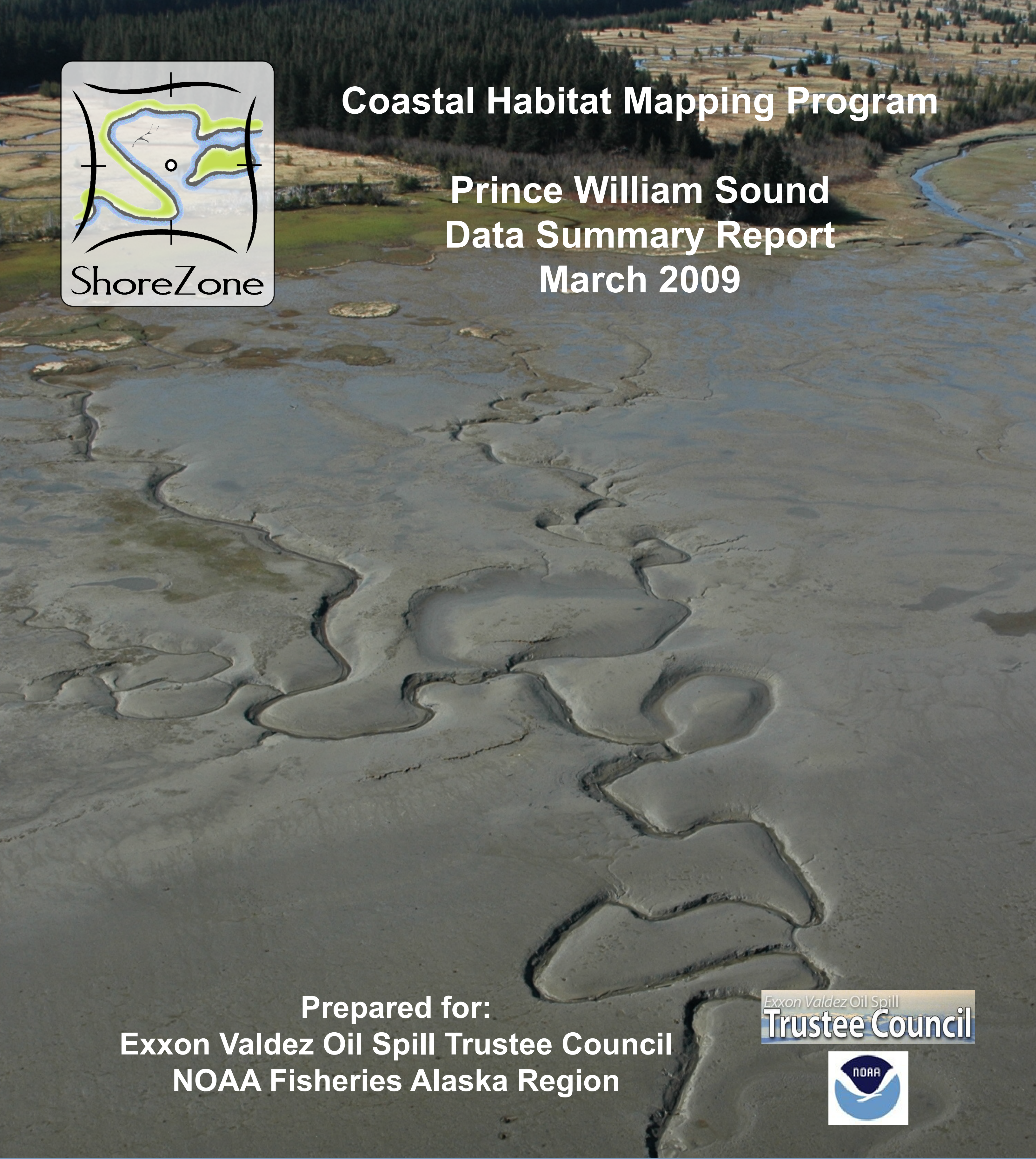
ShoreZone

Coastal Habitat Mapping Program

Prince William Sound
Data Summary Report
March 2009



Prepared for:
Exxon Valdez Oil Spill Trustee Council
NOAA Fisheries Alaska Region

Exxon Valdez Oil Spill Trustee Council

NOAA

Coastal & Ocean Resources Inc.

ARCHIPELAGO MARINE RESEARCH LTD.

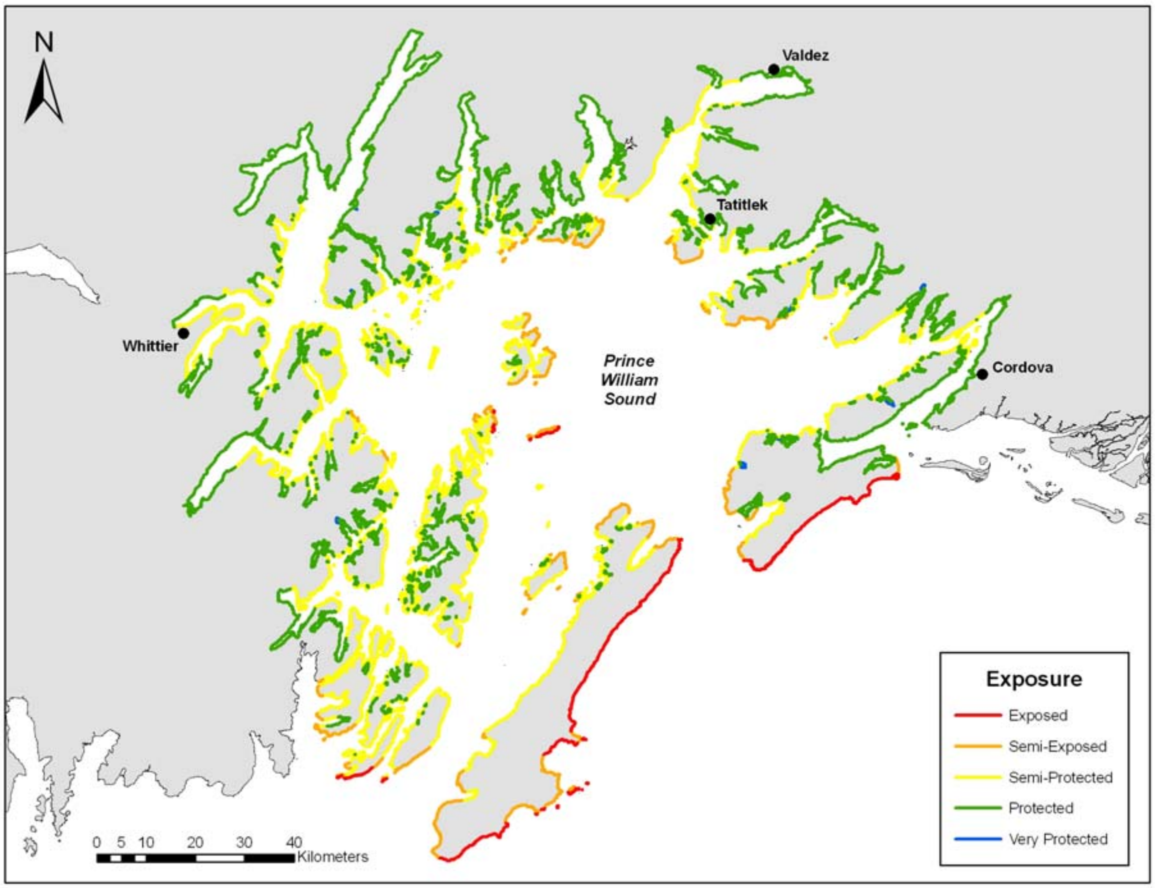
On the cover:
Boswell Bay, east Hinchinbrook Island
Tigertail Glacier, Nassau Fjord, west of Chenega Island
Outer coast, Hinchinbrook Island
Valdez

CORI Project: 2008-10

March 2009

ShoreZone Coastal Habitat Mapping Data Summary Report

Prince William Sound, Alaska



Prepared for:
Exxon Valdez Oil Spill Trustee Council
Prince William Sound Regional Citizens Advisory Council
NOAA National Marine Fisheries Service, Alaska Region

Prepared by:

COASTAL & OCEAN RESOURCES INC
214-9865 W. Saanich Rd., Sidney BC V8L 5Y8 Canada
(250) 655-4035
www.coastalandoceans.com
Jodi N. Harney, Ph.D.
jodi@coastalandoceans.com

ARCHIPELAGO MARINE RESEARCH LTD
525 Head Street, Victoria BC V9A 5S1 Canada
(250) 383-4535
www.archipelago.ca
Mary Morris, M.Sc., R.P.Bio.
marym@archipelago.ca

ABSTRACT

ShoreZone is a coastal habitat mapping and classification system in which georeferenced aerial imagery is collected specifically for the interpretation and integration of geomorphic and biological features of the intertidal zone and nearshore environment. Field surveys in Prince William Sound in 2004 and 2007 (funded by the **Exxon Valdez Oil Spill Trustee Council** and the **Prince William Sound Regional Citizens' Advisory Council**) collected aerial video and digital still photographs of the coastal and nearshore zone during zero-meter tide levels and lower. The imagery and associated audio commentary were used to map the geomorphic and biological features of the shoreline according to the ShoreZone Coastal Habitat Mapping Protocol for the Gulf of Alaska (Harney et al. 2008). This and other ShoreZone reports are available for download from the web sites of Coastal & Ocean Resources and NOAA Fisheries at www.coastalandoceans.com and www.alaskafisheries.noaa.gov/maps.

This report provides a basic summary of ShoreZone observations along 5,585 km of coast in Prince William Sound, Alaska. It is meant as a companion to the digital publication, the ArcGIS geodatabase, and should be used in conjunction with the ShoreZone protocol. The habitat inventory is comprised of 24,286 along-shore segments (units), averaging 230 meters in length. Because much of the study area occurs in sheltered inlets and fjords, wave exposures are mostly mapped as protected (47.5%) and semi-protected (43%). The most common shore types are sand and gravel flats and beaches, comprising a total shoreline length of 1,770 km (31.7%). Rock cliffs and ramps with sand and gravel beaches are also very common, representing another 1,005 km of shoreline (18%). Bedrock shorelines comprise 528 km (9.4%). True estuaries (possessing salt marsh vegetation, fresh water influence, and deltaic features) are mapped along 504 km of shoreline (9%). The dominance of lower wave exposures and sand-gravel sediment textures also means that the Oil Residence Index is very long for most shore segments: 81% have an ORI of 4 or 5, indicating oil residence times are on the order of months to years. Shorelines with significant human modifications (having more than 50% of the unit altered by human activities) are observed along 23 km of the coast (0.4% of shoreline in Prince William Sound). Most anthropogenic features occur in the communities of Cordova, Valdez, and Whittier. Glaciers are mapped along 23 km of shoreline (0.4%), and tidal channels comprise another 11 km of shoreline (0.2%). Eelgrass is mapped along 2,526 km of shoreline in Prince William Sound, more than 45% of the study area. Fringing salt marsh biota occurs along 1,763 km of shoreline (31%). Rockweed (*Fucus*) is ubiquitous, occurring along a total of 4,871 km (87%). The blue mussel bioband, an indicator of immobile substrates, particularly in fjord habitats, occurs along 933 km of shoreline in the Sound (16%). Soft brown kelps such as *Saccharina latissima* are also very common, mapped along 3,452 km of shoreline (62%). Canopy kelps (*Nereocystis*, *Macrocystis*, and *Alaria fistulosa*) are absent in most of the Sound, occurring only along 137 km of shoreline (<3%) and confined mostly to the southwest corner of the Sound.

ACKNOWLEDGMENTS AND USE CONSTRAINTS

The ShoreZone program is a partnership of scientists, GIS specialists, web specialists, non-profit organizations, and governmental agencies. We gratefully acknowledge the support of organizations working in partnership for the Alaska ShoreZone effort, including: Alaska Department of Fish and Game, Alaska Department of Natural Resources, Archipelago Marine Research Ltd., Coastal and Ocean Resources Inc., Cook Inlet Regional Citizens' Advisory Council, Exxon Valdez Oil Spill Trustee Council, National Park Service, NOAA National Marine Fisheries Service, Prince William Sound Regional Citizens' Advisory Council, The Nature Conservancy, United States Fish and Wildlife Service, and the University of Alaska. We also thank the staff of Coastal and Ocean Resources Inc. and Archipelago Marine Research Ltd. for their efforts in the field and in the office.

Principal funding for the ShoreZone program in Prince William Sound is supplied by the Exxon Valdez Oil Spill Trustee Council and the Prince William Sound Regional Citizens' Advisory Council. Web hosting and posting are contributed by the NOAA National Marine Fisheries Service in Juneau, Alaska.

Protocols for data access and distribution are established by the program partner agencies. Please see www.coastalandoceans.com for a list of partner agencies and related web sites. Video imagery can be viewed and digital stills downloaded online at www.alaskafisheries.noaa.gov/maps/. Any hardcopies or published data sets utilizing ShoreZone products shall clearly indicate their source. To ensure distribution of the most current public information or for correct interpretation, contact the ShoreZone project manager at Coastal and Ocean Resources, Inc. At the time of publication, that person is Dr. Jodi Harney.

To effectively and appropriately use ShoreZone data, the user shall refer to the ShoreZone Coastal Habitat Mapping Protocol (2008) available the web sites listed above. Data provided are derived from large, regional databases that are continually being updated and modified. The accuracy of some information is subject to change. Any published data sets utilizing ShoreZone products (printed, digital, or online) shall clearly indicate their source. If the user has modified the data in any way, the user is obligated to describe the types of modifications performed. The user specifically agrees not to misrepresent these data, nor to imply that changes made were approved by the ShoreZone program or its partners.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (APPENDIX A)

LIST OF FIGURES

[continued]

LIST OF FIGURES (CONTINUED)

LIST OF PLATES (APPENDICES B, C)

1 INTRODUCTION

1.1 Overview of the ShoreZone Coastal Habitat Mapping Program

The land-sea interface is a crucial realm for terrestrial and marine organisms, human activities, and dynamic processes. ShoreZone is a mapping and classification system that specializes in the collection and interpretation of aerial imagery of the coastal environment. Its **objective** is to produce an integrated, searchable inventory of geomorphic and biological features of the intertidal and nearshore zones which can be used as a tool for science, education, management, and environmental hazard planning and response.

The ShoreZone system was employed in the 1980s and 1990s to map coastal features in British Columbia and Washington state (Howes et al. 1994; Berry et al. 2004) (Figure 1.1). Between 2001 and 2003, ShoreZone imaging and mapping was initiated in the Gulf of Alaska, beginning with Cook Inlet, Outer Kenai, Katmai, and portions of the Kodiak Archipelago (Harper and Morris 2004). The ShoreZone program in **Alaska** (Figure 1.2) continues to grow through the efforts of a network of partners, including scientists, managers, GIS specialists, and web specialists in federal, state, and local government agencies and in private and non-profit organizations.

Oblique, low-altitude aerial video and digital still **imagery** of the coastal zone is collected during summer low tides (zero-meter tide level or lower), usually from a helicopter flying at <100 m altitude. During image collection, the aircraft's GPS position is recorded at 1-second intervals using electronic navigation software and is continuously monitored in-flight to ensure all shorelines have been imaged (Figure 1.3). Video and still images are spatially-referenced and time-synchronized using a 6-digit UTC time code (Figure 1.4). Video imagery is accompanied by continuous, simultaneous **commentary** by a geologist and a biologist aboard the aircraft. Imagery exists for nearly 45,000 km of coastline in the Gulf of Alaska and Southeast Alaska, all posted for public viewing and download on the NOAA ShoreZone web site at www. alaskafisheries.noaa.gov/maps.

Image interpretation and mapping is accomplished by a team of physical and biological scientists, who use the imagery, commentary, and a standard digital shoreline basemap to delineate along-shore coastal habitat **units** and to "map" their observations of physical, geomorphic, and sedimentary across-shore **components** within those units (Figure 1.5), using a set of database codes (Appendix A). Particular biological communities are mapped as **biobands** with respect to relative tidal position (Figure 1.6). Units are digitized as shoreline segments in ArcView or ArcGIS, then linked to the geomorphic and biological data housed in a relational database (Microsoft Access or SQL Server). Mapped habitat features include degree of wave exposure, substrate type, sediment texture, intertidal biota, and some nearshore subtidal biota.

Mapped data is in the form of **line** segments and **point** features. Line segments are the principal spatial features, representing along-shore units, each with a unique physical identifier (PHY_IDENT) that links the data to the digital shoreline in GIS. Point features (also called “variants”) are small features such as streams that are better represented as a point rather than a line. Such point features are also mapped as “forms” within the unit that contains them.

ShoreZone imagery provides a useful baseline, while **mapped resources** (such as substrate type, eelgrass occurrence, and wetland distribution) are important tools for scientists and managers, providing a spatial framework for coastal habitat assessment from local to regional scales. Both imagery and thematic data can be viewed and downloaded on the NOAA ShoreZone web site for many mapped regions in Alaska, from Southeast to the northern Gulf of Alaska.

Research and practical applications of ShoreZone data and imagery include:

- spill contingency planning
- environmental hazard response
- natural resource and conservation planning
- mariculture site review
- development evaluation
- linking habitat use and life-history strategy of nearshore fish and other intertidal organisms
- habitat suitability modeling
- development evaluation and mariculture site review
- ground-truthing of aerial data on smaller spatial scales
- public use for recreation, education, outreach, and conservation.

Specific applications have been developed which use ShoreZone data to examine modern questions regarding the coastal environment and nearshore habitats. Some examples include habitat analyses of herring spawning locations (Harney et al. 2009) and predicting the distribution of suitable coastal habitats for invasive species in Alaska, British Columbia, and Washington (the European green crab and *Spartina* cordgrass) (Harney 2007, 2008; Harney et al. 2009). Current research is also directed at predicting the sensitivity of shorelines to sea-level rise and erosion as a result of climate change (Paterson et al. 2009).

Protocols and standards for imaging and mapping are continually updated using lessons learned from **technological advancements**, ground-truthing studies, and communication among partners and users. The ShoreZone Coastal Habitat Mapping Protocol for the Gulf of Alaska (Harney et al. 2008) serves as a resource for definitions and a guide for appropriate use. This and other ShoreZone reports are available for download from the web sites of Coastal & Ocean Resources and NOAA Fisheries at www.coastalandoceans.com and www.alaskafisheries.noaa.gov/maps.

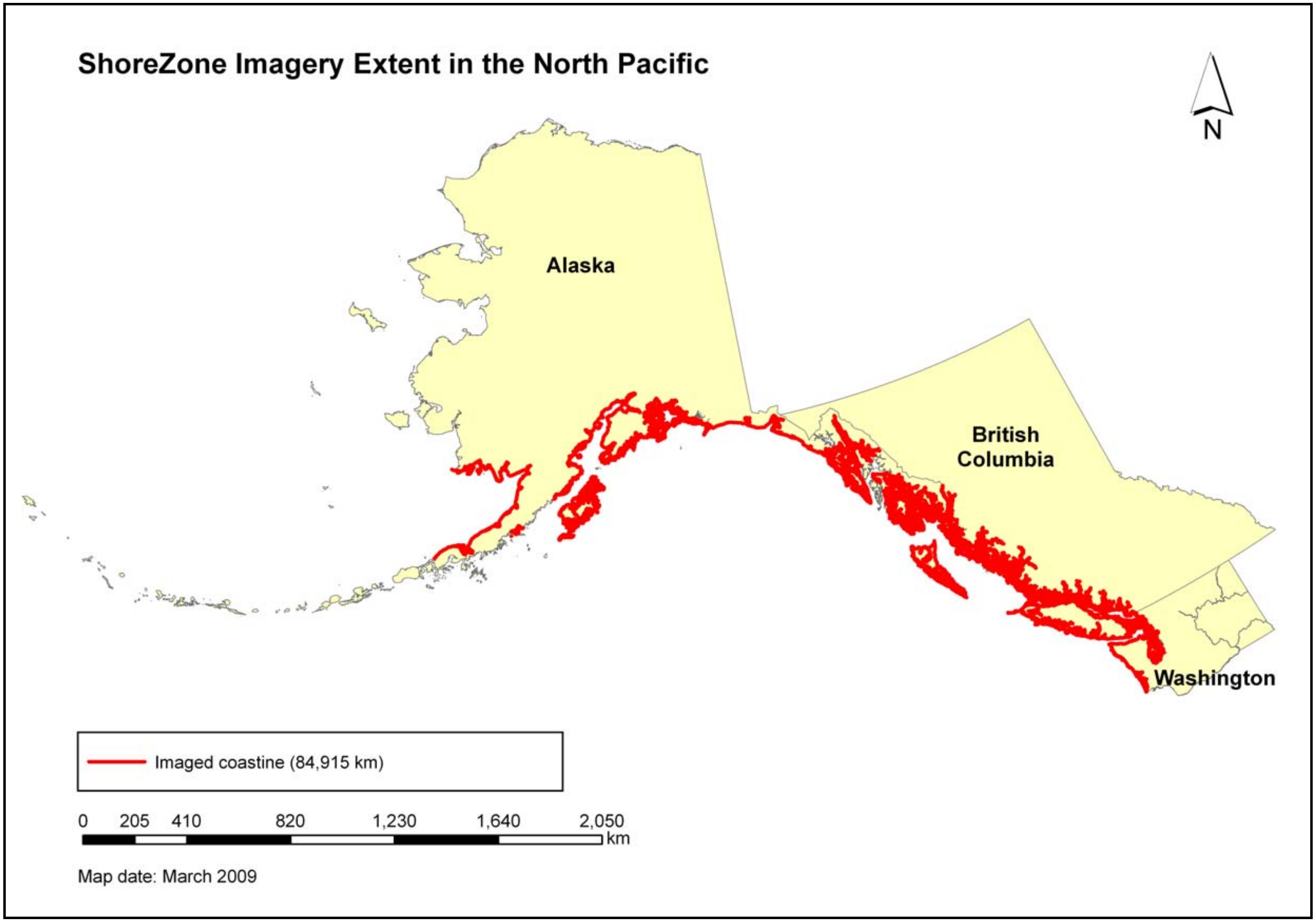


Figure 1.1. Extent of ShoreZone imagery in Alaska, British Columbia, and Washington State (84,915 km as of March 2009).

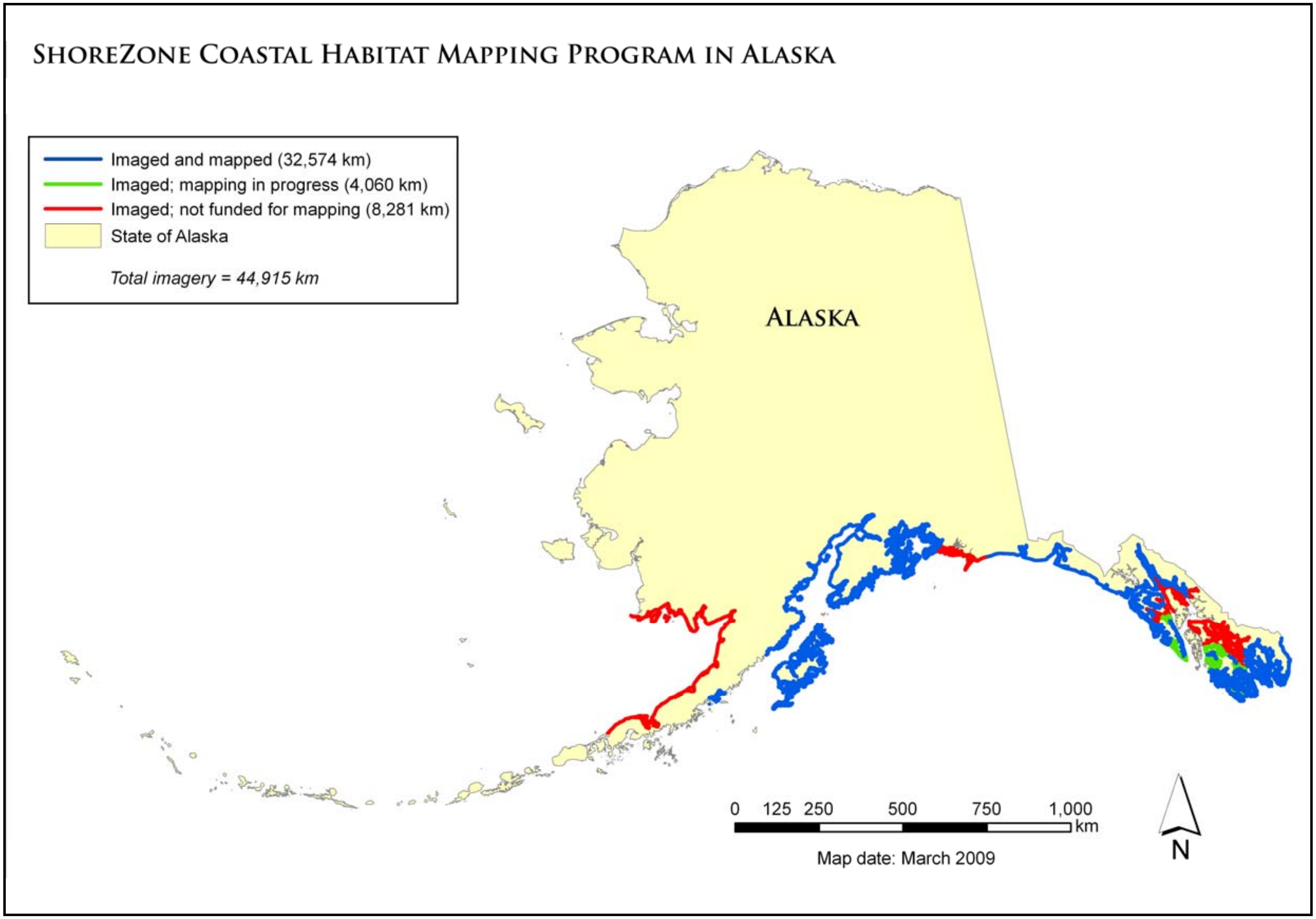


Figure 1.2. Extent of ShoreZone imagery and coastal habitat mapping in the State of Alaska (44,915 km as of March 2009).

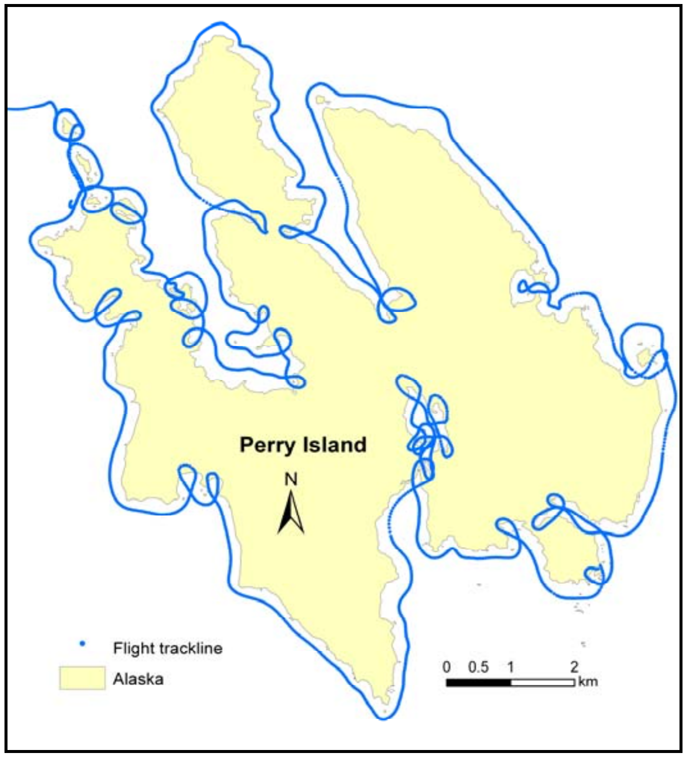


Figure 1.3. Example of recorded flight trackline showing 1-second GPS navigation fixes.

