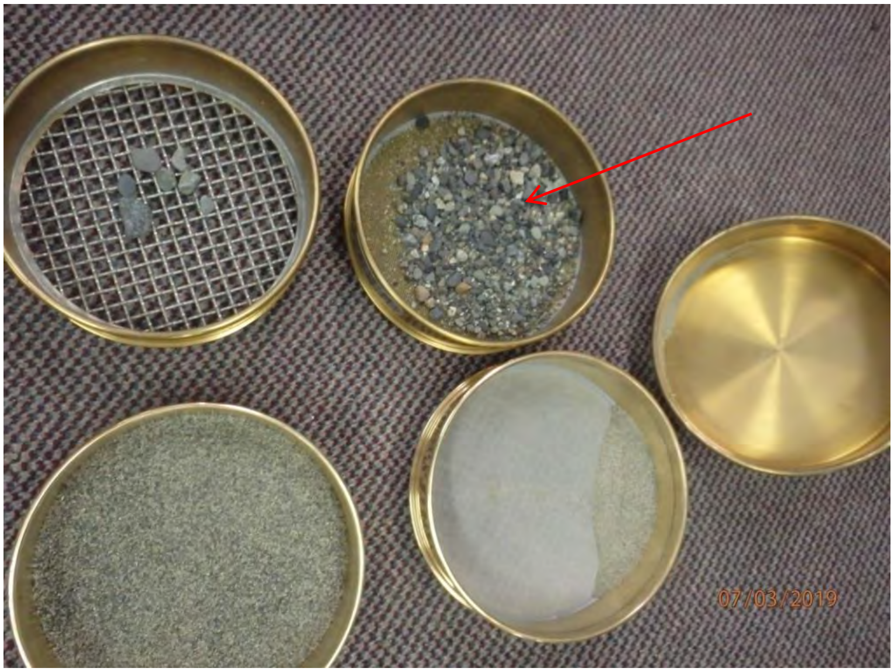
Analysis of collective beach units shows 27.5% of the sediment sampled represented the 0.21 mm – 0.42 mm (PSL) range, 19% represented the 1 mm to 9.5 mm (SS) range, 15.6% of the sediment sampled was considered to be too large (> 9.5 mm), 2 % of the sediment was considered to be too small (< 0.21 mm) and 35.9 % represented sediment that fell in the mid-range sand base (0.42 mm – 1 mm). Despite the apparent predominance of the PSL sediment particle range and greater number of potential PSL spawning beach units, the total length of habitat that was best suited to SS was greater in the field, due to the extensive length of some of the SS beach units.

The grain size analysis matched with the qualitative assessment of potential spawning habitat in the field in that no beaches were disqualified. Similar to the sediment analysis for Sidney Island, the sieve analysis indicated a general lack of fine-grained material, i.e. fine sand and silt, in each of the beach units.

EXAMPLE OF SEDIMENT FROM A BEACH UNIT WITH POTENTIAL PSL SPAWNING HABITAT – BEACH UNIT 5 – JAMES ISLAND.

RETAINED FRACTIONS OF SEDIMENT FROM A SAMPLE TAKEN FROM BEACH UNIT 5 (JAMES ISLAND). NOTE ABUNDANCE OF SEDIMENT IN THE 0.21 – 0.42 MM FRACTION (HIGHLIGHTED), INDICATING POTENTIAL PSL SPAWNING HABITAT.

EXAMPLE OF SEDIMENT FROM A BEACH UNIT MORE SUITED TO SS SPAWNING HABITAT – BEACH UNIT 1 – JAMES ISLAND.



RETAINED FRACTIONS OF SEDIMENT FROM A SAMPLE TAKEN FROM BEACH UNIT 1 (JAMES ISLAND). NOTE ABUNDANCE OF SEDIMENT IN THE 1 – 9.5 MM FRACTION (HIGHLIGHTED), INDICATING POTENTIAL SS SPAWNING HABITAT.

EXAMPLE OF SEDIMENT FROM A BEACH UNIT WITH POTENTIAL SS AND PSL SPAWNING HABITAT – BEACH UNIT 17 – JAMES ISLAND.

RETAINED FRACTIONS OF SEDIMENT FROM A SAMPLE TAKEN FROM BEACH UNIT 17 (JAMES ISLAND). NOTE ABUNDANCE OF SEDIMENT IN THE 1 – 9.5 MM AND 0.21 – 0.42 MM FRACTIONS (HIGHLIGHTED), INDICATING POTENTIAL SS AND PSL SPAWNING HABITAT. ALSO NOTE ABUNDANCE OF SAND IN THE 0.42 – 1 MM RANGE.

7 Discussion

7.1 Current Stressors to Forage Fish Spawning Habitat on James and Sidney Islands

7.1.1 Human-Related Modifications

Human modification of the foreshore habitat and the backshore zone was considered to be minimal on both James and Sidney Islands. Of the 31 beach units on Sidney Island, only one had foreshore modification (an access ramp encroaching into the upper intertidal zone in beach unit 15). Over the length of the beach unit, this encroachment was considered to represent a relatively low level of impact ("1-25% impacted"), as per the Data Dictionary code (Appendix 1).

Ten beach units (32% of the total assessed) on Sidney Island contained some degree of backshore modification, with the majority being associated with minor disturbance from beach access stairways (beach units 2, 4, 12 and 29) and drainage outflow pipes (beach units 2 and 24) occurring at isolated locations along the beach unit. Buildings (set well back from the foreshore zone) occurred in the backshore zones at beach units 1, 8 (caravan) and 16. The most significant backshore modification out of the 31 beach units on Sidney Island was the rip-rap wall adjacent to beach unit 24 (Red Snapper Beach).

Out of the 19 beach units on James Island, 4 (21% of the total assessed) were associated with foreshore modification, all representing a total foreshore impact of 1-25% of the beach unit: the rip-rap armouring along the spine of the sand spit connected to the southwestern shoreline in beach units 1 and 19; the pier extending out from beach unit 5; and the old landing area in beach unit 16. Eight beach units (42% of the total assessed) on James Island were considered to lie adjacent to backshore zones with some degree of modification (usually discontinuous and/or isolated modification along part of the beach unit). Two of these (beach units 1 and 19) were associated with backshore extensions of the rip-rap armouring and access road along the western side of the sand spit spine. Five beach units (2, 3, 4, 5 and 8) were associated with general vegetation clearance and/or road construction, mostly as part of the golf course development. One beach unit (15) was associated with a beach access stairway (part of the war time landing area access). Beach unit 19 was also associated with a building located in the backshore zone on the developed segment of the sand spit near the marina.

The majority of human-related modifications, both in terms of the foreshore and backshore zones, on both islands were limited to features located at an isolated part of the beach unit as opposed to along the length of the beach. For example, beach unit 2 on Sidney Island was 183 m long and it was only associated with one beach access stairway. Similarly, beach unit 11 on James Island was 695 m long and it was only associated with one small drainage pipe. The most significant combined foreshore and backshore encroachment that was associated with a mapped potential spawning beach occurred along beach unit 19 on James Island. This particular beach unit was associated with rip-rap armouring that extended along part of the beach.

Significant foreshore and backshore modification on Sidney Island that was not associated with a mapped potential SS or PSL spawning beach consisted of the breakwater and marina in Miner's Bay on Sidney Island. A marina also occurs in the sheltered lagoon on James Island. Both these development footprints have the potential of impacting upon the integrity of nearby potential SS and/or PSL spawning habitat, mostly through the potential spillage or leakage of hydrocarbons from boats and vehicles using the facilities.

