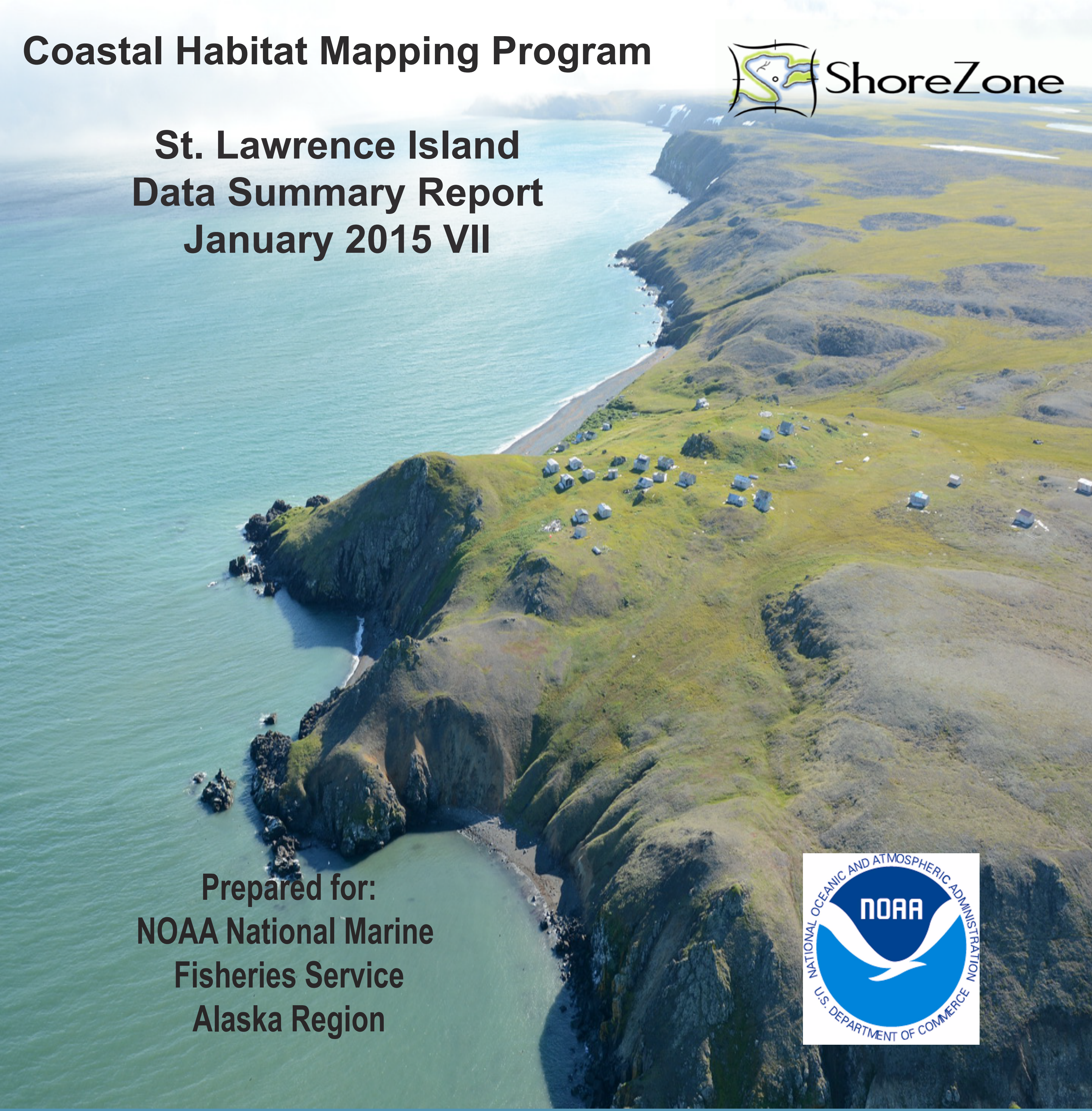
Coastal Habitat Mapping Program

ShoreZone

St. Lawrence Island
Data Summary Report
January 2015 VII



Prepared for:
NOAA National Marine
Fisheries Service
Alaska Region

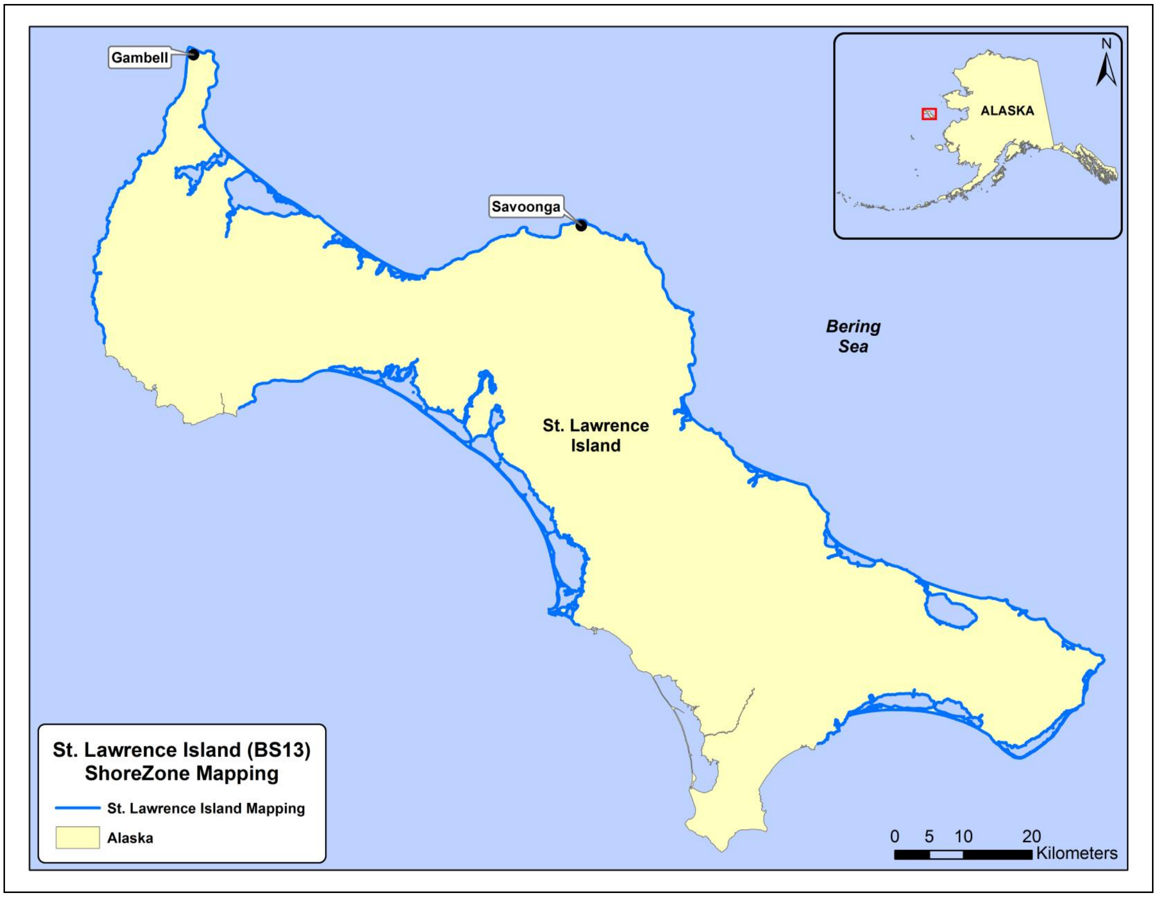
On the Cover:

Powooiliak Point
East of Niyrakpak Lagoon
Ynveeghik River Lagoon
Kineeghit Point

Coastal and Ocean Resources
a MER company

ShoreZone Coastal Habitat Mapping
Data Summary Report
January 2015 Version II

St. Lawrence Island Survey Area



Prepared for:

NOAA National Marine Fisheries Service, Alaska Region

Prepared by:

COASTAL & OCEAN RESOURCES
759A Vanalman Ave., Victoria BC V8Z 3B8 Canada
(250) 658-4050
www.coastalandoceans.com

SUMMARY

The purpose of this report is to provide a summary of the physical (geomorphological) and biological nearshore attributes mapped on St. Lawrence Island

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. The mapping methods are summarized in Harper and Morris (2014).