Figure 1.4. Example of a frame capture from video imagery in Zaikof Bay, northern Montague Island, Prince William Sound. Note GPS location, time code, and date burned on imagery, information which is also recorded in the navigational trackline.

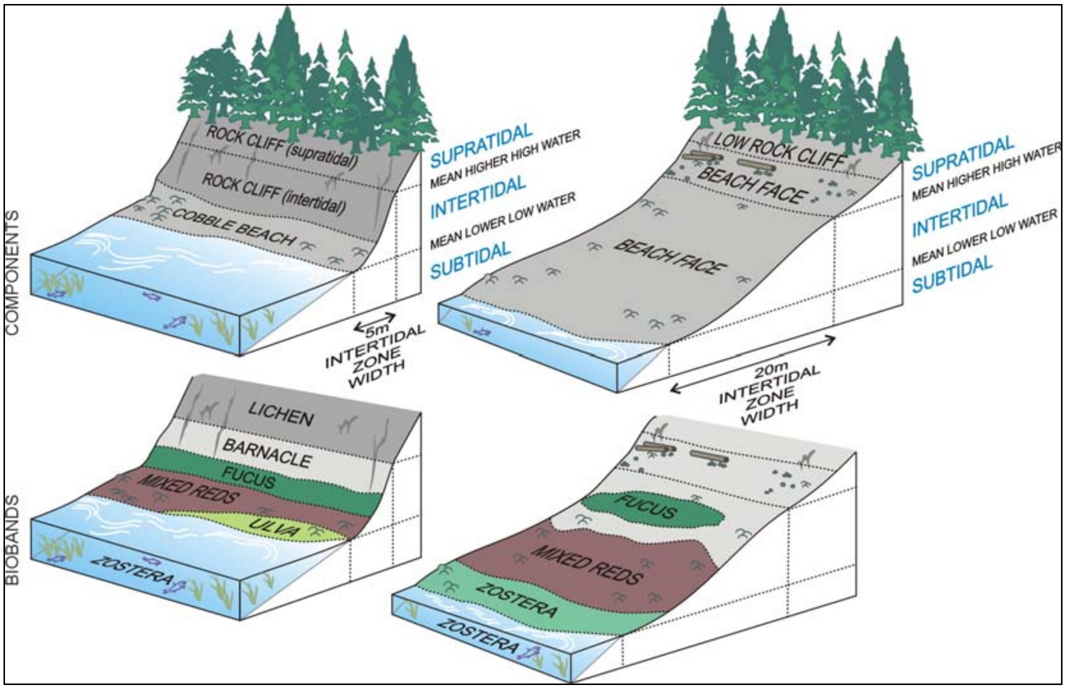


Figure 1.5. Schematic to illustrate how digital shorelines are segmented into along-shore units and across-shore components in the ShoreZone mapping system.

Figure 1.6. Example of digital still imagery, showing biobands in Louis Bay, Knight Island, Prince William Sound. Digital still photos are linked to the navigational tracklines by a unique time code, providing a GPS position on the shoreline for each image.

1.2 ShoreZone Mapping of Prince William Sound

Field surveys in Prince William Sound in 2004 and 2007 collected aerial video and digital still photographs of the coastal and nearshore zone during zero-meter tide levels and lower (daylight summer tides). The imagery and associated audio commentary were used to map the geomorphic and biological features of the shoreline according to the ShoreZone Coastal Habitat Mapping Protocol (Harney et al. 2008).

The purpose of this report is to provide a summary of the physical (geomorphic) and biological data mapped in the study area (Figure 1.7). The database associated with this summary report also includes 146 km of mapping east of Cordova (resulting from shared funding sources). Thematic and summary data for those areas are not included in this report.

The along-shore length of shoreline mapped in the Prince William Sound database is **5,585 kilometers**, in 24,286 along-shore segments (units), averaging 230 meters in length. Physical and biological data are summarized with illustrations in Sections 2 and 3, respectively.

Figure 1.7. Map of the study area in Prince William Sound (imaged in 2004 and 2007), for which physical (geomorphic) and biological ShoreZone data are summarized in this report (5,585 km).

2 PHYSICAL SHOREZONE DATA SUMMARY

2.1 Shore Types

The principal characteristics of each along-shore segment are used to assign an overall unit classification or "shore type" that represents the unit as a whole. ShoreZone mapping employs three along-shore **unit classification** systems: coastal shore types based on geomorphology and sediment texture (developed in British Columbia, "BC Class"); the "Environmental Sensitivity Index" (ESI class) used for hazard planning maps; and a biological shoreline classification system unique to ShoreZone, the "Habitat Class" (described in detail in Section 3.3).

The **BC Class** system is used to describe along-shore coastal units as one of 35 shore types defined on the basis of the principal geomorphic features, substrates, sediment textures, across-shore width, and slope of that section of coastline (after Howes et al. 1994; Table A-2). Coastal classes also characterize units dominated by organic shorelines such as marshes (BC Class 31), man-made features (BC Classes 32 and 33), high-current channels (BC Class 34), and glaciers (BC Class 35). Photographic examples of BC Class shore types in Prince William Sound are provided in Appendix B.

The occurrence of shore types mapped along 5,585 km of shoreline in Prince William Sound (on the basis of BC Class) is listed in Table 2.1. Grouped BC Classes are useful to illustrate the distribution of substrate types in the Sound (Figure 2.1) and to summarize data in graphic form (Figure 2.2). **Bedrock shorelines** (BC Classes 1-5) comprise 527.8 km (9.4%) of mapped shorelines. **Mixed rock and sediment shorelines** (BC Classes 6-20) comprise 2489.0 km of shoreline (44.6% of the Sound). Because they are so abundant, these shore types are further distinguished on the basis of geomorphology and sediment texture, shown in Figures 2.3 and 2.4. **Sediment-dominated shorelines** (BC Classes 21-30) comprise 2,163.5 km of Prince William Sound shorelines (38.7%). The most common shore type in the Sound are wide sand and gravel beaches and flats (BC Classes 24 and 25), mapped along a total length of 1,735 km of shoreline (31.7% of the study area; shown in blue in Figure 2.1). Organic shorelines represent 348.1 km (6%).

The shoreline Environmental Sensitivity Index is an integral component of oil-spill contingency planning, emergency response, and coastal resource management. The **ESI Class** system uses wave exposure and substrate type to assign along-shore coastal segments a ranking of 1-10 to indicate the relative degree of sensitivity to oil spills (1=least sensitive, 10=most sensitive) as well as a general shore type (NOAA 2002; Table A-3). Substrate permeability is important in estimating the residence time of oil on the shoreline, thus sediment texture is a key element in determining the ESI class. The occurrence of ESI shore types in Prince William Sound is listed in Table 2.2 and illustrated in map form in Figure 2.5.

Table 2.1. Shore types by BC Class observed in Prince William Sound.

Substrate Type	Shore Type (BC Class)	Shore Type (BC Class)	Sum of Unit Length (km)	# of Units	% Occurrence (by length)	Cumulative Occurrence (%, km)
Rock	1	Rock Ramp, wide	4.8	25	0.1%	**9.4%**
	2	Rock Platform, wide	8.1	30	0.1%	**527.8 km**
	3	Rock Cliff	462.1	2204	8.3%	
	4	Rock Ramp, narrow	51.6	386	0.9%	
	5	Rock Platform, narrow	1.2	15	0.0%	
Rock &	6	Ramp with gravel beach, wide	128.2	494	2.3%	**44.6%**
Sediment	7	Platform with gravel beach, wide	128.0	298	2.3%	**2,489.0 km**
	8	Cliff with gravel beach	443.9	1862	7.9%	
	9	Ramp with gravel beach	273.4	1317	4.9%	
	10	Platform with gravel beach	6.4	44	0.1%	
	11	Ramp w gravel & sand beach, wide	253.3	1085	4.5%	
	12	Platform with G&S beach, wide	232.7	777	4.2%	
	13	Cliff with gravel/sand beach	518.1	2561	9.3%	
	14	Ramp with gravel/sand beach	486.8	2378	8.7%	
	15	Platform with gravel/sand beach	14.5	112	0.3%	
	16	Ramp with sand beach, wide	0.0	0	0.0%	
	17	Platform with sand beach, wide	2.2	11	0.0%	
	18	Cliff with sand beach	0.7	5	0.0%	
	19	Ramp with sand beach, narrow	0.8	5	0.0%	
	20	Platform with sand beach, narrow	0.2	2	0.0%	
Sediment	21	Gravel flat, wide	79.0	321	1.4%	**38.7%**
	22	Gravel beach, narrow	50.1	220	0.9%	**2,163.5 km**
	23	Gravel flat or fan	0.2	1	0.0%	
	24	Sand & gravel flat or fan, wide	1174.9	5216	21.0%	
	25	Sand & gravel beach, narrow	595.4	3019	10.7%	
	26	Sand & gravel flat or fan, narrow	32.1	212	0.6%	
	27	Sand beach	5.0	22	0.1%	
	28	Sand flat	98.4	179	1.8%	
	29	Mudflat	127.3	221	2.3%	
	30	Sand beach	1.2	4	0.0%	
Organics	31	Organic shorelines, marshes	348.1	1172	6.2%	**6.2%** **348.1 km**
Man-made	32	Man-made, permeable	22.6	36	0.4%	**0.4% (23 km)**
	33	Man-made, impermeable	0.5	3	0.0%	
Channel	34	Channel	11.0	31	0.2%	**0.2% (11 km)**
Glacier/Ice	35	Glacier	23.1	18	0.4%	**0.4% (23 km)**

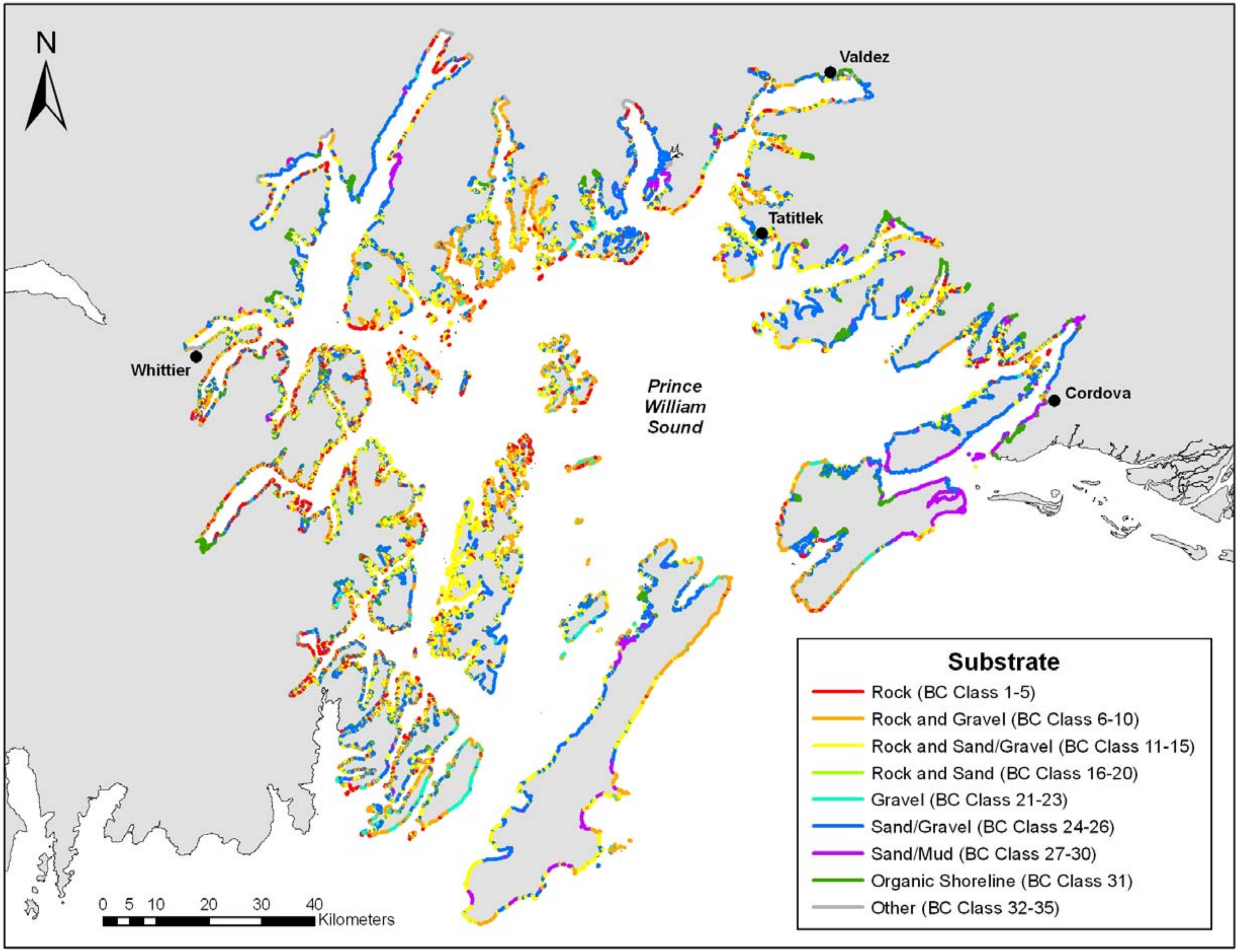


Figure 2.1. Distribution of principal substrate types in Prince William Sound (on the basis of grouped BC Classes).

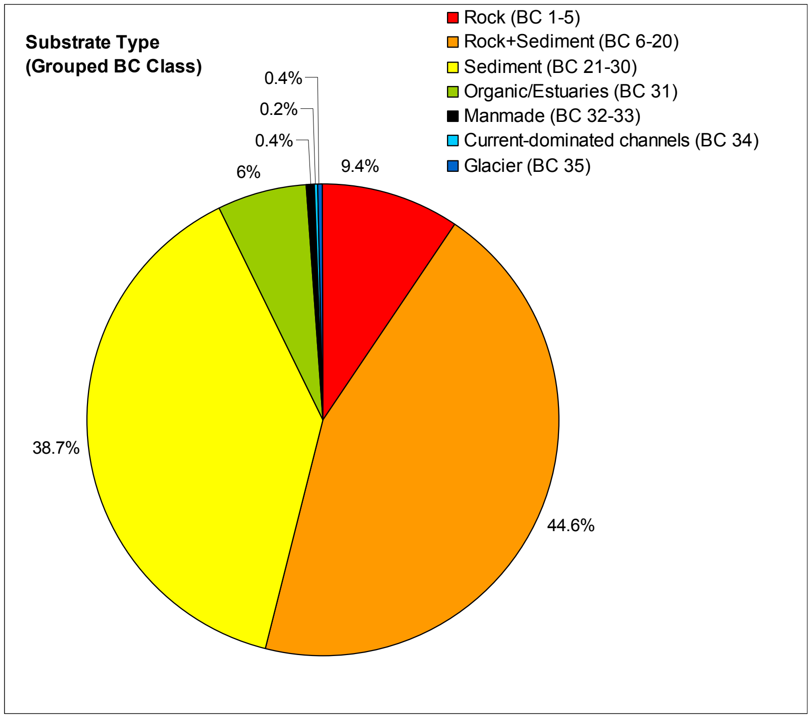


Figure 2.2. Relative abundance of principal substrate types (BC Classes 1-35) in Prince William Sound.

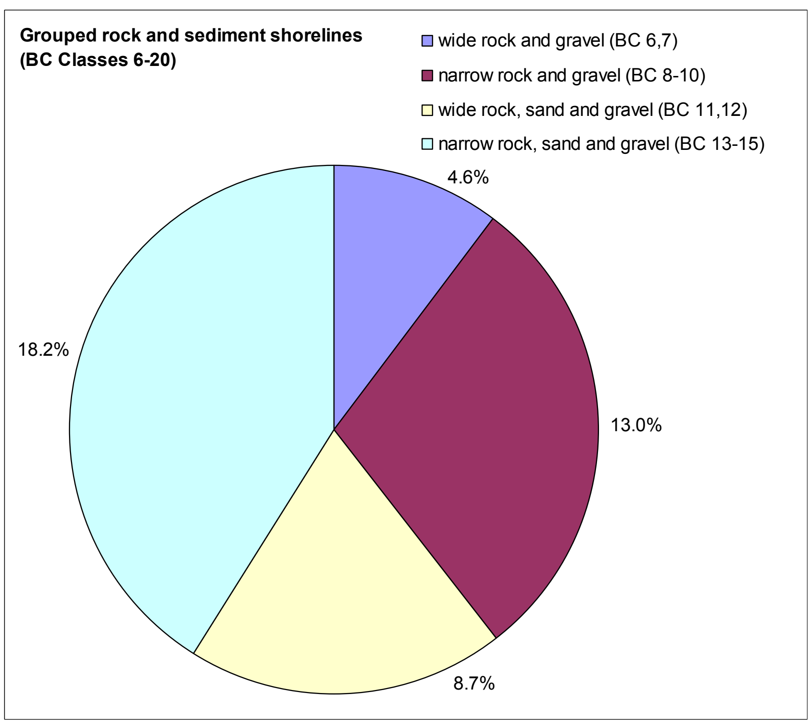


Figure 2.3. Relative abundance of mixed rock and sediment shoreline types (BC classes 6-20), grouped by geomorphology.

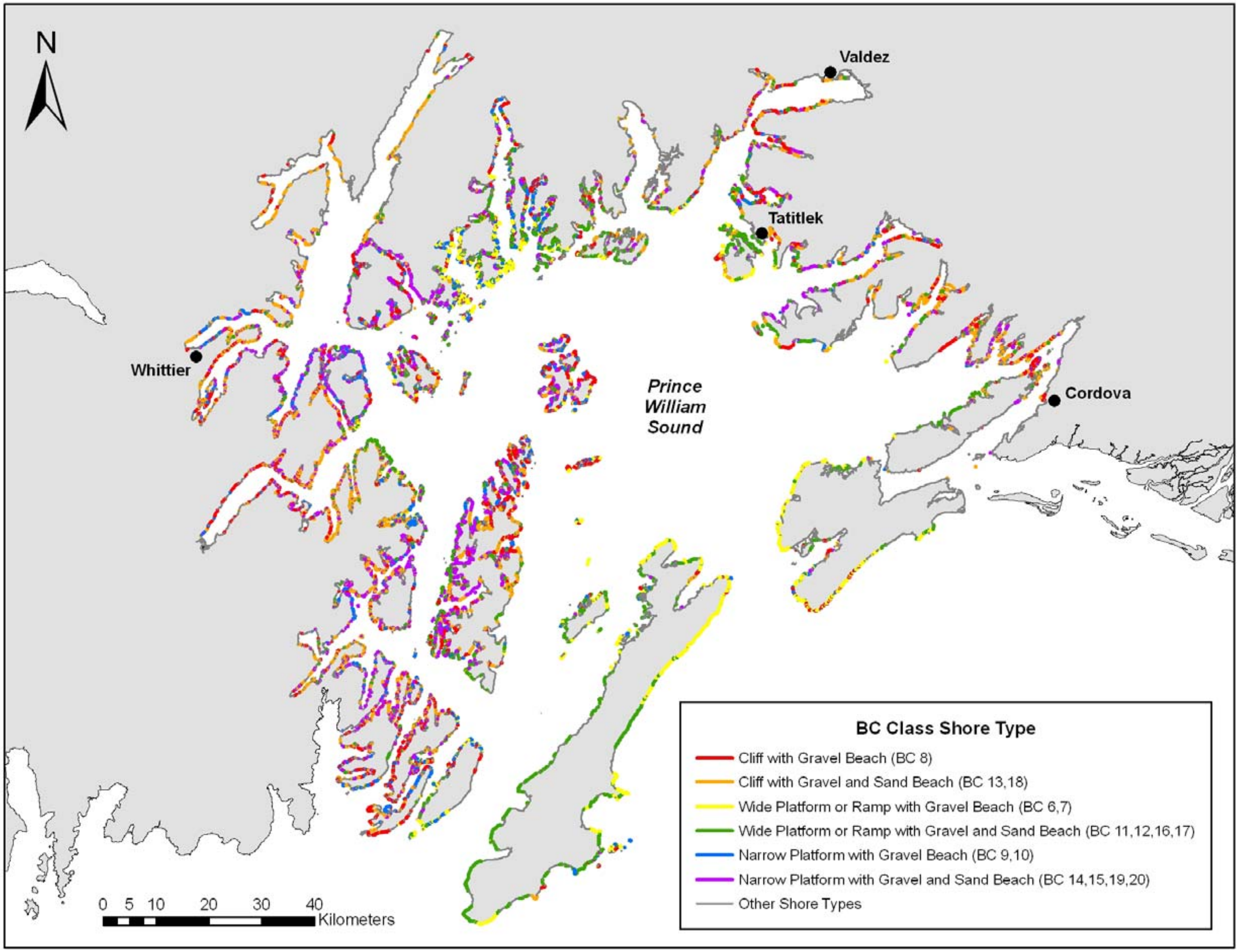


Figure 2.4. Distribution of mixed rock and sediment shorelines (BC Classes 6-20, grouped by geomorphology).

Table 2.2. Summary of shore types by ESI Class observed in Prince William Sound.

ESI Class	Description	Sum of Unit Length (km)	# of Units	% Occurrence (by length)
1A	Exposed rocky shores and banks	76.1	386	1.4%
1B	Exposed, solid, man-made structures	0	0	0.0%
1C	Exposed rocky cliffs with boulder talus base	69.9	329	1.3%
2A	Exposed wave-cut platforms in bedrock, mud, or clay	85.7	215	1.5%
2B	Exposed scarps and steep slopes in clay	0	0	0.0%
3A	Fine- to medium-grained sand beaches	64.6	83	1.2%
3B	Scarps and steep slopes in sand	0	0	0.0%
3C	Tundra cliffs	0	0	0.0%
4	Coarse-grained sand beaches	22.4	90	0.4%
5	Mixed sand and gravel beaches	2819.8	13018	50.5%
6A	Gravel beaches (granules and pebbles)	42.3	194	0.8%
6B	Gravel beaches (cobbles and boulders)	487.3	1864	8.7%
6C	Rip rap (man-made)	13.0	12	0.2%
7	Exposed tidal flats	30.3	76	0.5%
8A	Sheltered scarps in bedrock, mud, or clay; sheltered rocky shores (impermeable)	380.3	1886	6.8%
8B	Sheltered, solid, man-made structures; sheltered rocky shores (permeable)	232.3	1118	4.2%
8C	Sheltered riprap (man-made)	10.8	42	0.2%
8D	Sheltered rocky rubble shores	367.9	1749	6.6%
8E	Peat shorelines	0	0	0.0%
9A	Sheltered tidal flats	586.6	2392	10.5%
9B	Vegetated low banks	14.9	40	0.3%
9C	Hypersaline tidal flats	0	0	0.0%
10A	Salt- and brackish-water marshes	280.7	791	5.0%
10B	Freshwater marshes	0.5	1	0.0%
10C	Swamps	0	0	0.0%
10D	Scrub-shrub wetlands; mangroves	0	0	0.0%
10E	Inundated low-lying tundra	0	0	0.0%

Mixed sand and gravel beaches are ESI classes 4 and 5; gravel beaches (6A, 6B) are composed mainly of cobbles and boulders; tidal flats (9A) are >30 m wide and may contain organic material, fine sediment, sand, and some gravel (cobble and boulder veneer), and are generally confined to relatively protected areas at the heads of inlets.

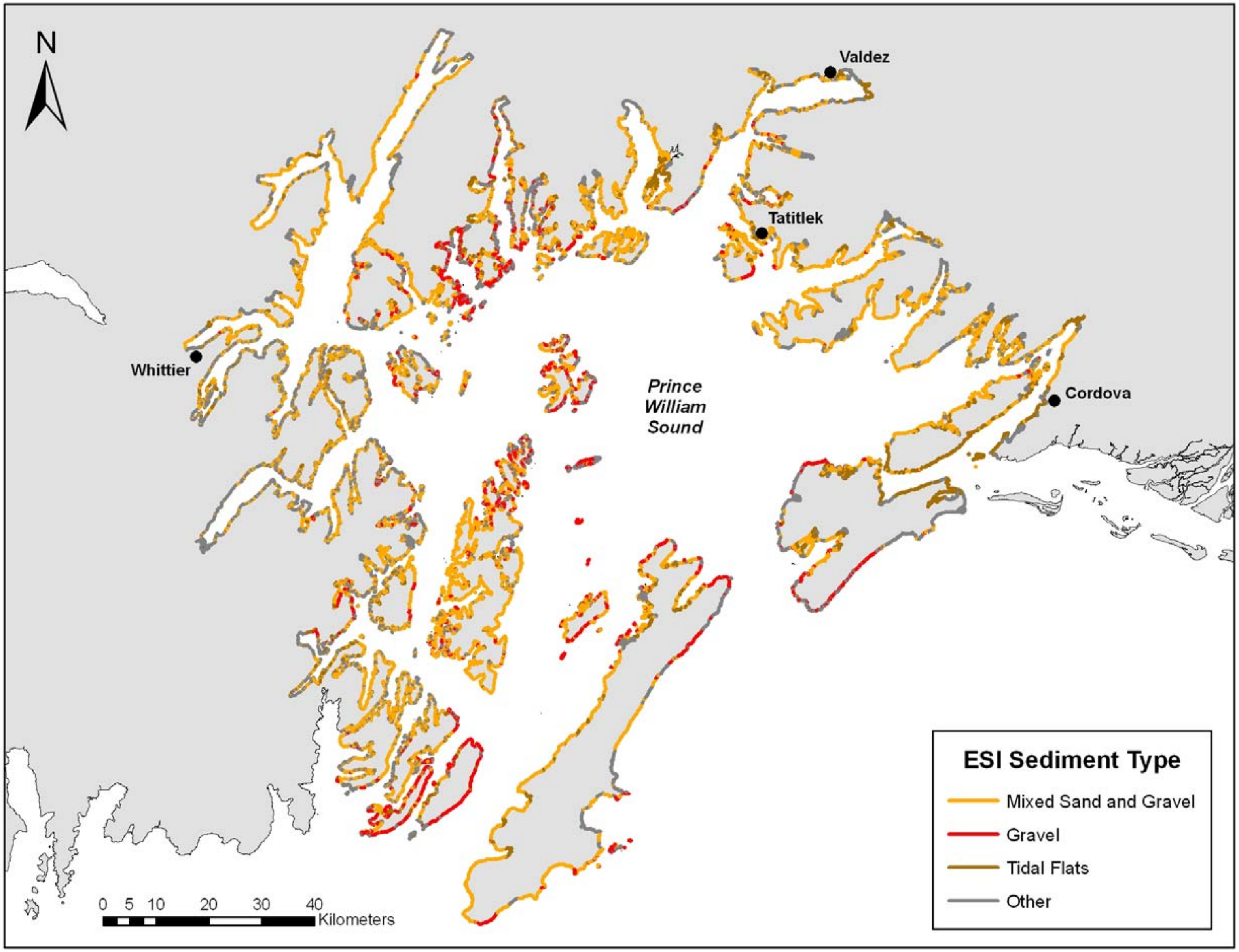


Figure 2.5. Distribution of beaches and tidal flats in Prince William Sound on the basis of grouped ESI class.