7.1.2 Natural Backshore Vegetation Characteristics

Considering the relative importance of shade to the survival of incubating SS eggs (relevant to summer-spawning stocks), it is important to reiterate the general lack of overhanging vegetation in the backshore zones that is generally related to natural conditions (unstable sand bluffs and sparsely-vegetated coastal sand ecosystems) on both James and Sidney Islands. Out of the 31 beach units on Sidney Island, 10 beach units (1, 5, 7, 8, 10, 16, 17, 18, 19 and 27) were considered to have fully exposed spawning zones (32% of the total assessed). Sixteen beach units (2, 3, 4, 6, 9, 11, 13, 14, 15, 20, 21, 22, 23, 24, 28 and 29) were considered to have only 1 – 25% of the spawning zone shaded (52% of the total assessed). Three beach units (12, 25 and 26) supported vegetation that shaded 26 – 50% of the spawning zone (only 1% of the total assessed). Beach units 30 and 31 supported the most shade vegetation, with 51 – 75% and 76 – 100% of the spawning zones shaded respectively (< 1% of the total assessed).

On James Island, 11 beach units (2, 3, 4, 5, 9, 10, 14, 15, 17, 18 and 19) were considered to have fully exposed spawning zones (58% of the total assessed). Three beach units (7, 8 and 13) supported vegetation that only shaded 1 – 25% of the spawning zone (16% of the total assessed). One beach unit (11) consisted of vegetation that shaded 26 – 50% of the spawning zone (<1% of the total assessed) and 4 beach units (1, 6, 12 and 16) were associated with backshore vegetation that shaded 51 – 75% of the spawning zone (only 21% of the total assessed).

7.1.3 Natural Long-term and Seasonal Coastal Morphological Changes

It is important to consider the long-term and large-scale forces that formed the beaches of Sidney and James Island in order to identify potential PSL and SS spawning habitat. These processes also influence morphological change in beach characteristics seasonally, over the short term of years to decades and the longer term of decades to centuries.

Significant portions of both Sidney and James Island were formed by glacial deposition (DeMarchi 2011). The sand and gravel cliffs of these islands provide a local source of sediment for SS and PSL spawning habitat. However, the continual erosive forces of wind and waves during winter storms means that slumping and slides will also periodically cover extant habitat with large quantities of new sediment. Such slides may also introduce unfavourable sediment (e.g. clay) onto adjacent beaches. Over the long-term this means that the cliffs of Sidney and James Islands will erode away completely. This erosion is also a threat to property, as can be seen in the numerous failed stairways observed by the survey team on Sidney Island and by recent slide activity.

EXAMPLE OF NATURALLY UNSTABLE SLOPE CONDITIONS THAT HAVE THE ABILITY TO MODIFY FORAGE FISH SPAWNING HABITAT. SLIDE NOTED BETWEEN BEACH UNITS 2 AND 3 ON SIDNEY ISLAND. NOTE INPUT OF CLAY FLOWING ONTO THE BEACH.

Seasonal changes are also likely to modify the capacity of the beaches to provide spawning habitat. In the winter, higher winds promote the movement of larger sediment particles and the formation of offshore sediment bars. In the summer, lighter winds are accompanied by the deposition of finer grains like sand and the formation of more persistent berms, Figure 5. Therefore, what might be a beach favourable to SS in the winter with pebbles dominant in the sediment may evolve to one more favourable to PSL in the summer as sand is deposited on the beach. The total area of beach available to spawning will also change as the changes in profile will influence the total area dried during low tide.

It was, therefore, important that the spawning habitat survey methodology allowed for likely seasonal changes when assessing potential spawning habitat for both PSL and SS. This consideration means that the survey is conservative in determining potential habitat so that some habitat may actually not be optimal. However, the benefit of a conservative method is that no actual spawning habitat will be omitted. This conservative methodology is also more likely to help prepare management options for changes to the morphology of the islands in years to come.

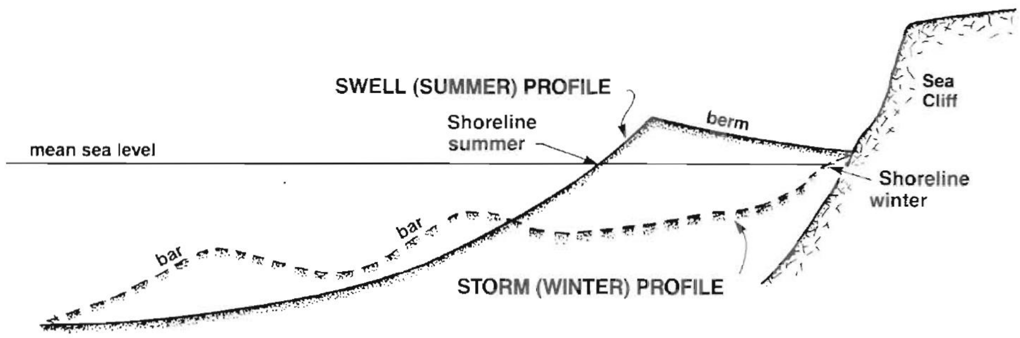


FIGURE 5. GENERAL REPRESENTATION OF TYPICAL CHANGES TO BEACH PROFILE OBSERVED ON THE BC COAST IN WINTER VERSUS SUMMER. THIS FIGURE IS FROM THOMSON (1981).

7.2 Protection of Forage Fish Spawning Habitat on James and Sidney Islands

Both James and Sidney Islands have been shown to contain significant lengths of potential forage fish (SS and/or PSL) spawning habitat. Much of this potential habitat occurs in association with Sensitive Coastal Ecosystems, which are instrumental in the processes that provide the basic resources that control the integrity of the habitat. Protection of forage fish spawning habitat, therefore, must consider both the foreshore area and connected backshore zone and must maintain the integrity of the interconnected processes. Any alterations along the foreshore and/or backshore zones have the potential of interrupting the natural supply and movement of sediment, given the fragility of the system and susceptibility to disturbance.

Human-related development pressures are currently limited on both James and Sidney Islands, but it is important to note that even small-scale changes such as constructing access stairways or concentrating storm drainage in pipes can have negative impacts (e.g. increasing erosion of unstable areas). While the impacts of any one individual disturbance activity may be difficult to measure, the cumulative impact of numerous small-scale activities can be significant. It will be important to maintain the current natural status of the foreshore and backshore zones on both islands, and it is encouraging that the land owners appear to be cognizant of the fragility of the habitat and wish to maintain the integrity of natural features and functions.

Current protective measures specific to the coastal backshore zone consist of a shoreline Development Permit Area (DPA) implemented by Islands Trust. Section 701 of the North Pender Associated Islands Official Community Plan (OCP) Bylaw No. 147 (2002) implements a15 m DPA upland from the natural tidal boundary. Any development proposals in this zone are subject to the DPA requirements to help protect the integrity of the coastal zone (including Sensitive Ecosystems).

In addition to the 15 m DPA, parts of Sidney Island are also applicable to a geotechnical DPA (as per Section 703 of the OCP). This DPA exceeds the 15 m DPA, and applies to properties along the western side of the island to Sallas Point and to properties along the bluffs adjacent to Miner's Bay (as per the map in Schedule E of the OCP). The geotechnical DPA recognizes the fragile nature of the unstable sand bluffs and helps to ensure that any development proposals do not exacerbate or alter natural erosion rates. The DPA also specifies the importance of "soft" engineering approaches to coastal erosion, where necessary, with the intent being to maintain the integrity of coastal processes.

The ITC also provides web-based informational resources to land owners related to the importance of forage fish and the protection of foreshore and backshore zones. This helps to raise awareness of forage fish and highlights the critical role these fish play in the marine food web.