This data summary report provides information on **geomorphological and biological features** for 1,095 km of shoreline mapped from the 2013 coastal imaging survey of St. Lawrence Island. The habitat inventory is comprised of 1,994 along-shore segments (units), averaging 550 m in length (note that the AK Coast 1:63,360 digital shoreline shows this mapping area encompassing 908 km, but mapping data based on better digital shorelines represent the same area with 1,095 km stretching along the coast).

Sediment-dominant shore types (Shore Types 21-30) are common along 706.4km (64.5%) the shoreline. Of these, sand and gravel beaches (Shore Type 25) are the most common, mapped along 249.7 km of shoreline (22.8% of the total study area). *Bedrock* shore types (Shore Types 1-5) are uncommon with only 1.8% mapped.. *Organic* shore types, usually dominated by fine sediment and marshes, are mapped along 123.9 km (11.3%) of the study area.

In terms of *Habitat Types* (a combination of substrate and exposure that is indicative of associated benthic communities), wave energy is the dominant structuring process (81% or shoreline). Repeatable assemblages of biota that can be recognized from the aerial imagery are termed *biobands*; 11 biobands were observed on St. Lawrence Island. The most widely distributed biobands are: Tundra (71%) and Dune Grass (51%).

Man-modified shorelines (Shore Types 32) are not common on St. Lawrence Island; 0.4% of the entire shoreline mapped. The most common types of shore modification observed are landfill and boat ramp (3.3 km and 0.5 km respectively). Most anthropogenic features are concentrated around the communities of Gambell and Savooga.

TABLE OF CONTENTS

LIST OF TABLES & FIGURES

1 INTRODUCTION

1.1 Overview of the ShoreZone Coastal Habitat Mapping Program

ShoreZone is a mapping and classification system that specializes in the collection and interpretation of aerial imagery of the coastal environment. Its objective is to produce an integrated, searchable inventory of geomorphic and biological features of the intertidal and nearshore zones which can be used as a tool for science, education, management, and environmental hazard planning.

ShoreZone is a procedure in which oblique low-altitude aerial imagery of the coastline is converted to habitat classes. The data includes both spatial representation that fixes the information on maps (i.e., a mapping system) and an attribute representation that classifies data into a discrete number of categories (i.e., a classification system). Both geological and biological attributes are mapped and classified with quality control (QC) procedures throughout the process. The mapping procedures are specified in the protocols (Harper and Morris 2014). These protocols include specifications for mapping procedures, interpretation tools, QAQC requirements and database specifications.

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 ShoreZone program continues to grow from Alaska to Oregon through the efforts of a network of partners, including scientists, managers, GIS specialists, and web specialists in federal, state, and local government agencies and in private and nonprofit organizations. The coastal mapping data and imagery are used for oil spill contingency planning, conservation planning, habitat research, development evaluation, mariculture site review, and recreation opportunities. Protocols and standards are updated through technological advancements (e.g., Harper and Morris 2014), and applications are developed that use ShoreZone data to examine issues relevant to coastal environments and nearshore habitats (Harney 2007, 2008). As of September 2014, mapped regions include close to 63,500 km of coastline Alaska and 45,000 km of coastline in British Columbia, Washington and Oregon (Figure 1).