2.2 Oil Residence Index (ORI)

The Oil Residence Index (ORI) is a rating between 1 and 5 that reflects the estimated persistence of spilled oil on a shoreline. A value of 1 reflects relatively short oil residence (days to weeks), while a value of 5 reflects potentially long oil residence times (months to years). An ORI value is applied to each across-shore component on the basis of sediment texture and wave exposure (Table A-5), as well as to each along-shore unit on the basis of shore type and wave exposure (Table A-6). For more information on the assignment of this attribute, please refer to the ShoreZone Protocol (Harney et al. 2008).

The dominance of lower wave exposures and sand-gravel sediment textures results in high Oil Residence Indices for most shore segments: 81% have an ORI of 4 or 5, indicating oil residence times are on the order of months to years (Table 2.3; Figure 2.6).

Table 2.3. Summary of Oil Residence Index for shore units mapped in Prince William Sound. Percentage of shoreline length is based on total shoreline in study area (5,885 km).

Relative Persistence	Oil Residence Index (ORI)	Estimated temporal persistence	Shoreline Length (km)	Shoreline Length (%)
Short	1	Days to weeks	41.0	1%
	2	**Weeks** to months	205.2	4%
Moderate	3	Weeks to **months**	857.7	15%
	4	**Months** to years	1704.4	31%
Long	5	Months to **years**	2777.2	50%

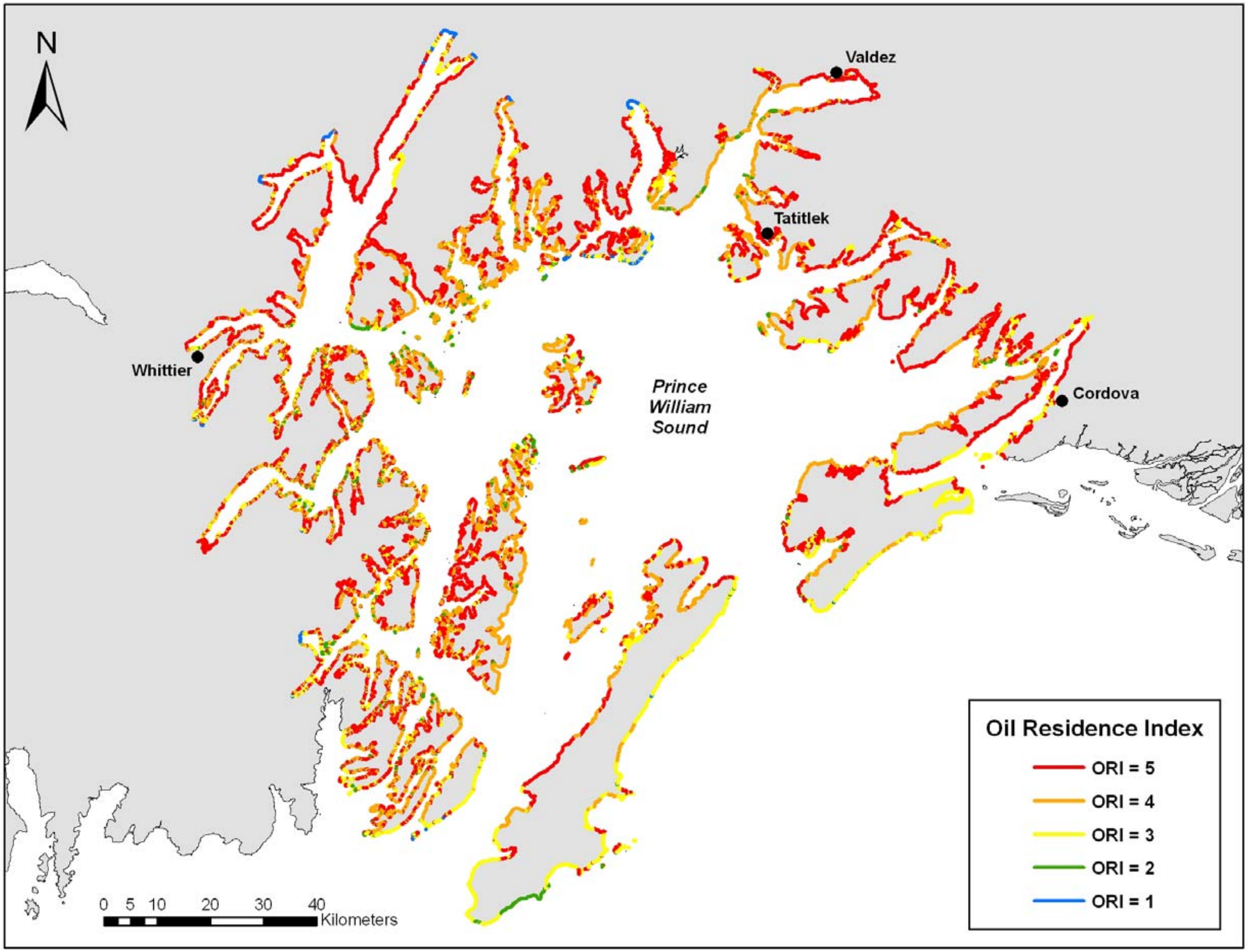


Figure 2.6. Oil Residence Index (ORI) for shorelines in Prince William Sound, based on substrate type and wave exposure.

2.3 Anthropogenic Shore Modifications

Man-made coastal structures such as marinas, wharves, seawalls, and docks are enumerated in ShoreZone mapping data using the codes for forms, materials, and shore modifications defined in Tables A-11 and A-12 of Appendix A. Specific types of shore modification features (such as boat ramps and land fill) and their relative proportions of the intertidal zone are recorded in the database in the "SM" fields of the Unit table and can be used to estimate the approximate length of shoreline altered by the feature (by multiplying the relative proportion of the feature in the unit by the unit length). For more information on the observation of such features and the calculation of this estimate, please refer to the ShoreZone protocol (Harney et al. 2008).

Specific types of shore modifications mapped in Prince William Sound are listed in Table 2.4 and shown in Figure 2.7. Shoreline units in which >50% of the unit is altered by human activities are classified as man-modified (BC Class 32 or 33). Man-made shorelines are uncommon in Prince William Sound, occurring along only 23 km of the coast surveyed (0.4%), mostly in the communities of Cordova, Valdez, and Whittier (Figure 2.8).

Table 2.4. Summary of shore modifications observed in Prince William Sound.

Shore Modification	Code	# of occurrences	Approx. shoreline length (km)*
boat ramp	BR	8	0.7
concrete bulkhead	CB	14	3.2
landfill	LF	51	8.9
riprap	RR	51	22.5
sheet pile	SP	12	1.5
wooden bulkhead	WB	25	1.8

*calculated from SM% field multiplied by unit length

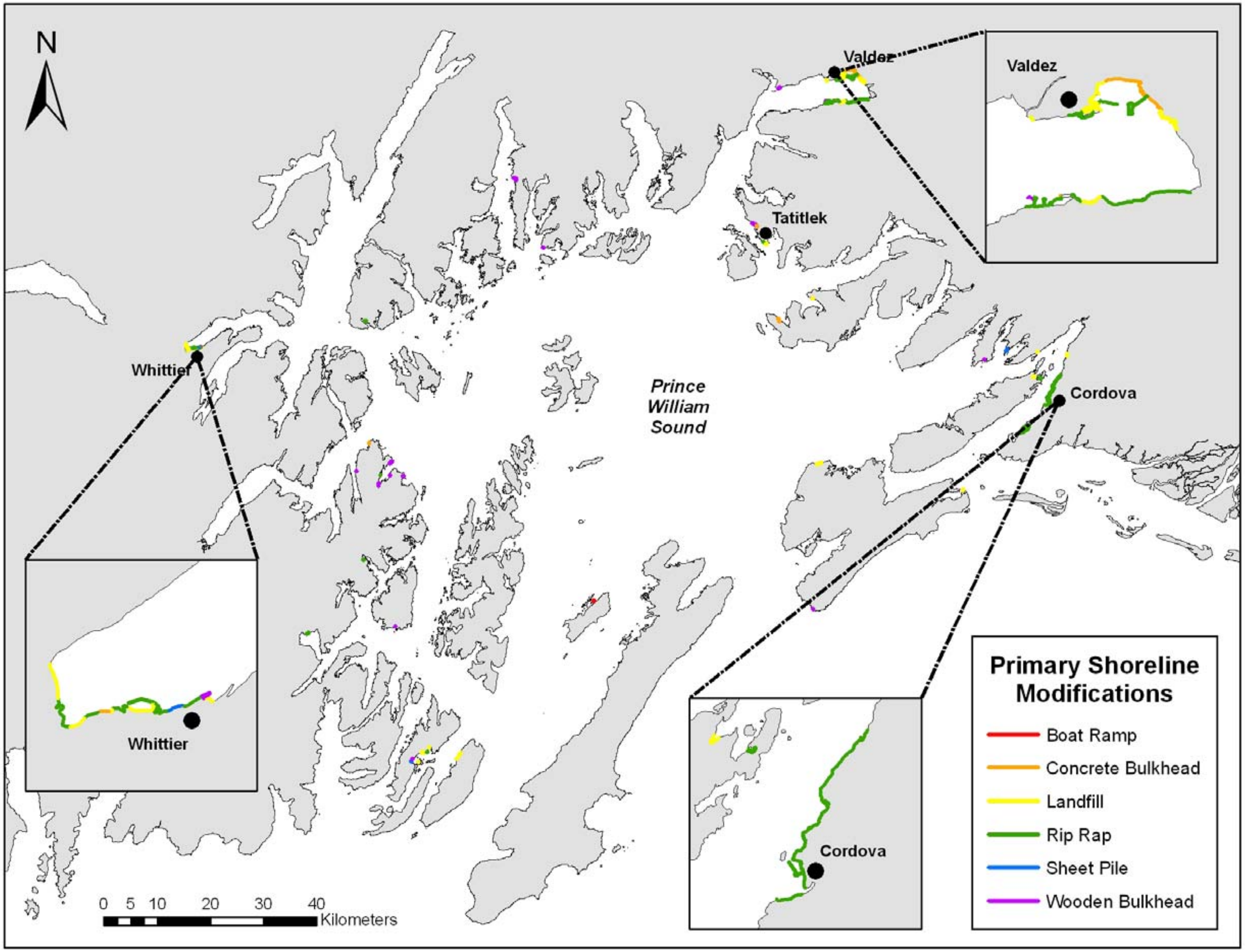


Figure 2.7. Units with shore modification features (<50% of unit; not classified as man-made).

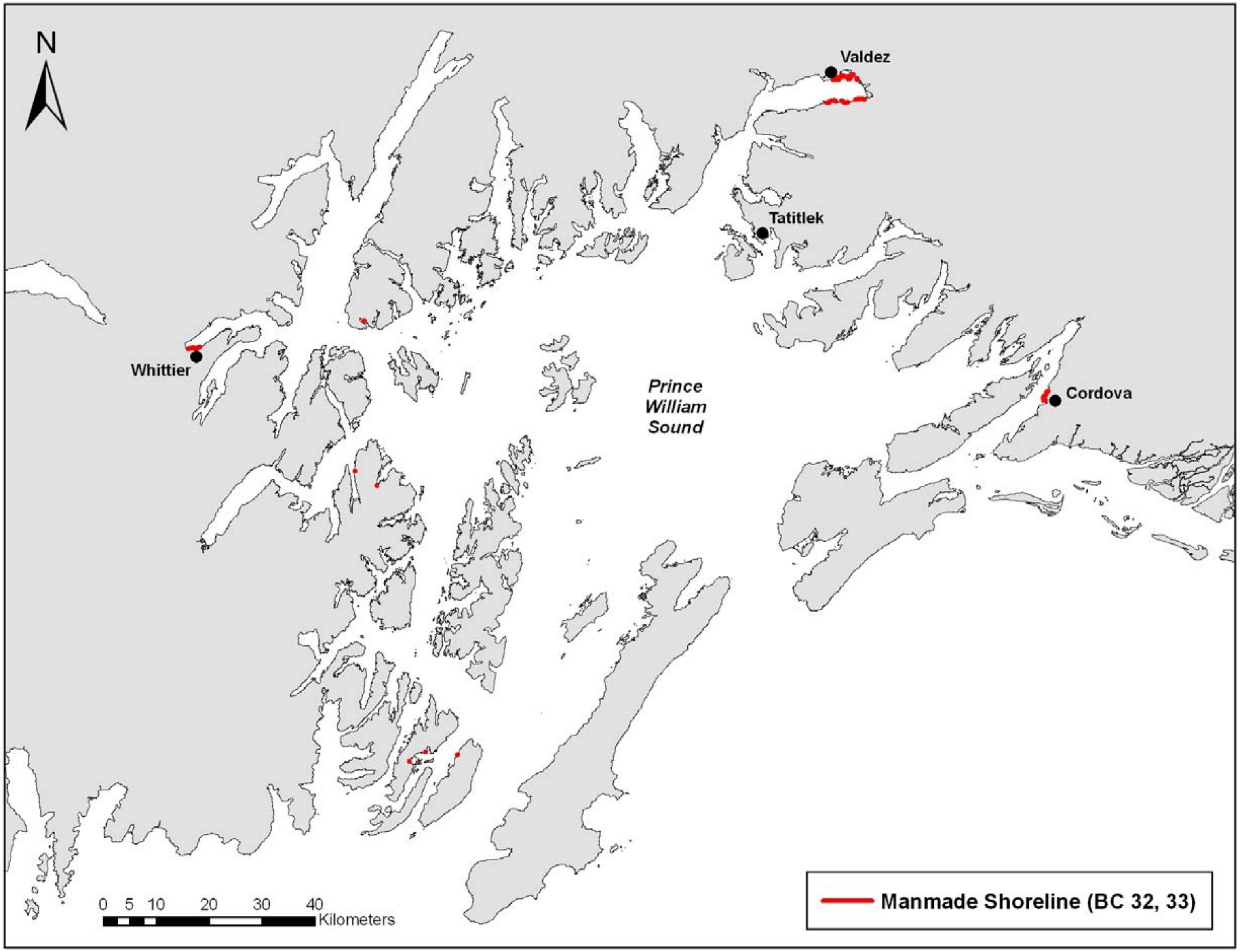


Figure 2.8. Units with shore modification features (>50% of unit; classified as man-made).

3 BIOLOGICAL SHOREZONE DATA SUMMARY

Biological ShoreZone mapping is based on the observation of patterns of biota in the coastal zone, with data recorded from observation of the occurrence and extent of species assemblages (called '**biobands'**) that are related to both the degree of wave exposure and the substrate on the shore. The observations of presence, absence and relative distribution of the biobands within each alongshore unit are recorded in the mapping, and from those observations, the biological mapper assigns interpreted classification of **biological wave exposure** and **habitat class** to each unit.

3.1 Biobands in Prince William Sound

Bioband Descriptions

A **bioband** is an observed assemblage of coastal biota, which grows in a typical across-shore elevation, and at characteristic wave energies and substrate conditions. Bands are spatially distinct, with alongshore and cross-shore patterns of color and texture that are visible in aerial imagery (Figure 3.1). Biobands are described across the shore, from the high supratidal to the shallow nearshore subtidal elevations; and are named for the dominant species or group that best represents the entire band (Table 3.1). Some biobands are characterized by a single indicator species (such as the Blue Mussel band (BMU)), while others represent an assemblage of co-occurring species (such as the Red Algae band (RED)). Bioband occurrence is recorded as 'patchy' (observed in less than half of the unit length) or 'continuous' (observed in more than half of the unit length).

Lower intertidal biobands are better indicators of wave exposure than those observed in the upper intertidal. Upper intertidal biota tend to be consistent between different wave exposure categories and geographic areas, so are considered weak indicators of exposure. An example is the ubiquitous Barnacle band (BAR), which is found across all exposure categories. Lower intertidal biobands are often diagnostic of particular wave exposures. For example, the Surfgrass band (SUR) is indicative of Semi-Exposed (SE) settings, while the Eelgrass band (ZOS) is indicative of Semi-Protected (SP) and Protected (P) environments.

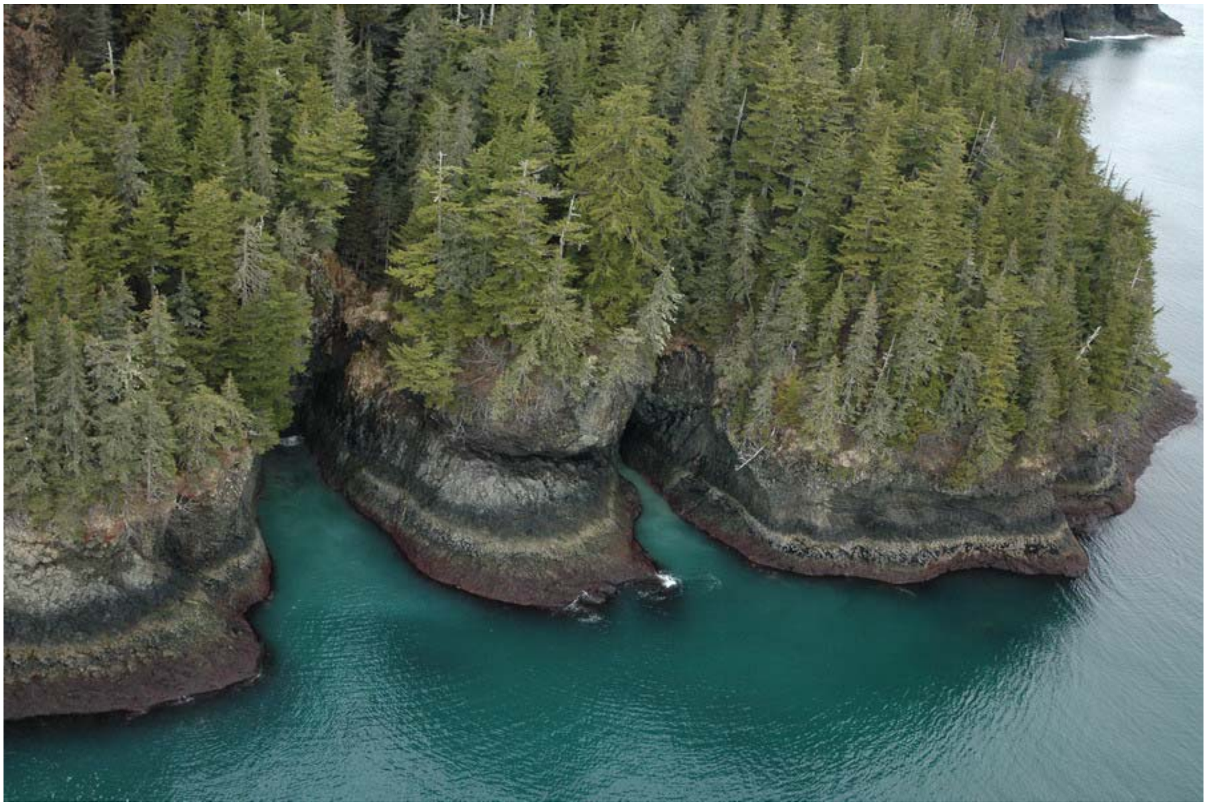


Figure 3.1. Example of biobands on Glacier Island. Along-shore biobands of color and texture are formed by biological assemblages of species in the intertidal zone. (PWS07_MM_06061.jpg)

Table 3.1. Summary of bioband definitions for Prince William Sound.

Zone	Bioband Name	Database Label	Colour	Diagnostic Indicator Species	Exposure *
Supratidal	Splash Zone	**VER**	Black or bare rock	Encrusting black lichens	Width varies with exposure
Supratidal	Dune Grass	**GRA**	Pale blue-green	*Leymus mollis*	P to E
Supratidal	Sedges	**SED**	Bright green to yellow-green	*Carex lyngbyei* *Carex* spp.	VP to SP
Supratidal	Salt Marsh	**PUC**	Light or bright green	*Puccinellia* sp. Other salt-tolerant herbs and grasses	VP to SE
Upper to Mid-Intertidal	Barnacle	**BAR**	Grey-white to pale yellow	*Balanus* sp. *Semibalanus* sp.	P to E
Upper to Mid-Intertidal	Rockweed	**FUC**	Golden-brown	*Fucus* sp.	P to SE
Upper to Mid-Intertidal	Green Algae	**ULV**	Green	*Ulva* sp. Other small green algae	P to E
Upper to Mid-Intertidal	Blue Mussel	**BMU**	Black or blue-black	*Mytilus trossulus*	P to E
Upper to Mid-Intertidal	Bleached Red Algae	**HAL**	Olive, golden or yellow-brown	Bleached foliose or filamentous red algae *Palmaria* sp. *Odonthalia* sp.	P to SE
Lower Intertidal and Nearshore Subtidal	Red Algae	**RED**	Dark to bright red or pink (corallines)	*Odonthalia* sp. *Neorhodomela* sp. *Palmaria* sp. Other foliose red algae, and other coralline algae	P to E
Lower Intertidal and Nearshore Subtidal	Alaria	**ALA**	Dark brown	*Alaria* sp.	SP to E
Lower Intertidal and Nearshore Subtidal	Soft Brown Kelps	**SBR**	Yellow-brown, olive brown or brown.	*Saccharina latissima* *Cystoseira* sp.	VP to SE
Lower Intertidal and Nearshore Subtidal	Dark Brown Kelps	**CHB**	Dark chocolate brown	Stalked *Laminaria* sp. *Cymathaere* sp. Other bladed kelps	SE to E
Lower Intertidal and Nearshore Subtidal	Surfgrass	**SUR**	Bright green	*Phyllospadix* sp.	SP to SE
Lower Intertidal and Nearshore Subtidal	Eelgrass	**ZOS**	Bright to dark green	*Zostera marina*	VP to SP
Sub-tidal	Dragon Kelp	**ALF**	Golden-brown	*Alaria fistulosa*	SP to SE
Sub-tidal	Bull Kelp	**NER**	Dark brown	*Nereocystis luetkeana*	SP to E

* Wave Exposure Codes: E = Exposed, SE = Semi-Exposed, SP = Semi-Protected, P = Protected, VP = Very Protected (The highest Biological Exposure Very Exposed (VE) does not occur in the region included in this summary report).

As ShoreZone biological mapping has been completed throughout Alaska, differences in the species assemblages that characterize the coastal habitats have observed on a broad geographic scale. Differences in biota are often the most obvious in the lower intertidal, in the same lower intertidal bands that are also the indicators for the wave exposure categories used in ShoreZone.

To recognize region-specific species assemblages, as well as to identify broad-scale trends in coastal habitats, a number of **bioareas** have been defined in Alaska (Tables 3.2 and A-7). A similar approach was applied in British Columbia to recognize the broad-scale ‘ecoregional’ differences and seven bioareas have been defined for the ShoreZone mapping there.

Bioarea boundaries are determined from on overview interpretation of biomapping and the distribution of major species (e.g., the canopy kelp species – Dragon Kelp (ALF), Giant Kelp (MAC) and Bull Kelp (NER)) as well as overall coastal habitats (e.g., relief, geomorphology, dominate shoreline characteristics) (Figure 3.2 and Table 3.2). For example, the Outer Kenai coast (KENA) is characterized by high wave exposures, with bull kelp as the dominant canopy kelp, while the high-energy shoreline of the Yakutat (SEYA) bioarea has sandy shorelines and virtually no canopy kelps present.

Bioareas are also defined by differences between species present in lower intertidal biobands, and four bands have definitions that are specific to the bioarea where they are observed. These four biobands are: Bleached Red Algae (HAL), Red Algae (RED), Soft Brown Kelps (SBR) and Dark Brown Kelps (CHB). So far, ground observations of biobands and indicator species distribution within the Prince William Sound bioarea is limited to the western sound. Further detail about the indicator and associated species for each of the four lower intertidal biobands for Prince William Sound will be added as that data becomes available.

Biomapping for Prince William Sound (the shoreline imaged during 2004 and 2007 surveys) have been assigned primarily to two bioareas: Prince William Sound (PRWS) and Outer Kenai (KENA), with a small section on the easternmost edge assigned to the Yakutat bioarea (SEYA) (Table 3.2 and Figure 3.3).

Example illustrations and full definitions of the biobands mapped in this project area of Prince William Sound are presented in Appendix C. Each bioband is shown with example photos, as well as expanded definitions of description of the characteristic across-shore elevation, colour, wave exposures where the band is most likely to be observed, along with a list of indicator and associated species. Each bioband photo is labelled by bioarea and by location.

Table 3.2. Description of bioareas identified in Alaska (to date).

Code	Bioarea	Characteristics
ANIA	Aniakchak	High wave exposure, wide bedrock platforms and mobile sediment beaches. Included in KATM bioareas for species descriptions, pending further delineation of bioarea boundaries. Likely transitional to Aleutian bioareas.
KATM	Katmai coast/northwest coast of Kodiak archipelago	Moderate to high wave exposures, affected by outflow from Cook Inlet, and separated from open Gulf of Alaska by Kodiak archipelago. Limited diversity of lower intertidal browns and canopy kelps, with diversity of red algae characterizing higher exposure sites. Includes both coasts of Shelikof Strait.
KODI	Kodiak archipelago, southeast, on Gulf of Alaska coast	Diversity of habitats and wave exposures, from Very Protected estuaries to Exposed rock cliffs. Fully marine and open to Gulf of Alaska. Lush lower intertidal brown algae, red algae and canopy kelps, in particular at north end. Southwest coast has wide rock platforms with surfgrass beds and sediment dominated offshore islands.
COOK	Cook Inlet	Sediment-dominated, wide, low-slope shorelines, moderate to lower wave exposures. Affected by silt-laden freshwater input, absence of Giant Kelp and Dragon Kelp. Very wide complexes of salt marshes and estuaries.
KENA	Outer Kenai coast	Rugged coastline, dominated by extremely steep shores and Very Exposed wave energy. Fjord heads with tidewater glaciers. Absence of Dragon Kelp and Giant Kelp biobands.
PRWS	Prince William Sound	Diverse habitat, with high Semi-Exposed to Very Protected wave exposures. Differences between conditions in eastern and western Sound, with interaction of circulation complexities. Numerous tidewater glaciers and affects of Copper River. Absence of Giant Kelp and Dragon Kelp.
SEYA	Southeast Alaska -- Yakutat	Exposed west-facing coast, open to Gulf of Alaska. Mobile, high-energy sediment beaches dominant. Limited canopy kelp distribution.
SEFJ	Southeast Alaska – Lynn Canal	Fjord landscape, bedrock dominated, moderate to low wave exposures, glacial silty waters. Low species diversity in intertidal, dense Blue Mussel bioband, absence of Dragon Kelp and Giant Kelp biobands.
SEIC	Southeast Alaska – Icy Strait	Glacial silty water with wide, sediment-dominated beaches, wide estuary flats and fringing salt marsh common. Only moderate and lower wave exposures. Dragon Kelp dominant canopy kelp.
SESI	Southeast Alaska – Sitka	Fully marine, west coast. Includes diversity of species, exposure and habitat categories, from Exposed to Very Protected. Giant Kelp abundant, Dragon Kelp limited distribution.
SEMJ	Southeast Alaska – Misty Fjords	Fjord landscape, bedrock-dominated, low wave exposures. Low species diversity. Absence of Giant Kelp and Dragon Kelp.
SECR	Southeast Alaska – Craig	Fully marine, west coast. High species diversity and habitat heterogeneity. Northern limit of California Mussel and Urchin Barrens biobands and certain species of other lower intertidal kelps. Southern limit of Dragon Kelp.

