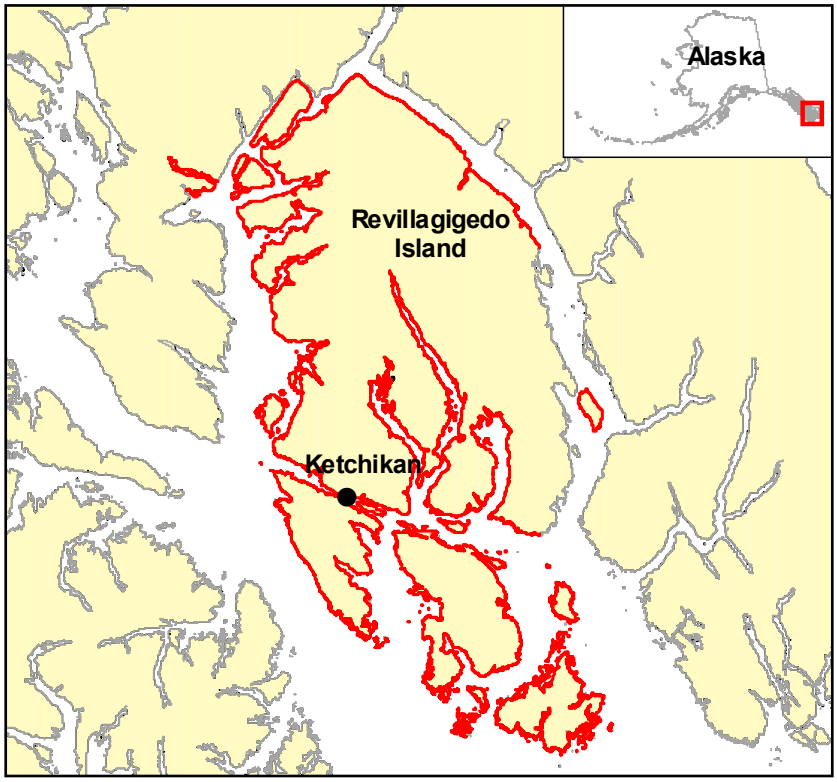
CORI Project: 2006-19 December 2007

ShoreZone Coastal Habitat Mapping
Interim Data Summary Report

Ketchikan Area, Revillagigedo Island
Southeast Alaska



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ShoreZone Mapping Data Summary
Ketchikan Area, Revillagigedo Island
Southeast Alaska
(2006 Imagery)

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SUMMARY

ShoreZone is a coastal habitat mapping and classification system in which georeferenced aerial imagery is collected specifically for the interpretation and integration of geological and biological features of the intertidal zone and nearshore environment.

This interim data summary report provides information on **geological and biological features** of 1,915 km of shoreline mapped in the Ketchikan area and portions of Revillagigedo Island in Southeast Alaska. The habitat inventory is comprised of 5,105 along-shore segments (units) averaging 350 m in length.

Because most of the region included in this summary report occurs in sheltered inlets and fjords, nearly all of the shoreline (90%) is classified as semi-protected and lower wave exposures. Estuaries are mapped along 208 km (10.9%) of shoreline in the study area.

Bedrock shorelines (BC Classes 1-5) comprise 261 km (13.6%) of mapped shorelines. More than half of the mapped coastal environment is characterized as mixed rock and sediment shorelines (BC Classes 6-20: 1,026 km or 53.6%). Sediment-dominated shorelines (BC Classes 21-30) comprise 256.9 km of the study area (13.4%). Of these, wide sand and gravel flats (BC Class 24) are the most common, mapped along 152.2 km of shoreline (7.9% of the total study area).

The distribution of beaches and tidal flats on the basis of ESI class reveals that mixed sand and gravel beaches constitute 544 km of shoreline in the study area. Gravel beaches composed mainly of cobbles and boulders are mapped along 179 km of shoreline. Tidal flats comprised of organic material, fine sediment, sand, and some gravel (cobble and boulder veneer) constitute 165 km of shoreline, generally confined to relatively protected areas at the heads of inlets.

Shorelines classified as man-modified (having more than 50% of the unit altered by human activities) occur along 29 km of shoreline in the study area. The most common type of shore modification observed is riprap (218 units), followed by wooden bulkheads (95 units).

Details concerning mapping methodology and the definition of 2007 standards are available in the ShoreZone Coastal Habitat Mapping Protocol for the Gulf of Alaska (Harney et al. 2007). This and other ShoreZone reports are available for download from the Coastal & Ocean Resources website (www.coastalandoceans.com).

1.0 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 intertidal zone and nearshore environment. Its objective is to produce an integrated, searchable inventory of geological and biological features which can be used as a tool for science, education, management, and environmental hazard mitigation.

The ShoreZone system was employed in the 1980s and 1990s to map coastal features in British Columbia and Washington state (Howes 2001; Berry et al. 2004). 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 program in Alaska continues to grow through the efforts of a network of partners, including scientists, managers, GIS specialists, and web specialists in federal, state, and local agencies and in private and nonprofit organizations.

Organizations working in partnership for the Alaska ShoreZone effort to date include: 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, and United States Fish and Wildlife Service.

ShoreZone imagery provides a useful baseline, while mapped resources (such as shoreline sediments, eelgrass and wetland distributions) are an important tool for scientists and managers. As of October 2007, mapped regions include more than 21,000 km of coastline in the Gulf of Alaska and 45,000 km of coastline in British Columbia and Washington state (Figures 1.1 and 1.2).

Oblique low-altitude aerial video and digital still imagery of the coastal zone is collected during the lowest tides of the year, usually from a helicopter flying at or below 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 imagery are georeferenced and time-synchronized using a 6-digit UTC time code (Figures 1.4 and 1.5). Video imagery is accompanied by continuous, simultaneous commentary by a geologist and a biologist aboard the aircraft.

Image interpretation and mapping is accomplished by a team of physical and biological scientists, who use the imagery and commentary to delineate along-shore

coastal habitat **units** and to “map” their observations of physical, geomorphic, sedimentary, and biological across-shore **components** within those units (Figure 1.6). Units are digitized as shoreline segments in ArcView or ArcGIS, then integrated with the geological and biological data housed in a relational Microsoft Access database. 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.

The ShoreZone program mandates that the information be widely accessible. Aerial exists for nearly 40,000 km of shoreline in Alaska, and much of it can be viewed online at CoastAlaska.net and www.fakr.noaa.gov/maps/szintro.htm. Thematic data (such as eelgrass, canopy kelps, sediment type, and other features) can also be viewed on these web sites for many mapped regions, including parts of Southeast Alaska and the Northern Gulf of Alaska.

The mapping system provides a spatial framework for coastal habitat assessment on local and regional scales. Research and practical applications of ShoreZone data and imagery include:

- natural resource planning and environmental hazard mitigation
- linking habitat use and life-history strategy of nearshore fish and other intertidal organisms;
- habitat suitability modeling (for example, to predict the spread of invasive species or the distribution of beaches appropriate for spawning fish;
- development evaluation and mariculture site review;
- ground-truthing of aerial data on smaller spatial scales; and
- public use for recreation, education, outreach, and conservation.

Details concerning mapping methodology and the definition of 2007 standards are available in the ShoreZone Coastal Habitat Mapping Protocol for the Gulf of Alaska (Harney et al. 2007). This and other ShoreZone reports are available for download from the Coastal & Ocean Resources website (www.coastalandoceans.com).

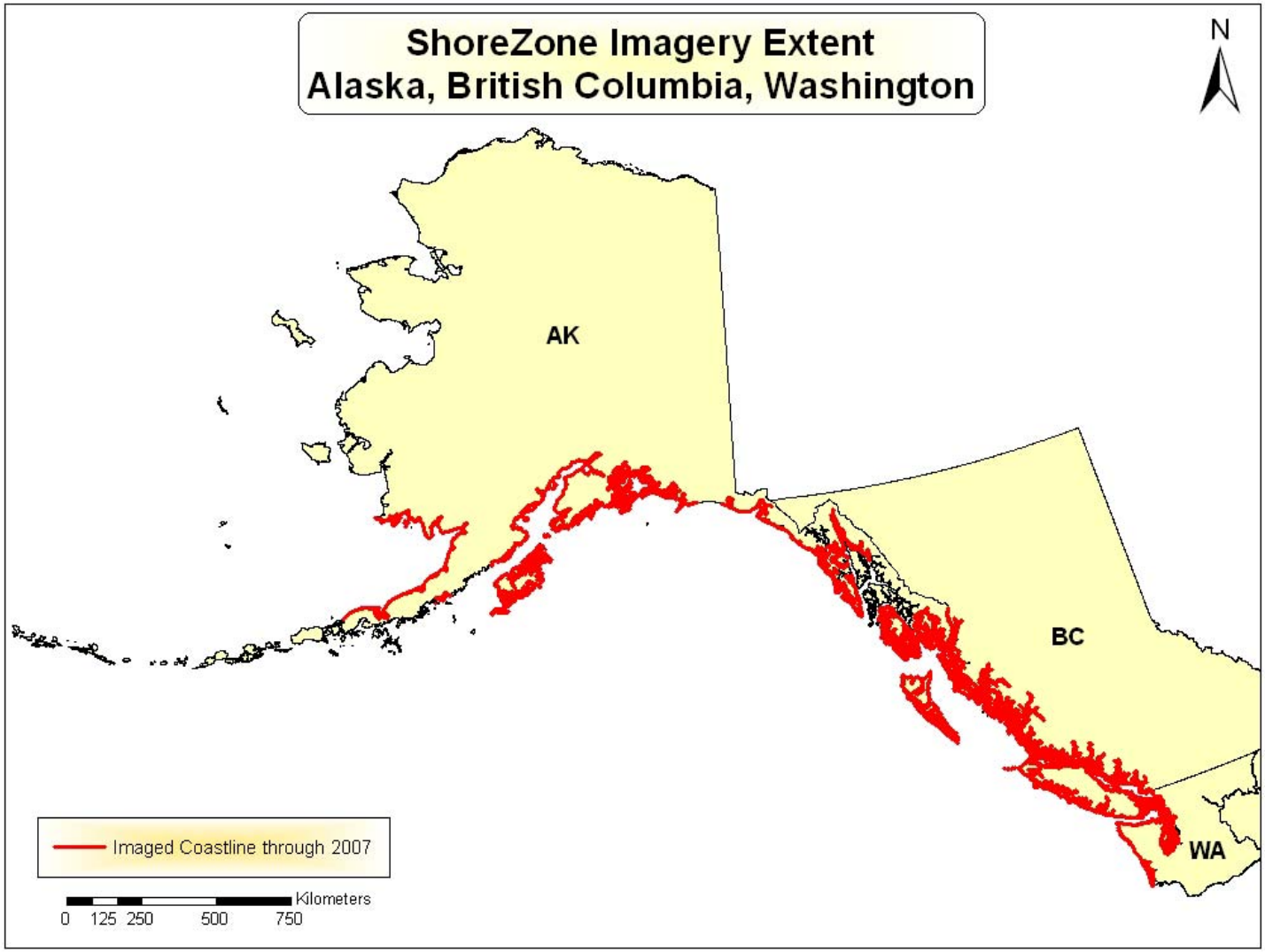


Figure 1.1. Extent of ShoreZone imagery in Alaska, British Columbia, and Washington State.