Figure 1. Extent of ShoreZone imagery in Alaska, British Columbia, and Washington State and Oregon (112,380 km)

ShoreZone video and still imagery provides a useful visual reference, and the mapped attributes (such as shoreline sediments, seagrass meadows, and salt marshes) are an important dataset for scientists and managers. The ShoreZone mapping system provides a spatial framework for coastal habitat assessments on local and regional scales. Research and practical applications of ShoreZone data and imagery include:

- natural resource and conservation planning
- environmental hazard response
- spill contingency planning
- 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
- public use for recreation, education, outreach, and conservation

Details concerning the mapping methods and the definition of 2014 standards are available in the ShoreZone Coastal Habitat Mapping Protocol for Alaska (Harper and Morris 2014). This and other ShoreZone reports are available for download from the ShoreZone website at www.ShoreZone.org.

The purpose of this report is to provide a summary of the physical (geomorphological) and biological atttributes mapped on St. Lawrence Island (Figure 2).

1.2 ShoreZone Mapping of St. Lawrence Island

The field survey conducted on St. Lawrence Island in 2013 collected aerial video and digital still photographs of the coastal and nearshore zones during minus tides (zero-meter tide levels and lower). The imagery and associated audio commentary are used to map the geomorphological and biological features of the shoreline according to the ShoreZone Coastal Habitat Mapping Protocol (Harper and Morris 2014). Not all the shoreline was imaged in 2013 due to weather constraints.

- The along-shore length of shoreline mapped in the database is **1,095 kilometers** in 1,994 along-shore segments (units), averaging 550 m in length. The digital shoreline used for this ShoreZone mapping project was put together using the PH53 Data Rescue Project shapefile.