Any proposals to carry out activities and/or construction in the foreshore and immediate backshore zones would also be subject to the Federal Fisheries Act. Section 32 of the Act states that "No person shall carry out any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery." In the Act, serious harm to fish is defined as:

- the death of fish;
- a permanent alteration to fish habitat of a spatial scale, duration or intensity that limits or diminishes the ability of fish to use such habitats as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes; and

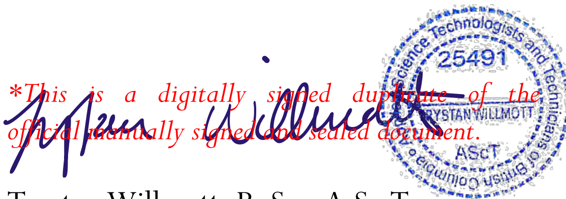
- the destruction of fish habitat of a spatial scale, duration, or intensity that fish can no longer rely upon such habitats for use as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes.

Guidelines from Fisheries and Oceans, Canada (DFO) indicate that as long as caution is exercised to avoid harm to fish, many development activities in fish habitat no longer require review or applications for approval. There is the potential, therefore, that impacts to forage fish habitat (both direct and indirect) may not be properly assessed and/or appreciated due to the current wording and application of the Act.

Any applications on Crown Land in the foreshore area below the high tide line (depending on scope) would also trigger the acquisition of a foreshore lease under the Provincial Land Act. Proposals such as private moorage docks would be assessed by the Provincial Government for compliance to either General Permission requirements, or in cases where these requirements cannot be met, to Special Permission requirements. These permission requirements generally help to reduce potential impacts on sensitive coastal features, but any development or activities in the foreshore or immediate backshore zones have the potential for negative impacts, especially when considering cumulative effects.

It appears that land owners on both islands are educated about the importance of functioning backshore and foreshore zones, but it is important to include a discussion about the ecological services that are provided by intact ecosystems. With significant changes to weather patterns and challenges posed by increasing sea level due to climate change, it is becoming increasingly important to maintain the integrity of natural processes and functions along dynamic interface habitats such as coastal zones. Functioning coastal ecosystems are much more resilient to changing conditions and can help reduce impacts to people and property. By avoiding the disruption of foreshore processes such as sediment supply, sediment movement and by maintaining the integrity of backshore zones, land owners can benefit from protection of property. Engineering fixes to coastal erosion can be expensive and often unnecessary undertakings – soft approaches such as working with and/or enhancing natural processes help to reduce financial costs and often result in more effective long-term solutions.

Prepared by:



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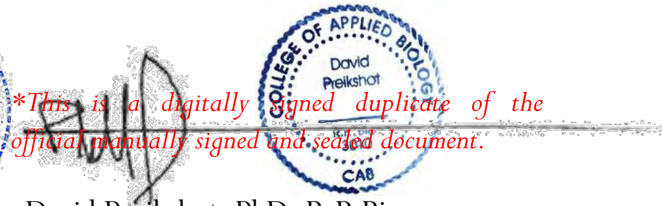
Trystan Willmott, B. Sc., A.Sc.T.



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David Preikshot, PhD, R.P.Bio.

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Ian Wright, P.Ag., R.B.Tech.

References

Archipelago Marine Research Ltd. 2014. Technical Data Report. Roberts Bank Terminal 2 Project Marine Fish and Fish Habitat Forage Fish Beach Spawn Survey.

De Graaf, R.C. 2013. North and South Pender Islands Beach Spawning Forage Fish Habitat Assessments.

De Graaf, R.C. 2014 a. Thetis, Hornby and Denman Islands Beach Spawning Forage Fish Habitat Suitability Assessments.

De Graaf, R.C. 2014 b. Gambier and Keats Islands Surf smelt and Pacific sand lance Spawning Habitat Suitability Assessments.

De Graaf, R.C. 2014 c. Bowen Island Surf smelt and Pacific sand lance Spawning Habitat Suitability Assessments.

De Graaf, R.C. 2017 a. Galiano Island Surf smelt and Pacific sand lance Beach Spawning Habitat Suitability Assessments.

De Graaf, R.C. 2017 b. Valdes Island, British Columbia. Surf smelt and Pacific sand lance Spawning Habitat Suitability Assessments.

De Graaf, R.C. 2017 c. Lasqueti Island. Surf smelt and Pacific sand lance Spawning Habitat Suitability Assessments.

De Graaf, R.C. 2017 d. Salt Spring Island and Wallace Island Surf smelt and Pacific sand lance Spawning Habitat Suitability Assessments.

De Marchi, D.A. 2011. An Introduction to the Ecoregions of British Columbia. Ecosystem Information Section, Ministry of Environment, Victoria, British Columbia: 163 p.

Penttila, D. 2007. Marine Forage Fishes in Puget Sound.Puget Sound Nearshore Partnership Report No. 2007-03. Published by Seattle District, U.W. Army Corps of Engineers, Seattle, Washington.

Thomson, R.E. 1981. Oceanography of the British Columbia coast. Can. Spec. Publ. Fish. Aquat. Sci. 56: 291 p.

Williams, H. and Wright, I. (Madrone Environmental Services Ltd.). 2017. SEM/TEM Mapping Updates and Disturbance Mapping in the Islands Trust Area.

APPENDIX 1

Data Dictionary and Field Data

FORAGE FISH SPAWNING BEACH UNIT DESCRIPTION DATA DICTIONARY

Type	Type of spatial data downloaded from GPS	Waypoint (a spatial coordinate)	
Ident	Waypoint number assigned by GPS	numerical designation	
Lat	Latitude in decimal minutes		
Long	Longitude in decimal minutes		
y_proj	UTM coordinate (Northing)		
x_proj	UTM coordinate (Easting)		
UTM Zone	UTM zone	10U N	
GPS Time	Time spatial coordinates logged by GPS unit	24 hour clock	
GPS Unit	GPS Unit type	GPSMAP	Garmin Map
GPS Model	Specific GPS model		76
Observation Date	GPS	DD/MONTH/YR	
WP POSITION	Position of spatial coordinate within the beach unit	Start - start of the beach (extreme end of beach)	
	Position of spatial coordinate within the beach unit	Mid - position between start and end point of beach	
	Position of spatial coordinate within the beach unit	End - end of the beach (extreme end of beach)	
HABITAT (Y/N)	Score of measure of potential spawning habitat	Y = presence of potential spawning habitat	
	Score of measure of potential spawning habitat	N=absence of potential spawning habitat	
SEDIMENT COVERAGE	along beach unit	C= continuous sediment coverage	
	along beach unit	D=discontinuous sediment	
Location	General Location of Beach	N Pender	
		S Pender	
Specific_Location	Name of area surveyed		
Species most likely	Beach spawning forage fish deemed most likely to utilize beach unit	SS = surf smelt	
		SS/PSL = surf smelt and Pacific sand lance	
		PSL = Pacific sand lance	