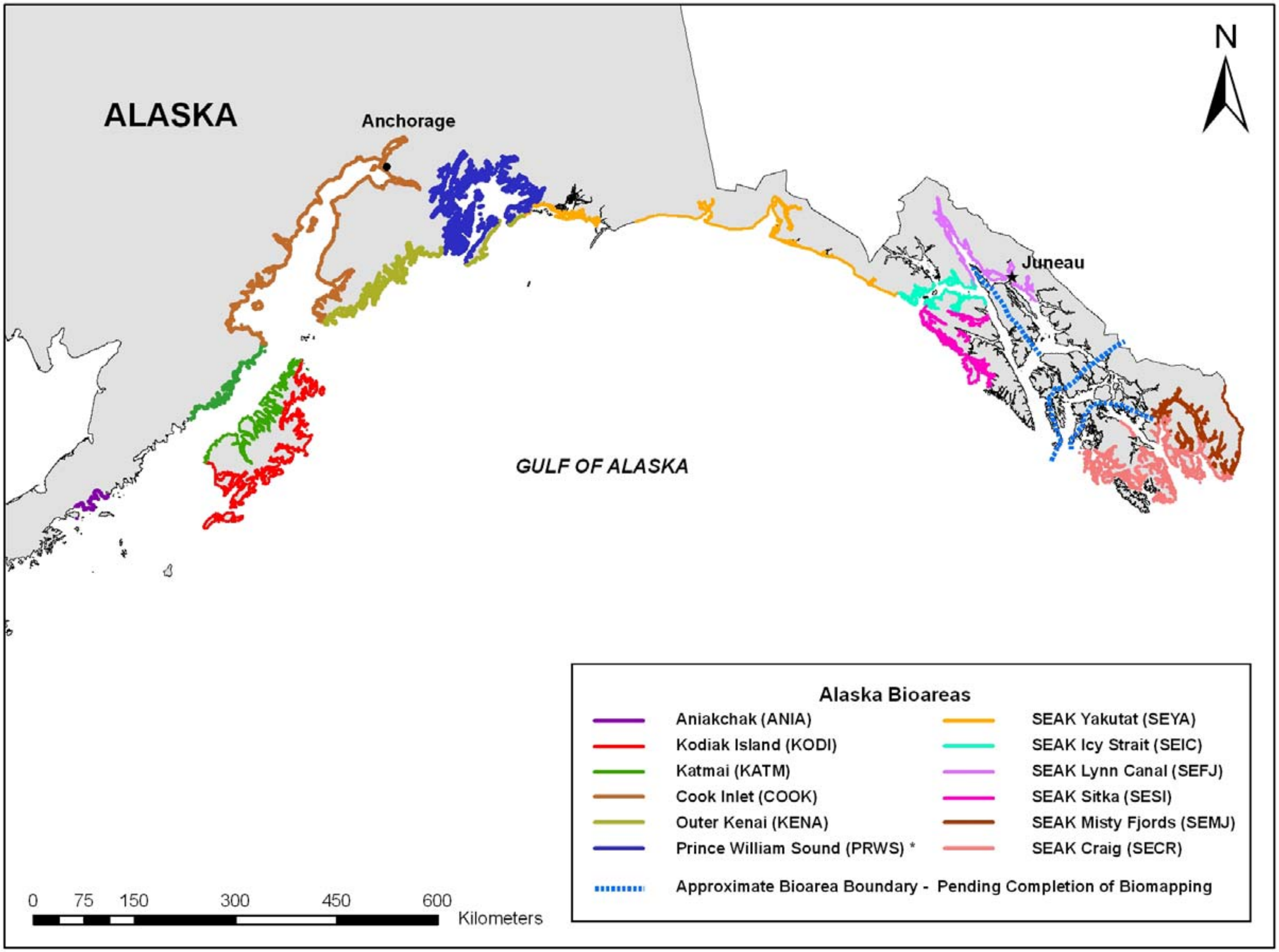


Figure 3.2. Map of bioareas identified in Alaska (to date). Bioareas are delineated on the basis of observed differences in the distribution of lower intertidal biota, nearshore canopy kelps, and coastal habitat classification.

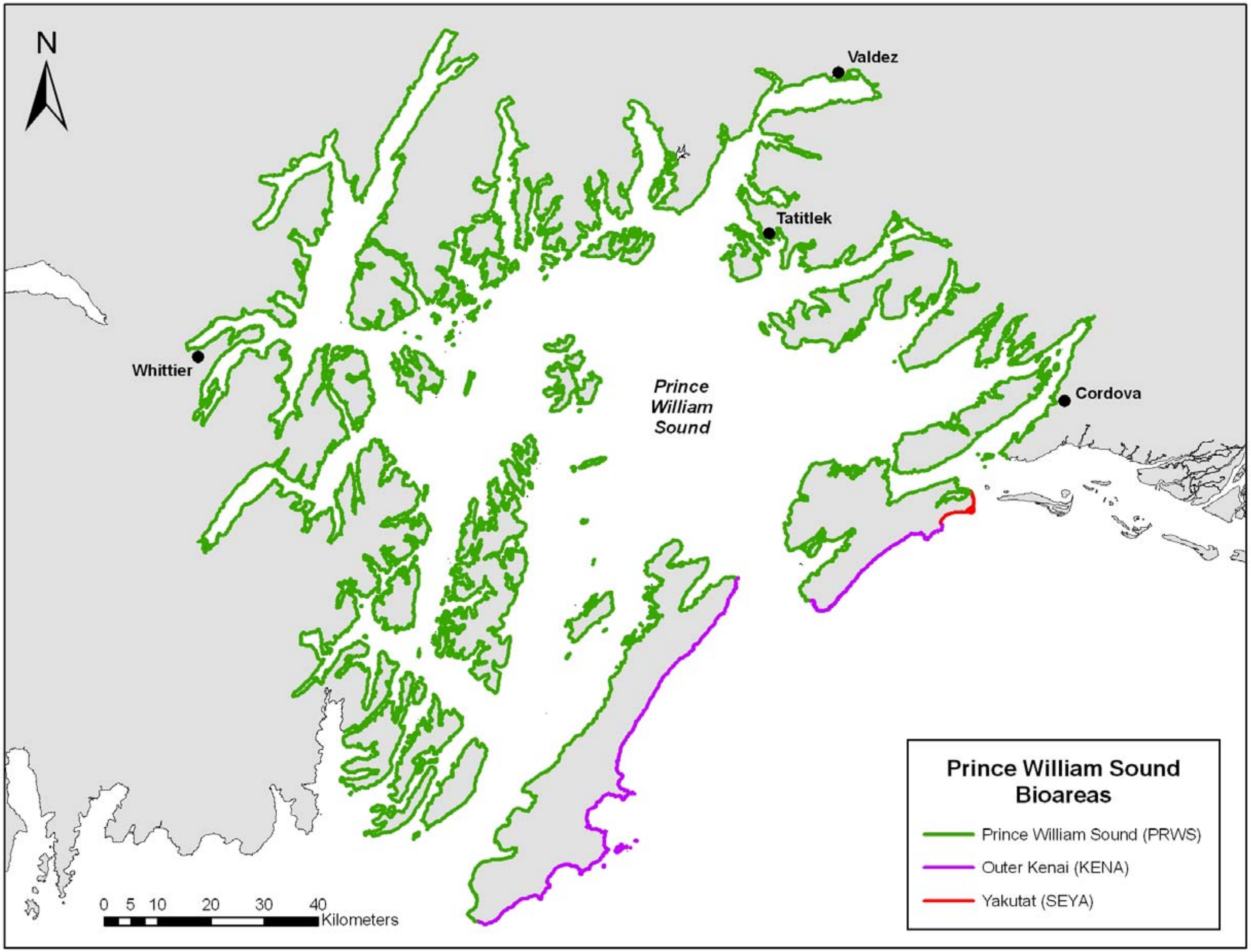


Figure 3.3. Bioareas identified in Prince William Sound region, showing Gulf of Alaska coast assigned to Outer Kenai bioareas (KENA) and easternmost end of Hinchinbrook Island assigned to the Yakutat bioarea (SEYA).

The occurrence of each bioband mapped in Prince William Sound is summarized in Table 3.3 and Figure 3.4.

Table 3.3. Bioband abundances mapped in Prince William Sound.

Bioband Names	Code	Continuous		Patchy		Total (km)	% of Mapped
		(km)	%	(km)	%		
Dune Grass	GRA	1,467	26	845	15	2,312	41
Sedges	SED	241	4	163	3	404	7
Salt Marsh	PUC	960	17	803	14	1,763	31
Barnacle	BAR	3,445	62	1,393	25	4,838	87
Rockweed	FUC	3,486	62	1,385	25	4,871	87
Green Algae	ULV	3,011	54	1,748	31	4,759	85
Blue Mussel	BMU	188	3	745	13	933	16
Bleached Red Algae	HAL	437	8	866	16	1,303	24
Red Algae	RED	1,534	27	1,144	20	2,678	47
Alaria	ALA	452	8	246	4	698	12
Soft Brown Kelps	SBR	2,437	44	1,015	18	3,452	62
Dark Brown Kelps	CHB	161	3	132	2	293	5
Surfgrass	SUR	163	3	175	3	338	6
Eelgrass	ZOS	1,635	29	891	16	2,526	45
Dragon Kelp	ALF	5	<1	11	<1	16	<1
Bull Kelp	NER	74	1	47	1	121	2

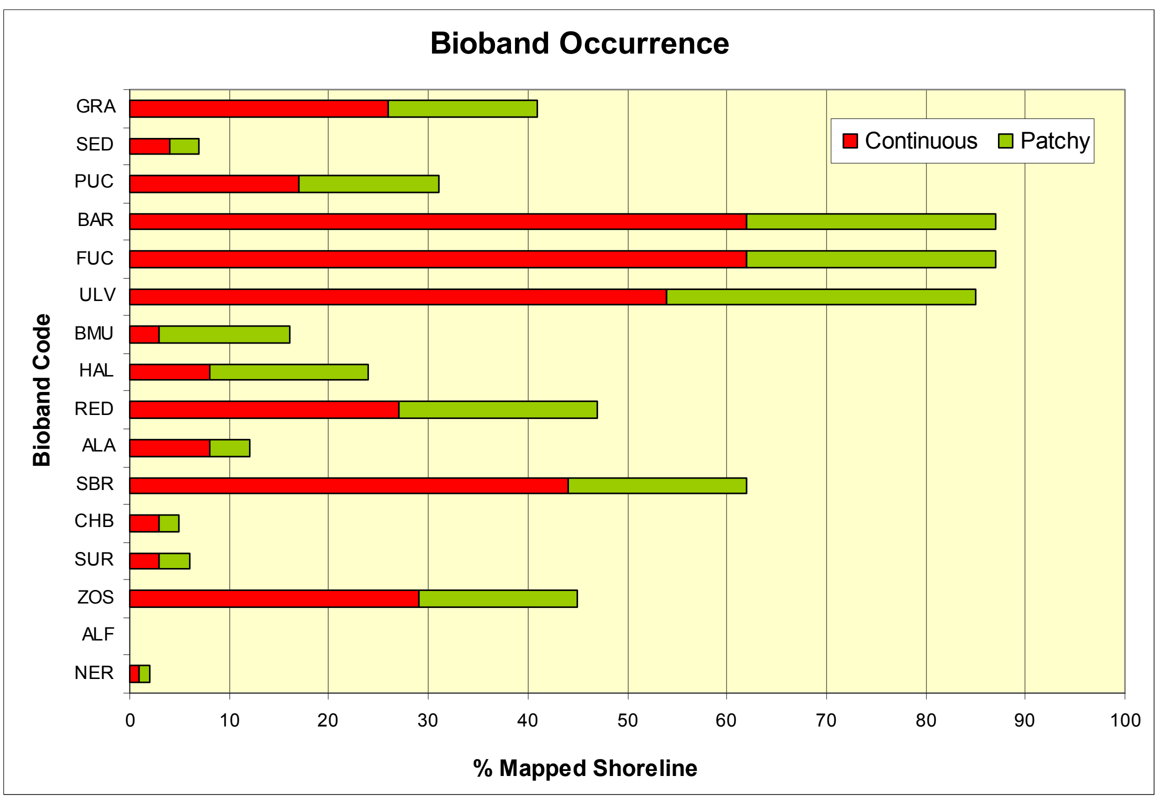


Figure 3.4. Occurrence of biobands mapped in Prince William Sound.

Bioband Distributions

The combination of biobands observed in each unit, along with bands' distributions as either 'patchy' or 'continuous' are used as indicators for the different biological wave exposures and habitat classes. Selected combinations of biobands are mapped below in Figures 3.5 to 3.8 to highlight regional differences observed in the Prince William Sound study area.

Salt-tolerant Grass, Sedge, and Herb Biobands

In biological ShoreZone mapping, combinations of the three biobands of salt-tolerant grasses, sedges and herbs (Dune Grass – GRA; Sedges – SED; and Salt Marsh – PUC) are used to define salt marsh and estuary habitats. These biobands are defined by vascular plants rather than by algae or invertebrates and always occur in the supratidal A zone (see further description and example illustrations in Appendix C, Plate C-2).

Although occurrences and combination of these biobands are part of the definition of estuary habitat classes; not all units where they occur are classified as an estuary habitat class, as the ShoreZone estuary definition includes fluvial processes and delta features (see Section 3.3). In fact, the most common of these biobands in the Sound is the Dune Grass (GRA) band which often occurs without the other bands, as a fringing strip of grass in the drift log line along the beach berm. Approximately 13% (~725 km) of the Sound's Dune Grass bioband occurrence is GRA alone as shown in orange in Figure 3.5.

The most common combination of the salt-tolerant grass, sedge and herb biobands is Dune Grass + Salt Marsh biobands, accounting for 21% (~1200 km) of the shoreline. Some of this is outside of the units that are classified as 'Estuary' habitat classes and would indicate shoreline where rooted vascular vegetation is found along the high water line. Only ~ 4% of the shoreline in the Sound was mapped with the Salt Marsh (PUC) bioband alone.

Salt-tolerant, supratidal and upper intertidal biobands mapped in Figure 3.5 are:

Dune Grass bioband alone (GRA)
– Commonly observed without any other associated biobands in the supratidal, in particular with beach berm and driftwood dunes on upper mobile beaches, or at narrow fringing salt marsh. Can be present at all wave exposures, from high-energy bare beaches to sheltered salt meadows

Dune Grass + Salt Marsh (GRA + PUC) co-occurring and
Salt Marsh (PUC) bioband alone
– Usually the Salt Marsh (PUC) band is observed with the Dune Grass (GRA) bioband, and can be at a slightly lower elevation in the across-shore. Both are considered indicators of fringing salt marsh or salt marsh/estuary areas and are usually in semi-protected and lower wave exposures

Dune Grass + **Sedges** + **Salt Marsh** (GRA + PUC + SED) co-occurring
– Co-occurrence of all three of these biobands is one of the best indicators of estuary habitat classes, in particular in larger estuarine features. Usually found at semi-protected or lower wave exposures, associated with freshwater input at the heads of bays and inlets. (See also Section 3.3, and Figures 3.19 and 3.25.)

Dune Grass + **Sedges** (GRA + SED) co-occurring and,
Sedges + **Salt Marsh** (SED + PUC) co-occurring and,
Sedges (SED) bioband alone
– The three least common combinations include Sedge (SED) bioband and are considered good indicators of estuary salt marsh or fringing salt marsh areas.

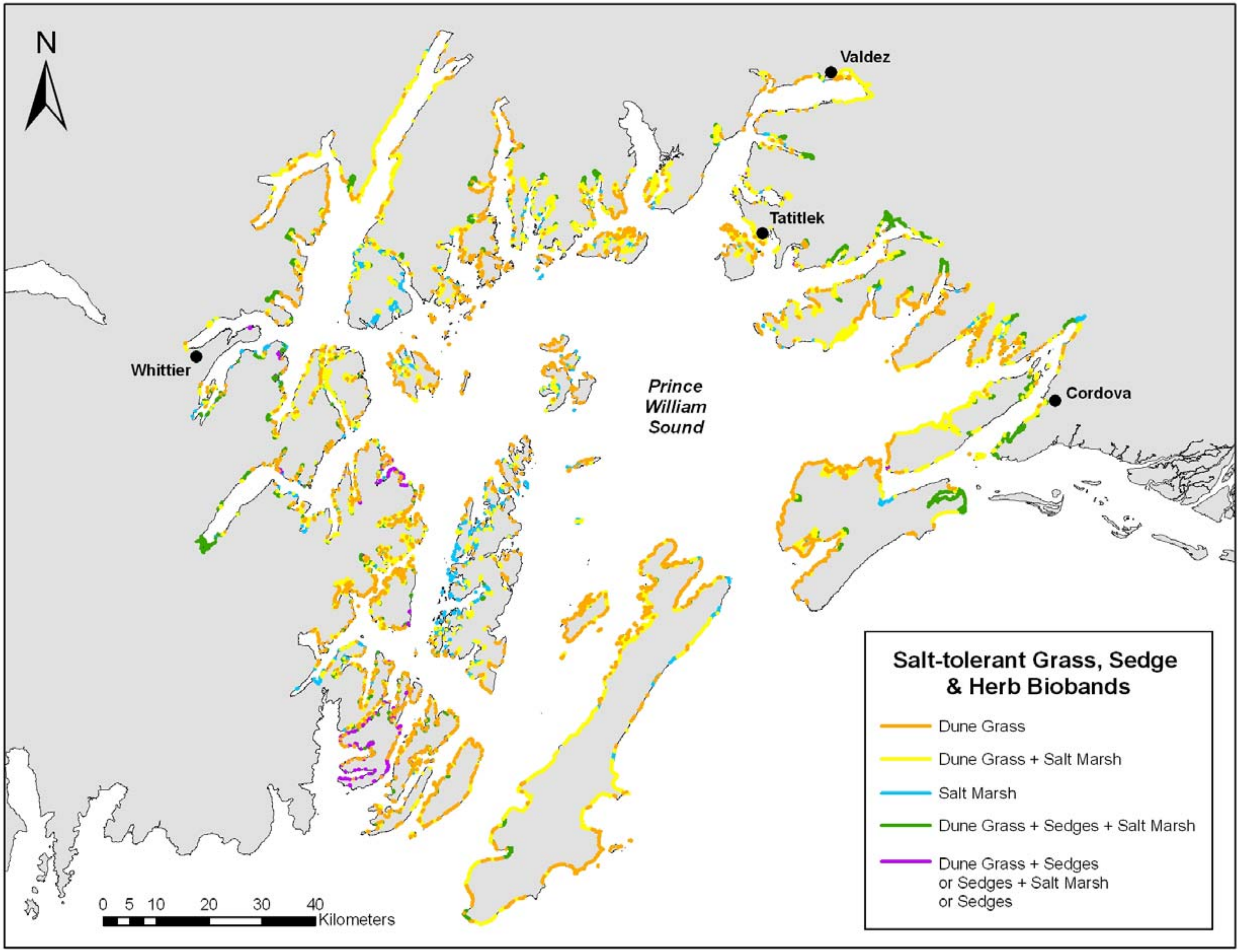


Figure 3.5. Distribution of salt-tolerant grass, sedge and herb biobands mapped in Prince William Sound.

Blue Mussel Bioband

The distribution of the Blue Mussel bioband is shown in Figure 3.6. Presence of the Blue Mussel bioband indicates immobile substrate and it is particularly associated with fjord habitats, where there is freshwater input and/or silty glacial water. The Blue Mussel band is observed at all wave exposures and is often associated with the Rockweed and Barnacle biobands. The Blue Mussel band is distributed across all sections of the Sound, with most of the 933 km of the shoreline where it was observed classified as ‘Patchy’ distribution (Table 3.3).

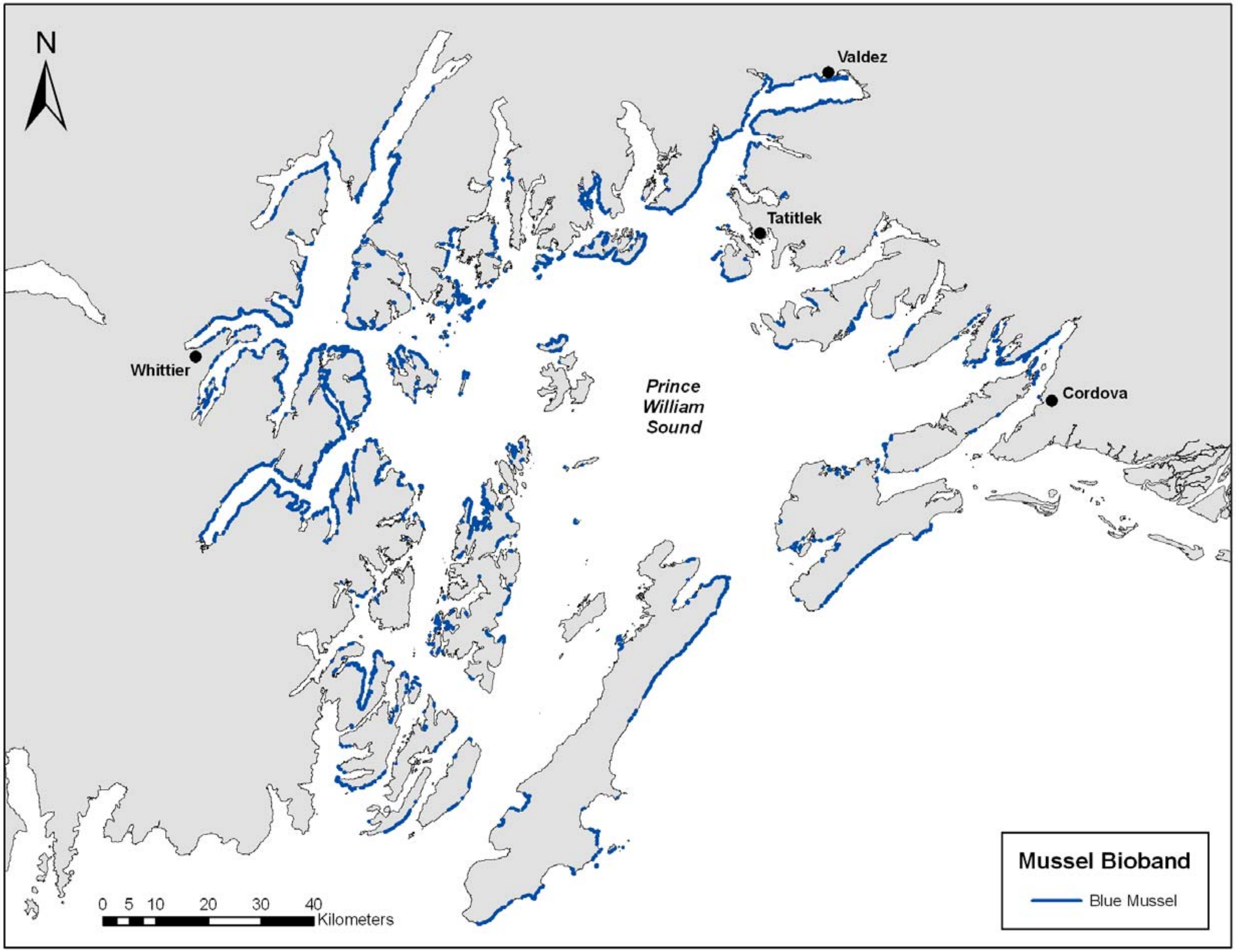


Figure 3.6. Distribution of the Blue Mussel bioband mapped in Prince William Sound.

Lower Intertidal Biobands

The combination of the lower intertidal biobands (Red Algae – RED; Alaria – ALA; Soft Brown Kelps – SBR; and Dark Brown Kelps – CHB) is the most diagnostic of differences between wave exposures and between regions, and represent the gradation in wave exposure across the area. The top six most frequently occurring combinations, of the 15 different combinations, are shown in Figure 3.7.

Soft Brown Kelps (SBR) and Red Algae (RED) bioband combinations occur in Semi-protected and lower wave exposures, and these are the combinations that are most common in the Sound, with nearly 1700 km (~30%) of the shoreline having these two biobands (shown in dark blue in Figure 3.7). Approximately 25% (~1385 km) of the Sound has Soft Brown Kelps bioband alone mapped (purple in Figure 3.7).

Combinations of Alaria, Dark Brown Kelps and Red Algae indicate higher wave energies, and those biobands are much less common in the project area, with the majority of the occurrence of those bands mapped along the Gulf of Alaska shorelines of Montague and Hinchinbrook Islands (Figure 3.7).