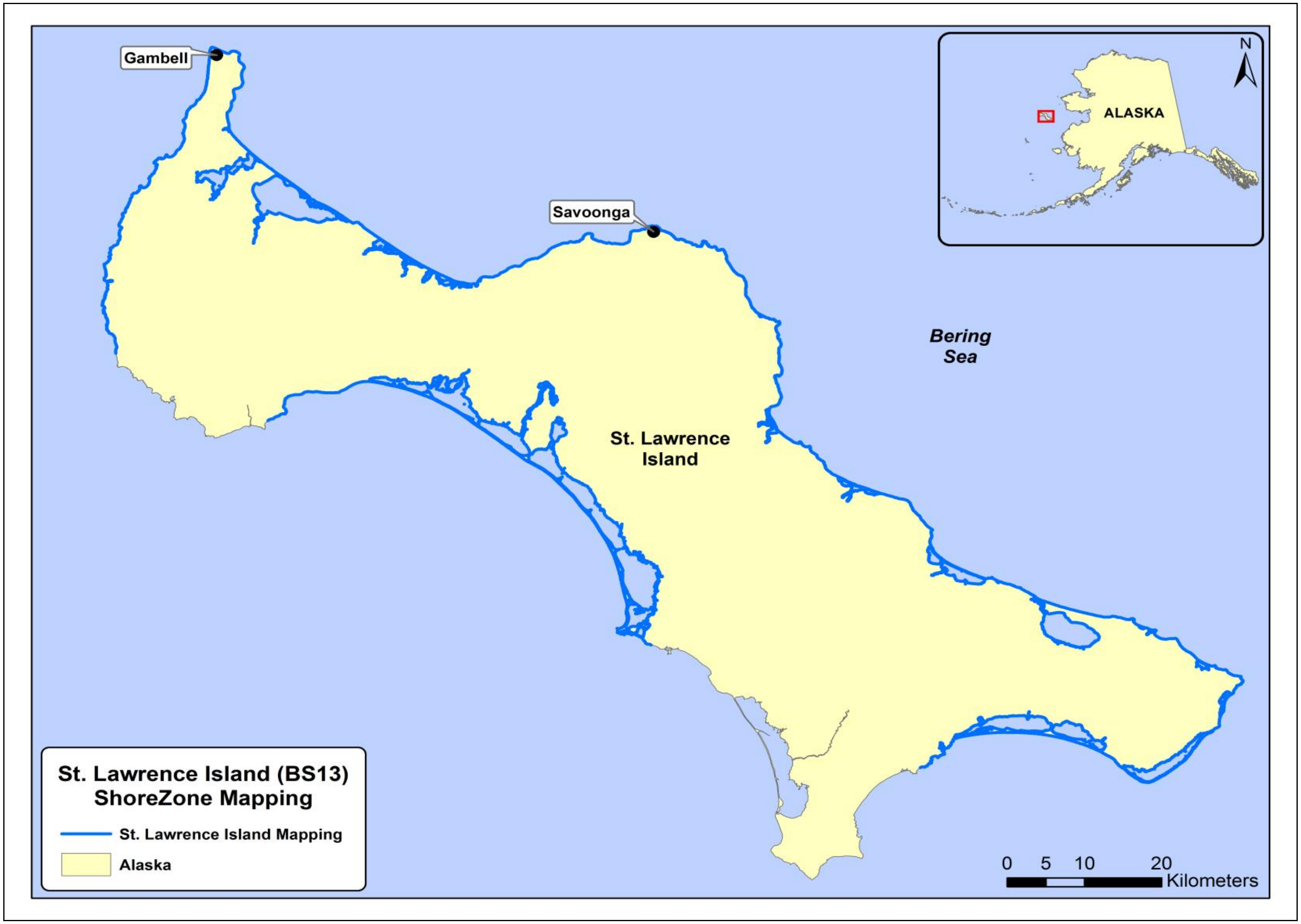


Figure 2. Map of the St Lawrence Island survey area.

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 along-shore **unit classification** systems: coastal shore types (“Coastal Class”) and the “Environmental Sensitivity Index” (ESI) class developed for oil-spill mitigation. A third shoreline classification system unique to ShoreZone (“Habitat Class”) is defined in Section 3.4.

The Shore Type system is used to describe along-shore coastal units as one of 39 shore types defined on the basis of the geomorphic features, substrate, sediment texture, across-shore width, and slope of that section of coastline (after Howes *et al* 1994; Appendix A, Table A-2 & Table A-3). Coastal classes also characterize units dominated by organic shorelines such as marshes and estuaries (Shore Type 31), man-made features (Shore Types 32 and 33), high-current channels (Shore Type 34), glaciers (Shore Type 35), lagoons (Shore Type 36), inundated tundra (Shore Type 37), ground ice slumps (Shore Type 38) and low vegetated peat (Shore Type 39).

The occurrence of shore types in the study area are listed in Table 2. Grouped Shore Types are useful to illustrate mapped distributions (Figure 3) and to summarize data in graphic form (Figure 4). **Bedrock shorelines** (Shore Types 1-5) comprise 19.6 km (1.8%) of mapped shorelines. **Rock and sediment shorelines** (Shore Types 6-20) comprise of 7.0% of the shoreline (76.3 km). **Sediment-dominated shorelines** (Shore Types 21-30) show up along 706.4 km (64.5%) of the coast (Figures 5). Of these, sand and gravel beach (Shore Type 25) are the most common, mapped along 249.7 km of shoreline (22.8% of the total study area). **Organic/estuarine shorelines** constitute 11.3% of the mapped shoreline. **Lagoons** are found on 4.6% of the coast while **Periglacial** shorelines make up the last 10.9%.

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 (Petersen *et al* 2002; Appendix A, Table A-4). The ESI system is an integral component of oil-spill contingency planning. 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 are listed in Table 3.

An updated version of ESI mapping, following the ESI guidelines, version 3.0 (Peterson *et al* 2002) is included in this report. Based on the intertidal zone, up to three ESI codes are now linked to each ShoreZone unit, including the most sensitive ESI code for each unit. The most sensitive ESI code can be found in the ShoreZone unit table, while an entirely new table has been created to address relevant information found in standard ESI data. This table consists of seven fields or geographic themes, which describe the shorelines' associated attributes. These include: Phy_Ident, ESI shoreline classification, geographic feature, source code for shoreline arcs, physiographic region, wetland polygons and most sensitive ESI. The Table (Table 1) below summarizes and describes the five new fields.