Sampling_time	Time beach unit surveyed according to surveyor	24 hour clock	
Anthropogenic Feature	Upper foreshore (beach berm and slope) converted from natural beach	foreshore infill	
Negative Sediment type	Description of sediments unsuitable for spawning resulting in score of negative potential spawning beach unit	Md = mud	Pb V = Pebble Veneer
		Cb = Cobble	
		Bd = Boulder	
		Rock ramp	
Sediment_Prim	A code describing sediment type resulting in score of potential spawning habitat within beach unit	Primary score accounts to 50% of the sediment size pooled over 30 m transect	
Sediment_Sec_1	A code describing sediment type resulting in score of potential spawning habitat within beach unit	Secondary score accounts for 25% of the sediment size pooled over 30 m transect	
Sediment_Sec_2	A code describing sediment type resulting in score of potential spawning habitat within beach unit	Teritiary score accounts for 25% of the sediment size pooled over 30 m transect	
			Use Numeric Codes or Abbreviations
			0 = mud/silt (<0.063mm)
			1 = sand (0.063 -2.0 mm)
		Alternative Codes (Prov BC RISC Method)	*2 = pea pebble (2mm-4mm) with sand base
		Si = Silt (<0.063mm)	*3=medium pebble (4mm-3.5 cm) with sand base
		Md = Mud	*4 = coarse pebble (3.6 - 6 cm) with sand base
		Sh = shell	5 = cobble (6-25 cm) sand base
		S = Sand (0.064 - 2mm)	7 = boulder (>25cm) with sand base
		G = granule (2-4 mm)	8 = pebble to boulders wthout sand base
		Pb = 4mm-6.4cm	9 = rock, no habitat
		Cb = Cobble (6-25cm)	10 = organics (shell hash, drift vegetation)
		BD = Boulder (> 25 cm)	**sand base is important
			*2-4 "classic surf smelt gravel mix"

OH Shading	A code indicating the percentage of beach length with vegetation **overhanging spawning zone** (up to 300 m maximum units) providing shade to potential embryos	1 = fully exposed spawning zone 2 = 1-25% shaded spawning zone 3 = 26-50% shaded spawning zone 4 = 51-75% shaded spawning zone 5 =76-100% shaded spawning zone
Vegetation	A code describing marine vegetation community (up to 300 m in length) present along foreshore and backshore (30 m set back buffer)	1 = shrubs 2 = trees 3 = grasses 4 = shrubs and trees 5= shrubs and grasses 6= trees and grasses 7 = shrubs, trees and grasses
ForeShore_Mod	A code describing the percentage of foreshore altered from natural either parallel to or perpendicular to spawning zone (up to 300 m maximum beach unit)	**1** = natural; 0% impacted **2** = 1-25% impacted **3** = 26-50% impacted **4** = 56-75% impacted **5** = 76-100% impacted

Field	Description	Code	Meaning
ForeShore_Structure	Codes describing the type of structures present along the foreshore that may impede sediment movement (degrading spawning habitat)	Perpendicular Structures	
		BR	*boat ramp*
		BW	*breakwater*
		DK	*dock*
		G	*groin*
		J	*jetty*
		N	*netting*
		OP	*outfall pipe*
		PC	*pier, concrete*
		PW	*pier, wood*
		RB	*railroad bed*
		RP	*ramp (misc)*
		Parallel Structures	
		CB	*concrete bulkhead*
		CNB	*concrete block*
		D	*dike*
		F	*fence*
		R	*road*
		RR	*riprap*
		S	*seawall*
		O	*other*
		Other Structures	
		BG	*building*
		BT	*boat*
		BTH	*boat house*
		FAQ	*floating aquaculture*
		FH	*floathouse*
		LB	*log boom*
		STW	*stairway/platform*
		none	

Field	Description	Codes
ForeShore_LU	Codes describing the land-use activity of the foreshore area	See Land Use table below

Land Use			
A	*agricultural*	P	*park*
AQ	*aquaculture*	PF	*port facility*
C	*commercial (misc)*	PL	*parking lot*
FT	*ferry terminal*	RL	*recreational*
I	*industrial (misc)*	RSL	*residential*
L	*log sort/dump*	T	*transportation*
M	*marina*	V	*vacant*

Field	Description	Codes
BackShore_Mod	A code describing whether or not the backshore zone has been modified from natural	Y= yes N=no
BackShore_Structure		same as ForeShore_Structure
BackShore_LU	Codes describing the land-use activity of the backshore area	See Land Use table below

Land Use			
A	*agricultural*	P	*park*
AQ	*aquaculture*	PF	*port facility*
C	*commercial (misc)*	PL	*parking lot*
FT	*ferry terminal*	RL	*recreational*
I	*industrial (misc)*	RSL	*residential*
L	*log sort/dump*	T	*transportation*
M	*marina*	V	*vacant*

Field	Description
Beach_Slope	The slope of the beach face (or flat) determined in degrees by clinometer
Width_of_Zone_m	The width of the beach face (or flat) determined in meters, centimeters at the time and intertidal height surveyed
Length_avail_beach_m	Length of the spawning sediments present along the beach unit measured in meters, centimeters at the time and intertidal height surveyed
sediment_depth_cm	the depth of the sediments measured at a random point along a 30 m transect tape; measured in cm to a max. depth of 20 cm