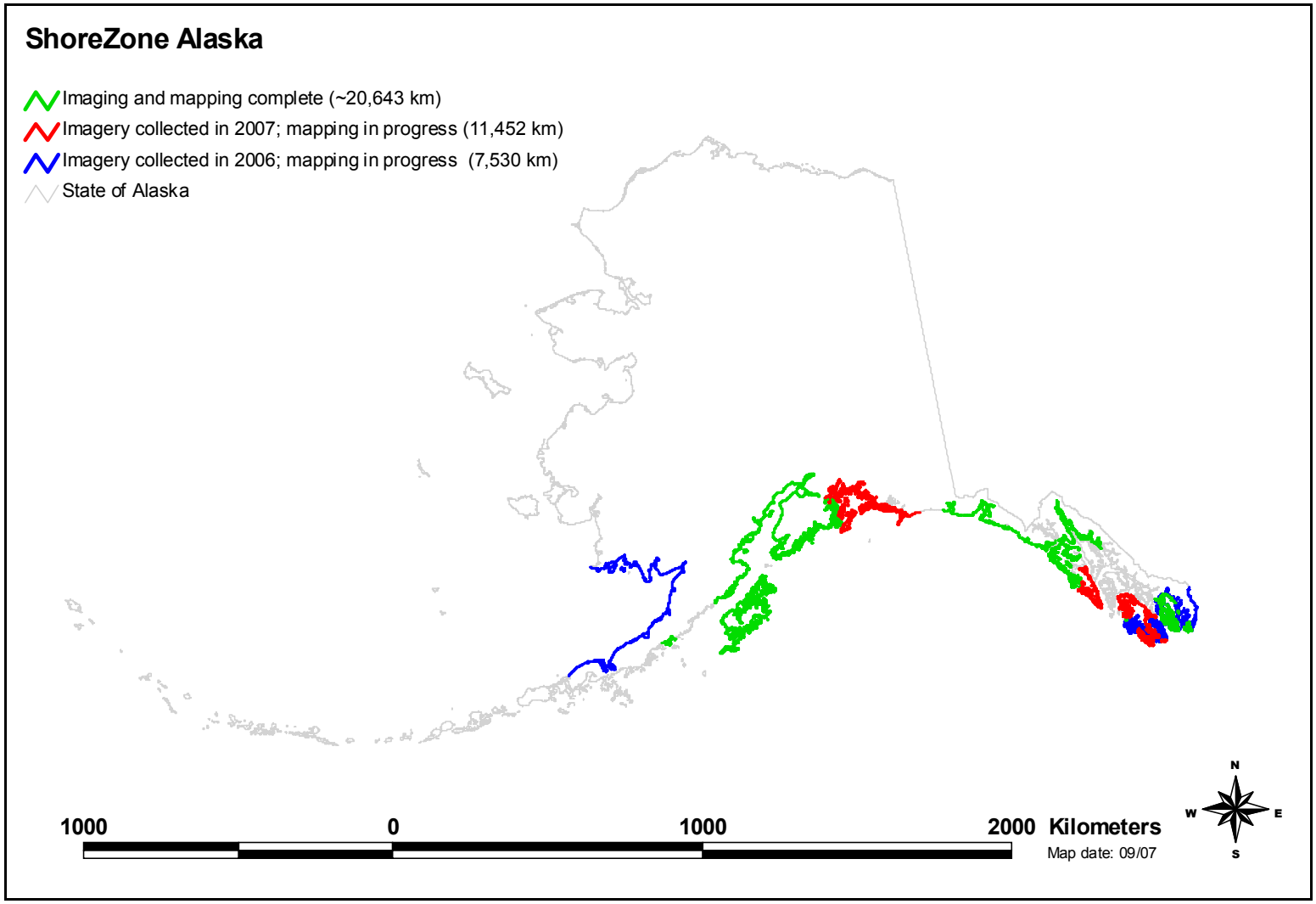


Figure 1.2. Extent of ShoreZone imagery (39,625 km) and coastal habitat mapping in the State of Alaska.

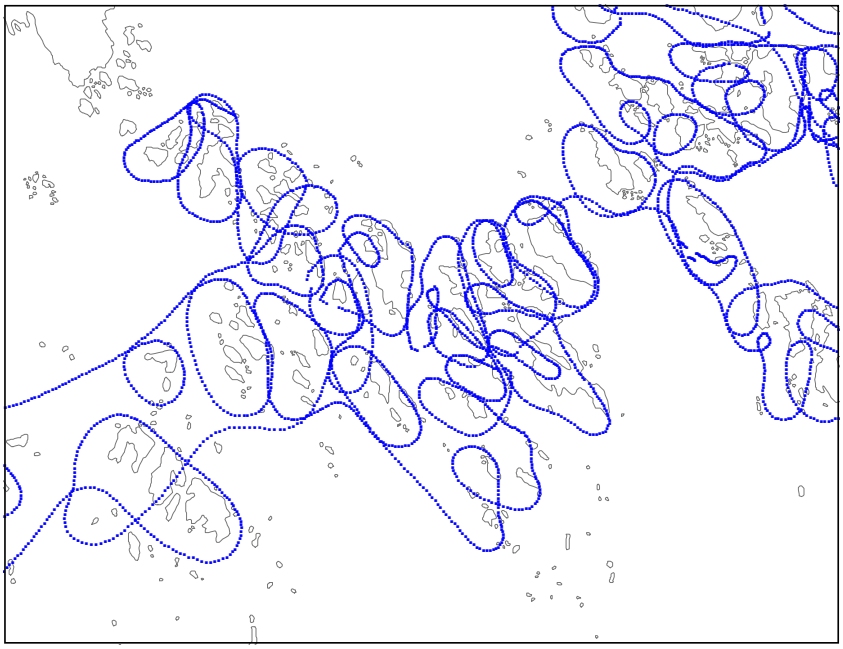


Figure 1.3. Example of recorded flight trackline, with blue dots showing 1-second GPS navigation fixes (Myriad Islands, western Chichagof Island, SE Alaska).

Figure 1.4. Example of frame capture from video imagery in Foul Bay, northwest Afognak Island in the Kodiak Archipelago. Latitude, longitude, and 6-digit UTC time stamp are burned onto each frame of video imagery.

Figure 1.5. Example of digital still imagery, showing biobands in Icy Strait, SE Alaska. Digital photographs are linked to flight survey trackline by 6-digit UTC time code, providing a GPS position for each image.

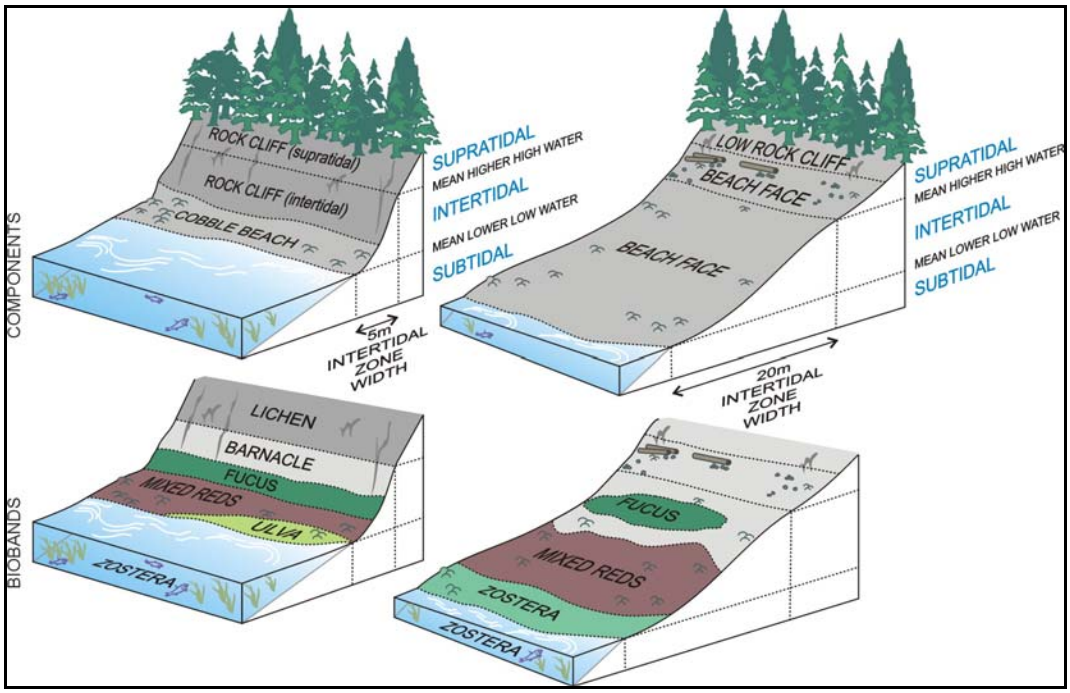


Figure 1.6. Schematic to illustrate how digital shorelines are segmented into alongshore units and across-shore components in the ShoreZone mapping system.

1.2 ShoreZone Mapping in the Ketchikan Area, Southeast Alaska

Field surveys on Revillagigedo Island in Southeast Alaska in 2006 collected aerial video and digital still photographs of the coastal and nearshore zone at zero-tides and lower. The imagery was used to map the geological and biological features of the shoreline. The study area for which ShoreZone coastal habitat mapping is complete is shown in Figure 1.7, and the purpose of this interim report is to provide a summary of that data.

The 1,915 km of shoreline was mapped in 5,476 along-shore segments (units), averaging 350 m in length. Physical (geological) and biological data are summarized with illustrations in Sections 2 and 3, respectively.

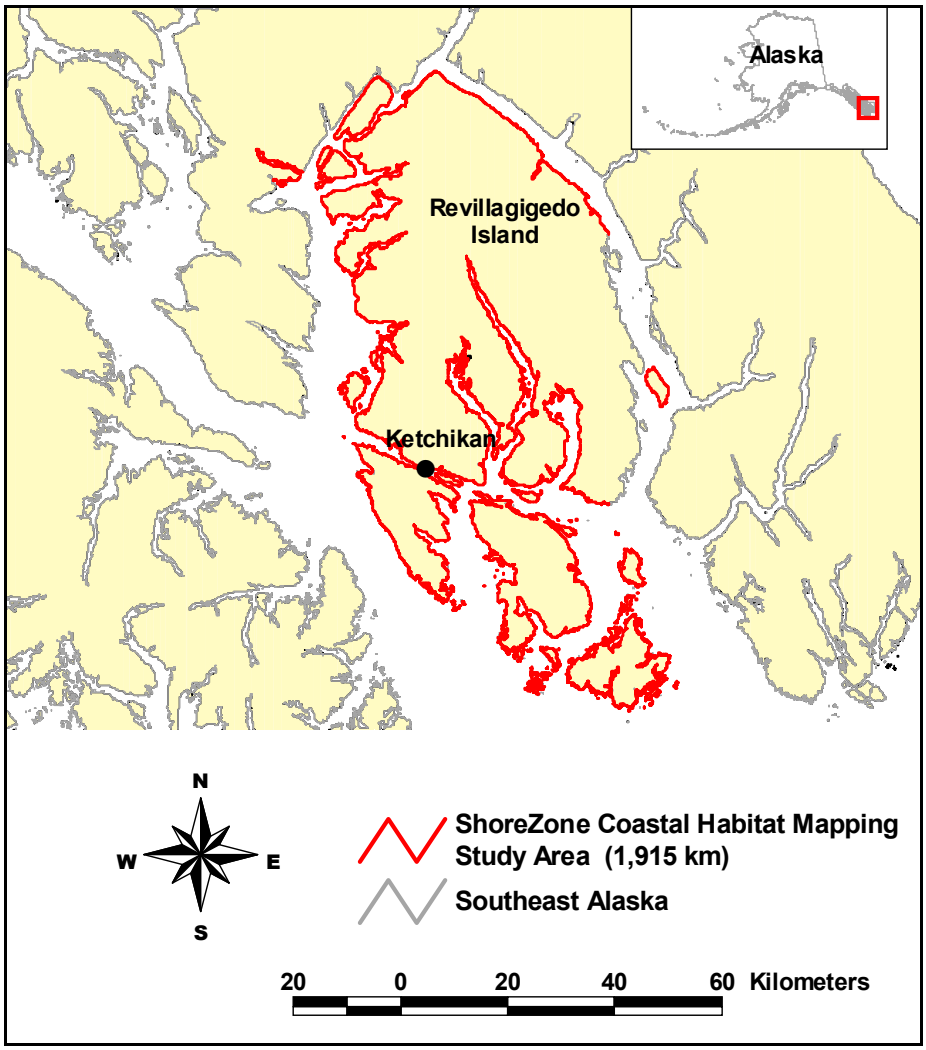


Figure 1.7. Map of study area for which geological and biological ShoreZone data are summarized in this interim report (1,915 km).

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 two unit classification systems: coastal shore types defined for British Columbia ("BC Class") and the "Environmental Sensitivity Index" (ESI) class developed for oil-spill mitigation. A shoreline classification system unique to ShoreZone ("Habitat Class") is defined in Section 3.3.

The BC Class system is used to describe alongshore coastal units as one of 34 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). Coastal classes also characterize units dominated by organic shorelines such as marshes and estuaries (BC Class 31), man-made features (BC Classes 32 and 33), high-current channels (BC Class 34), and glaciers (BC Class 35).

The occurrence of BC shore types in the study area (Ketchikan and portions of Revillagigedo Island) is listed in Table 2.1. Grouped BC Classes are useful to illustrate mapped distributions (Figure 2.1) and to summarize data in graphic form (Figure 2.2). **Bedrock shorelines** (BC Classes 1-5) comprise 261 km (13.6%) of mapped shorelines. More than half of the mapped coastal environment is characterized as **mixed rock and sediment shorelines** (BC Classes 6-20: 1,026 km or 53.6%). 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 256.9 km of the study area (13.4%). Of these, wide sand and gravel flats (BC Class 24) are the most common, mapped along 152.2 km of shoreline (7.9% of the total study area). Photographic examples of BC Class shore types in this area of Southeast Alaska are provided in Section 2.3.

The **NOAA Environmental Sensitivity Index (ESI Class)** is a shoreline classification system developed to categorize coastal regions on the basis of their oil-spill sensitivity. The ESI system uses wave exposure and principal substrate type to assign alongshore coastal units 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 (Peterson et al. 2002; Table A-3). The ESI system is an integral component of oil-spill contingency planning, emergency response, and coastal resource management. Substrate permeability is of principal importance 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 the study area is listed in Table 2.2. The distribution of beaches and tidal flats (on the basis of mapped ESI class referring to sediment texture) is shown in Figure 2.5.

Table 2.1. Summary of shore types by BC Class for the 1,915 km of mapped shoreline in the study area (Ketchikan area and portions of Revillagigedo Island, Southeast Alaska). Data are shown in map form in Figure 2.1 and in pie chart form in Figure 2.2.