The St. Lawrence Island ESI mapping was completed in 2002 and although the physical shoreline classification was not completed due to the remoteness of the island, the attributes that comprise the biological portion of ESI were compiled and mapped. These attributes include known aggregations of and critical habitat for birds, marine mammals, invertebrates and fish. Due to the lapse of time between the biological mapping and the physical mapping completed by Coastal and Oceans in 2015, we decided to ascertain if there were any relevant updates to the biological ESI attributes. To this end, we contacted appropriate personnel at agencies including Alaska Department of Fish and Game, the National Marine Fisheries Service, the U.S. Geological Survey and the U.S. Fish and Wildlife Service and inquired if they were aware of any information from the past decade pertinent to an ESI mapping update for St. Lawrence Island. While some new information was brought to our attention, it was decided there was not any new information relevant to the purpose of ESI mapping.

Table. 1 New ESI Table for ShoreZone

Geographic Themes	Variable Names	Description	Attribute Values
ESI (Arcs)	ESI (10, 10, C)	Shoreline classification	Ranges from 1 through 10 with various combinations and subcategories
	LINE (1, 1, C)	Geographic features	S = Shoreline I = Index H = Hydrography P = Pier B = Breakwater F or M = Non-shoreline arcs that form the boundary for a flat or polygon marsh G = Glacier E = Extent of study area
	SOURCE_ID (6, 6, I)	Source code for shoreline arcs	1 = Digital 2 = Low-altitude overflight 3 = Aerial photograph 4 = Digitized off paper topo 5 = Digitized off scanned topo 6 = National Wetlands Inventory digital data N = where N = number of additional sources
	ENVIR (1, 1, C)	Physiographic region	E = Estuarine L = Lacustrine R = Riverine
	WETLAND POLY	Wetland adjacent to unit	Y = Yes N = No

Table 2. Summary of Shore Types

Substrate Type	Shore Type		Sum of Unit Length (km)	# of Units	% Occurrence (by length)	Cumulative Occurrence (%, km)
	No.	Description				
Rock	2	Rock Platform, wide	0.3	2	0.0	1.8% 19.6km
	3	Rock Cliff	17.0	48	1.6	
	4	Rock Ramp, narrow	2.3	10	0.2	
Rock & Sediment	6	Ramp w gravel beach, narrow	2.8	8	0.3	7.0% 76.3km
	7	Platform w gravel beach, wide	0.8	7	0.1	
	8	Cliff with gravel beach	37.1	76	3.4	
	9	Ramp with gravel beach	22.1	73	2.0	
	11	Ramp w gravel & sand beach, wide	2.3	8	0.2	
	12	Platform with G&S beach, wide	1.5	8	0.1	
	13	Cliff with gravel/sand beach	2.2	10	0.2	
	14	Ramp with gravel/sand beach	7.1	24	0.6	
	17	Platform w sand beach, wide	0.2	1	0.0	
	18	Cliff with sand beach	0.1	1	0.0	
	19	Ramp w sand beach, narrow	0.3	3	0.0	
Sediment	21	Gravel flat, wide	5.9	13	0.5	64.5% 706.4km
	22	Gravel beach, narrow	54.5	164	5.0	
	23	Gravel flat or fan	0.6	2	0.1	
	24	Sand & gravel flat or fan	144.1	161	13.2	
	25	Sand & gravel beach, narrow	249.7	476	22.8	
	26	Sand & gravel flat or fan	30.9	76	2.8	
	27	Sand beach	7.8	13	0.7	
	28	Sand flat	59.5	66	5.4	
	29	Mudflat	4.8	9	0.4	
	30	Sand beach	148.7	272	13.6	
Organics	31	Organics/Estuarine	123.9	193	11.3	11.3% 123.9km
Man-made	32	Man-made, permeable	0.0	1	0.0	0.0% 0.0km
Lagoon	36	Lagoon	49.9	55	4.6	4.6% 49.9km
Perigalcial	37	Inundated tundra	6.0	5	0.5	10.9% 119.1km
	38	Ground ice slumps	2.3	9	0.2	
	39	Low vegetated peat	110.8	200	10.1	
Totals:			***1,095.4***	***1,994***	***100.0***	***100%***

*Note: Other Shore Types not observed.