BeachNumb	Island	Location	Sample_Date	Sample_Time	WP_POSITION	UTM_Zone	Northing	Easting	GPS_Model	Habitat	Sediment	Species	Anthro	Neg_Sed	Sed_P	Sed_S1	Sed_S2	OH_Shading	Vegetation	FS_Mod	FS_Struct	FS_LU	BS_Mod	BS_Struct	BS_LU	Beach_Slope	Zone_Width	Beach_Length	Sed_Depth	Tide_Height	Description
JI-1	James Island	Southern shoreline	2019-02-28	08:22	Start	10N	5382028.4	474212.6	Trimble Geo 7X	Y	D	SS/PSL	Yes	Cb	1	4	3	4	4	2	RR	None	Y	R	RSL	7	10	101	>20	2.7	Well-shaded beach; potential SS and PSL habitat. RR associated with access road along spit in part of the beach unit.
JI-2	James Island	Southern shoreline	2019-02-28	08:30	Start	10N	5381930.3	474219.0	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	4	3	1	1	5	1	None	None	Y	None	RSL	5	15	469	>20	2.7	Long beach unit, with potential spawning habitat for SS and PSL. Unstable sand bluffs beginning to become prominent. Fully exposed (no OH vegetation).
JI-3	James Island	Southern shoreline	2019-02-28	08:50	Start	10N	5382088.0	474626.7	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	2	3	1	5	1	None	None	Y	None	V	3	12	787	>20	2.7	Shift to predominantly sand sediment, but still potential spawning habitat for SS and PSL. Fully exposed (no OH vegetation); steep, unstable sand bluffs.
JI-4	James Island	Southern shoreline	2019-02-28	09:10	Start	10N	5382569.3	475248.6	Trimble Geo 7X	Y	C	SS/PSL	None	None	1	3	2	1	6	1	None	None	Y	R	RL	3	20	950	>20	2.7	Long beach unit, with predominantly sand sediment (still potential for SS and PSL). Backshore now subdued (end of sand bluffs). Golf course beyond immediate backshore zone. No OH vegetation.
JI-5	James Island	Southeastern shoreline	2019-02-28	09:30	Start	10N	5383447.6	475261.4	Trimble Geo 7X	Y	C	PSL	Yes	None	1	2	3	1	3	2	PW	None	Y	R	RL	5	12	1068	>20	2.7	Long, sandy beach unit (PSL habitat). Fully exposed (no OH vegetation). Golf course beyond immediate backshore zone. Old wooden pier and bridge/dock with access road in backshore zone in part of this beach unit.
JI-6	James Island	Eastern shoreline	2019-02-28	10:10	Start	10N	5383759.0	474354.5	Trimble Geo 7X	Y	C	SS	None	Cb	5	4	3	4	4	1	None	None	N	None	V	4	10	1070	>20	2.7	Well shaded SS beach.
JI-7	James Island	Northeastern shoreline	2019-02-28	10:37	Start	10N	5384649.7	473793.7	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	2	3	2	5	1	None	None	N	None	V	5	12	358	>20	2.7	Shift to predominantly sand sediment, but still potential SS and PSL habitat. Minimal shading now.
JI-8	James Island	Northern shoreline	2019-02-28	10:55	Start	10N	5384934.9	473592.5	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	4	5	1	2	6	1	None	None	Y	None	RL	4	15	909	>20	2.7	Trend towards larger (pebble) sediment type, but still potential habitat for SS and PSL. Minimal shading.
JI-9	James Island	Northern shoreline	2019-02-28	11:17	Start	10N	5384889.7	472693.9	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	4	5	1	3	1	None	None	N	None	V	4	12	747	>20	2.7	Shift back to predominantly sand sediment type (sand spit), but still potential habitat for SS and PSL. Exposed beach; minimal OH vegetation.
JI-10	James Island	Northern tip	2019-02-28	11:35	Start	10N	5384977.8	472118.8	Trimble Geo 7X	Y	C	SS/PSL	None	None	1	3	4	1	5	1	None	None	N	None	V	5	15	586	>20	2.7	Sand spit; potential SS and PSL habitat. Minimal OH vegetation.
JI-11	James Island	Northwestern shoreline	2019-02-28	11:57	Start	10N	5384530.4	472687.4	Trimble Geo 7X	Y	C	SS/PSL	None	Bd	1	3	4	3	7	1	None	None	N	OP	V	4	15	695	>20	2.7	Boulders now common. Beach more shaded, but with unstable sand bluffs at least half way along beach unit. Potential SS and PSL habitat.
JI-12	James Island	Northwestern shoreline	2019-02-28	12:26	Start	10N	5384172.1	473287.7	Trimble Geo 7X	Y	C	PSL	None	None	1	5	7	4	7	1	None	None	N	None	V	6	15	484	>20	2.6	Shift towards predominantly sand substrate; potential PSL spawning habitat. Beach well shaded.
JI-13	James Island	Western shoreline	2019-02-28	12:42	Start	10N	5383802.6	473597.8	Trimble Geo 7X	Y	C	SS/PSL	None	Bd	1	3	2	2	6	1	None	None	N	None	V	4	15	408	>20	2.5	Trend towards potential SS and PSL spawning habitat. Minimal shading now.
JI-14	James Island	Western shoreline	2019-02-28	12:59	Start	10N	5383483.1	473845.3	Trimble Geo 7X	Y	C	PSL	None	Cb	1	2	5	1	5	1	None	None	N	None	V	5	15	118	>20	2.4	Shift to sand sediment type (potential PSL spawning habitat). Exposed beach (minimal OH vegetation).
JI-15	James Island	Western shoreline	2019-02-28	13:13	Start	10N	5383326.4	473907.4	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	3	5	1	5	1	None	None	N	None	V	4	14	104	>20	2.4	Still predominantly sand sediment, but now potential spawning habitat for both SS and PSL. Minimal OH vegetation.
JI-16	James Island	Southwestern shoreline	2019-02-28	13:29	Start	10N	5383139.3	473954.8	Trimble Geo 7X	Y	C	SS/PSL	Yes	Cb	1	4	3	4	7	2	S	None	Y	STW	V	6	10	554	>20	2.4	Potential SS and PSL spawning habitat; well shaded beach.
JI-17	James Island	Southwestern shoreline	2019-02-28	14:24	Start	10N	5382607.6	473731.5	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	2	4	1	5	1	None	None	N	None	RSL	7	15	226	>20	2.0	Sheltered lagoon; potential SS and PSL spawning habitat (sand spit). Fully exposed (no shading).
JI-18	James Island	Southwestern shoreline	2019-02-28	14:38	Start	10N	5382812.1	473782.4	Trimble Geo 7X	Y	C	PSL	None	None	1	1	1	1	5	1	None	None	N	None	V	5	18	340	>20	1.9	Predominantly sand (potential PSL spawning habitat). Sand spit (fully exposed - no shading).
JI-19	James Island	Southwestern shoreline	2019-02-28	14:54	Start	10N	5382692.9	473664.4	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	3	4	1	5	2	RR	None	Y	BG, R, RR	RSL	9	20	951	>20	1.8	Shift to a larger (pebble) sediment type, but still potential spawning habitat for SS and PSL. Beach occurs at the base of a RR "wall" protecting the main island access road leading across the spit from the dock. One residence in backshore zone.
SI-1	Sidney Island	Park boundary-northwestern shoreline - Sandy Beach	2019-02-24	10:03	Start	10N	5385534.7	475933.9	Trimble Geo 7X	Y	C	PSL	None	None	1	3	4	1	5	1	None	None	Y	BG	RSL	4	12	383	>20	2.8	Wide, sandy beach flat. PSL habitat; wide, exposed beach - no overhanging vegetation.
SI-2	Sidney Island	Northwestern shoreline - Sandy Beach	2019-02-24	10:38	Start	10N	5385275.4	476203.8	Trimble Geo 7X	Y	C	PSL	None	Cb	1	3	4	2	6	1	None	None	Y	STW	RSL	2	14	184	>20	2.7	Sandy beach; PSL habitat. Some (limited) OH shading. Cobble component (narrow band below potential spawning area).
SI-3	Sidney Island	Western shoreline - Sandy Beach	2019-02-24	11:06	Start	10N	5385116.3	476316.5	Trimble Geo 7X	Y	C	PSL	None	Bd	1	4	7	2	4	1	None	None	Y	None	RSL	4	16	735	>20	2.4	Wide, sandy beach. Unstable sand cliffs; exposed- minimal OH vegetation. PSL habitat. Occasional boulders.
SI-4	Sidney Island	Western shoreline - Sandy Beach	2019-02-24	11:29	End	10N	5384197.3	477033.4	Trimble Geo 7X	Y	C	PSL	None	None	1	4	5	2	6	1	None	None	Y	STW, OP	RSL	6	15	453	>20	2.2	Wide sandy beach flat. PSL habitat; slopes now more stable and vegetated with some OH shading. Outflow pipes placed through unstable gully running out onto beach. Stairway/retaining structure down slope through backshore zone.
SI-5	Sidney Island	Western shoreline - Sandy Beach	2019-02-24	11:57	End	10N	5384020.0	477061.9	Trimble Geo 7X	Y	C	PSL	None	None	1	3	4	1	4	1	None	None	N	None	RSL	5	20	190	>20	2.1	Wide, exposed sandy point. PSL habitat. No OH vegetation.
SI-6	Sidney Island	Western shoreline - Crabtrap Beach	2019-02-24	12:10	End	10N	5383716.1	477122.7	Trimble Geo 7X	Y	C	PSL	None	None	1	3	4	2	7	1	None	None	N	None	RSL	6	20	312	>20	1.9	Wide, sandy beach; PSL habitat. Limited OH shade vegetation.
SI-7	Sidney Island	Western shoreline - Crabtrap Beach	2019-02-24	12:27	End	10N	5383372.9	477183.8	Trimble Geo 7X	Y	C	PSL	None	None	1	3	4	1	7	1	None	None	N	None	RSL	4	30	351	>20	1.7	Wide, exposed sand flat. No OH vegetation. PSL habitat.
SI-8	Sidney Island	Western shoreline - Crabtrap Beach	2019-02-24	13:01	End	10N	5383154.1	477298.8	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	3	4	1	5	1	None	None	Y	BG	RSL	3	50	250	>20	1.6	Shift to a pebble component, with habitat for SS and PSL. Access way down to beach. Old caravan in immediate backshore zone.
SI-9	Sidney Island	Western shoreline - Bluff Conservation Area	2019-02-24	13:20	End	10N	5382535.7	478052.6	Trimble Geo 7X	Y	C	PSL	None	Bd	1	7	5	2	4	1	None	None	N	None	RSL	5	36	992	>20	1.5	Shift back to sand component and PSL habitat. Unstable sand slopes; minimal OH shade vegetation. Long, continuous beach unit. Occasional boulders.
SI-10	Sidney Island	Southwestern shoreline - Bluff Conservation Area	2019-02-24	13:51	End	10N	5382458.6	478097.8	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	5	4	1	1	1	None	None	N	None	RSL	7	20	61	>20	1.3	Shift back to SS/PSL sediment mix. Very unstable slopes; no OH shade vegetation.
SI-11	Sidney Island	Southwestern shoreline - Bluff Conservation Area	2019-02-24	14:07	End	10N	5382343.4	478189.4	Trimble Geo 7X	Y	C	SS/PSL	None	Bd	3	1	5	2	4	1	None	None	N	None	RSL	6	20	115	>20	1.3	SS/PSL sediment mix. Slopes still unstable, with no OH vegetation. Some clay seeping from slope onto beach.
SI-12	Sidney Island	Southwestern shoreline - Sallas Point	2019-02-24	14:26	End	10N	5382133.5	478184.8	Trimble Geo 7X	Y	D	SS	None	Cb	4	3	7	3	7	1	None	None	Y	STW	RSL	6	15	62	>20	1.2	Small pocket beach with SS spawning habitat. Stairway down to beach. More OH shade vegetation here.