Combinations mapped, listed from highest to lowest wave exposures:

Dark Brown Kelps + **Alaria** + **Red Algae** (CHB + ALA + RED) co-occurring
– Combination of these three biobands together is a good indicator of Exposed to Semi-Exposed biological wave exposures

Alaria + **Red Algae** (ALA + RED) co-occurring or
Alaria + **Soft Brown Kelps** + **Red Algae** (ALA + SBR + RED) co-occurring
– Good indicators of Semi-Exposed to high Semi-Protected wave exposures

Red Algae (RED) bioband alone or
Soft Brown Kelps and **Red Algae** (SBR + RED) co-occurring or
Soft Brown Kelps (SBR) bioband alone
– Good indicators of Semi-Protected wave exposure

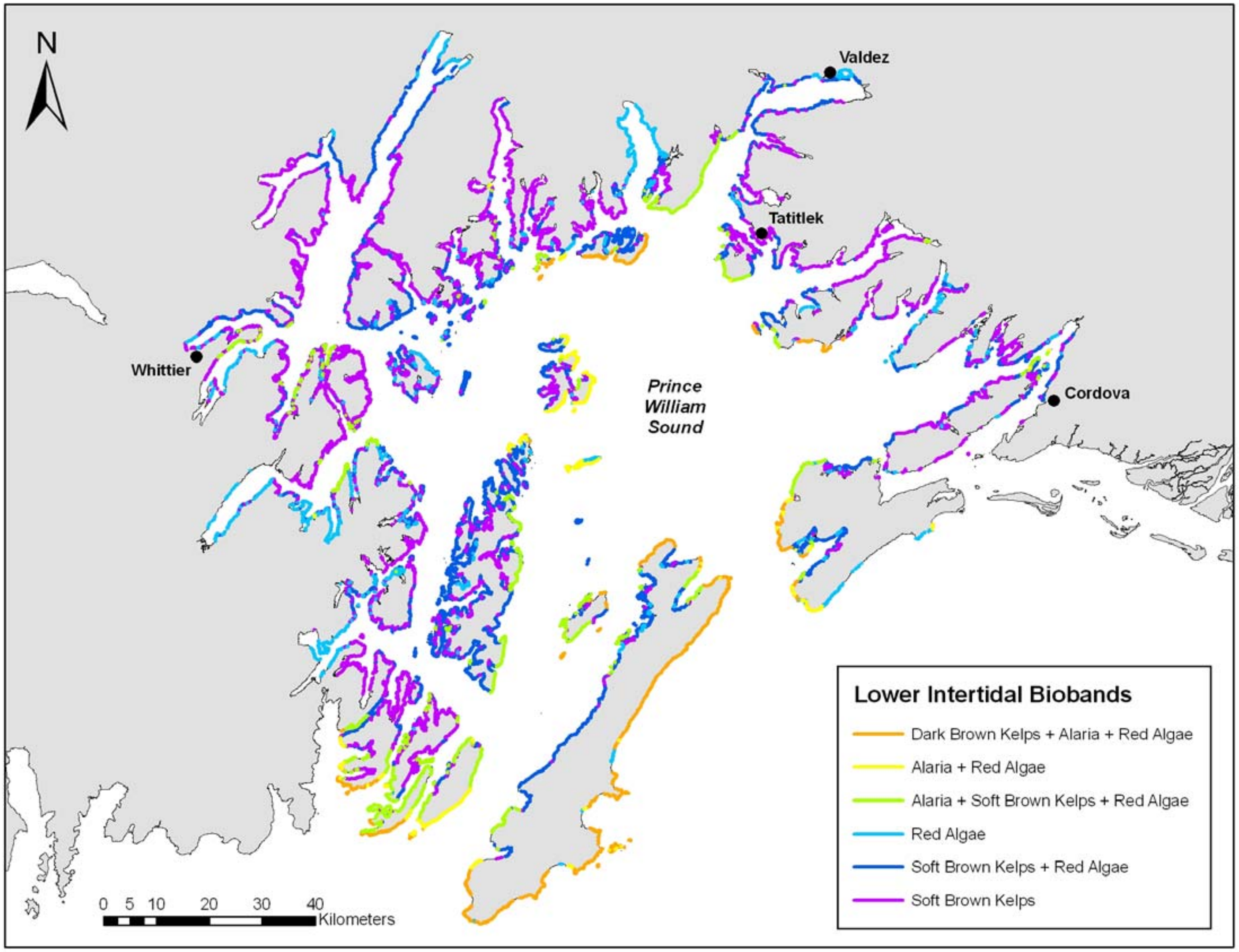


Figure 3.7. Distribution of lower intertidal biobands mapped in Prince William Sound.

Seagrass Biobands

The two species of seagrasses (Eelgrass – ZOS and Surfgrass – SUR) have different energy tolerances. Eelgrass is found in the lower to moderate energy wave exposures on sandy substrate, while Surfgrass is found in moderate to higher energy wave exposures on stable substrate.

The regional distribution of the seagrass biobands (Figure 3.8) reflects the wave exposures of the area, with most of the Surfgrass (SUR) observed on the outer, higher energy shorelines and the Eelgrass (ZOS) observed throughout the Sound in the sheltered inlets and protected bays.

Eelgrass was observed along ~2,500 km of the shoreline in the Sound, with nearly two-thirds of that mapped as 'continuous' distribution (Table 3.3).

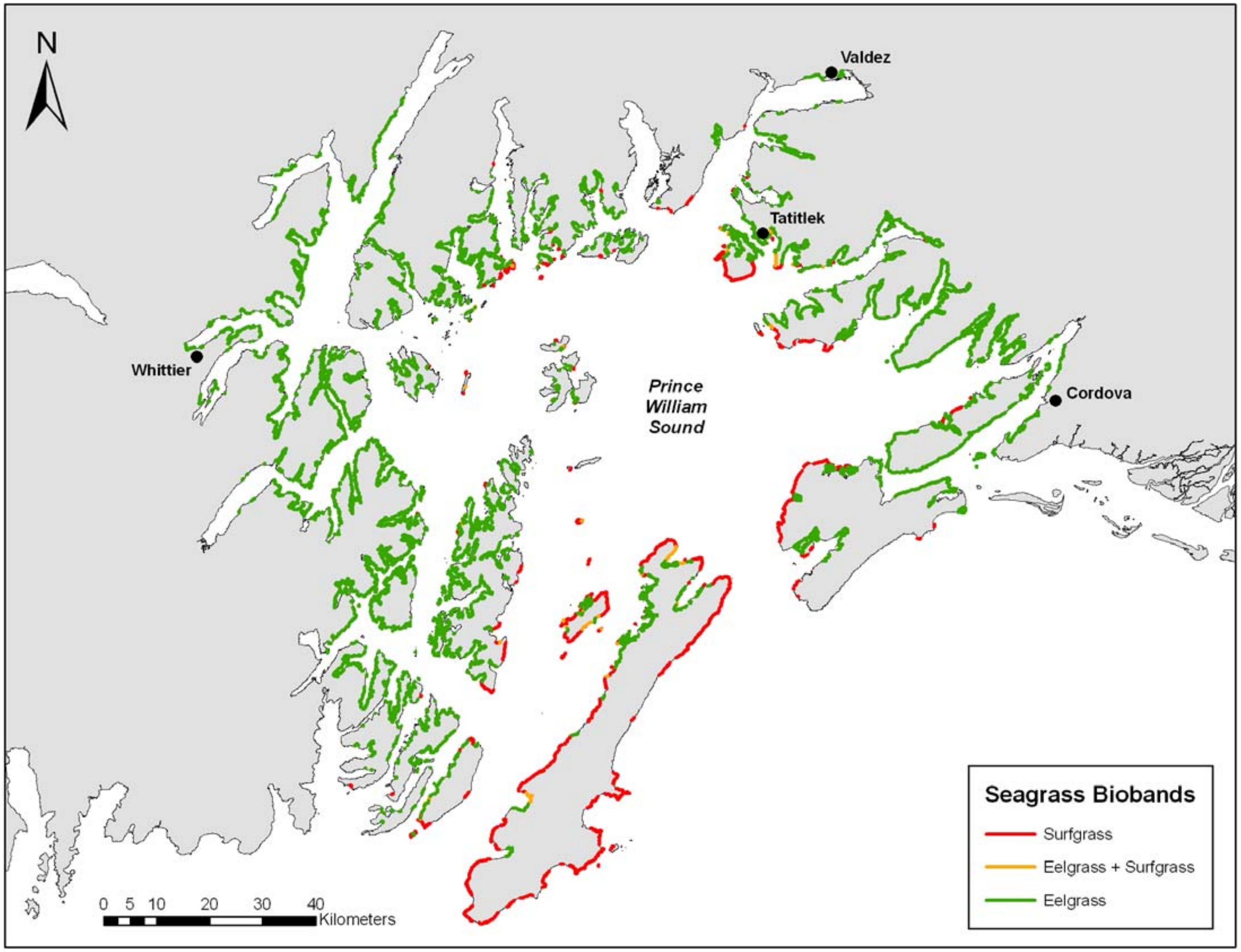


Figure 3.8. Distribution of seagrass biobands mapped in Prince William Sound.

Canopy Kelp Biobands

The three species of canopy kelps (Bull Kelp – NER; Dragon Kelp – ALF; and Giant Kelp – MAC) have different energy tolerances. Bull Kelp is found in the highest-energy areas on stable substrates and also in current-affected areas; Dragon Kelp is observed in moderate exposures; and Giant Kelp is found in moderate to lower wave exposures.

In the Prince William Sound study area, very little canopy kelp was observed, and most of it was Bull Kelp (Figure 3.9 and Table 3.3). Small areas of Dragon Kelp were seen in the channels at the southwestern most edge of the sound; Giant Kelp was not observed in the Sound during the ShoreZone survey.

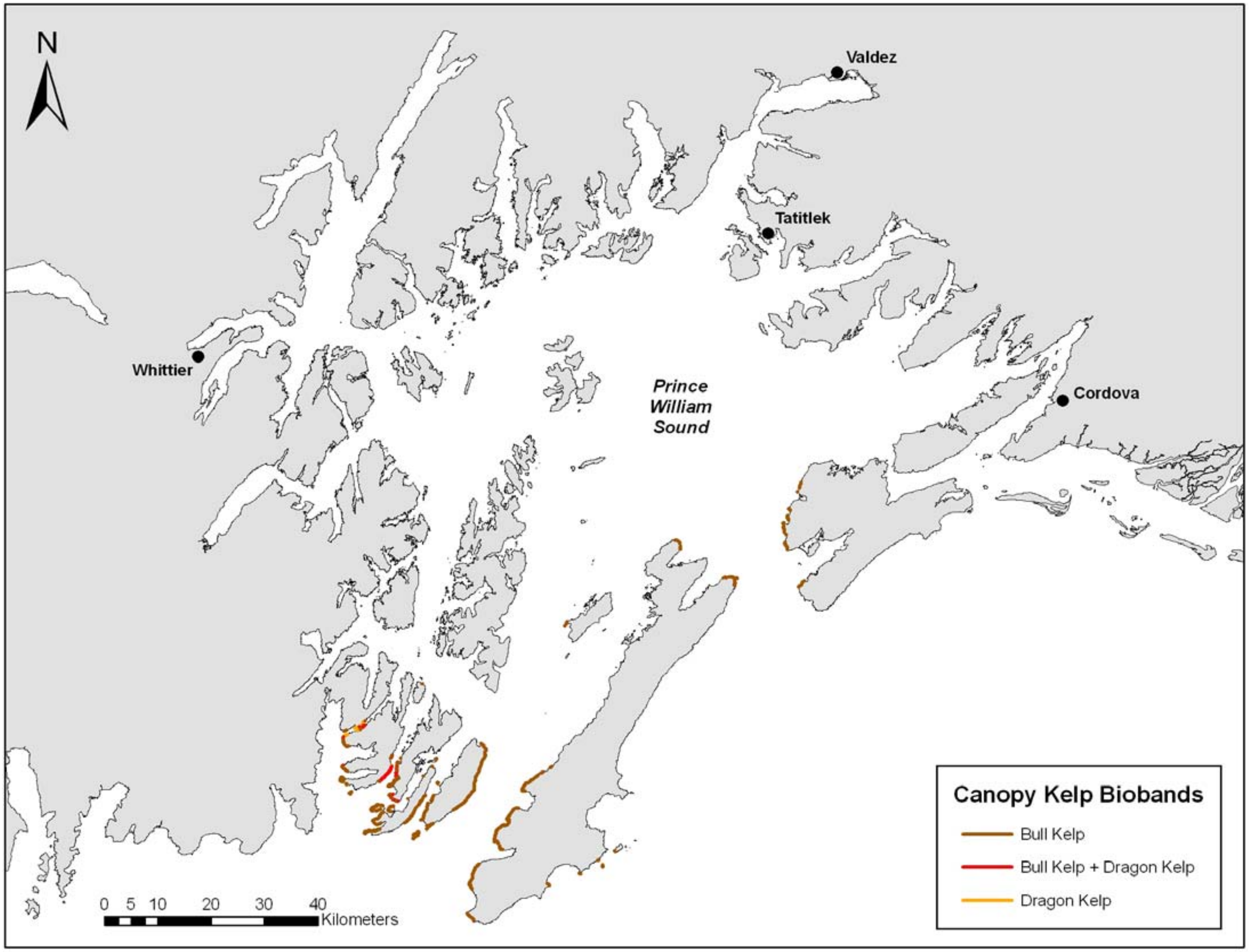


Figure 3.9. Distribution of canopy kelp biobands mapped in Prince William Sound.

3.2 Biological Wave Exposure

Biological wave exposure categories range from Very Protected (VP) to Very Exposed (VE) and are defined on the basis of a set of indicator species and a typical set of biobands. Biological wave exposure is a classified attribute that is determined during biological mapping from observations of the presence and abundance of biota in each alongshore unit, where the assemblage of biota observed in the shore unit is used as a proxy for the energy conditions at that site. The value determined is recorded in the EXP_BIO field in the database.

The six biological wave exposure categories are the same as those used in the physical ShoreZone mapping to characterize wave exposure of an alongshore unit on the basis of fetch window estimates and coastal geomorphology (EXP_OBSER in the UNIT table of the database). However, the biological categories are defined by presence or absence of indicator species and biobands rather than from wave fetch; and have been determined to be a better index of exposure than are estimates derived from fetch measurements. The biological wave exposure category is used in assigning an Oil Residence Index (ORI) to each shore unit.

Wave energy tolerances of the species assemblages that comprise the ShoreZone biobands are known from scientific literature and expert knowledge. Some biobands are observed in all wave exposure categories and are considered "associated species" bands in determining wave exposure (e.g. the Barnacle band (BAR)), while other biobands are considered "indicators" because they are closely associated with particular exposures. For example, the Dark Brown Kelps band (CHB) is consistently associated with higher wave exposures (Semi-Exposed to Exposed).

Species and biobands listed for each wave exposure category are considered "typical" but not "obligate." That is, not all species occur in every unit classified with a particular biological wave exposure. The combination of biobands, indicator species, and interpretation by biological mappers determines the wave exposure category for each unit.

Typical indicator and associated species and biobands are summarized for each biological wave exposure category from mapped areas in Prince William Sound with example illustrations in Tables 3.4 through 3.7 and Figures 3.10 through 3.13.

Note that the indicator and associated species listed for the exposure categories are not based on formal ground survey data, but are instead based on opportunistic observations and photos collected during the aerial surveys, as well as on expert knowledge and ground surveys from the region.

Table 3.4. Typical and associated species of biobands for the Very Exposed (VE)* and Exposed (E) biological wave exposure categories in Prince William Sound.

Zone	Indicator Species	Associated Species	Bioband Name	Bioband Code
Upper Intertidal		*Leymus mollis*	Dune Grass	GRA
	Verrucaria		Splash Zone	VER
		Balanus glandula *Semibalanus balanoides*	Barnacle	BAR
	Semibalanus carriosus		Barnacle	BAR
	Mytilus trossulus		Blue Mussel	BMU
Lower Intertidal	Coralline red algae		Red Algae	RED
	Alaria 'nana' morph		Alaria	ALA
	Lessoniopsis littoralis		Dark Brown Kelps	CHB
	Laminaria setchellii		Dark Brown Kelps	CHB
	Nereocystis luetkeana		Bull Kelp	NER

* Very Exposed (VE) was not observed in the project area included in this summary report.

Figure 3.10. Biological wave exposure: Exposed.
Exposed (E) bedrock shoreline along the outer coast of Montague Island. A wide Splash Zone (VER) band of *Verrucaria* overlies a band of Barnacle (BAR), *Fucus* (FUC) and Red Algae (RED). Shore units classified as Exposed (E) are uncommon in the section of Prince William Sound covered in this summary report, and include about 3% of the shoreline. (PWS07_ML_01776.jpg).

Table 3.5. Typical and associated species of biobands for the Semi-Exposed (SE) biological wave exposure category in Prince William Sound.

Zone	Indicator Species	Associated Species	Bioband Name	Bioband Code
Upper Intertidal		*Leymus mollis*	Dune Grass	GRA
	Verrucaria		Splash Zone	VER
		Balanus glandula *Semibalanus balanoides*	Barnacle	BAR
		Fucus distichus	Rockweed	FUC
	Semibalanus carriosus		Barnacle	BAR
	Mytilus trossulus		Blue Mussel	BMU
Lower Intertidal and Nearshore Subtidal	Mixed filamentous and foliose red algae		Red Algae	RED
	Alaria 'marginata' morph		Alaria	ALA
	Phyllospadix sp.		Surfgrass	SUR
	Laminaria setchellii		Dark Brown Kelps	CHB
	Saccharina subsimplex		Dark Brown Kelps	CHB
	Saccharina sessile smooth morph		Dark Brown Kelps	CHB
	Alaria fistulosa		Dragon Kelp	ALF *
	Nereocystis luetkeana		Bull Kelp	NER

* ALF – Dragon Kelp was uncommon in the project area included in this summary report, but abundant in other bioareas, at this wave exposure.

Figure 3.11. Biological wave exposure: Semi-Exposed.
The Semi-Exposed (SE) bedrock on Ingot Island shows biological components typical of this exposure category. This includes a medium Splash Zone (VER) band of *Verrucaria* and biobands of Barnacle (BAR) and Red Algae (RED).
(PWS07_ML_04692.jpg).

Table 3.6. Typical and associated species of biobands for the Semi-Protected (SP) biological wave exposure category in Prince William Sound.

Zone	Indicator species	Associated Species	Bioband Name	Bioband Code
Upper Intertidal		*Leymus mollis* *	Dune Grass	GRA
		Carex spp. *	Sedges	SED
		Puccinellia *	Salt Marsh	PUC
		Plantago maritima *	Salt Marsh	PUC
		Glaux maritima *	Salt Marsh	PUC
	Verrucaria		Splash Zone	VER
Lower Intertidal and Nearshore Subtidal		*Balanus glandula* *Semibalanus balanoides*	Barnacle	BAR
	Semibalanus carriosus		Barnacle	BAR
		Fucus distichus	Rockweed	FUC
	Mytilus trossulus		Blue Mussel	BMU
		Ulva spp.	Green Algae	ULV
	Bleached mixed red algae		Bleached Red Algae	HAL
	Mixed red algae including *Odonthalia*		Red Algae	RED
	Alaria 'marginata' morph		Alaria	ALA
	Zostera marina		Eelgrass	ZOS
	Saccharina latissima		Soft Brown Kelps	SBR
		Nereocystis luetkeana	Bull Kelp	NER

* Associated with estuaries and fringing wetlands at this wave exposure.

Figure 3.12. Biological wave exposure: Semi-Protected.
Biobands of Barnacle (BAR), Rockweed (FUC), Green Algae (ULV) and patchy Red Algae (RED) cover this western platform at Knowles Head. This collection of biobands is typical of the Semi-Protected (SP) exposure category of Prince William Sound. (PWS07_HA_00232.jpg).

Table 3.7. Typical and associated species of biobands for the Protected (P) and Very Protected ** (VP) biological wave exposure categories in Prince William Sound.

	Indicator species	Associated Species	Bioband Name	Bioband Code
Upper Intertidal		*Leymus mollis* *	Dune Grass	GRA
		Carex spp. *	Sedges	SED
		Puccinellia *	Salt Marsh	PUC
		Plantago maritima *	Salt Marsh	PUC
		Glaux maritima *	Salt Marsh	PUC
	Verrucaria		Splash Zone	VER
		Balanus glandula *Semibalanus balanoides*	Barnacle	BAR
		Fucus with epiphyte *Pylaiella*	Rockweed	FUC
	Mytilus trossulus		Blue Mussel	BMU
Lower Intertidal	*Ulva* spp.		Green Algae	ULV
	Zostera marina		Eelgrass	ZOS
	Saccharina latissima (not in Very Protected)		Soft Brown Kelps	SBR

* Associated with estuaries and fringing wetlands at this wave exposure.
** Very Protected categories are assigned to units showing sparse coverage of same indicator/associated species as Protected, and are often included with Protected in data summaries.

Figure 3.13. Biological wave exposure: Protected.
The bioband assemblage of fringing Salt Marsh (PUC), Rockweed (FUC), Green Algae (ULV), and Eelgrass (ZOS) in the nearshore subtidal indicates the low wave exposure of this Protected (P) shoreline on the north side of Esther Passage.
(PWS07_HA_02364).

The occurrence of five biological wave exposure categories mapped in the study area is summarized for Prince William Sound in Table 3.8 and Figure 3.14. Almost all of the shoreline in the study area was classified with a wave exposure of Semi-Protected or lower (91%). Only a few units were considered as Exposed (3% of the mapped shoreline length) and about 6% of the shoreline was mapped in the moderate Semi-Exposed category. A summary map of the distribution of the biological wave exposure categories mapped is shown in Figure 3.15.

Table 3.8. Summary of biological wave exposure categories in the Prince William Sound study area.

Biological Wave Exposure	Code	Length (km)	% of Mapped
Exposed	E	164	3
Semi-Exposed	SE	330	6
Semi-Protected	SP	2403	43
Protected	P	2653	48
Very Protected	VP	35	<1

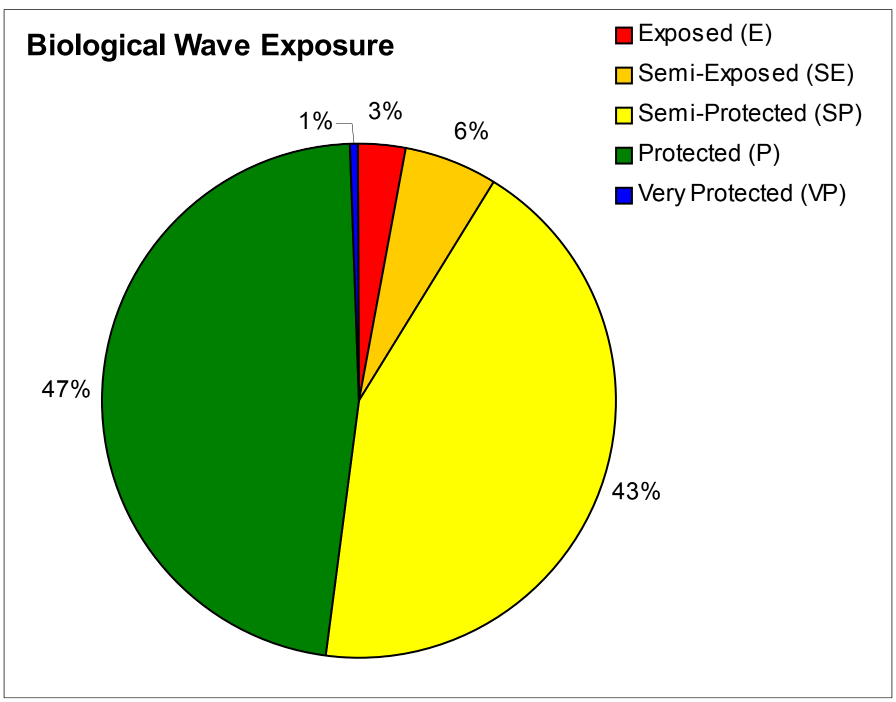


Figure 3.14. Summary of biological wave exposure categories in Prince William Sound.

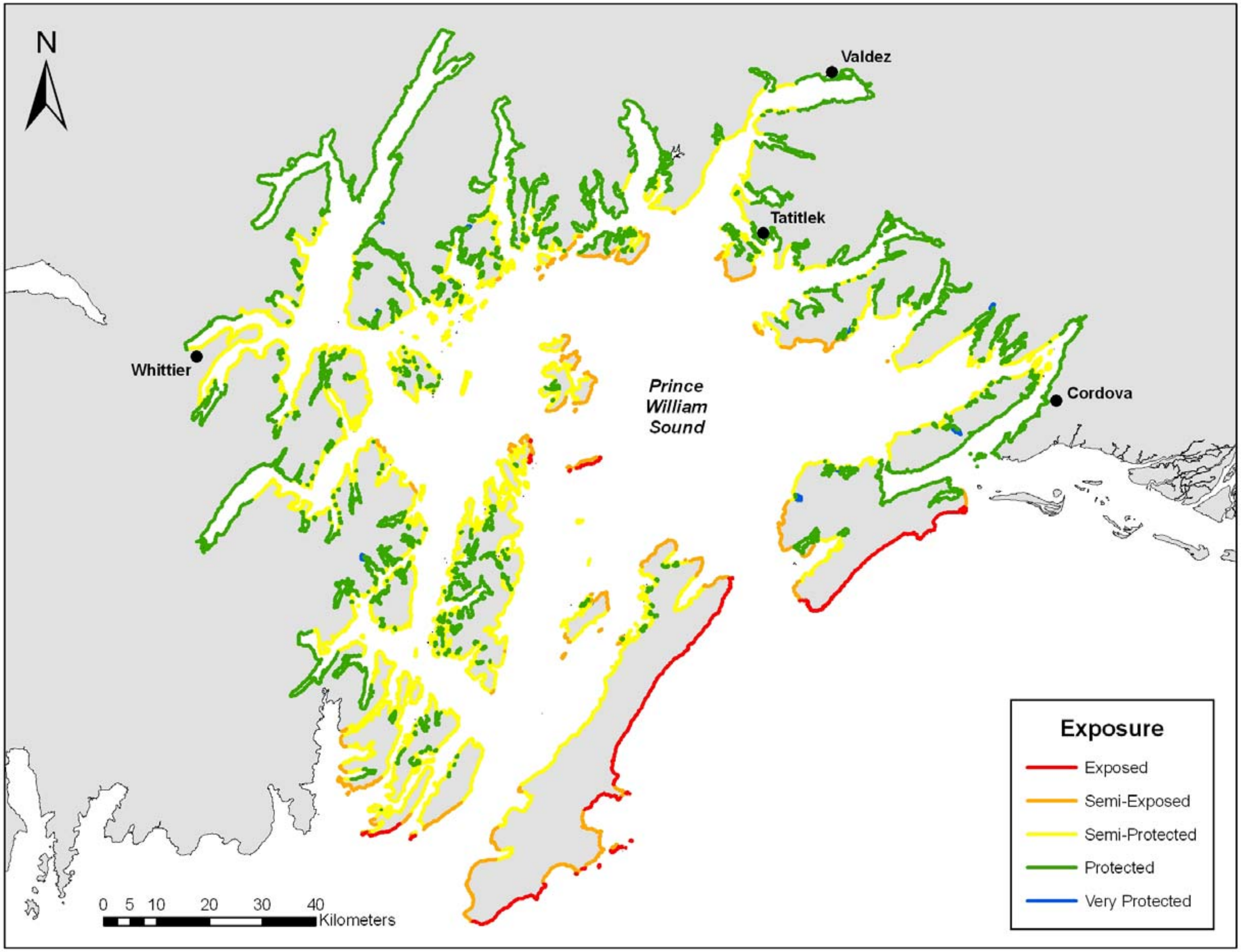


Figure 3.15. Distribution of biological wave exposure categories mapped in Prince William Sound.

3.3 Habitat Class

Habitat use by coastal species is determined by both physical and biological characteristics. The ShoreZone habitat mapping system considers geomorphic, energetic, and physical attributes, as well as the distribution and ecological function of organisms, to classify coastal areas and describe their habitats.

Habitat Class is a summary classification that combines both physical and biological characteristics observed for a particular shoreline unit. It is intended to provide a simplified biophysical characterization of the unit on the basis of detailed alongshore and cross-shore attributes that have been mapped.

The species assemblages observed at a particular location are a reflection of both the physical characteristics of that shore segment as well as the wave exposure. Thus, the species assemblage observed on an Exposed shore with a mixture of rock and mobile sediment will be distinct from the species assemblage observed on a Protected shore with a wetland complex. Figures 3.16 to 3.25 below illustrate examples of habitat classes observed in the area included in this summary report. Further descriptions of the habitat class definitions are presented in Appendix A, Table A-8.

Where the dominant structuring process in the shore unit is wave energy, the interaction of the wave exposure and the substrate type determines the **substrate mobility**. Stability of the substrate determines the presence and abundance of attached biota. Where the substrate is stable (such as bedrock), well-developed epibenthic assemblages occur. Where the substrate is mobile (such as on sandy beaches), the epibenthic community may be sparse or absent. Most units have the habitat class category determined by wave energy as the dominant structuring process.