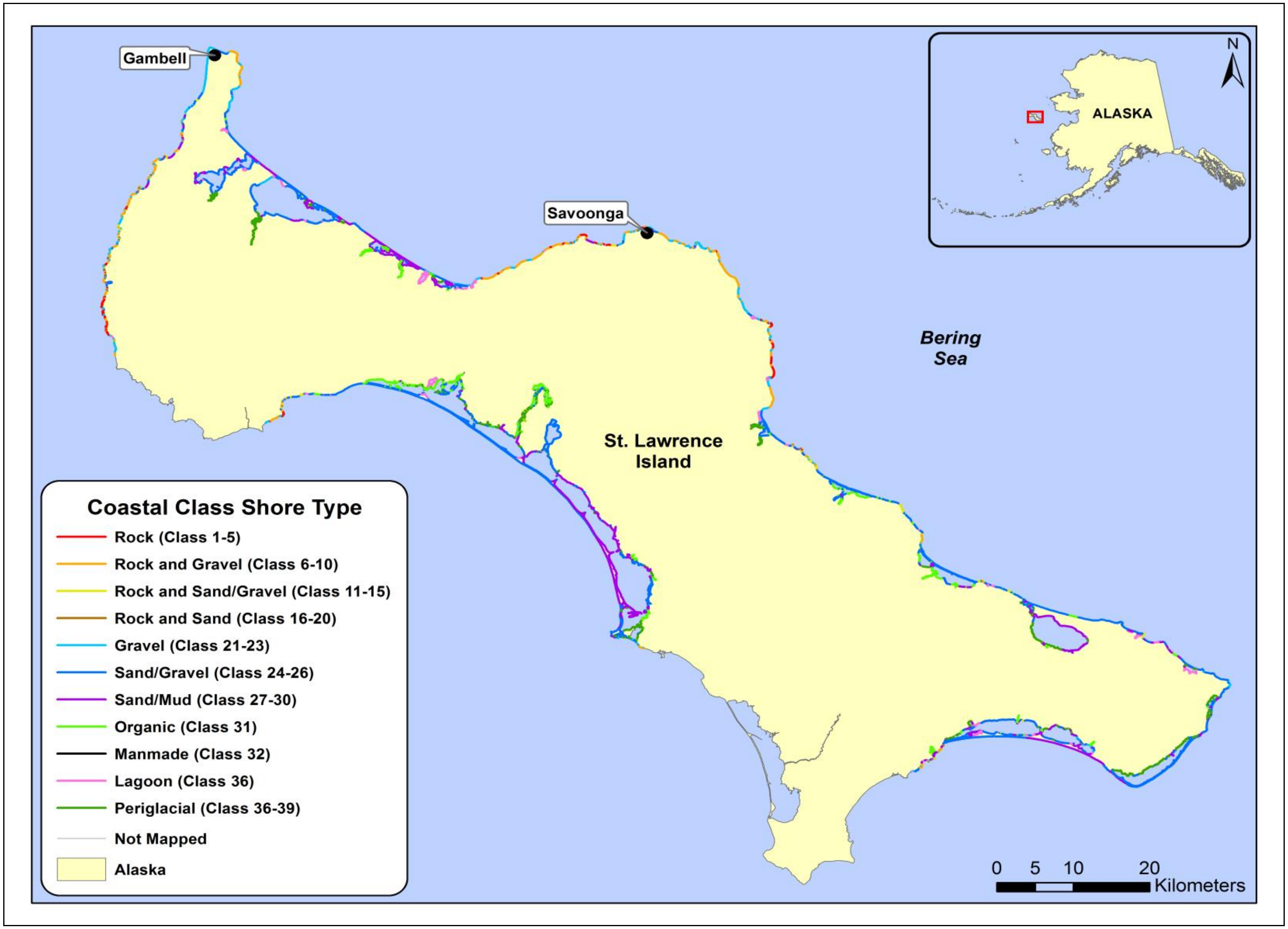


Figure 3. Map of the distribution of principal substrate types (on the basis of grouped Shore Types) in the study area. Data are listed by individual class and summarized by grouped classes in Table 2.