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	2.9	10	0.2%	**13.6%**
	2	Rock Platform, wide	3.2	9	0.2%	**261 km**
	3	Rock Cliff	186.4	428	9.7%	
	4	Rock Ramp, narrow	66.4	214	3.5%	
	5	Rock Platform, narrow	1.9	7	0.1%	
Rock & Sediment	6	Ramp with gravel beach, wide	76.5	228	4.0%	**53.6%**
	7	Platform with gravel beach, wide	49.6	110	2.6%	**1026 km**
	8	Cliff with gravel beach	85.2	208	4.4%	
	9	Ramp with gravel beach	284.9	812	14.9%	
	10	Platform with gravel beach	8.2	29	0.4%	
	11	Ramp w gravel & sand beach, wide	161.5	409	8.4%	
	12	Platform with G&S beach, wide	179.5	458	9.4%	
	13	Cliff with gravel/sand beach	17.2	71	0.9%	
	14	Ramp with gravel/sand beach	148.3	477	7.7%	
	15	Platform with gravel/sand beach	9.9	40	0.5%	
	16	Ramp with sand beach, wide	0.8	3	0.0%	
	17	Platform with sand beach, wide	1.3	2	0.1%	
	18	Cliff with sand beach	0.6	2	0.0%	
	19	Ramp with sand beach, narrow	2.0	4	0.1%	
	20	Platform with sand beach, narrow	0.0	0	0.0%	
Sediment	21	Gravel flat, wide	10.5	58	0.5%	**13.4%**
	22	Gravel beach, narrow	28.4	94	1.5%	**257 km**
	23	Gravel flat or fan	0.4	1	0.0%	
	24	Sand & gravel flat or fan	152.2	478	7.9%	
	25	Sand & gravel beach, narrow	42.2	194	2.2%	
	26	Sand & gravel flat or fan	2.1	12	0.1%	
	27	Sand beach	0.0	0	0.0%	
	28	Sand flat	9.4	23	0.5%	
	29	Mudflat	11.7	27	0.6%	
	30	Sand beach	0.1	1	0.0%	
Organics/Marsh	31	Estuaries, marshes	339.3	600	17.7%	**17.7% (340**
Man-made	32	Man-made, permeable	27.2	83	1.4%	**1.5% (29 km)**
	33	Man-made, impermeable	1.7	5	0.1%	
Channel	34	Channel	3.0	8	0.2%	**0.2% (3 km)**
Glacier/Ice	35	Glacier	0.0	0	0.0%	**0%**

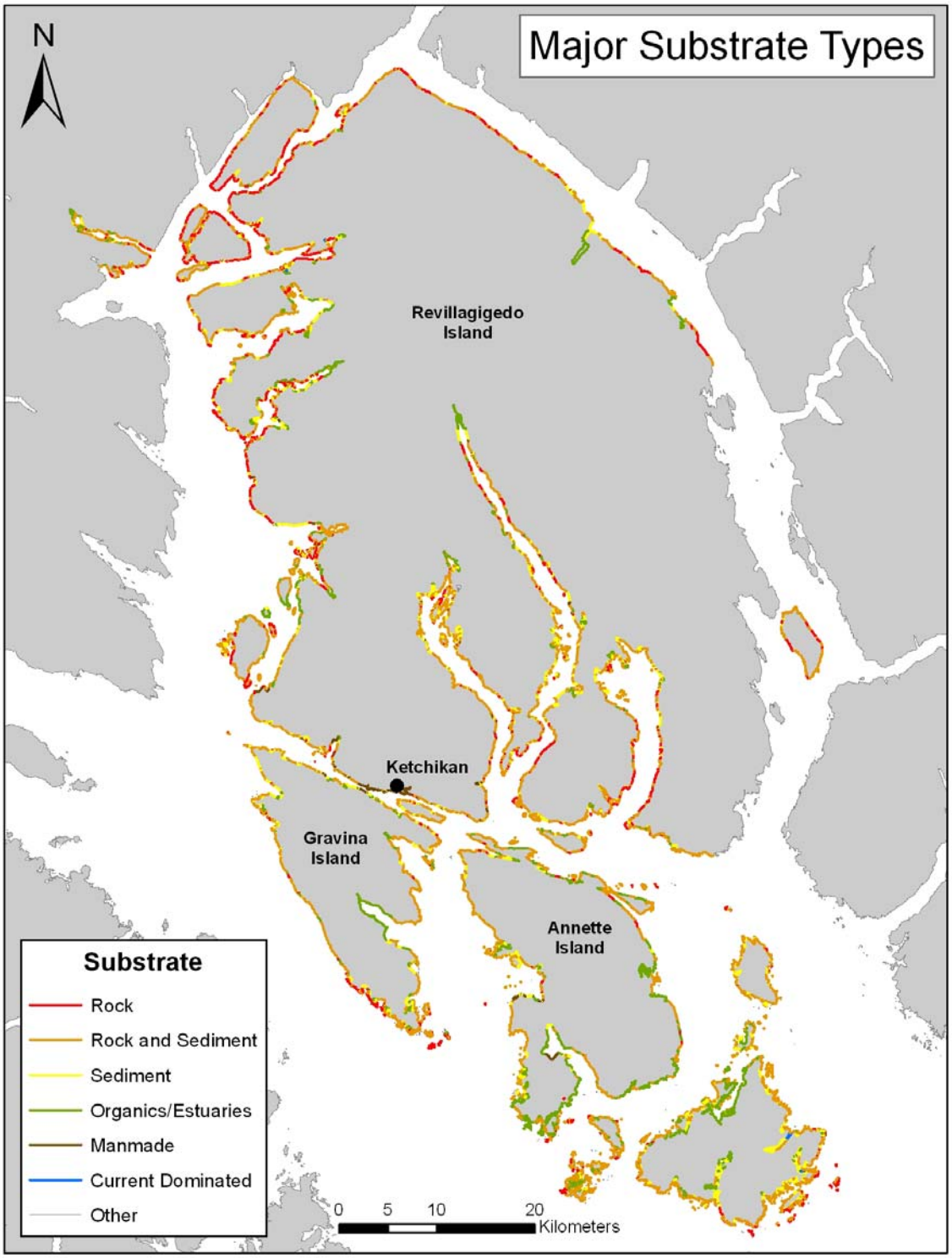


Figure 2.1. Map of the distribution of principal substrate types (on the basis of grouped BC Classes) in the Ketchikan area and portions of Revillagigedo Island. Data are listed by individual class and by grouped classes in Table 2.1.

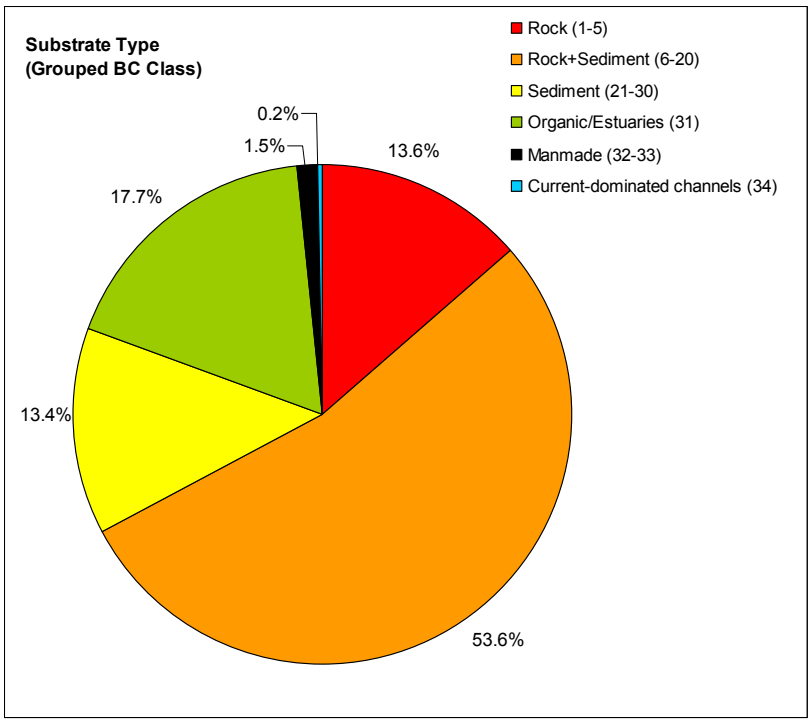


Figure 2.2. Abundance of principal substrate types (on the basis of grouped BC Classes) in Ketchikan area and portions of Revillagigedo Island, Southeast Alaska). Numerical data are listed in Table 2.1. See Section 2.3 for shore type example photographs.

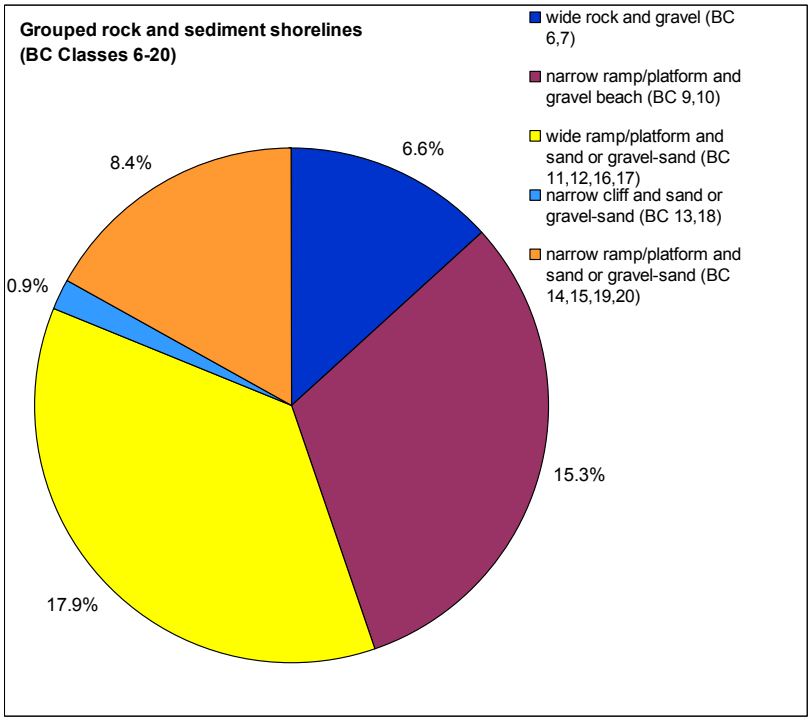


Figure 2.3. Grouped BC classes illustrating the abundance of mixed rock and sediment shorelines (BC classes 6-20) in the study area.

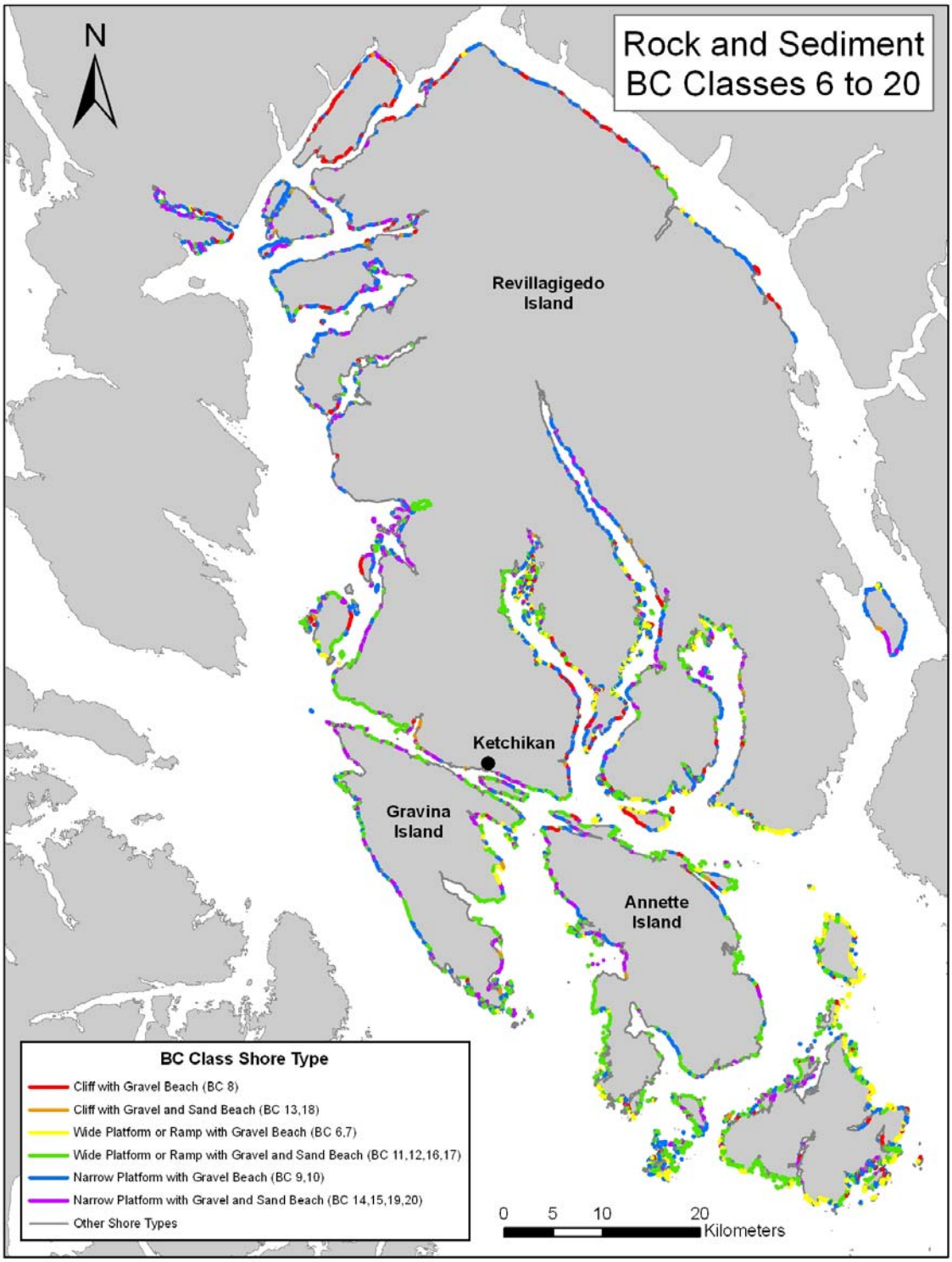


Figure 2.4. Map of the distribution of mixed rock and sediment shorelines (on the basis of grouped BC Classes) in the Ketchikan area and portions of Revillagigedo Island. Data are listed by individual class and by grouped classes in Table 2.1.