Three classes of substrate mobility used in ShoreZone habitat characterization are:

- **Immobile or Stable:** substrates such as bedrock, boulders, and cobbles (could even be pebbles on a low-exposure coast) (Figure 3.16).
- **Partially Mobile:** mixed substrates such as a rock platform with a beach or sediment veneer, or units where energy varies across the beach. The partial mobility of the sediment limits the development of a full bioband assemblage that would likely occur on a stable rock shoreline (Figure 3.17).
- **Mobile:** substrates such as sandy beaches where coastal energy levels are sufficient to frequently move sediment, thereby limiting the development of epibenthic biota (Figure 3.18).

Less common Habitat Classes are those determined by dominant structuring processes other than wave energy (Appendix A, Table A-8). Except for the anthropogenic shorelines, these habitat classes are all considered rare or uncommon.

These habitat types are:

- **Estuary** types with wetlands and salt marsh vegetation along low energy sediment shores influenced by freshwater (Figure 3.19).
- **Current-Dominated** channels where high tidal currents create anomalous assemblages of biota. Usually associated with lower wave exposure conditions in adjacent shore units (Figure 3.20).
- **Glacier** shorelines are ice-dominated and are usually found at fjord heads, where active glacial processes are structuring the coastal habitat (Figure 3.21).
- **Anthropogenic** features where the shoreline has been modified or disturbed. This category distinguishes between permeable and impermeable anthropogenic material, however for reporting purposes both categories have been combined. Examples include wharves or areas of rip rap or fill (Figure 3.22).
- **Lagoon** units have enclosed or constricted area of brackish or salty water, (Figure 3.23), often found in the supratidal; however, large shallow lagoons sometimes form the subtidal zone in multiple consecutive units. Lagoons were mapped only as 'secondary habitat classes'.

The occurrence of 17 generalized habitat classes in Prince William Sound is summarized in Table 3.9 and Figure 3.22. Approximately 90% of the habitat classes mapped are structured by wave energy, and almost 80% of those are in the semi-protected and lower wave energy categories. The estuary habitat class, in which salt marsh biobands associated with freshwater stream and fluvial processes are the dominant structuring force, is mapped along 9% of the shoreline.

A striking feature of Prince William Sound is the presence of more than a dozen tidewater glaciers. These account for ~1% of the total shoreline length and influence the ocean circulation and water conditions throughout the Sound. Approximately 1% of the shoreline was classified as human-modified, largely mapped in Cordova, Valdez, Whittier, and other settlement areas.

A summary map of the distribution of habitat classes mapped in the Prince William Sound study area is shown in Figure 3.25.

Figure 3.16. Habitat Class: Semi-Protected, Immobile.
Example of the Semi-Protected, **Immobile** habitat class on this small island at the mouth of Dryer Bay. The bedrock supports a dense cover of biobands, including Barnacles (BAR), Rockweed (FUC) and Green Algae (ULV) with a medium Splash Zone (VER) band of *Verrucaria* above. (PWS07_ML_03261.jpg).

Figure 3.17. Habitat Class: Semi-Protected, Partially Mobile.
This Semi-Protected, **Partially Mobile** shoreline in Heather Bay shows a dense cover of biota on the stable bedrock platform, with bare mobile sediment on adjacent beaches. (PWS07_MM_06856.jpg).

Figure 3.18. Habitat Class: Semi-Protected, Mobile.
This Semi-Protected, **Mobile** beach in Canoe Passage, Hawkins Island is bare of attached biota. (PWS07_MM_12087.jpg).

Figure 3.19. Habitat Class: Estuary.
This is an example of an **Estuary** habitat on the north side of Esther Passage. Dune Grass (GRA), Sedges (SED) and Salt Marsh (PUC) biobands cover a large area in the supratidal, while the delta fan has a sparse cover of Rockweed (FUC) and Barnacle (BAR) biobands. (PWS07_HA_02413.jpg).

Figure 3.20. Habitat Class: Current-Dominated.
This **Current-Dominated** channel habitat creates a biologically rich and diverse area in Port Fidalgo due to its current energy. Biobands of Red Algae (RED), Alaria (ALA) and Soft Brown Kelps (CHB) are abundant. (PWS07_MM_10095.jpg).

Figure 3.21. Habitat Class: Glacier.
The tidewater edge of the Harriman **Glacier**, Harriman Fjord completely dominates the shoreline at the head of fjord. Biota are absent and the intertidal is covered by calving glacial ice (PWS07_ML_07544.jpg).

Figure 3.22. Habitat Class: Anthropogenic.
This modified shoreline in Cordova is an example of an **Anthropogenic** habitat class. (PWS07_MM_10391.jpg).

Figure 3.23. Habitat Class: Lagoon.
This backshore **Lagoon** in Cochrane Bay is an example of a shore unit where the lagoon secondary habitat class was mapped. This feature is associated with wetland biobands such as Dune Grass (GRA), Salt Marsh (PUC) and Sedges (SED) surrounding an isolated basin of brackish water. (PWS07_ML_06855.jpg)

Table 3.9. Summary of habitat classes observed in Prince William Sound.

Dominant Structuring Process	Habitat Class		Habitat Class Codes*	Length (km)	% of Mapping
	Exposure Category	Substrate Mobility			
Wave energy	Exposed	Stable	E_I	14	<1
		Partially Mobile	E_P	125	2
		Mobile	E_M	25	<1
	Semi-Exposed	Stable	SE_I	46	1
		Partially Mobile	SE_P	245	4
		Mobile	SE_M	36	1
	Semi-Protected	Stable	SP_I	293	5
		Partially Mobile	SP_P	1933	35
		Mobile	SP_M	81	1
	Protected/ Very Protected**	Stable	P_I, VP_I	171	3
		Partially Mobile	P_P, VP_P	1928	35
		Mobile	P_M, VP_M	108	2
Fluvial processes	Estuary		E_E, SE_E SP_E, P_E, VP_E	504	9
Current energy	Current-Dominated		SP_C, P_C	13	<1
Glacial processes	Glacier		P_G	28	1
Man-modified	Anthropogenic		SP_X, SP_Y, P_X, P_Y	35	1
		TOTALS		**5585**	100
	Lagoon***		SE_L, SP_L, P_L, VP_L	225	4

*See Appendix A, Tables A-8 and A-9 for full definitions of Habitat Class rationale and codes. Note that the Very Exposed (VE) categories were not mapped in the study area.
**Very Protected/ Partially Mobile was grouped with Protected because it accounted for <0.5% of the shoreline.
***Lagoons are only mapped as a 'Secondary Habitat Class'.

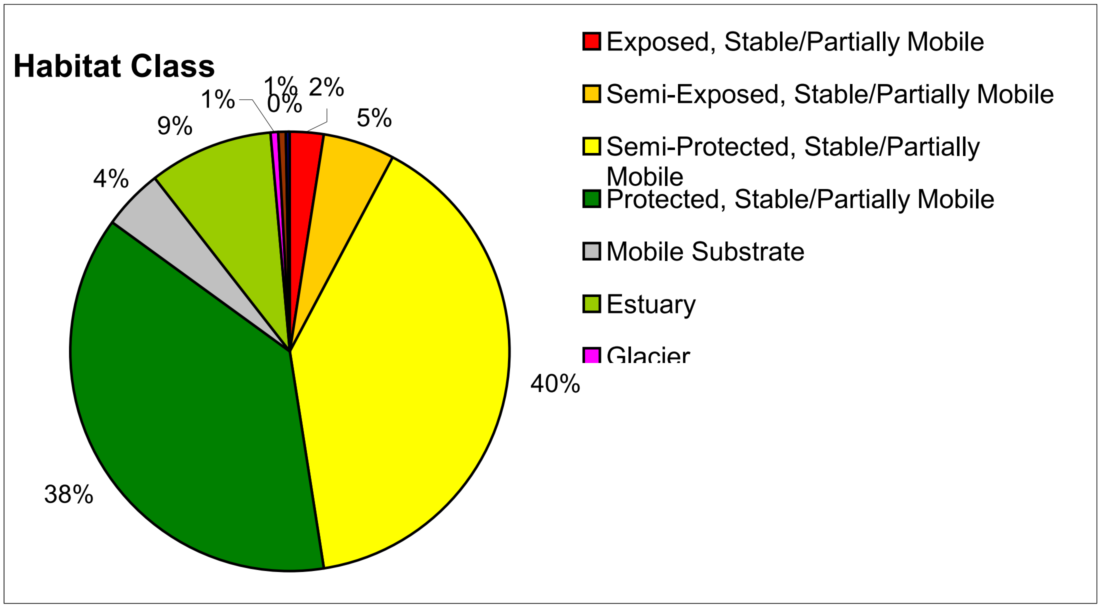


Figure 3.24. Summary of habitat classes in Prince William Sound. Note that the Very Exposed (VE) categories were not mapped in the study area and that Very Protected/ Partially Mobile classes were grouped with Protected/ Partially Mobile because it accounted for <0.5% of the mapping.

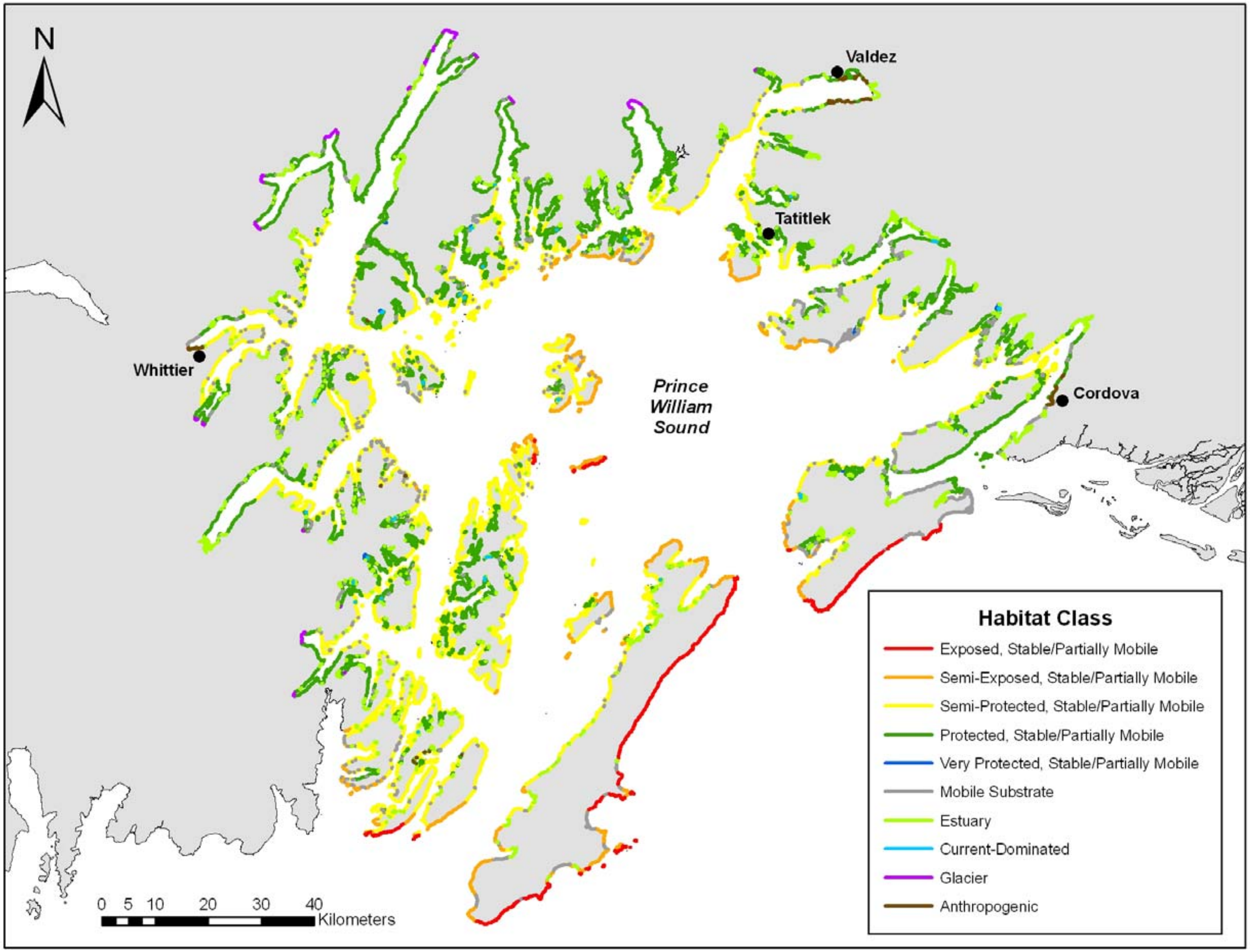


Figure 3.25. Distribution of habitat class categories in Prince William Sound.

4.0 REFERENCES

Berry, H.D., Harper, J.R., Mumford, T.F., Jr., Bookheim, B.E., Sewell, A.T., and Tamayo, L.J. 2004. Washington State ShoreZone Inventory User's Manual, Summary of Findings, and Data Dictionary. Reports prepared for the Washington State Dept. of Natural Resources Nearshore Habitat Program. Available online at: www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_nrsh_inventory_projects.aspx

Harney, J.N. 2007. Modeling habitat capability for the non-native European green crab (*Carcinus maenas*) using the ShoreZone mapping system in Southeast Alaska, British Columbia, and Washington State. Report prepared for NOAA National Marine Fisheries Service (Juneau, AK). 75 p.

Harney, J.N. 2008. Evaluation of a Habitat Suitability Model for the Invasive European Green Crab (*Carcinus maenas*) Using Species Occurrence Data from Western Vancouver Island, British Columbia. Report prepared for NOAA National Marine Fisheries Service (Juneau, AK). 51 p.

Harney, J.N., Lindeberg, M.L., Moffitt, S., and Morrow, K. 2009. Insight into herring spawning habitat using ShoreZone coastal mapping data in Prince William Sound, Alaska. Abstract presented at the Marine Science in Alaska Symposium, Anchorage, Jan. 2009.

Harney, J.N., Morris, M., and Harper, J.R. 2008. ShoreZone Coastal Habitat Mapping Protocol for the Gulf of Alaska. Report prepared for The Nature Conservancy, NOAA National Marine Fisheries Service, and the Alaska State Department of Natural Resources (Juneau, AK). 153 p.

Harper, J.R., and Morris, M.C. 2004. ShoreZone Mapping Protocol for the Gulf of Alaska. Report prepared for the Exxon Valdez Oil Spill Trustee Council (Anchorage, AK). 61 p.

Howes, D., Harper, J.R., and Owens, E.H. 1994. Physical Shore-Zone Mapping System for British Columbia. Report prepared by Environmental Emergency Services, Ministry of Environment (Victoria, BC), Coastal and Ocean Resources Inc. (Sidney, BC), and Owens Coastal Consultants (Bainbridge, WA). 71 p.

National Oceanic and Atmospheric Administration (NOAA). 2002. Environmental Sensitivity Index Guidelines, Version 3.0. Technical Memorandum NOS OR&R 11 (Seattle, WA). 192 p. Available online at response.restoration.noaa.gov.

Paterson, B., Harney, J.N., and Bornhold, B.D. 2009. Using ShoreZone coastal habitat mapping data to identify sensitivity to sea level change and erosion associated with predicted climate change. Abstract submitted to the Pacific Estuarine Research Society Conference (Bellingham, WA). April 2009.

ShoreZone reports and protocols are available for download online at: www.coastalandoceans.com/downloads.html.

APPENDIX A DATA DICTIONARY

Table	Description
A-1	Data dictionary for UNIT table
A-2	Classification of shore types (“BC Class”) employed in ShoreZone
A-3	Environmental Sensitivity Index (ESI) shore type classification
A-4	Exposure matrix used for estimating observed physical exposure (EXP_OBSER) on the basis of fetch distance
A-5	Oil Residence Index (ORI) definitions and look-up matrix on the basis of shore type (columns) and substrate type (rows) for across-shore components
A-6	Oil Residence Index (ORI) definitions and look-up matrix on the basis of shore type (BC_CLASS, in columns) and biological wave exposure (EXP_BIO, in rows) for along-shore units
A-7	Data dictionary for BIOUNIT table
A-8	Habitat Class Codes
A-9	Habitat Class Definitions
A-10	Data dictionary for the XShr table (across-shore components)
A-11	‘Form’ Code Dictionary
A-12	‘Material’ Code Dictionary
A-13	Data dictionary for the BioBand table
A-14	Data dictionary for the photos table (tblBioSlide)
A-15	Data dictionary for the GroundStationNumber table

Table A-1. Data dictionary for UNIT table

Field Name	Type	Description
UnitRecID	N	Automatically-generated number field; the database "primary key" for unit-level relationships
PHY_IDENT	T	Unique physical identifier; an alphanumeric string comprised of the Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0); this field is completed by the database manager using an update query
REGION	T	2-digit coastal region number (see reference maps and GIS materials)
AREAS	T	2-digit coastal area number (see reference maps and GIS materials)
PHY_UNIT	T	4-digit physical along-shore unit number; segmented during physical mapping and delineated on paper maps and in GIS
SUBUNIT	T	Set to 0 for line features (units) or non-zero for point features (also called variants); several subunits in a unit are numbered sequentially (1, 2, 3…) according to the order occurring within the unit (based on UTC time)
TYPE	T	Single-letter description of Unit type: a (L)ine (unit) or (P)oint feature (variant)
BC_CLASS	N	Coastal class or "shore type" of the unit based primarily on substrate type, across-shore width, and slope; derived from the Howes et al. (1994) system applied in coastal British Columbia (Table A-2)
ESI	T	Environmental Sensitivity Index (shore unit classification (Table A-3)
LENGTH_M	N	Along-shore length in meters; calculated after digitizing using ArcGIS and updated using database query
GEO_MAPPER	T	Last name of the physical mapper
GEO_EDITOR	T	Last name of the physical mapper who QA/QCs the work (10% of all units are reviewed by an editor)
GEO_MAP_DATE		blank; the mapping date is automatically recorded in the DATE_ENTERED field
VIDEOTAPE	T	Title of the videotape (DVD imagery) used for mapping; naming convention for 2006 and on is SE06_GL_08, in which 06 is year, GL is team, 08 is tape
HR	T	Hour at which unit starts; based on the first two digits of the 6-digit UTC time on video when start of unit is at center of screen
MIN	T	Minute at which unit starts; based on third and fourth digits of 6-digit UTC time on video when start of unit is at center of screen
SEC	T	Seconds at which unit starts; based on the last two digits of the 6-digit UTC time on video when start of unit is at center of screen
EXP_OBSER	T	Estimate of wave exposure as observed by the physical mapper, as a function of the relative fetch (Table A-5), with a consideration of geomorphology.
SED_SOURCE	T	Estimated sediment source for the unit: (A)longshore, (B)ackshore, (F)luvial, (O)ffshore, (X) not identifiable
SED_ABUND	T	Code indicating the relative sediment abundance within the shore-unit, (A)bundant, (M)oderate, (S)carce

[continued]

Table A-1. Data dictionary for UNIT table (continued)

Field Name	Type	Description
SED_DIR	T	One of the eight cardinal points of the compass indicating dominant sediment transport direction (N, NE, E, SE, S, SW, W, NW). (X) Indicates transport direction could not be discerned from imagery.
CHNG_TYPE	T	Code indicating the stability of the shore unit, reflecting the relative degree of "measurable change" during a 3-5 year time span: (A)ccretional, (E)rosional, (S)table
SHORENAME	T	Name of a prominent geographic feature near the unit (from nautical chart or gazetteer)
UNIT_COMMENTS	T	Text field used for miscellaneous comments and notes during physical mapping
SHORE_PROB	T	Comment on nature of difference between digital shoreline and observed shoreline
SM1_TYPE	T	2-letter code indicating the *primary* type of shore modification occurring within the unit: BR = boat ramp; CB = concrete bulkhead; LF = landfill; SP= sheet pile; RR = rip rap and WB = wooden bulkhead
SM%	N	Estimated % occurrence of the primary shore modification type in tenths (i.e. "2" = 20% occurrence with the unit alongshore)
SM2_TYPE	T	2-letter code indicating the *secondary* type of shore modification occurring within the unit
SM2%	N	Estimated % occurrence of the *secondary* type of shore modification occurring within the unit
SM3_TYPE	T	2-letter code indicating the *tertiary* type of shore modification occurring within the unit
SM3%	N	Estimated % occurrence of the *tertiary* seawall type in tenths (i.e., "2" = 20% occurrence within the unit)
SMOD_TOTAL	N	Total % occurrence of shore modification in the unit in tenths
RAMPS	N	Number of boat ramps that occur within the unit; ramps must impact some portion of the shore-zone and generally be constructed of concrete, wood or aggregate
PIERS_DOCK	N	Number of piers or wharves that occur within the unit; piers or docks must extend at least 10 m into the intertidal zone; does not include anchored floats
REC_SLIPS	N	Estimated number of recreational slips at docks of the unit; based on small boat length ~<50'
DEEPSEA_SLIP	N	Estimated number of slips for ocean-going vessels in the unit; based on ship length ~>100'
ITZ	N	Sum of the across-shore width of all the intertidal components (B zones) within the unit
EntryDate ModifiedDate	D/T	Date and time the unit was physically mapped (or modified)

Table A-2. Classification of shore types ("BC Class") employed in ShoreZone

SUBSTRATE	SEDIMENT	WIDTH	SLOPE	COASTAL CLASS	NO.
ROCK	N/A	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Rock Ramp, wide	1
			FLAT (<5°)	Rock Platform, wide	2
		NARROW (<30 m)	STEEP (>20°)	Rock Cliff	3
			INCLINED (5-20°)	Rock Ramp, narrow	4
			FLAT(<5°)	Rock Platform, narrow	5
ROCK & SEDIMENT	GRAVEL	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Ramp with gravel beach, wide	6
			FLAT (<5°)	Platform with gravel beach, wide	7
		NARROW (<30 m)	STEEP (>20°)	Cliff with gravel beach	8
			INCLINED (5-20°)	Ramp with gravel beach	9
			FLAT (<5°)	Platform with gravel beach	10
	SAND & GRAVEL	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Ramp w gravel & sand beach, wide	11
			FLAT (<5°)	Platform with G&S beach, wide	12
		NARROW (<30 m)	STEEP (>20°)	Cliff with gravel/sand beach	13
			INCLINED (5-20°)	Ramp with gravel/sand beach	14
			FLAT (<5°)	Platform with gravel/sand beach	15
	SAND	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Ramp with sand beach, wide	16
			FLAT (<5°)	Platform with sand beach, wide	17
		NARROW (<30 m)	STEEP (>20°)	Cliff with sand beach	18
			INCLINED (5-20°)	Ramp with sand beach, narrow	19
			FLAT (<5°)	Platform with sand beach, narrow	20
SEDIMENT	GRAVEL	WIDE (>30 m)	FLAT (<5°)	Gravel flat, wide	21
		NARROW (<30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Gravel beach, narrow	22
			FLAT (<5°)	Gravel flat or fan	23
	SAND & GRAVEL	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	n/a	
			FLAT (<5°)	Sand & gravel flat or fan	24
		NARROW (<30 m)	STEEP >20°)	n/a	
			INCLINED (5-20°)	Sand & gravel beach, narrow	25
			FLAT (<5°)	Sand & gravel flat or fan	26
	SAND / MUD	WIDE (>30m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Sand beach	27
			FLAT (<5°)	Sand flat	28
			FLAT (<5°)	Mudflat	29
		NARROW (<30m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Sand beach	30
			FLAT (<5°)	n/a	n/a
	ORGANICS	n/a	n/a	Organic shorelines, marshes	31
ANTHRO-POGENIC	Man-made	n/a	n/a	Man-made, permeable	32
			n/a	Man-made, impermeable	33
CHANNEL	Current	n/a	n/a	Channel	34
GLACIER	Ice	n/a	n/a	Glacier	35

(after Howes et al. [1994] "BC Class" system in British Columbia)

Table A-3. Environmental Sensitivity Index (ESI) shore type classification

Class	Description
1A	Exposed rocky shores; exposed rocky banks
1B	Exposed, solid man-made structures
1C	Exposed rocky cliffs with boulder talus base
2A	Exposed wave-cut platforms in bedrock, mud, or clay
2B	Exposed scarps and steep slopes in clay
3A	Fine- to medium-grained sand beaches
3B	Scarps and steep slopes in sand
3C	Tundra cliffs
4	Coarse-grained sand beaches
5	Mixed sand and gravel beaches
6A	Gravel beaches; Gravel Beaches (granules and pebbles
6B	Gravel Beaches (cobbles and boulders)
6C	Rip rap (man-made)
7	Exposed tidal flats
8A	Sheltered scarps in bedrock, mud, or clay; Sheltered rocky shores (impermeable)
8B	Sheltered, solid man-made structures; Sheltered rocky shores (permeable)
8C	Sheltered rip rap
8D	Sheltered rocky rubble shores
8E	Peat shorelines
9A	Sheltered tidal flats
9B	Vegetated low banks
9C	Hypersaline tidal flats
10A	Salt- and brackish-water marshes
10B	Freshwater marshes
10C	Swamps
10D	Scrub-shrub wetlands; mangroves
10E	Inundated low-lying tundra

(after NOAA 2000)

Table A-4. Exposure matrix used for estimating observed physical exposure (EXP_OBSER) on the basis of approximate fetch distance

Maximum Fetch (km)	Modified Effective Fetch (km)				
	<1	**1 - 10**	**10 - 50**	**50 - 500**	**>500**
<1	very protected	n/a	n/a	n/a	n/a
<10	protected	protected	n/a	n/a	n/a
10 – 50	n/a	semi-protected	semi-protected	n/a	n/a
50 – 500	n/a	semi-exposed	semi-exposed	semi-exposed	n/a
>500	n/a	n/a	semi-exposed	exposed	exposed

Codes for exposures:	very protected	VP
	protected	P
	semi-protected	SP
	semi-exposed	SE
	exposed	E
	very exposed	VE

Table A-5. Oil Residence Index (ORI) definitions and look-up matrix on the basis of shore type (columns) and substrate type (rows) for across-shore components

Relative Persistence	Oil Residence Index (ORI)	Estimated temporal persistence
Short	1	Days to weeks
	2	**Weeks** to months
Moderate	3	Weeks to **months**
	4	**Months** to years
Long	5	Months to **years**

Substrate	VE	E	SE	SP	P	VP
rock	1	1	1	2	3	3
man-made, impermeable	1	1	1	2	2	2
boulder	2	3	5	4	4	4
cobble	2	3	5	4	4	4
pebble	2	3	5	4	4	4
sand w/ pebble, cobble, or boulder	1	2	3	4	5	5
sand w/o pebble, cobble, or boulder	2	2	3	3	4	4
mud	*	*	*	3	3	3
organics/vegetation	*	*	*	5	5	5
man-made, permeable	2	2	3	3	5	5

*These combinations are unusual and must be reviewed by individual case

Table A-6. Oil Residence Index (ORI) definitions and look-up matrix on the basis of shore type (BC_CLASS, in columns) and biological wave exposure (EXP_BIO, in rows) for along-shore units