SI-13	Sidney Island	Southern shoreline - Sallas Point	2019-02-24	15:50	End	10N	5381759.0	478297.4	Trimble Geo 7X	Y	C	SS	None	Cb	3	4	5	2	4	1	None	None	N	None	RSL	7	25	77	>20	1.3	SS spawning habitat pocket beach.
SI-14	Sidney Island	Southern shoreline - Sallas Point	2019-02-24	16:03	End	10N	5381702.2	478371.3	Trimble Geo 7X	Y	D	SS	None	Cb	4	3	2	2	4	1	None	None	Y	None	RSL	4	30	23	>20	1.2	Small SS spawning habitat pocket beach.
SI-15	Sidney Island	Southern shoreline - Sallas Point	2019-02-24	16:15	End	10N	5381736.3	478546.4	Trimble Geo 7X	Y	C	SS/PSL	Yes	Cb	3	1	4	2	6	2	RP	RL	Y	RP	RSL	7	20	151	>20	1.2	SS beach. Full southern exposure. Old boat ramp/access down to beach with rip rap.
SI-16	Sidney Island	Southern shoreline - Jackspring Beach	2019-02-24	16:34	End	10N	5381897.4	478633.8	Trimble Geo 7X	Y	C	SS	None	Cb	3	4	5	1	6	1	None	None	Y	BG	RSL	8	20	309	>20	1.5	Long, continuous SS spawning habitat beach. Full southern exposure. Mostly backs onto park land, but private Lot adjacent to the western segment. No OH vegetation, with natural wetland behind beach berm.
SI-17	Sidney Island	southern shoreline - Jackspring Beach	2019-02-24	16:49	End	10N	5382295.2	478996.3	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	3	1	4	1	3	1	None	None	N	None	P	8	10	333	>20	1.5	Sediment grades into SS /PSL mix. Long, continuous beach.
SI-18	Sidney Island	Southern shoreline - Wymond Point	2019-02-27	12:37	End	10N	5382156.6	479482.1	Trimble Geo 7X	Y	D	SS	None	Cb	4	3	2	1	6	1	None	None	N	None	P	11	15	43	>20	2.4	Isolated pocket beach; potential SS spawning habitat.
SI-19	Sidney Island	Southern shoreline - Wymond Point	2019-02-27	12:52	End	10N	5382029.8	479928.0	Trimble Geo 7X	Y	C	SS	None	Cb	4	3	2	1	6	1	None	None	N	None	P	11	12	30	>20	2.4	Isolated pocket beach. Potential SS spawning habitat.
SI-20	Sidney Island	Southern shoreline - Wymond Point	2019-02-27	13:08	End	10N	5382141.3	480087.0	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	4	5	2	6	1	None	None	N	None	P	11	10	46	>20	2.3	Pocket beach; potential spawning habitat for SS and PSL.
SI-21	Sidney Island	Southern shoreline - Barnacle Beach	2019-02-27	13:38	End	10N	5382658.5	479949.2	Trimble Geo 7X	Y	C	SS	None	Cb	4	3	5	2	7	1	None	None	N	None	P	13	20	90	>20	1.9	Wide pebble beach; potential spawning habitat for SS.
SI-22	Sidney Island	Southern shoreline - Barnacle Beach	2019-02-27	13:49	End	10N	5382524.5	479904.7	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	3	4	2	6	1	None	None	N	None	P	11	10	49	>20	1.9	Short beach segment with SS and PSL potential spawning habitat.
SI-23	Sidney Island	southern shoreline - Barnacle Beach	2019-02-27	13:55	Start	10N	5382524.5	479904.7	Trimble Geo 7X	Y	C	SS	None	Cb	3	2	4	2	6	1	None	None	N	None	P	13	15	76	>20	1.9	Short segment of potential SS habitat.
SI-24	Sidney Island	Southern shoreline - Red Snapper Beach	2019-02-27	14:20	End	10N	5383169.5	480127.5	Trimble Geo 7X	Y	C	SS	None	Cb	4	1	3	2	4	1	None	None	Y	RR, OP	RSL	12	20	241	>20	1.8	Wide, long beach; potential spawning habitat for SS. Rip rap wall in immediate backshore and outfall pipe.
SI-25	Sidney Island	Eastern shoreline	2019-02-27	15:17	End	10N	5384498.3	478800.6	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	2	3	1	3	4	1	None	None	N	None	RSL	6	20	126	>20	1.4	Well shaded SS/PSL pocket beach.
SI-26	Sidney Island	Eastern shoreline	2019-02-27	15:25	End	10N	5384540.7	478763.3	Trimble Geo 7X	Y	C	SS	None	Cb	3	4	2	3	4	1	None	None	N	None	RSL	12	20	48	>20	1.4	Well shaded pebble beach with potential spawning habitat for SS.
SI-27	Sidney Island	Eastern shoreline - Miners Bay	2019-02-27	16:07	Start	10N	5385957.6	476861.3	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	4	3	1	6	1	None	None	N	None	RSL	6	30	384	>20	1.1	Exposed beach with potential SS and PSL spawning habitat; unstable sand bluffs.
SI-28	Sidney Island	Eastern shoreline - Miners Bay	2019-02-27	16:20	Start	10N	5385583.0	476938.7	Trimble Geo 7X	Y	C	SS	None	Cb	4	1	5	2	6	1	None	None	N	None	RSL	6	25	391	>20	1.1	Shift to cobble and pebble - potential SS spawning habitat, but some sand underneath could also be suitable for PSL. Minimal shading; unstable sand bluffs.
SI-29	Sidney Island	Eastern shoreline - Miners Bay	2019-02-27	16:32	Start	10N	5385223.5	477089.8	Trimble Geo 7X	Y	C	SS	None	Cb	5	1	4	2	6	1	None	None	N	STW	RSL	6	20	615	>20	1.1	Pebble/cobble beach. Minimal shading; unstable bluffs.
SI-30	Sidney Island	Eastern shoreline - Miners Bay	2019-02-27	16:49	Start	10N	5384785.7	477508.6	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	3	1	2	4	7	1	None	None	N	None	RSL	5	20	402	>20	1.1	Well shaded beach with potential spawning habitat for SS and PSL.
SI-31	Sidney Island	Eastern shoreline - Miners Bay	2019-02-27	17:04	Start	10N	5384632.1	477872.6	Trimble Geo 7X	Y	C	SS/PSL	None	Cb	1	4	3	5	7	1	None	None	N	None	RSL	4	30	163	>20	1	Well shaded potential spawning habitat for SS and PSL.
N/A	Sidney Island	Eastern shoreline - near Barnacle Beach	2019-02-27	13:22	Mid	10N	5382326.5	480005.6	Trimble Geo 7X			SS																			Small pocket beach. Steep cliffs; no reasonable safe access. SS potential spawning habitat. Pebble mix.