Table 2.2. Summary of shore types by ESI Class for the 1,915 km of mapped shoreline in the study area (Ketchikan area and portions of Revillagigedo Island, Southeast Alaska).

ESI Class	Description	Sum of Unit Length (km)	# of Units	% Occurrence (by length)
1A	Exposed rocky shores and banks	31.1	70	1.6%
1B	Exposed, solid, man-made structures	0.0	0	0.0%
1C	Exposed rocky cliffs with boulder talus base	10.7	32	0.6%
2A	Exposed wave-cut platforms in bedrock, mud, or clay	66.0	184	3.4%
2B	Exposed scarps and steep slopes in clay	0.0	0	0.0%
3A	Fine- to medium-grained sand beaches	0.0	0	0.0%
3B	Scarps and steep slopes in sand	0.0	0	0.0%
3C	Tundra cliffs	0.0	0	0.0%
4	Coarse-grained sand beaches	1.5	4	0.1%
5	Mixed sand and gravel beaches	542.7	1698	28.3%
6A	Gravel beaches (granules and pebbles)	48.1	198	2.5%
6B	Gravel beaches (cobbles and boulders)	131.7	334	6.9%
6C	Rip rap (man-made)	0.2	1	0.0%
7	Exposed tidal flats	10.6	25	0.6%
8A	Sheltered scarps in bedrock, mud, or clay; sheltered rocky shores (impermeable)	192.1	546	10.0%
8B	Sheltered, solid, man-made structures; sheltered rocky shores (permeable)	90.7	217	4.7%
8C	Sheltered riprap (man-made)	5.8	17	0.3%
8D	Sheltered rocky rubble shores	289.5	778	15.1%
8E	Peat shorelines	0.0	0	0.0%
9A	Sheltered tidal flats	165.2	434	8.6%
9B	Vegetated low banks	1.0	1	0.1%
9C	Hypersaline tidal flats	0.0	0	0.0%
10A	Salt- and brackish-water marshes	327.8	566	17.1%
10B	Freshwater marshes	0.0	0	0.0%
10C	Swamps	0.0	0	0.0%
10D	Scrub-shrub wetlands; mangroves	0.0	0	0.0%
10E	Inundated low-lying tundra	0.0	0	0.0%

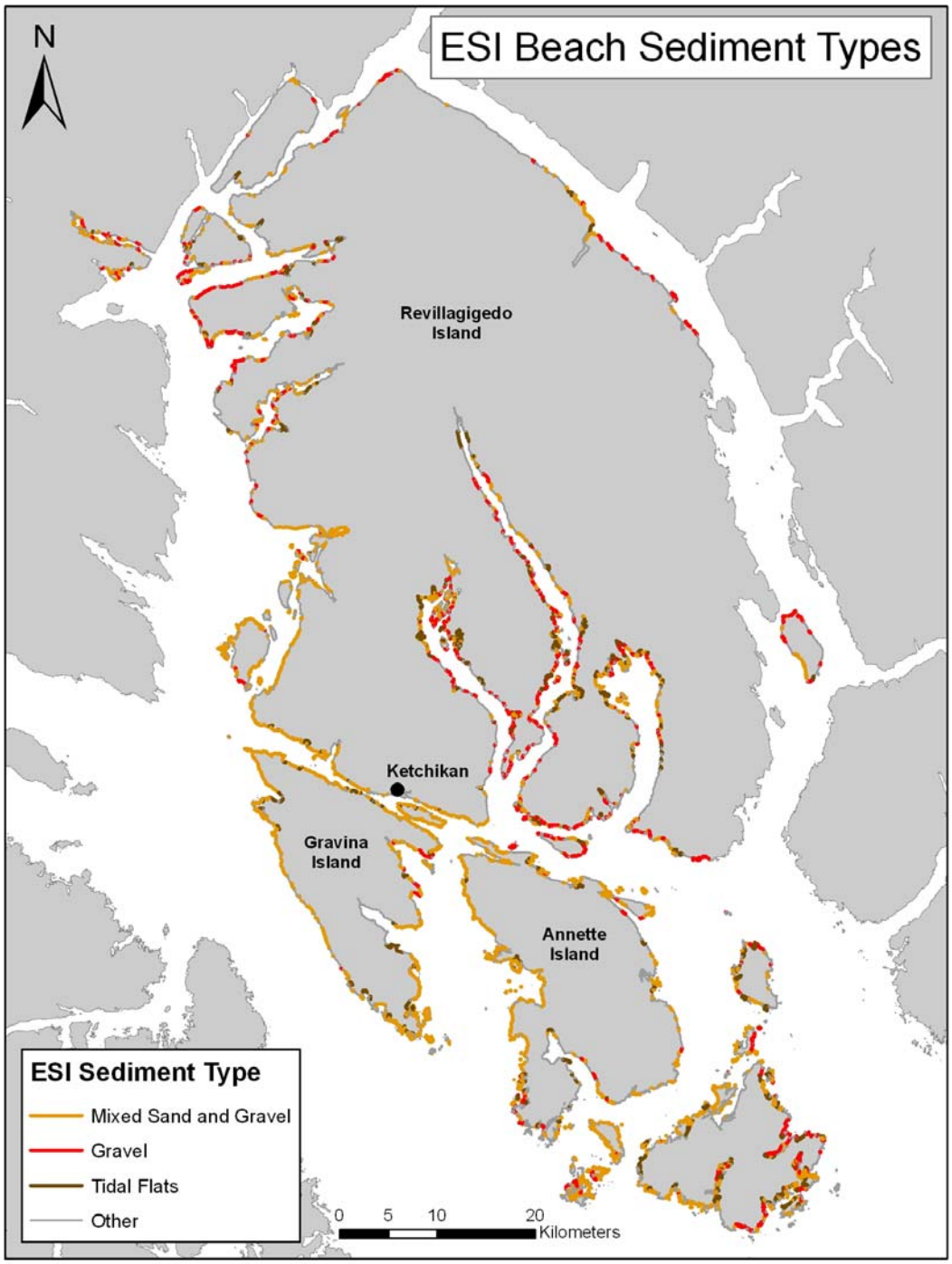


Figure 2.5. Distribution of beaches and tidal flats on the basis of ESI class. Mixed sand and gravel beaches refer to ESI classes 4 and 5 (544 km of shoreline). Gravel beaches refer to ESI classes 6A and 6B (179 km) and are composed mainly of cobbles and boulders. Tidal flats (ESI class 9A, 165 km) are >30 m wide and may contain organic material, fine sediment, sand, and some gravel (cobble and boulder veneer); they are generally confined to relatively protected areas at the heads of inlets.

2.2 Anthropogenic Shore Modifications

Shore-protection features and coastal access constructions such as seawalls, rip rap, docks, dikes, and wharves are enumerated in ShoreZone mapping data. Overall, shorelines classified as man-modified (having more than 50% of the unit altered by human activities, assigned BC Classes 32 and 33) occur along 29 km (1.5%) of shoreline in the study area. The types of shore modification features (such as boat ramps, bulkheads, and rip rap) and their relative proportions of the intertidal zone are mapped into the database in the "SHORE_MOD" fields of the UNIT table (see Table A-1 for a description of these fields).

The distribution of shore modifications mapped in the study area (Table 2.3) is shown in Figure 2.6. The inset boxes provide detail on the type of modification found in the coastal communities of Ketchikan and Metlakatla.

Table 2.3. Summary of shore modifications mapped in the 1,915 km of mapped shoreline in the study area (Ketchikan area and portions of Revillagigedo Island, Southeast Alaska).

Shore Modification	Code	# of Units
wooden bulkhead	WB	95
boat ramp	BR	22
concrete bulkhead	CB	10
landfill	LF	48
sheet pile	SP	6
riprap	RR	218

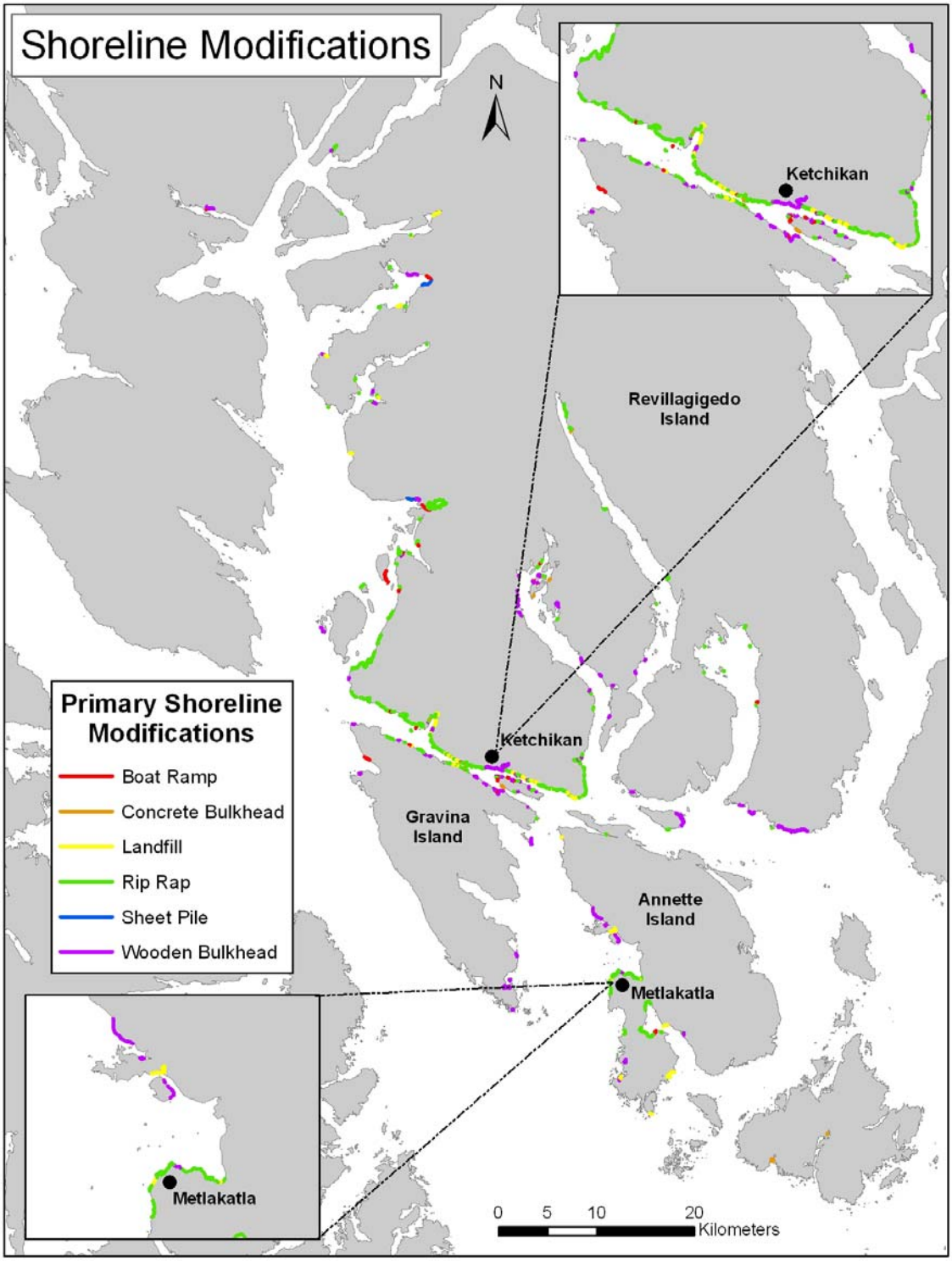


Figure 2.6. Map of the distribution of units in which shore modification features were observed in Ketchikan area and portions of Revillagigedo Island.

2.3 Physical Illustrations: Shore Types and Geomorphic Features

The following pages provide illustrated examples of shore types and geomorphic features mapped in the study area (Ketchikan and portions of Revillagigedo Island).