BC CLASS	**Very Exposed (VE)**	**Exposed (E)**	**Semi-Exposed (SE)**	**Semi-Protected (SP)**	**Protected (P)**	**Very-Protected (VP)**
1	1	1	1	2	3	3
2	1	1	1	2	3	3
3	1	1	1	2	3	3
4	1	1	1	2	3	3
5	1	1	1	2	3	3
6	2	3	5	4	4	4
7	2	3	5	4	4	4
8	2	3	5	4	4	4
9	2	3	5	4	4	4
10	2	3	5	4	4	4
11	1	2	3	4	5	5
12	1	2	3	4	5	5
13	1	2	3	4	5	5
14	1	2	3	4	5	5
15	1	2	3	4	5	5
16	1	2	3	3	4	4
17	1	2	3	3	4	4
18	1	2	3	3	4	4
19	1	2	3	3	4	4
20	1	2	3	3	4	4
21	2	3	5	4	4	4
22	2	3	5	4	4	4
23	2	3	5	4	4	4
24	1	2	3	4	5	5
25	1	2	3	4	5	5
26	1	2	3	4	5	5
27	2	2	3	3	4	4
28	2	2	3	3	4	4
29	*	*	*	3	3	3
30	2	2	3	3	4	4
31	5	5	5	5	5	5
32	2	2	3	3	5	5
33	1	1	1	2	2	2
34	*	*	3	4	4	4
35	1	1	1	1	1	1

*These combinations are unusual and must be reviewed by individual case

Table A-7. Data dictionary for BIOUNIT table

Field Name	Type	Description
UnitRecID	N	Automatically-generated number field; the database “primary key” required for relationships between tables
PHY_IDENT	T	Unique physical identifier; an alphanumeric string comprised of the Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0)
BIOAREA	T	Geographic division used to describe regional differences in observed biota and coastal habitats (*additional note follows)
EXP_BIO	T	Biological Exposure, estimated on the basis of observed indicator species (see Section 3.2 for details)
HAB_CLASS	T	Primary Habitat Classification determined by the biological mapper that combines the exposure (EXP_BIO) and the geomorphic features of the shoreline (see Table A-8 and A-9)
HAB_OBS	N	Original categories used to classify habitat type; not used in current protocol but kept for backward-compatibility with earlier projects; replaced by HAB_CLASS
HAB_CLASS_LTRS	T	Habitat Class in alphabetic code, derived from the HAB CLASS lookup table
BIO_SOURCE	T	The source used to interpret coastal zone biota: **V**ideotape, (**V2**) lower quality video imagery, **S**lide, **I**nferred
HAB_CLASS2	N	Secondary Habitat Classification determined by the biological mapper used to denote lagoon habitat types (**additional note follows)
HC2_SOURCE	T	Source used to interpret the Secondary Habitat Class (HC2) “lagoon”: **OBS**erved as viewed from video, **L**oo**KUP** referring to ‘Form’ Code (Table A-11) **Lo** or **Lc** in across-shore physical component table (XShr)
HC2_Note	T	Comment field for Secondary Habitat Class (HC2)
RIPARIAN%	N	Estimate of the percentage of alongshore length of the intertidal zone, in which the shoreline is shaded by overhanging riparian vegetation; all substrate types (***additional note follows)
RIPARIAN_M	N	Length in meters, of the unit shaded by overhanging riparian vegetation; all substrate types; calculated using LENGTH_M field of UNIT table
BIO_UNIT_COMMENT	T	Biological comments regarding the entire along-shore unit
BIO_MAPPER	T	The initials of the biological mapper that provided the biological interpretation of the imagery
BIO_MAP_DATE	D/T	Date of biological mapping
PHOTO	Y/N	Identifies if there is a photo (digital or slide) associated with the unit (see BIOSLIDE table)

[continued]

Table A-7. Data dictionary for BIOUNIT table (continued)

*** Further description of the BIOAREA attribute:**

BIOAREA NAME (Alaska ShoreZone mapping to date)	**BIOAREA Code**	**SUFFIX used in database to identify bioarea**
Outer Kenai	KENA	8
Cook Inlet	COOK	9
Kodiak Island	KODI	10
Katmai / Shelikof Strait side of Kodiak Island	KATM	11
Aniakchak	ANIA	11
Southeast Alaska -- Lynn Canal (fjord)	SEFJ	12
Southeast Alaska -- Sitka	SESI	12
Southeast Alaska -- Icy Strait	SEIC	12
Southeast Alaska -- Yakutat	SEYA	12
Southeast Alaska -- Misty Fjords	SEMJ	12
Southeast Alaska -- Craig	SECR	12
Prince William Sound	PRWS	13

**** Further description of the HabClass2 attribute:**

The 'Secondary Habitat Class' was added as an attribute in the BioUnit Table during biological mapping of the Kodiak Archipelago in order to specifically identify *lagoon* habitats. Many backshore lagoons were observed in the Kodiak region, and they represent an unusual coastal habitat that differs from other estuaries and marshes.

Units classified as *lagoons* contain brackish or salt water contained in a basin with limited drainage. They are often associated with wetlands and may include wetland biobands in the upper intertidal. Single units classified as lagoons often have the lagoon form in the A zone; however, some lagoons are large and may encompass several units when the lagoon form is mapped as the C zone. Further detail is provided in the Physical Mapping section.

***** Further description of the Riparian% attribute:**

As an attribute in the BioUnit table, this category is intended to be an index for the potential habitat for upper beach spawning fishes.

The value recorded in the 'Riparian%' field is an estimate of the percentage of the unit's total alongshore length in which riparian vegetation (trees and shrubs) shades the upper intertidal zone. Shading of the highest high water line is a good estimate of riparian shading; therefore, shading of wetland herbs and grasses is not included in the estimate, nor is any shading of the splash zone alone.

Shading must be visible in the upper intertidal zone, and the shading vegetation must be woody trees or shrubs. Riparian overhanging vegetation is also an indicator of lower wave exposures, in which the splash zone is narrow. Shading may occur in on sediment-dominated or in rocky intertidal settings.

Table A-8. Habitat Class Codes

Habitat Class attribute is a classification of the biophysical characteristics of an entire unit, and provides a single attribute that describes the typical intertidal biota together with the geomorphology. That is, a typical example of a Habitat Class includes a combination of biobands, and their associated indicator species (which determine the Biological Exposure category) and the geomorphic features of the Habitat Class.

The biological mapper observes and records the biobands in the unit, if any, and determines the Biological Exposure Category (EXP_BIO). The Habitat Class is determined on the basis of presence/absence of biobands, exposure category, geomorphology, and spatial distribution of biota within the unit.

Within the database, both a numeric code and an alpha code are used. Both codes are listed in Table A-9, in which the matrix includes all combinations of Dominant Structuring Process on the vertical axis, and Biological Exposure on the horizontal axis.

Biological Exposure Categories

VE	– Very Exposed
E	– Exposed
SE	– Semi-Exposed
SP	– Semi-Protected
P	– Protected
VP	– Very Protected

Dominant Structuring Process Categories

Wave	Stability of the substrate depends on the type of substrate and on the wave energy level – Immobile: on Bedrock; or Bedrock & Sediment; or Sediment-dominated (in low energy settings) – Partially Mobile on Rock & Sediment; or Sediment – Mobile on Sediment (bare beach)
Fluvial	– Estuary (saltmarsh vegetation associated with freshwater stream, often with delta form)
Current	– Current-Dominated saltwater channel
Glacial	– Glacier ice
Anthropogenic	– Man-modified impermeable substrate – Man-modified permeable substrate
Lagoon	– Backshore lagoon, only recorded as a Secondary Habitat Class

Table A-9. Habitat Class Definitions

*shaded boxes in the Habitat Class matrix are not applicable in most regions

Dominant Structuring Process	Substrate Mobility	Coastal Type	Description	Biological Exposure Category*					
				Very Exposed **VE**	Exposed **E**	Semi-Exposed **SE**	Semi-Protected **SP**	Protected **P**	Very Protected **VP**
Wave Energy	***Immobile***	***Rock or Rock & Sediment or Sediment***	The epibiota in the immobile mobility categories is influenced by the wave exposure at the site. In high wave exposures, only solid bedrock shorelines will be classified as 'immobile'. At the lowest wave exposures, even pebble/cobble beaches may show lush epibiota, indicating an immobile Habitat Class.	10 VE_I	20 E_I	30 SE_I	40 SP_I	50 P_I	60 VP_I
Wave Energy	***Partially Mobile***	***Rock & Sediment or Sediment***	These units describe the combination of sediment mobility observed. That is, a sediment beach that is bare in the upper half of the intertidal with biobands occurring on the lower beach would be classed as 'partially mobile'. This pattern is seen at moderate wave exposures. Units with immobile bedrock outcrops intermingled with bare mobile sediment beaches, as can be seen at higher wave exposures, could also be classified as 'partially mobile'.	11 VE_P	21 E_P	31 SE_P	41 SP_P	51 P_P	61 VP_P
Wave Energy	***Mobile***	***Sediment***	These categories are intended to show the 'bare sediment beaches', where no epibenthic macrobiota are observed. Very fine sediment may be mobile even at the lowest wave exposures, while at the highest wave exposures; large-sized boulders will be mobile and bare of epibiota.	12 VE_M	22 E_M	32 SE_M	42 SP_M	52 P_M	62 VP_M
Fluvial/Estuarine Processes		***Estuary***	Units classified as the 'estuary' types always include salt marsh vegetation in the upper intertidal, are always associated with a freshwater stream or river and often show a delta form. Estuary units are usually in lower wave exposure categories.	13 VE_E	23 E_E	33 SE_E	43 SP_E	53 P_E	63 VP_E
Current energy		***Current-Dominated channel***	Species assemblages observed in salt-water channels are structured by current energy rather than by wave energy. Current-dominated sites are limited in distribution and are rare habitats.	14 VE_C	24 E_C	34 SE_C	44 SP_C	54 P_C	64 VP_C
Glacial processes		***Glacier***	In a few places in coastal Alaska, saltwater glaciers form the intertidal habitat. These Habitat Classes are rare and include a small percentage of the shoreline length.	15 VE_G	25 E_G	35 SE_G	45 SP_G	55 P_G	65 VP_G
Man-modified		***Anthropogenic – Impermeable***	Impermeable man-made Habitats are intended to specifically note units classified as Coastal Class 33.	16 VE_X	26 E_X	36 SE_X	46 SP_X	56 P_X	66 VP_X
Man-modified		***Anthropogenic – Permeable***	Permeable man-made Habitats are intended to specifically note shore units classified as Coastal Class 32.	17 VE_Y	27 E_Y	37 SE_Y	47 SP_Y	57 P_Y	67 VP_Y
Lagoon		***Lagoon***	Units classified as Lagoons in the Secondary Habitat Class contain brackish or salty water that is contained within a basin that has limited drainage. They are often associated with wetlands and may include wetland biobands in the upper intertidal.	18 VE_L	28 E_L	38 SE_L	48 SP_L	58 P_L	68 VP_L

Table A-10. Data dictionary for the XShr table (across-shore components)

Field Name	Type	Description
UnitRecID	N	Automatically-generated number field; the database “primary key” for unit-level relationships
XshrRecID	N	Automatically-generated number field; the database “primary key” for across-shore relationships
PHY_IDENT	T20	Unique physical identifier; an alphanumeric string comprised of the Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0)
CROSS_LINK	T20	Unique across-shore identifier; an alphanumeric string comprised of the PHY_IDENT followed by the Zone and Component separated by slashes (e.g. 12/03/0552/0/A/1)
ZONE	T1	Code indicating the across-shore position (tidal elevation) of the component: (A) supratidal, (B) intertidal, (C) subtidal
COMPONENT	Is	Subdivision of zones, numbered from highest to lowest elevation in across-shore profile (e.g. A1 is the highest supratidal component; B1 is the highest intertidal; B2 is lower intertidal)
Form1	T20	Principal geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix1	T1	Veneer indicator field; blank = no veneer; “v” = veneer
Mat1	T20	Material (substrate and/or sediment type) that best characterizes Form1, described by a specific set of codes (Table A-12)
FormMat1Txt	T50	Automatically-generated field that is the translation of codes used in Form1 and Mat1 into text
Form2	T20	Secondary geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix2	T1	Veneer indicator field; blank = no veneer; “v” = veneer
Mat2	T20	Material (substrate and/or sediment type) that best characterizes Form2, described by a specific set of codes (Table A-12)
FormMat2Txt	T50	Automatically-generated field that is the translation of codes used in Form2 and Mat3 into text
Form3	T20	Tertiary geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix3	T1	Veneer indicator field; blank = no veneer; “v” = veneer
Mat3	T20	Material (substrate and/or sediment type) that best characterizes Form3, described by a specific set of codes (Table A-12)
FormMat3Txt	T50	Automatically-generated field that is the translation of codes used in Form3 and Mat3 into text
Form4	T20	Fourth-order geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix4	T1	Veneer indicator field; blank = no veneer; “v” = veneer
Mat4	T20	Material (substrate and/or sediment type) that best characterizes Form4, described by a specific set of codes (Table A-12)
FormMat4Txt	T50	Automatically-generated field that is the translation of codes used in Form4 and Mat4 into text
WIDTH	N	Mean across-shore width of the component (e.g. A1) in meters
SLOPE	N	Estimated across-shore slope of the mapped geomorphic Form in degrees; must be consistent with Form codes (Table A-11)
PROCESS	T4	Dominant coastal process affecting the morphology: (F)luvial, (M)ass wasting (landslides), (W)aves, (C)urrents, (E)olian (wind, as with dunes) (O)ther
COMPONENT_ORI	N	Oil Residence Index on the basis of substrate type; 1 is least persistent, 5 is most persistent (Tables A-5 and A-6)

Table A-11. 'Form' Code Dictionary

A = Anthropogenic

a	pilings, dolphin
b	breakwater
c	log dump
d	derelict shipwreck
f	float
g	groin
h	shell midden
i	cable/ pipeline
j	jetty
k	dyke
m	marina
n	ferry terminal
o	log booms
p	port facility
q	aquaculture
r	boat ramp
s	seawall
t	landfill, tailings
w	wharf
x	outfall or intake
y	intake

B = Beach

b	berm (intertidal or supratidal)
c	washover channel
f	face
i	inclined (no berm)
m	multiple bars / troughs
n	relic ridges, raised
p	plain
r	ridge (single bar; low to mid intertidal)
s	storm ridge (occas marine influence; supratidal)
t	low tide terrace
v	thin veneer over rock (also use as modifier)
w	washover fan

C = Cliff

stability/geomorph

a	active / eroding
p	passive (vegetated)
c	cave

slope

i	inclined (20°-35°)
s	steep (>35°)

Cliff cont.

height

l	low (<5m)
m	moderate (5-10m)
h	high (>10m)

modifiers (optional)

f	fan, apron, talus
g	surge channel
t	terraced
r	ramp

D = Delta

b	bars
f	fan
l	levee
m	multiple channels
p	plain (no delta, <5°)
s	single channel

E = Dune

b	blowouts
i	irregular
n	relic
o	ponds
r	ridge/swale
p	parabolic
v	veneer
w	vegetated

F = Reef

(no vegetation)

f	horizontal (<2°)
i	irregular
r	ramp
s	smooth

I = Ice

g	glacier

L = Lagoon

o	open
c	closed

M = Marsh

c	tidal creek
e	levee
f	drowned forest
h	high
l	mid to low (discontinuous)
o	pond
s	brackish, supratidal

O = Offshore Island

(not reefs)

b	barrier
c	chain of islets
t	table shaped
p	pillar/stack
w	whaleback

elevation

l	low (<5m)
m	moderate (5-10m)
h	high (>10m)

P = Platform

(slope <20°)

f	horizontal
g	surge channel
h	high tide platform
i	irregular
l	low tide platform
r	ramp (5-19°)
t	terraced
s	smooth
p	tidepool

R = River Channel

a	perennial
i	intermittent
m	multiple channels
s	single channel

T = Tidal Flat

b	bar, ridge
c	tidal channel
e	ebb tidal delta
f	flood tidal delta
l	levee
p	tidepool
s	multiple tidal channels
t	flats

(after Howes et al. 1994)

Table A-12. 'Material' Code Dictionary

A = Anthropogenic

a	metal (structural)
c	concrete (loose blocks)
d	debris (man-made)
f	fill, undifferentiated mixed
o	concrete (solid cement blocks)
r	rubble, rip rap
t	logs (cut trees)
w	wood (structural)

B = Biogenic

c	coarse shell
f	fine shell hash
g	grass on dunes
l	dead trees (fallen, not cut)
o	organic litter
p	peat
t	trees (living)

C = Clastic

(strike-out items out are no longer used but remain for reference)

a	angular blocks (>25cm diameter)
b	boulders (rounded, subrounded,>25cm)
c	cobbles
d	diamicton (poorly-sorted sediment containing a range of particles in a mud matrix)
f	fines/mud (mix of silt/clay, <0.0.63 mm diameter)
k	clay (compact, finer than fines/mud, <4 μm diameter)
p	pebbles
r	rubble (boulders>1 m diameter)
s	sand (0.063 to 2 mm diameter)
x	angular fragments (mix of block/rubble)
v	sediment veneer (used as modifier)

R = Bedrock

SEDIMENT TEXTURE
(Simplified from Wentworth grain size scale)

GRAVELS

boulder	> 25 cm diameter
cobble	6 to 25 cm diameter
pebble	0.5 cm to 6 cm diam

SAND

very fine to very coarse:
0.063 mm to 2 mm diameter

FINES ("MUD")

includes silt and clay

silt	0.0039 to 0.063 mm
clay	<0.0039 mm

TEXTURE CLASS BREAKS

sand / silt	63 μm (0.063 mm)
pebble / granule	0.5 cm (5 mm)
cobble / pebble	6 cm
boulder / cobble	25 cm

SHORE MODIFICATIONS

WB	wooden bulkhead
BR	boat ramp
CB	concrete bulkhead
LF	landfill
SP	sheet pile
RR	riprap

% are 0-10 (default value 0)

(after Howes et al. 1994)

Note: The 'material' descriptor consists of one primary term code and associated modifiers (e.g. Cash). If only one modifier is used, indicated material comprises 75% of the volume of the layer (e.g. Cs), if more than one modifier, they are ranked in order of volume. A surface layer can be described by prefix *v* for veneer (e.g. vCs/R).

Table A-13. Data dictionary for the BioBand table

Field	Type	Description
UnitRecID	N	Automatically-generated number field; the database "primary key" required for relationships between tables
XshrRecID	N	Automatically-generated number field; the database "primary key" required for relationships between tables
PHY_IDENT	T20	Unique physical identifier; an alphanumeric string comprised of the Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0)
CROSS_LINK	T20	Unique alphanumeric identifier of component made up of: REGION, AREA, PHYS_UNIT, SUBUNIT, ZONE and COMPONENT fields
Note: all Biobands are coded **P**atchy (<50% cover) or **C**ontinuous (>50% cover) except the **VER** band, which is coded by width: **N**arrow (<1m), **M**edium (1-5m) or **W**ide (>5m). See Section 3.1.		
VER	T1	Bioband for Splash Zone (black lichen **VER***ucaria*) in supratidal
GRA	T1	Bioband code for Dune **GRA**ss in supratidal
SED	T1	Bioband for **SED**ges in supratidal
PUC	T1	Bioband for Salt Marsh grasses, including **PUC***cinellia* and other salt tolerant grasses, herbs and sedges, in supratidal
BAR	T1	Bioband for **BAR**nacle (*Balanus/Semibalanus)* in upper intertidal
FUC	T1	Bioband for Rockweed, the **FUC**us/barnacle in upper intertidal
ULV	T1	Bioband for Green Algae, including mixed filamentous and foliose greens (**ULV***a*, *Cladophora, Acrosiphonia*) in mid-intertidal
BMU	T1	Bioband for **B**lue **MU**ssel (*Mytilus trossulus)* in mid-intertidal
MUS	T1	Bioband for California **MUS**sel/gooseneck barnacle assemblage (*Mytilus californianus/Pollicipes polymerus*) in mid-intertidal
HAL*	T1	Bioband for Bleached Red Algae, including mixed filamentous and foliose reds (*Palmaria, Odonthalia,* **HAL***osaccion*) in mid-intertidal
RED*	T1	Bioband for **RED** Algae, including mixed filamentous and foliose reds (*Odonthalia, Neorhodomela, Palmaria*) in lower intertidal
ALA	T1	Bioband for stand of large or small morph of **ALA***ria spp*.
SBR*	T1	Bioband for **S**oft **B**rown **K**elps, including unstalked large-bladed laminarins, in lower intertidal and nearshore subtidal
CHB*	T1	Bioband for Dark Brown Kelps, including stalked bladed dark **CH**ocolate-**B**rown kelps in lower intertidal and nearshore subtidal
SUR	T1	Bioband for **SUR**fgrass (*Phyllospadix*) in lower intertidal and nearshore subtidal
ZOS	T1	Bioband for **ZOS***tera* (Eelgrass) in lower intertidal and subtidal
URC	T1	Bioband for **URC**hin Barrens (*Strongylocentrotus fransicanus*) in nearshore subtidal
ALF	T1	Bioband for Dragon Kelp (**AL***aria* **F***istulosa*) in nearshore subtidal
MAC	T1	Bioband for Giant Kelp (**MAC***rocystis integrifolia*) in nearshore subtidal
NER	T1	Bioband for Bull Kelp (**NER***eocystis luetkeana*) in nearshore subtidal

***Further Description of BIOBAND by BIOAREA (see also Table A-7 and footnotes)**

Different species assemblages in four lower intertidal biobands are observed, and are used to help define geographic regions in ShoreZone as separate bioareas. In addition to the BIOAREA code assigned to each unit in the BIOUNIT table, the lower intertidal biobands: Bleached Red Algae, Red Algae, Soft Brown Kelps, and Dark Brown Kelps (**HAL**, **RED**, **SBR** and **CHB** bands) are labeled with a suffix number to specifically match the bioband code to a particular bioarea. More bioareas are being defined as new coastal areas are being mapped. Details of the species composition in these diagnostic lower intertidal bands are being added as ground station surveys are completed in mapped areas.

Table A-14. Data dictionary for the photos table (tblBioSlide)

Field Name	Type	Description
SlideID	N	A unique numeric ID assigned to each slide or photo
UnitRecID	N	Automatically-generated number field; the database "primary key" required for relationships between tables
SlideName	T50	A unique alphanumeric name assigned to each slide or photo
ImageName	T75	Full image name with .jpg extension (required to enable "PhotoLink")
TapeTime	D/T	Exact time during aerial video imaging (AVI) survey when digital image was collected; used to link photo to digital trackline and position
SlideDescription	T255	Text field for biological comments regarding the digital photo or slide
Good Example?	Y/N	When set to "Y," photo is representative of a particular biological feature or classification type
ImageType	T10	Media type of original image: "Digital" or "Slide"
FolderName	T50	Name of the folder in which digital images are stored (required to enable "PhotoLink")
PhotoLink	Hyper-link	Enables linkage to photos placed in directories near the database
PHY Good Example?	Y/N	When set to "Y," photo is geomorphological representative of a particular feature or classification type
PHY SlideComment	T255	Text field for geomorphological comments regarding the digital photo or slide

Table A-15. Data dictionary for the GroundStationNumber table

Field Name	Type	Description
StationID	N	A unique numeric ID given to each ground station
UnitRecID	N	Automatically-generated number field; the database "primary key" required for relationships between tables
Station	T50	Unique alphanumeric name assigned to each ground station
StationDescription	T255	Text field for comments regarding the ground station
Location	T50	General location of each ground station

APPENDIX B SHORE TYPES IN PRINCE WILLIAM SOUND

Plate	Description
B-1	Shore Type: Rock (BC Classes 1-5)
B-2	Shore Type: Rock (BC Classes 1-5)
B-3	Shore Type: Rock and Sediment (BC Classes 6-20)
B-4	Shore Type: Rock and Sediment (BC Classes 6-20)
B-5	Shore Type: Rock and Sediment (BC Classes 6-20)
B-6	Shore Type: Sediment (BC Classes 21-30)
B-7	Shore Type: Sediment (BC Classes 21-30)
B-8	Organic Shorelines and Marshes (BC Class 31)
B-9	Shore Type: Organic Shorelines and Marshes (BC Class 31)
B-10	Shore Type: Human-Altered Shorelines (BC Classes 32-33)
B-11	Shore Type: Current-Dominated Channels (BC Class 34)
B-12	Geomorphic Components: Marshes and Wetlands
B-13	Geomorphic Components: Deltas, Mudflats, and Tidal Flats
B-14	Geomorphic Components: Beach Berms and Ridges
B-15	Geomorphic Components: Beach Berms and Ridges
B-16	Geomorphic Components: Lagoons
B-17	Geomorphic Components: Glaciers
B-18	Anthropogenic Components: Coastal Structures and Modifications
B-19	Anthropogenic Components: Coastal Structures and Modifications
B-20	Other Interesting Components: Drowned Forests, Shell Middens

Plate B-1. Shore Type: Rock (BC Classes 1-5)

	
BC Class 1 (wide rock ramp)	BC Class 3 (steep rock cliff)
West Hinchinbrook Island (Unit 02/06/1165)	Glacier Island (Unit 02/03/3572)
PWS07_MM_00527.jpg	PWS07_MM_06093.jpg

Plate B-2. Shore Type: Rock (BC Classes 1-5)

BC Class 2 (wide rock platform)	BC Class 3 (steep rock cliff)
West Hinchinbrook Island (Unit 02/06/1163)	Outer Hinchinbrook Island (Unit 02/06/1403)
PWS07_MM_00518.jpg	PWS07_MM_01113.jpg

Plate B-3. Shore Type: Rock and Sediment (BC Classes 6-20)

BC Class 6 (wide ramp with gravel beach)	BC Class 9 (narrow ramp with gravel beach)
Smith Island (Unit 02/05/0001)	SW Cochrane Bay (Unit 02/02/7035)
PWS07_HA_00944.jpg	PWS07_ML_06887.jpg

Plate B-4. Shore Type: Rock and Sediment (BC Classes 6-20)

	
BC Class 11 (wide ramp with gravel and sand beach)	BC Class 13 (narrow cliff with gravel and sand beach)
Yale Arm (Unit 02/02/7537)	Boulder Bay (Unit 02/04/2206)
PWS07_ML_08301.jpg	PWS07_MM_09409.jpg

Plate B-5. Shore Type: Rock and Sediment (BC Classes 6-20)

BC Class 17 (wide platform with sand beach)	BC Class 19 (narrow ramp with sand beach)
West Montague Island (02/06/0768)	Orca Inlet (Unit 02/04/7037)
PWS07_ML_01084.jpg	PWS07_MM_10688.jpg

Plate B-6. Shore Type: Sediment (BC Classes 21-30)

BC Class 21 (wide gravel flat)	BC Class 24 (wide sand and gravel flat or fan)
Wooded Island (Unit 02/06/0002)	Passage Canal (Unit 02/02/7048)
PWS07_ML_01382.jpg	PWS07_ML_06313.jpg

Plate B-7. Shore Type: Sediment (BC Classes 21-30)

	
BC Class 28 (wide sand flat)	BC Class 29 (wide mud flat)
Southeast Hinchinbrook Island (Unit 02/06/7048)	Boswell Bay, East Hinchinbrook Island (Unit 02/06/7055)
PWS07_MM_10851.jpg	PWS07_MM_10961.jpg

Plate B-8. Shore Type: Organic Shorelines and Marshes (BC Class 31)