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APPENDIX 2

Beach Unit Field Photos

Sidney Island – Western Shoreline (Beach Units 1 – 14) – Sandy Beach, Crabtrap Beach and Sallas Point

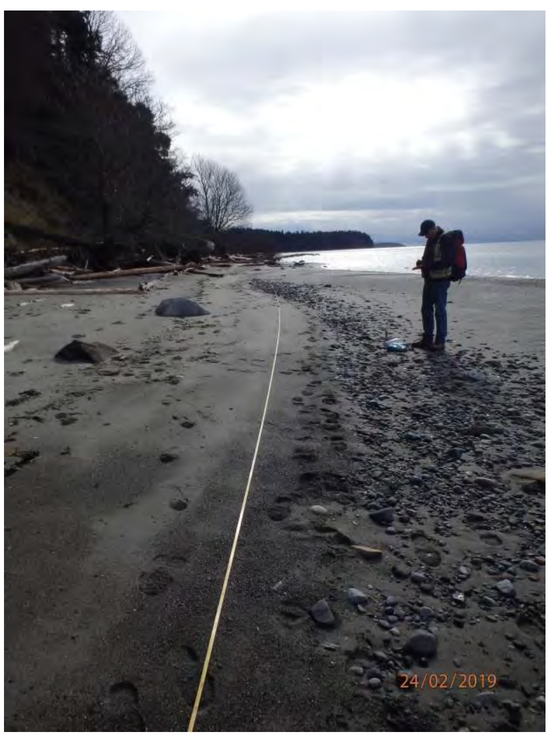
Four photos show the characteristics of each Beach Unit Transect and are in the following sequence: view to the North; view to the South; view to the East (towards the backshore zone); and close-up of the sediment type. Any additional photos that show specific features are labelled accordingly.

Beach Unit 1


24/02/2019


24/02/2019

Beach Unit 2




24/02/2019


24/02/2019

Beach Unit 3


24/02/2019


24/02/2019

Beach Unit 4


24/02/2019


24/02/2019

RETAINING STRUCTURE AND STAIRWAY IN THE BACKSHORE ZONE – BEACH UNIT 4.

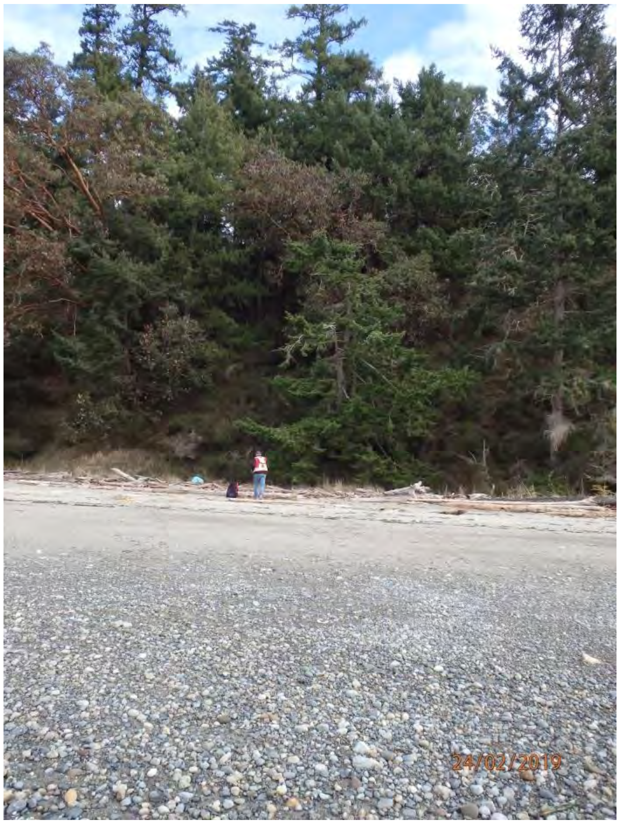
STORM OUTFALL PIPES DISCHARGING ONTO THE BEACH – BEACH UNIT 4.

Beach Unit 5


24/02/2019


24/02/2019

Beach Unit 6


24/02/2019


24/02/2019

Beach Unit 7


24/02/2019

Beach Unit 8


24/02/2019


24/02/2019

CARAVAN IN THE BACKSHORE ZONE AND BEACH ACCESS TRAIL – BEACH UNIT 8.

Beach Unit 9


24/02/2019


24/02/2019

Beach Unit 10


24/02/2019

Beach Unit 11


24/02/2019


40
50
60
70
80
24/02/2019

CLAY SEEPING FROM UNSTABLE BLUFFS ONTO THE BEACH - BEACH UNIT 11.

Beach Unit 12


24/02/2019


24/02/2019

Beach Unit 13


24/02/2019


24/02/2019

Beach Unit 14


24/02/2019


10
30
40
50
70
24/02/2019

Sidney Island – Southern Shoreline (Beach Units 15 – 19) – Jackspring Beach and Wymond Point

Four photos show the characteristics of each Beach Unit Transect and are in the following sequence: view to the West; view to the East; view to the North (towards the backshore zone); and close-up of the sediment type. Any additional photos that show specific features are labelled accordingly.

Beach Unit 15


24/02/2019


24/02/2019

Beach Unit 16


24/02/2019


24/02/2019

Beach Unit 17


24/02/2019


24/02/2019

WETLAND ECOSYSTEM BEHIND THE BEACH BERM ADJACENT TO BEACH UNIT 17.

Beach Unit 18


27/02/2019


27/02/2019

Beach Unit 19


27/02/2019


27/02/2019

Sidney Island – Southeastern Shoreline (Beach Units 20 – 24) – Barnacle Beach, Bootlegger Point and Red Snapper Beach

Four photos show the characteristics of each Beach Unit Transect and are in the following sequence: view to the North; view to the South; view to the West (towards the backshore zone); and close-up of the sediment type. Any additional photos that show specific features are labelled accordingly.

Beach Unit 20


27/02/2019


27/02/2019

Beach Unit 21


27/02/2019


27/02/2019

Beach Unit 22 – No photos available

Beach Unit 23


27/02/2019


27/02/2019

Beach Unit 24


27/02/2019


27/02/2019

RIP RAP RETAINING STRUCTURE AND OUTFALL PIPE – BEACH UNIT 24.

Sidney Island – Eastern Shoreline and Miner's Bay (Beach Units 25 – 31)

Four photos show the characteristics of each Beach Unit Transect and are in the following sequence: view to the North; view to the South; view to the West (towards the backshore zone); and close-up of the sediment type. Any additional photos that show specific features are labelled accordingly.

Beach Unit 25


27/02/2019


27/02/2019

Beach Unit 26


27/02/2019


27/02/2019

STAIRWAY ACCESS IN THE BACKSHORE ZONE – BEACH UNIT 26.

Beach Unit 27


27/02/2019


27/02/2019

Beach Unit 28


27/02/2019


27/02/2019

Beach Unit 29


27/02/2019


27/02/2019

STAIRWAY ACCESS IN THE BACKSHORE ZONE – BEACH UNIT 29.