Shore Type: Rock (BC Classes 1-5)
Shore Type: Rock and Sediment (BC Classes 6-20)
Shore Type: Sediment (BC Classes 21-30)
Shore Type: Organic Shorelines, Marshes, and Estuaries (BC Class 31)
Shore Type: Human-Altered Shorelines (BC Classes 32-33)
Shore Type: Current-Dominated Channels (BC Class 34)
Geomorphic Features: Marshes and Wetlands
Geomorphic Features: Deltas, Mudflats, and Tidal Flats
Geomorphic Features: Beach Berms and Ridges
Geomorphic Features: Lagoons
Anthropogenic Features: Coastal Structures and Seawalls

Shore Type: Rock (BC Classes 1-5)

BC Class 2 (wide rock platform)	BC Class 3 (steep rock cliff)
Cone Island (12/01/2173)	Hassler Pass (Unit 12/01/3136)
SE06_MM_06925.JPG	SE06_MM_03071.JPG

Shore Type: Rock (BC Classes 1-5)

BC Class 3 (steep rock cliff)	BC Class 4 (narrow rock ramp)
SE Revillagigedo Island (Unit 12/01/8332)	South Revillagigedo Island, near Mountain Point (Unit 12/01/0182)
SE06_MM_04981.JPG	SE06_MM_00286.JPG

Shore Type: Rock and Sediment (BC Classes 6-20)

BC Class 9 (ramp with gravel beach)	BC Class 12 (wide platform with gravel and sand beach)
Yes Bay (Unit 12/01/7091)	Gedney Pass (Unit 12/01/3163)
SE06_MM_02639.JPG	SE06_MM_03261.JPG

Shore Type: Rock and Sediment (BC Classes 6-20)

BC Class 14 (narrow ramp with gravel and sand beach)	BC Class 19 (narrow ramp with sand beach)
Hassler Island (12/01/3067)	Neets Bay (Unit 12/01/9044)
SE06_MM_03054.JPG	SE06_MM_03720.JPG

Shore Type: Sediment (BC Classes 21-30)

BC Class 22 (narrow gravel beach)	BC Class 24 (wide sand and gravel flat or fan)
Yes Bay (Unit 12/01/7114)	Revillagigedo Island (Unit 12/01/2133)
SE06_MM_02700.JPG	SE06_MM_06893.JPG

Shore Type: Sediment (BC Classes 21-30)

BC Class 25 (narrow sand and gravel beach)	BC Class 29 (wide mudflat)
Hassler Pass (Unit 12/01/3066)	Revillagigedo Island (Unit 12/01/2279/0)
SE06_MM_03052.JPG	SE06_HA_0774.JPG

Shore Type: Organic Shorelines, Marshes, and Estuaries (BC Class 31)

BC Class 31 (organic shorelines, marshes, and estuaries)	BC Class 31 (organic shorelines, marshes, and estuaries)
Yes Bay (Unit 12/01/7070)	Hassler Island (Unit 12/01/3096)
SE06_MM_02554.JPG	SE06_MM_03103.JPG

Shore Type: Human-Altered Shorelines (BC Classes 32-33)

BC Class 32 (man-made, permeable)	BC Class 32 (man-made, permeable)
Shrimp Bay (Unit 12/01/3220)	Revillagigedo Island (Unit 12/01/0150)
SE06_MM_03388.JPG	SE06_MM_00240.JPG

Shore Type: Current-Dominated Channels (BC Class 34)

BC Class 34 (current-dominated channel)	BC Class 34 (current-dominated channel)
Gedney Pass (Unit 12/01/3248)	Shrimp Bay (12/01/3193)
SE06_MM_03430.JPG	SE06_MM_03317.JPG

Geomorphic Features: Marshes and Wetlands

BC Class 31, Forms Mho (high marsh with ponds), Ml (low, discontinuous marsh), and Ttc (tidal flat and channels)	BC Class 31, Forms Msh (supratidal, high, brackish marsh) and Mloc (low, discontinuous marsh with ponds and tidal creeks)
Shrimp Bay (Unit 12/01/3198)	Revillagigedo Island (Unit 12/01/2049)
SE06_MM_03340.JPG	SE06_MM_06819.JPG

Geomorphic Features: Deltas, Mudflats, and Tidal Flats

BC Class 24, Form Df (delta fan)	BC Class 16, Form Tt (tidal flat)
Revillagigedo Island (Unit 12/01/1106)	White River Camp (Unit 12/01/1129)
SE06_ML_00146.JPG	SE06_ML_00180.JPG

Geomorphic Features: Deltas, Mudflats, and Tidal Flats

BC Class 31, Form Dfm (delta fan with multiple channels)	BC Class 24, Form Df (delta fan)
Margarite Bay (Unit 12/01/8102)	Traitors Cove (Unit 12/01/8045)
SE06_MM_04217.JPG	SE06_MM_04111.JPG

Geomorphic Features: Beach Berms and Ridges

BC Class 24, Form Bb (beach berm)	BC Class 25, Form Bf (beach face)
Tatoosh Islands (Unit 12/01/8412)	Gnat Cove (Unit 12/01/1797)
SE06_MM_05217.JPG	SE06_MM_06356.JPG

Geomorphic Features: Lagoons

BC Class 31, Form Lo (open lagoon)	BC Class 12, Form Lo (open lagoon)
Revillagigedo Island (Unit 12/01/2117)	Pennock Island (Unit 12/01/0228)
SE06_MM_06881.JPG	SE06_MM_00350.JPG

Anthropogenic Features: Coastal Structures and Shore Modifications

BC Class 32, Form Aw (wharf)	BC Class 32, Forms Aw (wharf), As (seawall), and Af (floats)
Ward Cove (Unit 12/01/0068)	Revillagigedo Island (Unit 12/01/0140)
SE06_MM_00065.JPG	SE06_MM_00191.JPG

3 BIOLOGICAL SHOREZONE DATA SUMMARY

3.1 Biobands

Biological ShoreZone mapping includes both observed and interpreted data. 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)).

Biological ShoreZone mapping is based on the principle that the occurrence and extent of biobands is directly related to both the degree of wave exposure and the substrate type in the coastal zone. The observed presence, absence, and distribution (mapped as “continuous” or “patchy”) of biobands within an alongshore unit are used to assign the interpreted characteristics of **biological wave exposure** and **habitat class** for the unit.

Figure 3.1. Alongshore biobands of color and texture formed by biological assemblages of species in the intertidal zone. Shown is a rocky shoreline along the Semi-Protected (SP) side of northern Black Island. (SE06_MM_02778.jpg)

Table 3.1. Summary of bioband definitions for southeast Alaska.

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
	Dune Grass	**GRA**	Pale blue-green	*Leymus mollis*	P to E
	Sedges	**SED**	Bright green to yellow-green	*Carex* sp.	VP to SP
	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
	Rockweed	**FUC**	Golden-brown	*Fucus* sp.	P to SE
	Green Algae	**ULV**	Green	*Ulva* sp. Other small green algae	P to E
	Blue Mussel	**BMU**	Black or blue-black	*Mytilus trossulus*	P to E
	California Mussel	**MUS ****	Grey-blue	California Mussel (*M. californianus*), gooseneck barnacles (*Pollicipes polymerus)*	SE to E
	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
	Alaria	**ALA**	Dark brown	*Alaria* sp.	SP to E
	Soft Brown Kelps	**SBR**	Yellow-brown, olive brown or brown.	*Saccharina latissima* *Cystoseira* sp.	VP to SE
	Dark Brown Kelps	**CHB**	Dark chocolate brown	Stalked *Laminaria* sp. *Cymathere* sp. Other bladed kelps	SE to E
	Surfgrass	**SUR**	Bright green	*Phyllospadix* sp.	SP to SE
	Eelgrass	**ZOS**	Bright to dark green	*Zostera marina*	VP to SP
Sub-tidal	Urchin Barrens	**URC ****	Underwater coralline white	*Strongylocentrotus franciscanus*	SP to SE
	Dragon Kelp	**ALF**	Golden-brown	*Alaria fistulosa*	SP to SE
	Giant Kelp	**MAC**	Golden-brown	*Macrocystis integrifolia*	P to SE
	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.)

** California Mussel (MUS) and Urchin Barrens (URC) biobands have been added to the biological mapping in the area of southernmost southeast Alaska included in this summary report. Previously, MUS and URC were mapped in British Columbia, but have not been observed elsewhere in Alaska.

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.

As mapping has been completed in different geographic areas, differences in the species assemblages that characterize the lower intertidal biobands have become apparent. These biobands are: Bleached Red Algae (HAL), Red Algae (RED), Soft Brown Kelps (SBR) and Dark Brown Kelps (CHB). These four biobands are also particularly important as biological indicators of wave exposure.

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 (listed in Appendix A, Table A-7). Seven bioareas have also been defined for the British Columbia coast.

Separate bioband definitions are written for each bioarea and as ground surveys are completed, detail is added to the definitions of indicator and associated species for each of the four lower intertidal biobands. So far in southeast Alaska, in the absence of species detail from on-the-ground sites, the different bioareas are based on overview interpretation of 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) (Table 3.2).

Biomapping for the northern part of southeast Alaska (the shoreline imaged during 2004 and 2005 surveys) have been assigned to four bioareas: Yakutat (SEYA), Lynn Canal (SEFJ), Icy Strait (SEIC), and Sitka (SESI) (Figure 3.2). The 2006 imagery summarized in this report has been assigned to two more bioareas: Craig (SECR) and Misty Fjords (SEMJ). As the imagery and mapping for southeast Alaska is completed, the boundaries between these bioareas will be adjusted, based on the observed biota. Additional bioareas may be added, if necessary.

Example illustrations and full definitions of the biobands mapped in this project area of southeast Alaska follow the summary map page (below). Each photo is labelled by bioareas and by location. The URC band was observed in the mapping encompassed in this report. The MUS band was not observed in this area and therefore example photos are not available, however the biological commentator noted seeing this band in the 2006 and 2007 southeast Alaska AVI surveys so we anticipate it appearing in future mapping.

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

Bioarea Codes	Bioarea	Characteristics
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, wide, sediment-dominated beaches common, fringing salt marsh common, moderate and lower wave exposures, wide estuary flats common. 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.

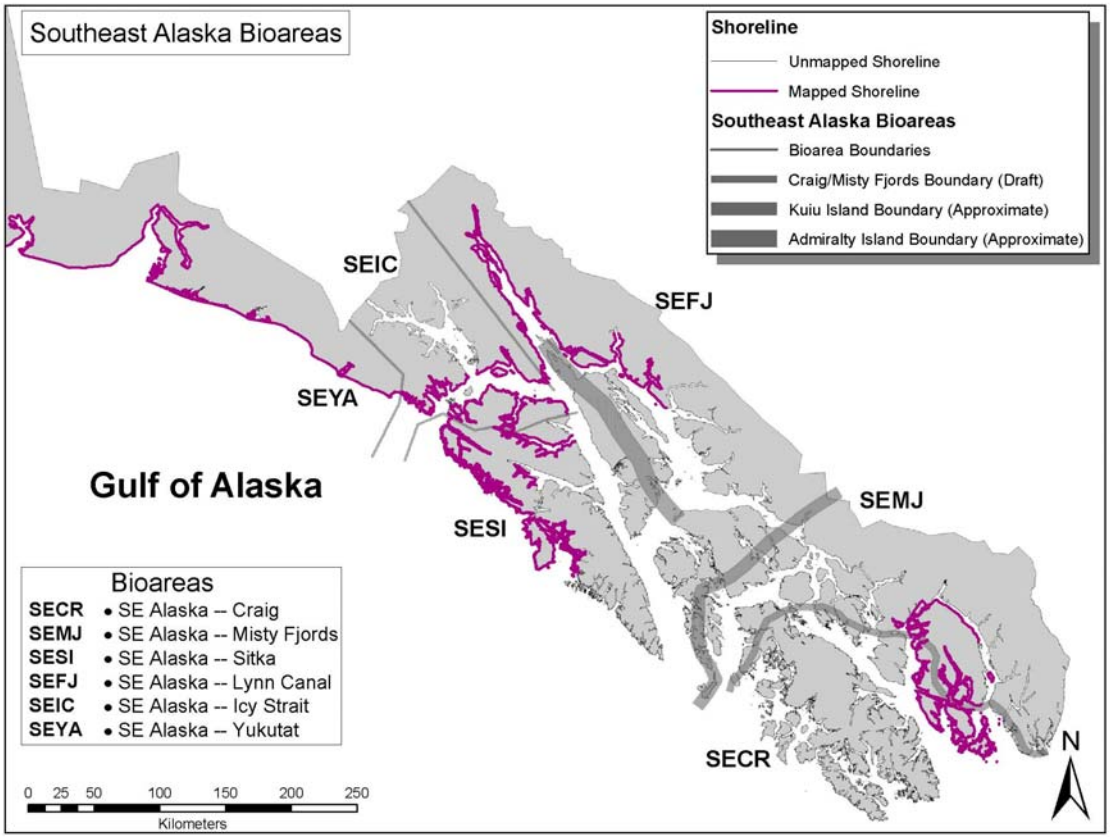


Figure 3.2. Map of bioareas identified in Southeast Alaska (to date).

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 wide Splash Zone (VER) band of *Verrucaria* can be seen on this immobile Semi-Exposed (SE) shore of eastern Mary Island.

SE06_MM_10204.jpg

Bioarea SECR

A dark black stripe of *Verrucaria* representing the Splash Zone (VER) is distinct above underlying bands of Rockweed (FUC) and Red Algae (RED) on the northern tip of Duke Island.