	
BC Class 31 (organic shorelines and marshes)	BC Class 31 (organic shorelines and marshes)
Port Gravina (Unit 02/04/1237)	Granite Bay, Esther Island (Unit 02/02/9055)
PWS07_HA_00569.jpg	PWS07_HA_01685.jpg

Plate B-9. Shore Type: Organic Shorelines and Marshes (BC Class 31)

	
BC Class 31 (organic shorelines and marshes)	BC Class 31 (organic shorelines and marshes)
Sawmill Bay, Valdez Arm (Unit 02/03/6106)	College Fjord (Unit 02/02/7455)
PWS07_MM_07132.jpg	PWS07_ML_08011.jpg

Plate B-10. Shore Type: Human-Altered Shorelines (BC Classes 32-33)

BC Class 32 (man-made, permeable)	BC Class 32 (man-made, permeable)
Cordova (Unit 02/04/7007)	Valdez (Unit 02/03/6245)
PWS07_MM_10430.jpg	PWS07_MM_07440.jpg

Plate B-11. Shore Type: Current-Dominated Channels (BC Class 34)

	
BC Class 34 (current-dominated channel)	BC Class 34 (current-dominated channel)
South Bay, Perry Island (Unit 02/02/8126)	Quillian Bay, Esther Island (02/02/9167)
PWS07_HA_03046.jpg	PWS07_HA_01935.jpg

Plate B-12. Geomorphic Components: Marshes and Wetlands

	
Forms mapped in this unit: high marsh (Mh), low marsh with ponds (Mlo), and river channels (Rm). BC Class 31.	Forms mapped in this unit: low marsh (Ml), delta fan (Df), and river channels (Rm). BC Class 31.
Sahlin Lagoon, Sheep Bay (Unit 02/04/0057)	Simpson Bay (Unit 02/04/0389)
PWS07_HA_03753.jpg	PWS07_HA_04318.jpg

Plate B-13. Geomorphic Components: Deltas, Mudflats, and Tidal Flats

	
Form Df (delta fan); BC Class 24 (wide sand and gravel flat or fan)	Form Tt (tidal flat), BC Class 24
West Hawkins Island (Unit 02/04/0003)	Cedar Bay, north Hawkins Island (Unit 02/04/7091)
PWS07_HA_03624.jpg	PWS07_MM_11181.jpg

Plate B-14. Geomorphic Components: Beach Berms and Ridges

	
Form Bs (supratidal storm berm), BC Class 28 (wide sand flat)	Form Br (intertidal beach ridge), BC Class 14 (ramp with sand/gravel beach)
Patton Bay, SE Montague Island (Unit 02/06/0032)	Sheep Bay (Unit 02/04/0132)
PWS07_ML_01488.jpg	PWS07_HA_03920.jpg

Plate B-15. Geomorphic Components: Beach Berms and Ridges

Form Bn (raised, relict ridges), BC Class 24 (wide sand/gravel flat or fan)	Form Bf (beach face), BC Class 24 (wide sand/gravel flat or fan)
West Montague Island (Unit 02/06/0689)	SW Cochrane Bay (Unit 02/02/7022)
PWS07_ML_00680.jpg	PWS07_ML_06847.jpg

Plate B-16. Geomorphic Components: Lagoons

	
Form Lo (open lagoon)	Form Lo (open lagoon)
Southwest Cochrane Bay (Unit 02/02/7027)	Cedar Bay, north Hawkins Island (Unit 02/04/7282)
PWS07_ML_06871.jpg	PWS07_MM_11883.jpg

Plate B-17. Geomorphic Components: Glaciers

	
Form Ig (glacier), BC Class 35	Form Ig (glacier), BC Class 35
Harvard Glacier, College Fjord (Unit 02/02/7485)	Surprise Glacier, Surprise Inlet, Harriman Fjord (Unit 02/02/7388)
PWS07_ML_08154.JPG	PWS07_ML_07640.jpg

Plate B-18. Anthropogenic Components: Coastal Structures and Shore Modifications

Form Aw (wharf), BC Class 32 (man-made)	Forms Aq (aquaculture site) and Awr (wharf, boat ramp), BC Class 32
Valdez (Unit 02/03/6241)	Lake Bay hatchery, Esther Island (Unit 02/02/9138)
PWS07_MM_07432.jpg	PWS07_HA_01876.jpg

Plate B-19. Anthropogenic Components: Coastal Structures and Shore Modifications

	
Forms An (ferry terminal), Asj (seawall, jetty), Ap (port facility), BC Class 32	Forms As (seawall) composed of Material Ar (riprap), BC Class 32 (man-made)
Ferry terminal, Valdez (Unit 02/03/6241)	Cordova (Unit 02/04/7005)
PWS07_MM_07432.jpg	PWS07_MM_10417.jpg

Plate B-20. Other Interesting Components: Drowned Forests, Shell Middens

	
Form Mhf (high marsh and drowned forest), BC Class 31 (organic shoreline)	Forms Ah (shell midden), BC Class 11 (wide ramp with gravel/sand beach)
Pigot Bay (Unit 02/02/7135)	Sheep Bay (Unit 02/04/0168)
PWS07_ML_06669.jpg	PWS07_HA_03986.jpg

APPENDIX C BIOBANDS IN PRINCE WILLIAM SOUND

Plate	Description
C-1	The Splash Zone (VER) Bioband
C-2	The Dune Grass (GRA), Sedges (SED), and Salt Marsh (PUC) Biobands
C-3	The Barnacle (BAR) Bioband
C-4	The Rockweed (FUC) Bioband
C-5	The Green Algae (ULV) Bioband
C-6	The Blue Mussel (BMU) Bioband
C-7	The Bleached Red Algae (HAL) Bioband
C-8	The Red Algae (RED) Bioband
C-9	The Alaria (ALA) Bioband
C-10	The Soft Brown Kelps (SBR) Bioband
C-11	The Dark Brown Kelps (CHB) Bioband
C-12	The Surfgrass (SUR) Bioband
C-13	The Eelgrass (ZOS) Bioband
C-14	The Dragon Kelp (ALF) Bioband
C-15	The Bull Kelp (NER) Bioband

Plate C-1. The Splash Zone (VER) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
A	**Splash Zone**	**VER**	Black or bare rock	*Verrucaria sp*. Encrusting black lichens	Visible as a dark stripe, on bare rock, marking the upper limit of the intertidal zone. This band is observed on bedrock, or on low energy boulder/cobble shorelines. Note: This band is recorded by width Narrow (N) = less than 1m Medium (M) = 1m to 5m Wide (W) = more than 5m	Width varies with exposure. N=VP-SP M=SP-SE W=SE-VE	*Littorina sp*.

	
A narrow Splash Zone (VER) band of *Verrucaria* can be seen on this immobile shore in Pigot Bay	A dark black stripe of *Verrucaria* representing the Splash Zone (VER) is distinct above underlying bands of Rockweed (FUC) on Egg Rocks.
PWS07_ML_06565.jpg	PWS07_HA_02889.jpg
Bioarea PRWS	Bioarea PRWS

Plate C-2. The Dune Grass (GRA), Sedges (SED), and Salt Marsh (PUC) Biobands

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
A	**Dune Grass**	**GRA**	Pale blue-green	*Leymus mollis*	Found in the upper intertidal zone, on dunes or beach berms. This band is often the only band present on high-energy beaches.	P-E	
A	**Sedges**	**SED**	Bright green, yellow-green to red-brown.	*Carex lynbyei*	Appears in wetlands around lagoons and estuaries. Usually associated with freshwater. This band can exist as a wide flat pure stand or be intermingled with dune grass. Often the PUC band forms a fringe below.	VP-SP	*Carex* spp.
A	**Salt Marsh**	**PUC**	Light, bright, or dark green, with red-brown	*Puccinellia* sp. *Plantago maritima* *Glaux maritima*	Appears around estuaries, marshes, and lagoons. Usually associated with freshwater. Often fringing the edges of GRA and SED bands. PUC can be sparse *Puccinellia* and *Plantago* on coarse sediment or a wetter, peaty meadow with assemblage of herbs and sedges (including *Potentilla, Spergularia, Achillea, Dodecatheon* and other associated species*).*	VP-SE	*Carex* sp. *Potentilla anserine* *Honckenya peploides* *Salicornia virginica* *Triglochin maritima*

A mixture of Dune Grass (GRA), Sedges (SED) and Salt Marsh (PUC) can be seen at the beginning of the growing season in this Protected (P) estuary in the northern arm of Jack Bay.

PWS07_MM_07831.jpg

Bioarea PRWS

Brown Dune Grass (GRA) with fringing Salt Marsh (PUC) beginning to grow along this bare beach Markarka Point, Hawkins Island.

PWS07_MM_12248.jpg

Bioarea PRWS

Plate C-3. The Barnacle (BAR) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
upper B	**Barnacle**	**BAR**	Grey-white to pale yellow	*Balanus* sp. *Semibalanus* sp.	Visible on bedrock or large boulders. Can form an extensive band in higher exposures where algae have been grazed away.	P-E	*Endocladia muricata* *Gloiopeltis furcata* *Porphyra* sp. *Fucus* sp.

Located below the *Verrucaria* (VER), a continuous band of Barnacles (BAR) is visible in the high intertidal range of this Semi-Exposed (SE) shoreline at Point Eleanore, Eleanore Island.

PWS07_HA_00973.jpg

Bioarea PRWS

A band of creamy white Barnacles (BAR) extends across the Semi-Protected (SP) shore in the south islands of the Dutch group.

PWS07_HA_02799.jpg

Bioarea PRWS

Plate C-4. The Rockweed (FUC) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
upper B	**Rockweed**	**FUC**	Golden-brown	*Fucus* sp.	Appears on bedrock cliffs and boulder, cobble or gravel beaches. Commonly occurs at the same elevation as the barnacle band.	P-SE	*Balanus* sp. *Semibalanus* sp. *Ulva* sp. *Pylaiella* sp.

	
Golden-brown Rockweed (FUC) underlies a narrow Splash Zone (VER) along the shores of the Esther Passage	A dense covering of Rockweed (FUC) forms a continuous band along the flats this Protected (P) estuary in Esther Passage
PWS07_HA_02282.jpg	PWS07_HA_02393.jpg
Bioarea PRWS	Bioarea PRWS

Plate C-5. The Green Algae (ULV) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B	**Green Algae**	**ULV**	Green	*Ulva* sp. *Monostroma* sp. *Enteromorpha* sp. *Cladophora* sp. *Acrosiphonia* sp.	Found on a variety of substrates. This band can consist of filamentous and/or foliose green algae. Filamentous species often form a low turf of dark green.	P-E	Filamentous red algae.

	
Green Algae (ULV) forms a continuous band along the mobile beach in Sawmill Bay.	A continuous Green Algae (ULV) band occurs at the water line, below the *Fucus* (FUC) band in Port Valdez
PWS07_MM_07152.jpg	PWS07_MM_07742.jpg
Bioarea PRWS	Bioarea PRWS

Plate C-6. The Blue Mussel (BMU) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B	**Blue Mussel**	**BMU**	Black or blue-black	*Mytilus trossulus*	Visible on bedrock and on boulder, cobble or gravel beaches. Appears in dense clusters that form distinct black patches or bands, either above or below the barnacle band.	P-VE	*Fucus* sp. *Semibalanus* sp. *Balanus* sp. *Filamentous red algae.*

	
A Blue Mussel (BMU) bioband occurs below the barnacle (BAR) band on this Semi-Protected (SP) shoreline in the east arm of upper Long Bay. Note the difference between the distinct blue-black band of Blue Mussel (BMU) below, and the *Verrucaria* (VER) band of the Splash Zone above.	A continuous bands of Blue Mussel (BMU) occurs below the Barnacle (BAR band and above the Red Algae band (RED) on Glacier Island.
PWS07_MM_05322.jpg	PWS07_MM_06063.jpg
Bioarea PRWS	Bioarea PRWS

Plate C-7. The Bleached Red Algae (HAL) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B	**Bleached Red Algae**	**HAL**	Olive, golden or yellow-brown	Bleached foliose red algae *Palmaria* sp. *Odonthalia* sp.	Common on bedrock platforms, and cobble or gravel beaches. Distinguished from the RED band by colour. The bleached colour usually indicates lower wave exposure than where the RED band is observed, and may be caused by nutrient deficiency.	P-SE	*Halosaccion glandiforme* *Mazzaella* sp. Filamentous green algae

	
A continuous band of Bleached Red Algae (HAL) can be seen at the water line southwest of Salmo Point on the north-eastern side of Hawkins Island.	HAL band above water line on northwest side of Green Island, near Putnum Pt., mixed with SBR and ULV.
PWS07_MM_11732.jpg	PWS07_ML_00407.jpg
Bioarea PRWS	Bioarea PRWS

Plate C-8. The Red Algae (RED) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B	**Red Algae**	**RED**	Corallines*:* pink or white Foliose or filamentous*:* Dark red, bright red, or red-brown.	*Corallina* sp. *Lithothamnion* sp. *Neoptilota* sp. *Odonthalia* sp. *Neorhodomela* sp. *Palmaria* sp. *Mazzaella* sp.	Appears on most substrates except fine sediments. Lush coralline algae indicates highest exposures; diversity of foliose red algae indicates medium to high exposures, and filamentous species, often mixed with green algae, occur at medium and lower exposures.	P-VE	*Pisaster* sp. *Nucella* sp. *Katharina tunicata* mixed large browns of the CHB bioband

	
Along this Semi-Protected (SP) shoreline on the west coast of Montague Island, a bright band of Red Algae (RED) is visible in the lower intertidal.	A band of Red Algae (RED) can be seen on Salmo Point, north Hawkins Island
PWS07_ML_02579.jpg	PWS07_MM_11702.jpg
Bioarea PRWS	Bioarea PRWS

Plate C-9. The Alaria (ALA) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B & C	**Alaria**	**ALA**	Dark brown or red-brown	*Alaria marginata* *Alaria* sp.	Common on bedrock cliffs and platforms, and on boulder/cobble beaches. This often single-species band has a distinct ribbon-like texture, and may appear iridescent in some imagery.	SP-E	Foliose red algae *Laminaria* sp.

Alaria (ALA) can be seen here draped over the immobile bedrock on Salmo Point, Hawkins Island.

PWS07_MM_11649.jpg

Bioarea PRWS

Alaria (ALA) is seen on Busby Island and can be easily identified by its ribbon-like texture and red-brown colour.

PWS07_MM_08698.jpg

Bioarea PRWS

Plate C-10. The Soft Brown Kelps (SBR) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B & C	**Soft Brown Kelps**	**SBR**	Yellow-brown, olive brown or brown.	*Saccharina latissima* *Cystoseira* sp.	This band is defined by non-floating large browns and can form lush bands in semi-protected areas. The kelp fronds have a ruffled appearance and can be encrusted with diatoms and bryozoans giving the blades a 'dusty' appearance.	VP-SP	*Alaria* sp. *Cymathaere* sp. *Saccharina sessile* (bullate)

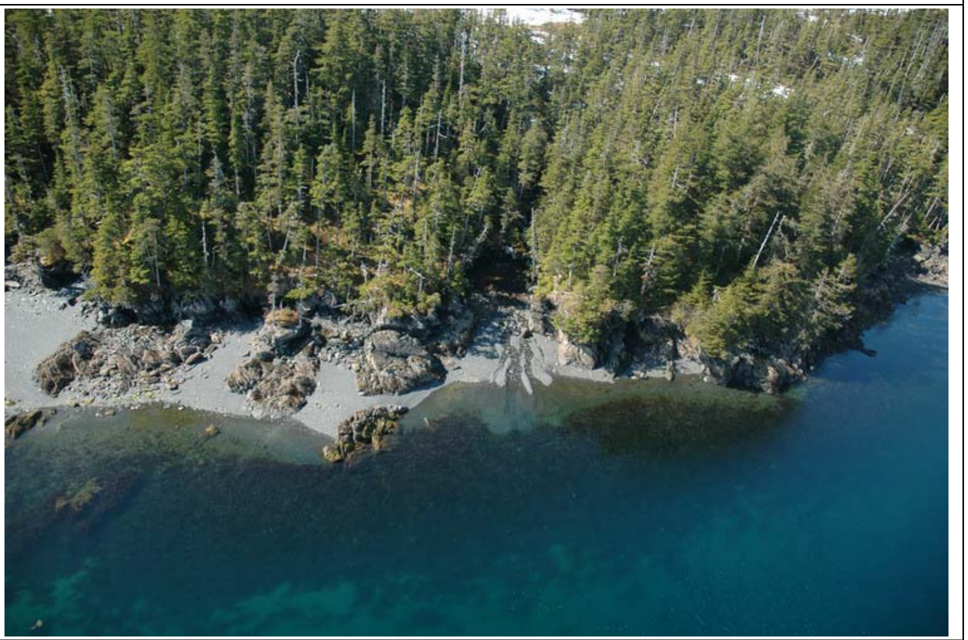
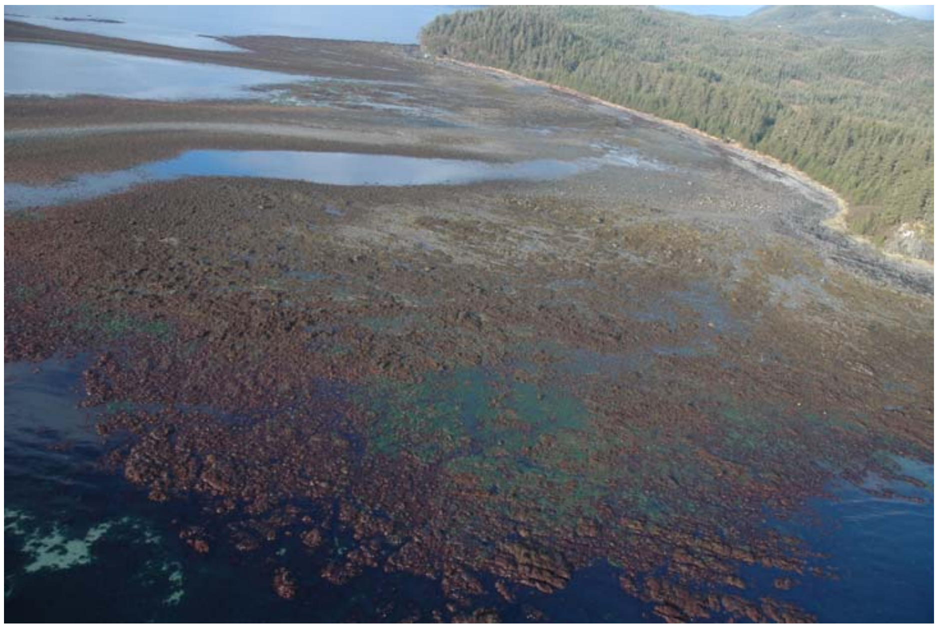
	
Soft Brown Kelps (SBR) are visible just below the edge of the water in Port Valdez	Lush Soft Brown Kelps (SBR) form a continuous band in the subtidal zone on Heather Island.
PWS07_MM_07738.jpg	PWS07_ML_06634.jpg
Bioarea PRWS	Bioarea PRWS

Plate C-11. The Dark Brown Kelps (CHB) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B & C	**Dark Brown Kelps**	**CHB**	Dark chocolate brown	*Laminaria setchellii* *Saccharina subsimplex* *Lessoniopsis littoralis* *Hedophyllum sessile* (smooth)	Found at higher wave exposures, these stalked kelps grow in the lower intertidal. Blades are leathery, shiny, and smooth. A mixture of species occurs at the moderate wave exposures, while single-species stands of *Lessoniopsis* occur at high exposures.	SE-VE	*Cymathaere* sp. *Pleurophycus* sp. *Costaria* sp. *Alaria* sp. Filamentous and foliose red algae



A band of Dark Brown Kelps (CHB) occurs here in the lower intertidal and extends into the subtidal zone on Montague Point, Montague Island.

PWS07_ML_02194.jpg

Bioarea KENA

A thick wide CHB band above and below the water, near Graveyard Point on Montague Island. The trademark “shininess” can be seen here.

PWS07_ML_02237.jpg

Bioarea KENA

Plate C-12. The Surfgrass (SUR) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B & C	**Surfgrass**	**SUR**	Bright green	*Phyllospadix* sp.	Appears in tidepools on rock platforms, often forming extensive beds. This species has a clearly defined upper exposure limit of semi-exposed and its presence at Exposed wave energy often indicates a wide cross-shore profile, where wave energy is dissipated by wave run-up across the broad intertidal zone.	SP-SE	Foliose and coralline red algae

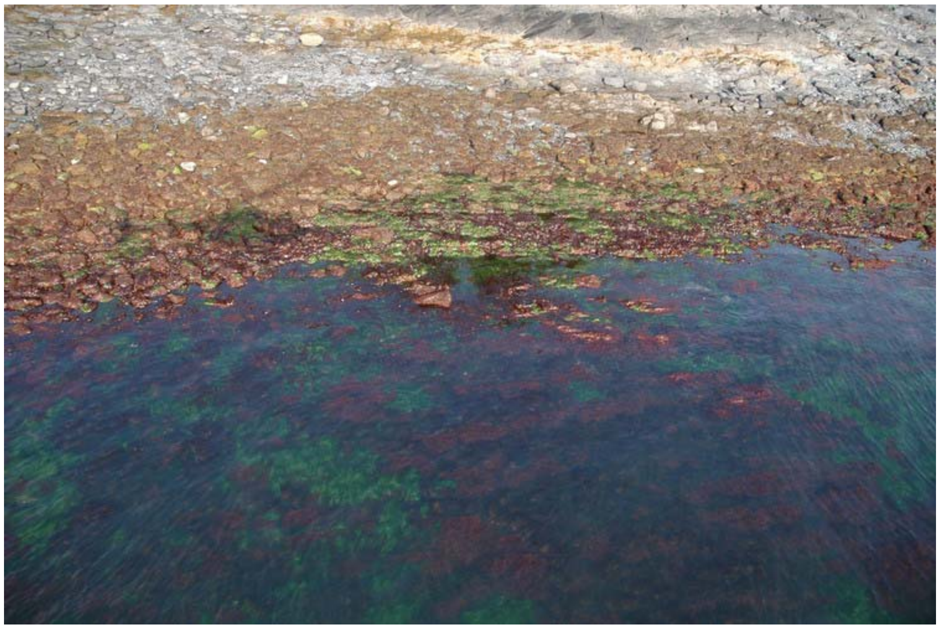
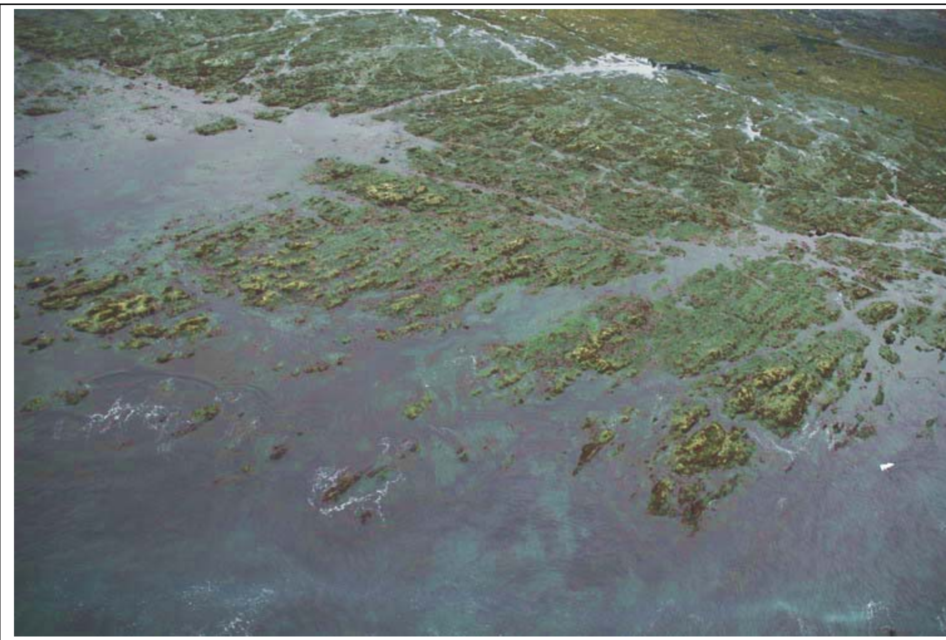
	
Surfgrass (SUR) is visible underwater with *Alaria* (ALA) dominating the surrounding subtidal zone of Discovery Point, Knight Island.	Rocky platform covered with a thick bed of surfgrass (SUR), on the southeast side of Montague Island, near Jeanie Point. Surfgrass (SUR) is occurs with Chocolate Browns (CHB) below the water line.
PWS07_ML_02736,jpg	PWS07_ML_01294.jpg
Bioarea PRWS	Bioarea KENA

Plate C-13. The Eelgrass (ZOS) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B & C	**Eelgrass**	**ZOS**	Bright to dark green	*Zostera marina*	Commonly visible in estuaries, lagoons or channels, generally in areas with fine sediments. Eelgrass can occur in sparse patches or thick dense meadows.	VP-SP	*Pylaiella* sp.

	
Eelgrass (ZOS) is visible in the subtidal and lower intertidal zones with patchy Soft Browns (SBR) in Hobo Bay, Port Wells.	A lush Eelgrass (ZOS) band is located in the lower intertidal and subtidal zones of this estuary in Herring Bay.
PWS07_ML_07311.jpg	PWS07_ML_05842.jpg
Bioarea PRWS	Bioarea PRWS

Plate C-14. The Dragon Kelp (ALF) Bioband

Zone	Bioband Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
C	**Dragon Kelp**	**ALF**	Golden-brown	*Alaria fistulosa*	Canopy-forming alga with very long blade and hollow floating midrib, found in nearshore habitats. If associated with NER, it occurs inshore of the bull kelp.	SP-SE	*Alaria* sp. *Nereocystis luetkeana*

	
The ALF band forms an extensive canopy in the subtidal, with NER farther offshore, at Point Gustavus in Icy Strait.	Long, narrow strands of dark brown dragon kelp can be seen in the subtidal of this boulder-cobble beach in Gilbert Bay, Port Snettisham. The kelp can be identified by its rope-like appearance imparted by hollow, floating midribs and long blades.
SE05_ML_5987.jpg*	SE05_ML_9672.jpg*
Bioarea SEIC	Bioarea SEFJ

*Note: Dragon Kelp occurs in a few places in southwest Prince William Sound, but it is not common. These photo examples are from Southeast Alaska.

Plate C-15. The Bull Kelp (NER) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
C	**Bull Kelp**	**NER**	Dark brown	*Nereocystis luetkeana*	Distinctive canopy-forming kelp with many long strap-like blades growing from a single floating bulb atop a long stipe. Can form an extensive canopy in nearshore habitats, usually further offshore than *Alaria fistulosa* and *Macrocystis*. Often indicates higher current areas if observed at lower wave exposures.	SP-VE	*Alaria fistulosa** *Macrocystis integrifolia*

A Bull Kelp (NER) bed off of Montague Point, Northern Montague Island. Blades are not well developed because it is early in the growing season, but the round stipe and floating bulbs can be seen well.

PWS07_ML_02191.jpg

Bioarea KENA

A bed of Bull Kelp (NER) off of Point Woodcock, McLeod Harbour, Montague Island. Very thick density, but blades still not fully developed, due to being early in the growing season.

PWS07_ML_00927.jpg

Bioarea PRWS