Beach Unit 30


27/02/2019


27/02/2019

Beach Unit 31


27/02/2019


27/02/2019

James Island – Southern Shoreline (Beach Units 2 – 4)

Four photos show the characteristics of each Beach Unit Transect and are in the following sequence: view to the East; view to the West; view to the North (towards the backshore zone); and close-up of the sediment type.

Beach Unit 2


28/02/2019

Beach Unit 3


28/02/2019


50
60
70
80
9
10
28/02/2019

Beach Unit 4


28/02/2019


70
60
50
40
30
28/02/2019

James Island – Eastern Shoreline (Beach Units 5 – 7)

Four photos show the characteristics of each Beach Unit Transect and are in the following sequence: view to the North; view to the South; view to the West (towards the backshore zone); and close-up of the sediment type. Any additional photos that show specific features are labelled accordingly.

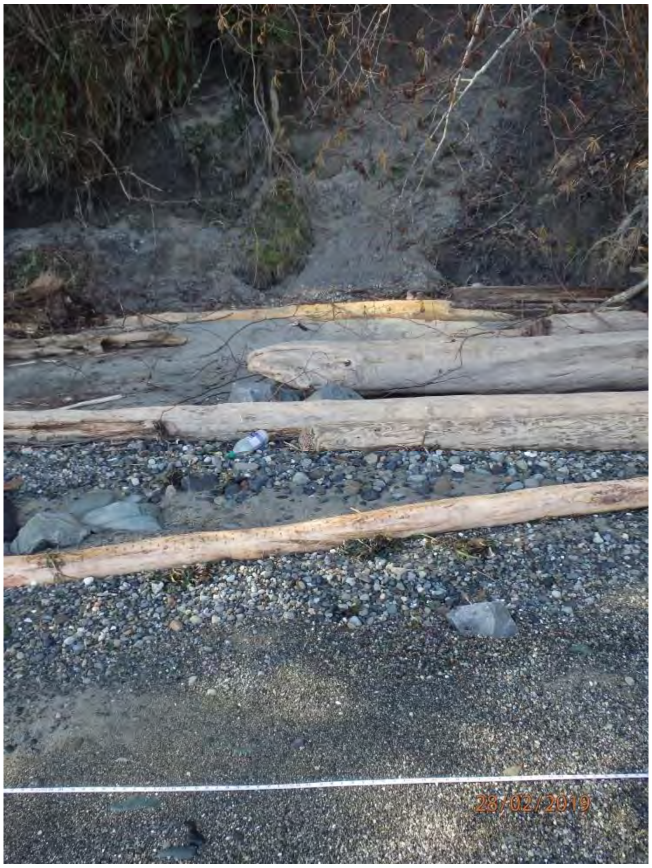
Beach Unit 5


28/02/2019


28/02/2019

WOODEN PIER – BEACH UNIT 5.

Beach Unit 6


28/02/2019


80
90
25 m
10
28/02/2019

Beach Unit 7


28/02/2019


28/02/2019

James Island – Northern Shoreline (Beach Units 8 – 10)

Four photos show the characteristics of each Beach Unit Transect and are in the following sequence (unless otherwise specified): view to the West; view to the East; view to the South (towards the backshore zone); and close-up of the sediment type.

Beach Unit 8


28/02/2019


28/02/2019

Beach Unit 9


28/02/2019


28/02/2019

Beach Unit 10

(VIEW TO THE NORTH)

(VIEW TO THE SOUTH)

(VIEW TO THE EAST)

James Island – Western Shoreline (Beach Units 11 – 16)

Four photos show the characteristics of each Beach Unit Transect and are in the following sequence: view to the North; view to the South; view to the East (towards the backshore zone); and close-up of the sediment type. Any additional photos that show specific features are labelled accordingly.

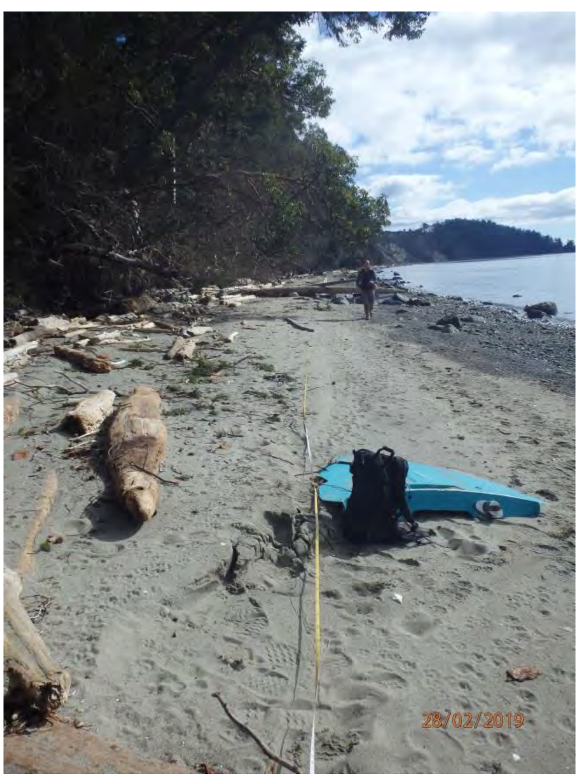
Beach Unit 11


28/02/2019


28/02/2019

OUTFALL PIPE – BEACH UNIT 11.

Beach Unit 12




28/02/2019


28/02/2019

Beach Unit 13


28/02/2019


28/02/2019

Beach Unit 14


28/02/2019


28/02/2019

Beach Unit 15


28/02/2019


28/02/2019

Beach Unit 16


28/02/2019


28/02/2019

ABOVE AND BELOW: RIP-RAP/SEA WALL – BEACH UNIT 16.

James Island (Southwestern shoreline) – Eastern shore of Sand Spit - Beach Unit 17

Four photos show the characteristics of the Beach Unit Transect and are in the following sequence: view to the North; view to the South; view to the West (towards the backshore zone); and close-up of the sediment type.

Beach Unit 17


28/02/2019


28/02/2019

James Island (Southwestern shoreline) – Western shore of Sand Spit - Beach Unit 18

Four photos show the characteristics of the Beach Unit Transect and are in the following sequence: view to the East; view to the West; view to the North (towards the backshore zone); and close-up of the sediment type.

Beach Unit 18


28/02/2019


60
70
80
90
28/02/2019

James Island (Southwestern shoreline) – western shore of Sand Spit - Beach Units 19 and 1

Four photos show the characteristics of the Beach Unit Transect and are in the following sequence: view to the North; view to the South; view to the East (towards the backshore zone); and close-up of the sediment type. Any additional photos showing specific features are labelled accordingly.

Beach Unit 19


28/02/2019


28/02/2019

RIP-RAP ARMOURING ALONG THE MAIN JAMES ISLAND ACCESS ROAD LEADING FROM THE DOCK – BEACH UNIT 19.

RESIDENCE IN THE BACKSHORE ZONE – BEACH UNIT 19.

Beach Unit 1


28/02/2019


28/02/2019

APPENDIX 3

GPS Data Collection Specifications

SCHEDULE "C"

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 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.

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.

4. Deliverables and Archiving

4.01

The following digital files must be archived and delivered to Islands Trust GIS staff and other appropriate agency(s) in the following formats:

Deliverable	Digital Format
Uncorrected GPS data	GPS manufacturer's proprietary
Reference station data	downloaded format
Originally corrected GPS • Including complete metadata report for all dynamic and static point features, including but not limited to Max HDOP, Max PDOP, and Horizontal Precision	ESRI Shapfile