SE06_MM_15303.jpg

Bioarea SECR

The Dune Grass (GRA), Sedges (SED), and Marsh grasses, herbs and sedges (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. Often appears as a mosaic of greens.	*Carex ramenskii* *Carex lynbyei* *Carex sp.* *Eleocharis sp.* *Eriophorum sp.*	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	
A	**Salt Marsh**	**PUC**	Light, bright, or dark green, with red-brown	*Puccinellia sp.* *Plantago maritima* *Triglochin sp.* *Honkenya peploides*	Appears in wetlands around lagoons, marshes, and estuaries. Usually associated with freshwater. Often fringing the edges of GRA and SED bands.	VP-SE	*Carex sp.*

A mixture of tall, blue-green Dune Grass (GRA) and lush Sedges (SED) can be seen in this Protected (P) estuary on the northern end of Dog Island northwest of Duke Island.

SE06_MM_15440.jpg

Bioarea SECR

A Very-Protected (VP) estuary displaying an extensive saltmarsh at the head of George Inlet, Revillagigedo Island.

SE06_ML_00302.jpg

Bioarea SEMJ

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.*

A continuous band of creamy white Barnacles (BAR) covers this Protected (P) immobile rock on Hassler Island.

SE06_MM_03114.jpg

Bioarea SEMJ

Below a medium (M) *Verrucaria* (VER) band, a frosting of Barnacles (BAR) forms in the high intertidal range of this Semi-Exposed (SE) portion of Davidson Point on Annette Island.

SE06_MM_08122.jpg

Bioarea SECR

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.* *Pilayella sp.*

Rockweed (FUC) forms a wide golden band in the upper intertidal along with Green Algae (ULV) on this Semi-Protected (SP) platform on Pennock Island in Tongass Narrows.

SE06_MM_00369.jpg

Bioarea SECR

A dense covering of Rockweed (FUC) forms a continuous band on northwest Duke Island.

SE06_MM_15481.jpg

Bioarea SECR

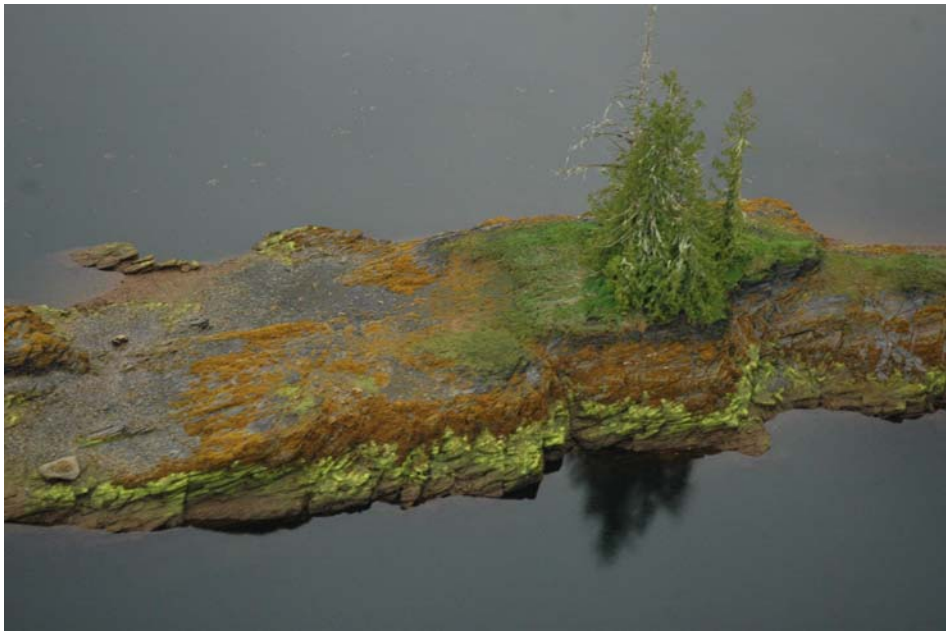
The Green Algae (ULV) Bioband

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.

Bright Green Algae (ULV) forms a continuous band at the waterline below an overhanging riparian zone on Revillagigedo Island along the Protected (P) waters of Long Arm.

SE06_MM_04603.jpg

Bioarea SECR



Distinct bands of Green Algae (ULV) and Rockweed (FUC) extend across this Protected (P) islet off Bull Island at the north end of George Inlet.

SE06_ML_00444.jpg

Bioarea SECR

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.

Thick Blue Mussel (BMU) dominate this immobile bedrock creating a distinct blue-black band below a Barnacle (BAR) band along Cleveland Peninsula.

SE06_MM_02431.jpg

Bioarea SEMJ

Patchy Blue Mussel (BMU) span the intertidal bedrock of this Semi-Protected shore in Behm Canal. Note the difference between the Blue Mussel (BMU) and the narrow *Verrucaria* band above of the Splash Zone (VER).

MM_04338.jpg

Bioarea SEMJ

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

Bleached Red Algae (HAL) spans across the intertidal zone in the Tatoosh Islands off western Betton Island in Behm Canal.

SE06_MM_05228.jpg

Bioarea SEMJ

The bleached tips and dark roots of this Bleached Red Algae (HAL) is *Odonthalia sp.*, found in Cat Passage, of Cat Island along with a distinct band of Bull Kelp (NER) in the nearshore subtidal.

SE06_MM_10055.jpg

Bioarea SECR

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

A dark brick red Red Algae (RED) band is seen in the lower intertidal, with a distinct overlying band of Rockweed (FUC) on Duke Island in Felice Strait.

SE06_MM_15309.jpg

Bioarea SECR

Red Algae (RED) seen in association with bands of Blue Mussel (BMU), Rockweed (FUC) and Barnacles (BAR) occur on the Semi-Protected (SP) shores of Cleveland point, heading into Yes Bay.

SE06_MM_02454.jpg

Bioarea SEMJ

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.*

This Semi-Protected (SP) Partially mobile shore shows a continuous *Alaria* (ALA) band along the lower intertidal and nearshore subtidal of Annette Point.

SE06_MM_08499.jpg

Bioarea SECR

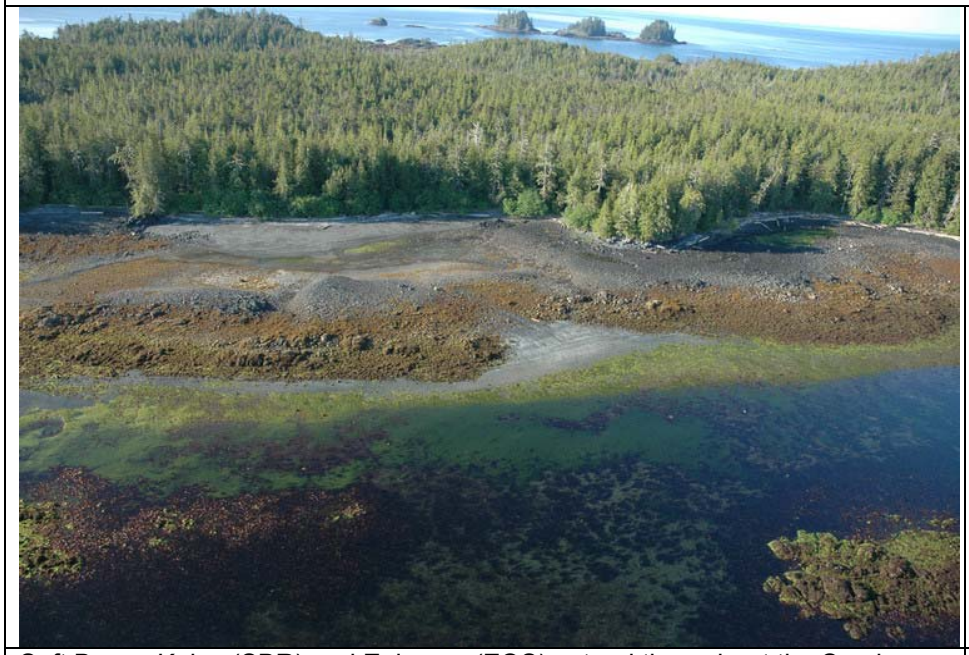
Alaria (ALA) caps the tops of these offshore reefs of Duck Island and can be easily identified by its ribbon-like texture and red-brown colour.

MM_09984.jpg

Bioarea SECR

The Soft Brown Kelps (SBR) Bioband

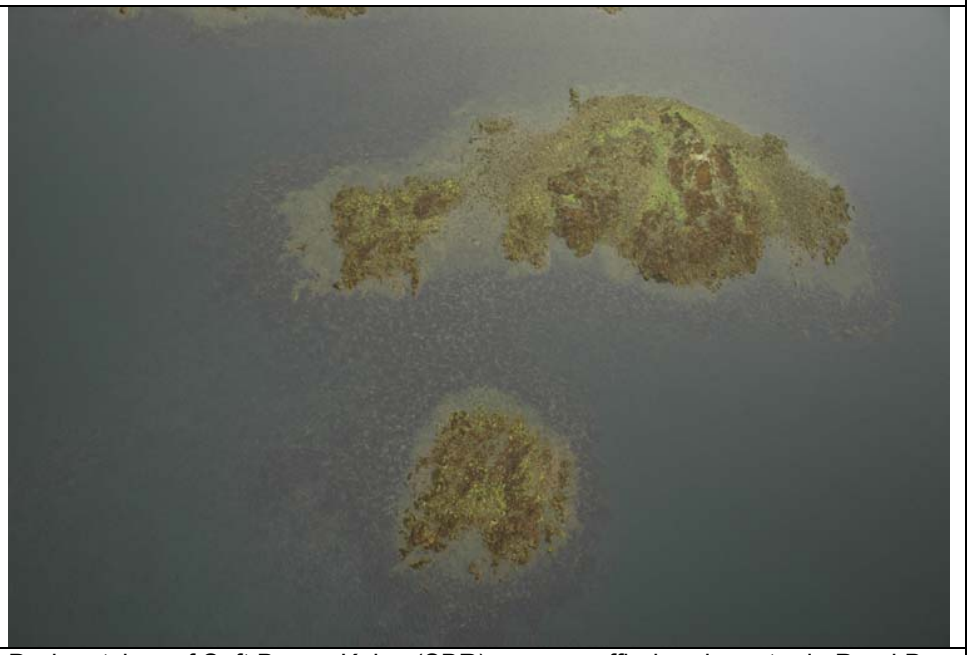
Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
B & C	**Soft Brown Kelps**	**SBR**	Yellow-brown, olive brown or brown.	*Saccharina latissima* *Cystoseira sp.* *Sargassum muticum*	This band is defined by non-floating large browns and can form 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.* *Cymathere sp.* *Saccharina sessile* (bullate)



Soft Brown Kelps (SBR) and Eelgrass (ZOS) extend throughout the Semi-Protected (SP) nearshore subtidal of Kelp Island and act as good indicators of a lower biological wave exposure.

MM_09536.jpg

Bioarea SECR



Dark patches of Soft Brown Kelps (SBR) appear ruffled underwater in Pond Bay off Dog Island northwest of Duke Island.

MM_15428.jpg

Bioarea SECR

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 setchelli* *Saccharina subsimplex* *Laminaria yezoensis* *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	*Cymathere sp.* *Pleurophycus sp.* *Costaria sp.* *Alaria sp.* *Neoptilota sp.*

A band of Dark Brown Kelps (CHB) occurs here in the lower intertidal and extends into the subtidal zone of this Semi-Exposed (SE) islet in the Percy Islands.

SE06_MM_15751.jpg

Bioarea SECR

Along the western side of Gravina Island the shiny smooth blades of Dark Brown Kelps (CHB) are visible in the lower intertidal zone and nearshore subtidal along with Bull Kelp (NER). This band is indicative of higher wave exposures, as is seen here along this Semi-Exposed (SE) shoreline.

SE06_MM_00742.JPG

Bioarea SECR

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 in units of Exposed wave energy 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) can be see growing on boulders under the sediment with Soft Brown Algae (SBR) and *Alaria* (ALA) along this Semi-Protected (SP) partially mobile beach on the east side of Mary Island.	Patches of Surfgrass (SUR) mixed with lush Dark Brown Kelps (CHB) are visible in this Semi-Exposed (SE) rock platform in the Percy Islands.
SE06_MM_10202.jpg	SE06_MM_15744.jpg
Bioarea SECR	Bioarea SECR

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	*Pilayella sp.*

Eelgrass (ZOS) is visible in the subtidal zone with Soft Brown (SBR) band underneath on this Partially-Mobile shore of Kelp Island.

SE06_MM_09531.jpg

Bioarea SECR

A lush Eelgrass (ZOS) band is located in the lower intertidal and subtidal of this Partially-mobile beach on the western side of Mary Island.

SE06_MM_10289.jpg

Bioarea SECR

The Urchin Barrens (URC) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
C	**Urchin Barrens**	**URC**	Underwater, coralline white	*Strongylocentrotus franciscanus*	Shows rocky substrate clear of macroalgae. Often has a pink-white colour of encrusting coralline red algae. May or may not see urchins.	SP-SE, current	

A continuous Urchin Barrens (URC) band surrounds this Semi-Protected (SP) islet off Edge Pt., Mary Island.

SE06_MM_10152.jpg

Bioarea SECR

Urchin Barrens (URC), and even individual urchins, are visible here in the underwater zone below a canopy of *Macrocystis* (MAC) and *Nereocystis* (NER) on a southeastern islet in the Percy Islands.

SE06_MM_15979.jpg

Bioarea SECR

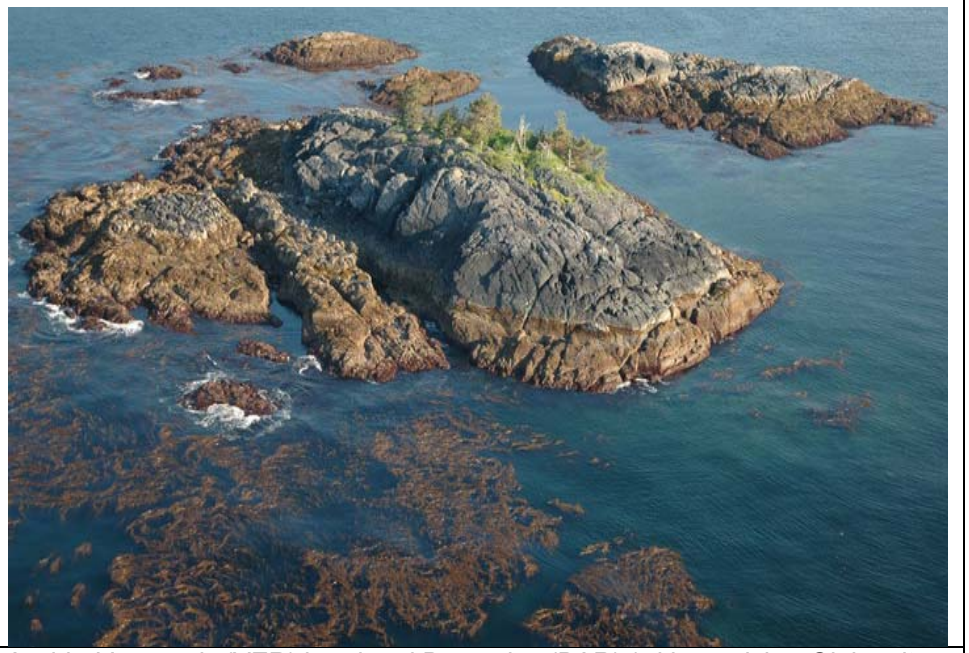
The Giant Kelp (MAC) Bioband

Zone	Bio-band Name	Database Label	Colour	Indicator Species	Physical Description	Exposure	Associate Species
C	**Giant Kelp**	**MAC**	Golden-brown	*Macrocystis integrifolia*	Canopy-forming giant kelp, long stipes with multiple floats and fronds. If associated with NER, it occurs inshore of the bull kelp.	P-SE	*Nereocystis luetkeana* *Alaria fistulosa*

A dense canopy of Giant Kelp (MAC) with its long stipes and multiple floats and fronds can be seen here along the west side of Duke Island.

SE06_MM_15536.jpg

Bioarea SECR



A wide *Verrucaria* (VER) band and Barnacles (BAR) (with overlying *Gloiopeltus* sp.) are surrounded by a lush canopy of Giant Kelp (MAC) in the subtidal zone of Kelp Island.

SE06_MM_09550.jpg

Bioarea SECR

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*	A 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*

The exposed shores of an island off Davidson Point show the presence of Bull Kelp (NER), which acts as an indicator of higher wave exposures.

SE06_MM_08109.jpg

Bioarea SECR

Bull Kelp (NER) is easily identified by the floating bulb and long stipe of each plant, as seen here on Cat Island north of Duke Island.

SE06_MM_10044.jpg

Bioarea SECR

3.2 Biological Wave Exposure

Biological Wave Exposure is a summary attribute that is interpreted during biological mapping from observations of the presence and abundance of biota in each alongshore unit ("EXP_BIO" in the database). It is considered the most representative index of actual wave exposure. 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. The six categories and codes 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).

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 (e.g. the Barnacle band (BAR)), while other biobands are considered "indicators" because they are closely associated with particular wave 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 southeast Alaska with example illustrations in Tables 3.3 through 3.6 and in Figures 3.3 through 3.6.

The occurrence of five biological wave exposure categories is summarized for southeast Alaska in Table 3.7. Because most of the region included in this summary report was in sheltered inlets and fjords, nearly all of the shoreline was classified as Semi-Protected and lower wave exposures (90%). Only a few units were considered as Exposed and about 10% of the shoreline was mapped as Semi-Exposed.

A summary map of the distribution of the biological wave exposure categories in the 2006 mapped areas of southeast Alaska is shown in Figure 3.7. The Very Exposed category has not been applied in biological mapping of southeast Alaska because it is used only in the classification of areas that have steep vertical cliffs with no offshore platforms or reefs to dissipate wave energy. The locations in which the Very Exposed category has been mapped occur on the Outer Kenai coast, in Kenai Fjords National Park, and on the southwest coast of Moresby Island, British Columbia.

Table 3.3. Typical and associated species of biobands.
Exposure category: Exposed (E) and Very Exposed (VE). *

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 mapped in the project area included in this summary report.

Figure 3.3. Biological exposure: Exposed.
Exposed (E) bedrock shoreline of the northernmost islet in the Percy Islands. A wide Splash Zone (VER) band of *Verrucaria* overlies bands of Barnacle (BAR), Red Algae (RED), *Alaria* (ALA), Dark Brown Kelps (CHB) and Bull Kelp (NER) in the nearshore subtidal. This assemblage of biobands is typically found in Exposed areas, a biological exposure category that was not frequently encountered in this particular region of southeast Alaska. (SE06_MM_15955.jpg)

Table 3.4. Typical and associated species of biobands.
Exposure category: Semi-Exposed (SE).

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	diverse mixed red algae, including *Odonthalia, Palmaria* and others		Red Algae	RED
	Neoptilota		Red Algae	RED
	Alaria 'marginata' morph		Alaria	ALA
	Phyllospadix sp.		Surfgrass	SUR
	Laminaria setchellii		Dark Brown Kelps	CHB
	Laminaria yezoensis		Dark Brown Kelps	CHB
	Saccharina subsimplex morph		Dark Brown Kelps	CHB
	Saccharina sessile smooth morph		Dark Brown Kelps	CHB
	Alaria fistulosa		Dragon Kelp	ALF
		Macrocystis integrifolia	Giant Kelp	MAC
	Nereocystis luetkeana		Bull Kelp	NER

Figure 3.4. Biological exposure: Semi-Exposed.
The Semi-Exposed (SE) bedrock of these islands off Kelp and Duke Island show biological components typical of this exposure category. This includes a medium Splash Zone (VER) band of *Verrucaria* and biobands of Barnacle (BAR), Red Algae (RED) a nearshore fringe of Bull Kelp (NER) and subtidal Urchin Barrens (URC). (SE06_MM_09563.jpg)

Table 3.5. Typical and associated species of biobands.
Exposure category: Semi-Protected (SP).

Zone	Indicator species	Associated Species	Bioband Name	Bioband Code
Upper Intertidal		*Leymus mollis* *	Dune Grass	GRA
		Carex spp. *	Sedges	SED
		Puccinellia *	Salt Marsh	PUC
		Triglochin *	Salt Marsh	PUC
		Plantago 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 and other foliose green algae	Green Algae	ULV
	Palmeria sp. (bleached)		Bleached Red Algae	HAL
	Mixed red algae including *Odonthalia*		Red Algae	RED
	Alaria 'marginata' morph		Alaria	ALA
	Zostera marina		Eelgrass	ZOS
	Cystoseira sp.		Soft Brown Kelps	SBR
	Cymathere sp.		Soft Brown Kelps	SBR
	Saccharina latissima		Soft Brown Kelps	SBR
	Nereocystis luetkeana		Bull Kelp	NER

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

Figure 3.5. Biological exposure: Semi-Protected.
Biobands of Barnacle (BAR), Rockweed (FUC), Green Algae (ULV) and Red Algae (RED) cover this western platform of Duke Island, with Soft Brown Kelps (SBR) and Giant Kelp (MAC) in the nearshore subtidal. This collection of biological components typifies the Semi-Protected (SP) exposure category of this region.
(SE06_MM_15536.jpg)

Table 3.6. Typical and associated species of biobands.
Exposure category: Protected (P) and Very Protected (VP).

	Indicator species	Associated Species	Bioband Name	Bioband Code
Upper Intertidal		*Leymus mollis* *	Dune Grass	GRA
		Carex spp. *	Sedges	SED
		Puccinellia *	Salt Marsh	PUC
		Triglochin *	Salt Marsh	PUC
		Plantago maritima *	Salt Marsh	PUC
	Verrucaria		Splash Zone	VER
		Balanus glandula *Semibalanus balanoides*	Barnacle	BAR
		Fucus with epiphyte *Pilayella*	Rockweed	FUC
	Mytilus trossulus		Blue Mussel	BMU
Lower Intertidal	*Ulva/* foliose green algae		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.

Figure 3.6. Biological exposure: Protected.
The low wave exposure of this Protected (P) shoreline in Traitors Cove is indicated by the bioband assemblage of Barnacle (BAR), Rockweed (FUC), Green Algae (ULV), Red Algae (RED) and continuous Soft Brown Kelps (SBR) in the nearshore subtidal. The Red Algae (RED) bioband was commonly mapped in the Misty Fjord bioareas (SEMJ) and was typically seen as a low turf of filamentous red algae, in the lower intertidal (SE06_MM_04036.jpg).

Table 3.7. Summary of biological wave exposure categories in the study area (Ketchikan area and portions of Revillagigedo Island, Southeast Alaska).

Biological Wave Exposure		Length (km)	% of Mapping
Exposed	E	14.0	1%
Semi-Exposed	SE	190.8	10%
Semi-Protected	SP	737.4	39%
Protected	P	896.0	47%
Very Protected	VP	76.6	4%

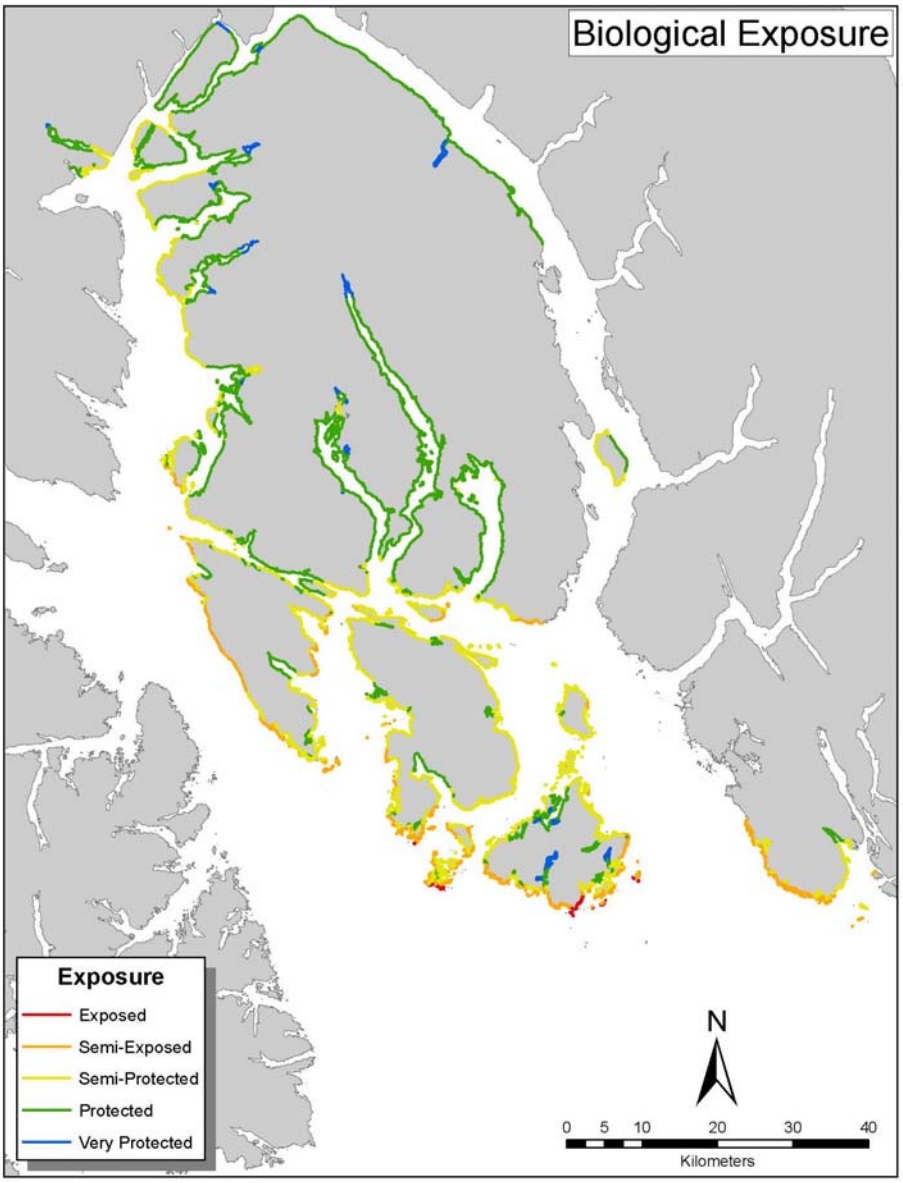


Figure 3.7. Distribution of biological wave exposure categories in the study area (Ketchikan area and portions of Revillagigedo Island, Southeast Alaska).

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 3.8 to 3.14 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 3.8).
- **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 3.9).
- **Mobile:** substrates such as sandy beaches where coastal energy levels are sufficient to frequently move sediment, thereby limiting the development of epibenthic biota (Figure 3.10).

Less common Habitat Classes are those determined by dominant structuring processes other than wave energy (Appendix A, Table A-8). These other habitat classes have only limited occurrence along the coast and, except for the anthropogenic shorelines, are also highly valued habitats. These habitat types are:

- **Estuary** types with wetlands and salt marsh vegetation along low energy sediment shores influenced by freshwater (Figure 3.11).
- **Current-Dominated** channels where high tidal currents create anomalous assemblages of biota. Usually associated with lower wave exposure conditions in adjacent shore units (Figure 3.12).
- **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 3.13).
- **Lagoon** units have enclosed or constricted area of brackish or salty water, (Figure 3.14), 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 fifteen generalized habitat classes for this summary project area in southernmost southeast Alaska is summarized in Table 3.8. Nearly 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. Eleven percent of the shoreline was mapped as Estuary habitat class, where salt marsh biobands associated with freshwater stream and fluvial processes are the dominant structuring force. About 2% of the shoreline was classified as modified shoreline, accounting for the shoreline mapped in the city of Ketchikan and adjacent areas. Note that the area included in this summary report only represents the lower wave exposure habitat classes (Table 3.8).

A summary map of the distribution of habitat classes mapped in the study area (Ketchikan area and portions of Revillagigedo Island, Southeast Alaska) is shown in Figure 3.15.

Figure 3.8. Habitat Class: Semi-Protected, Immobile.
Example of the Semi-Protected, **Immobile** habitat class on Gravina Island. The bedrock supports a dense cover of biobands, including Barnacles (BAR), Red Algae (RED) and *Alaria* (ALA), with a medium Splash Zone (VER) band of *Verrucaria* above. (SE06_MM_00930.jpg)

Figure 3.9. Habitat Class: Semi-Protected, Partially Mobile.
This Semi-Protected, **Partially Mobile** shoreline of Annette Point on Annette Island shows a dense cover of biota on the stable bedrock platform, with bare mobile sediment on adjacent beaches. (SE06_MM_08514.jpg)

Figure 3.10. Habitat Class: Semi-Protected, Mobile.
This Semi-Protected, **Mobile** beach in Hall Cove, Duke Island, is bare of attached biota. (SE06_MM_09242.jpg)

Figure 3.11. Habitat Class: Estuary.
This is an example of an **Estuary** habitat class at the end of Traitors Cove. 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. (SE06_MM_04099.jpg)

Figure 3.12. Habitat Class: Current Dominated.
This **Current-Dominated** channel habitat creates a biologically rich and diverse area in Traitors Cove due to its current energy. Biobands of Barnacles (BAR), Rockweed (FUC), Red Algae (RED), Alaria (ALA) and Dark Brown Kelps (CHB) are abundant. These types of habitats are rare and limited in distribution. (SE06_MM_04152.jpg)

Figure 3.13. Habitat Class: Anthropogenic.
This modified shoreline in Yes Bay is an example of an **Anthropogenic** habitat class. (SE06_MM_02659.jpg)

Figure 3.14. Habitat Class: Lagoon.
This backshore **Lagoon** on Duke Island 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. (SE06_MM_09061.jpg)

Table 3.8. Summary of habitat classes in the study area (Ketchikan area and portions of Revillagigedo Island, Southeast Alaska).

Dominant Structuring Process	Habitat Class		Habitat Class Codes *	Length (km)	% of Mapping
	Exposure Category	Substrate Mobility			
Wave Energy	Exposed	Stable	10, 20	5.8	<1%
		Partially Mobile	11, 21	8.2	<1%
		Mobile	12, 22	0.0	0%
	Semi-Exposed	Stable	30	36.2	2%
		Partially Mobile	31	151.8	8%
		Mobile	32	0.5	<1%
	Semi-Protected	Stable	40	53.2	3%
		Partially Mobile	41	627.4	33%
		Mobile	42	3.2	<1%
	Protected	Stable Substrate	50, 60	172.9	9%
		Partially Mobile	51, 61	596.1	31%
		Mobile Substrate	52, 62	8.4	<1%
Fluvial	Estuary		23, 33,43, 53, 63	208.1	11%
Current-dominated	Current-Dominated		34, 44, 54	9.7	<1%
Modified	Anthropogenic		36, 37, 46, 47, 56, 57, 66, 67	33.3	2%
		TOTALS:		1914.8	100%
Lagoon **	Lagoon		38, 48, 58, 68	48.6	3%

* See Appendix A, Table A – 8 for full definitions of Habitat Class rationale and codes.
** Lagoons are only mapped as a 'Secondary Habitat Class'.

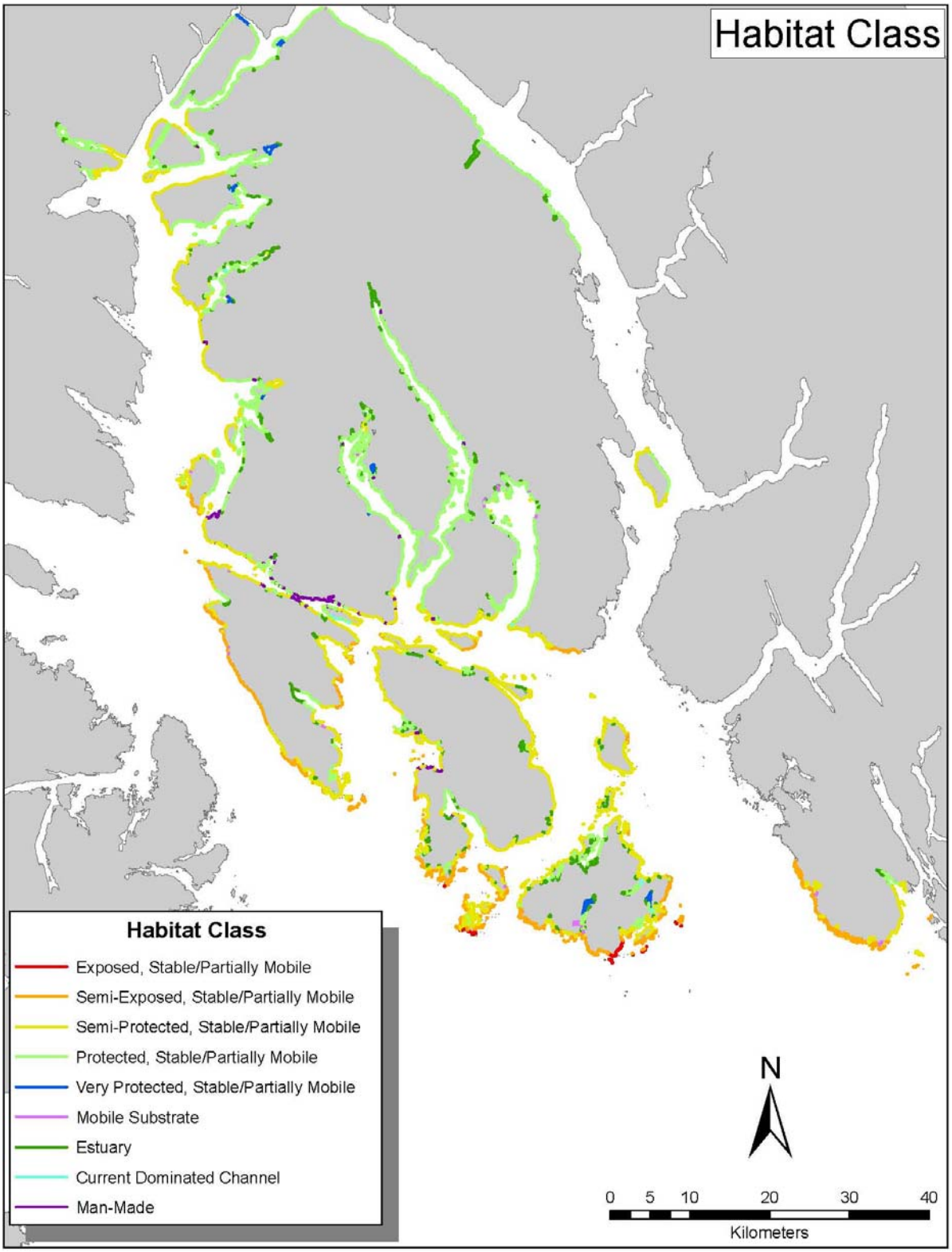


Figure 3.15. Distribution of habitat class categories in the study area (Ketchikan area and portions of Revillagigedo Island, Southeast Alaska).

4.0 REFERENCES AND ACKNOWLEDGMENTS

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ShoreZone reports are available at:
http://www.coastalandoceans.com/downloads.html

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APPENDIX A DATA DICTIONARY

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Table A-1. Data dictionary for UNIT 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); 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
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.

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

Field Name	Type	Description
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 employed in ShoreZone mapping
(derived from the Howes et al. [1994] "BC Class" system in British Columbia)

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	Estuaries	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

Table A-3. Environmental Sensitivity Index (ESI) Shore Type classification

(after Peterson et al. [2002])

ESI No.	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; ,angroves
10E	Inundated low-lying tundra

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

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

Table A-6. Oil Residence Index (ORI) look-up matrix based on exposure (columns) and substrate type (rows)

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	999	999	999	3	3	3
organics/vegetation	999	999	999	5	5	5
man-made, permeable	2	2	3	3	5	5

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); this field is completed by the database manager using an update query
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)
HAB_OBS	N	Original categories used to classify habitat type; not used in 2007 standard 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 biologist 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)

*See additional notes on following page

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 last higher 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 splashzone 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 splashzone 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 geomorphological features of the Habitat Class.

The biomapper 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 the spatial distribution of the biota within the unit.

Within the database, both a numeric code and an alpha code are used. Both codes are listed in Table A-8, in which the matrix includes all combinations of 'Dominant Structuring Process' on the vertical axis, and 'Biological Wave Category' 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	– Impermeable substrate – 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
	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
	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
		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 across-shore component table (XShr)
(after Howes et al. 1994)

Field Name	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 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 (after Howes et al. 1994)

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°)
g	surge channel
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

Table A-12. 'Material' Code Dictionary (after Howes et al. 1994)

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	trees, fallen not cut, dead
o	organic litter
p	peat
t	trees (alive)

C = Clastic

a	angular blocks (>25cm)
b	boulders (round, subround,>25cm)
c	cobbles
d	diamicton (poorly-sorted sediment containing a range of particles in a mud matrix)
f	fines or mud (mix of silt and clay)
~~g~~	~~gravel (unsorted mix pebble, cobble, boulder >2 mm)~~
k	clay (finer than mud; <0.0039 mm)
p	pebbles
r	rubble (boulders>1 m)
s	sand (0.063 to 2 mm)
~~$~~	~~silt (0.0039 to 0.063 mm)~~
x	angular fragments (mixed block & rubble)
v	sediment veneer (used as modifier)

R = Bedrock

rock type:

i	igneous
m	metamorphic
s	sedimentary
v	volcanic

rock structure:

1	bedding
2	jointing
3	massive

U = Undefined

SEDIMENT TEXTURE
(Simplified from Wentworth grain sizescale)

GRAVELS

boulder	> 25 cm
cobble	6 to 25 cm
pebble	0.5 cm to 6 cm
granule	2 mm to 5 mm

SAND

from very fine to very coarse:
all between 0.063 mm and 2 mm

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)

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); this field is completed by the database manager using an update query
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, coded by width **N**arrow (<1m), **M**edium (1-5m) or **W**ide (>5m). See Section 3.1 for details.		
VER	T1	Bioband for Splash Zone (black lichen VER*rucaria*) in supratidal
GRA	T1	Bioband code for Dune GRAss in supratidal
SED	T1	Bioband for mixed SEDges in supratidal
PUC	T1	Bioband for Salt Marsh grasses, including PUC*cinellia* and other salt tolerant grasses and herbs, in supratidal
BAR	T1	Bioband for BARnacle (*Balanus/Semibalanus)* in upper intertidal
FUC	T1	Bioband for FUCus/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 Blue Mussel (*Mytilus trossulus)* in mid-intertidal
MUS	T1	Bioband for California MUSsel/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 Soft Brown Kelps, including unstalked large-bladed laminarins, in lower intertidal and nearshore subtidal
CHB	T1	Bioband for Dark Brown Kelps, including stalked bladed dark CHocolate-Brown kelps in lower intertidal and nearshore subtidal
SUR	T1	Bioband for SURfgrass (*Phyllospadix*) in lower intertidal and nearshore subtidal
ZOS	T1	Bioband for ZOS*tera* (Eelgrass) in lower intertidal and subtidal
URC	T1	Bioband for URChin 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 BIOSLIDE 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 biological representative of a particular 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