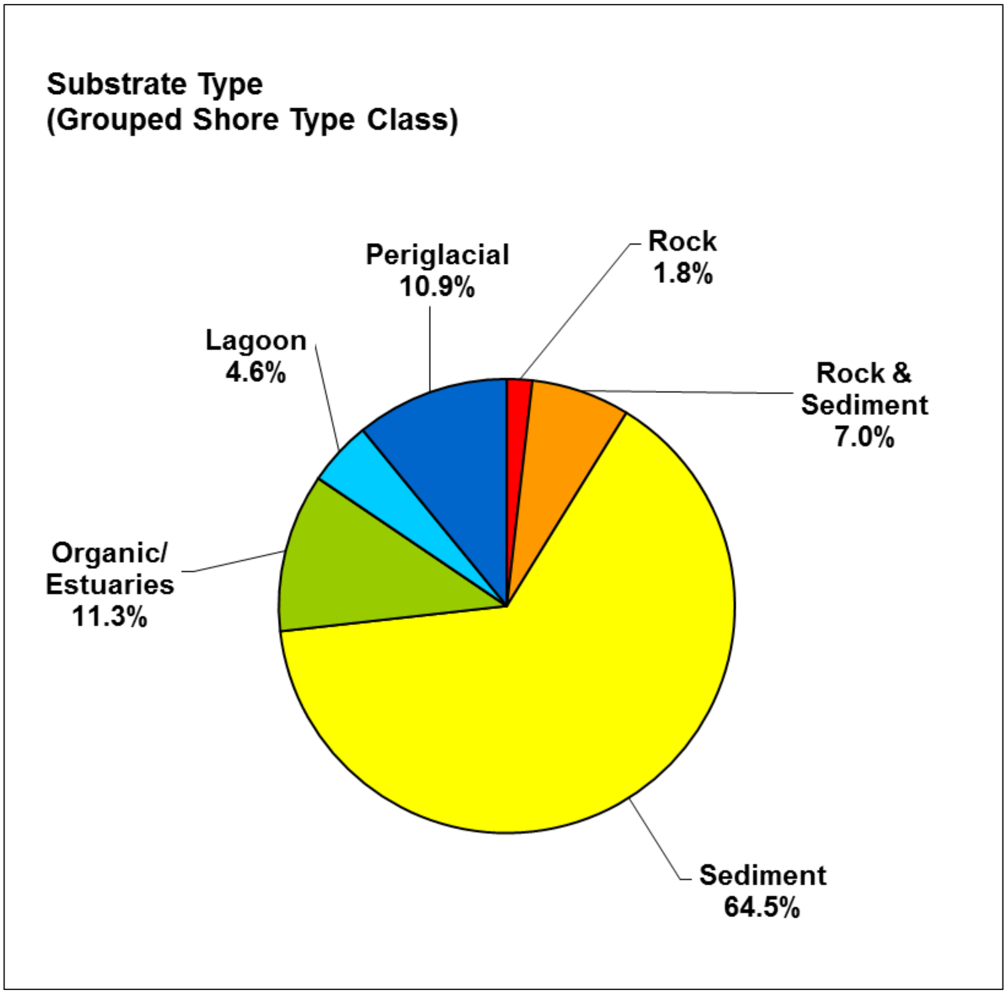


Figure 4. Relative abundance of principal substrate types (on the basis of grouped Shore Types) in the study area. Data are summarized in Table 2.

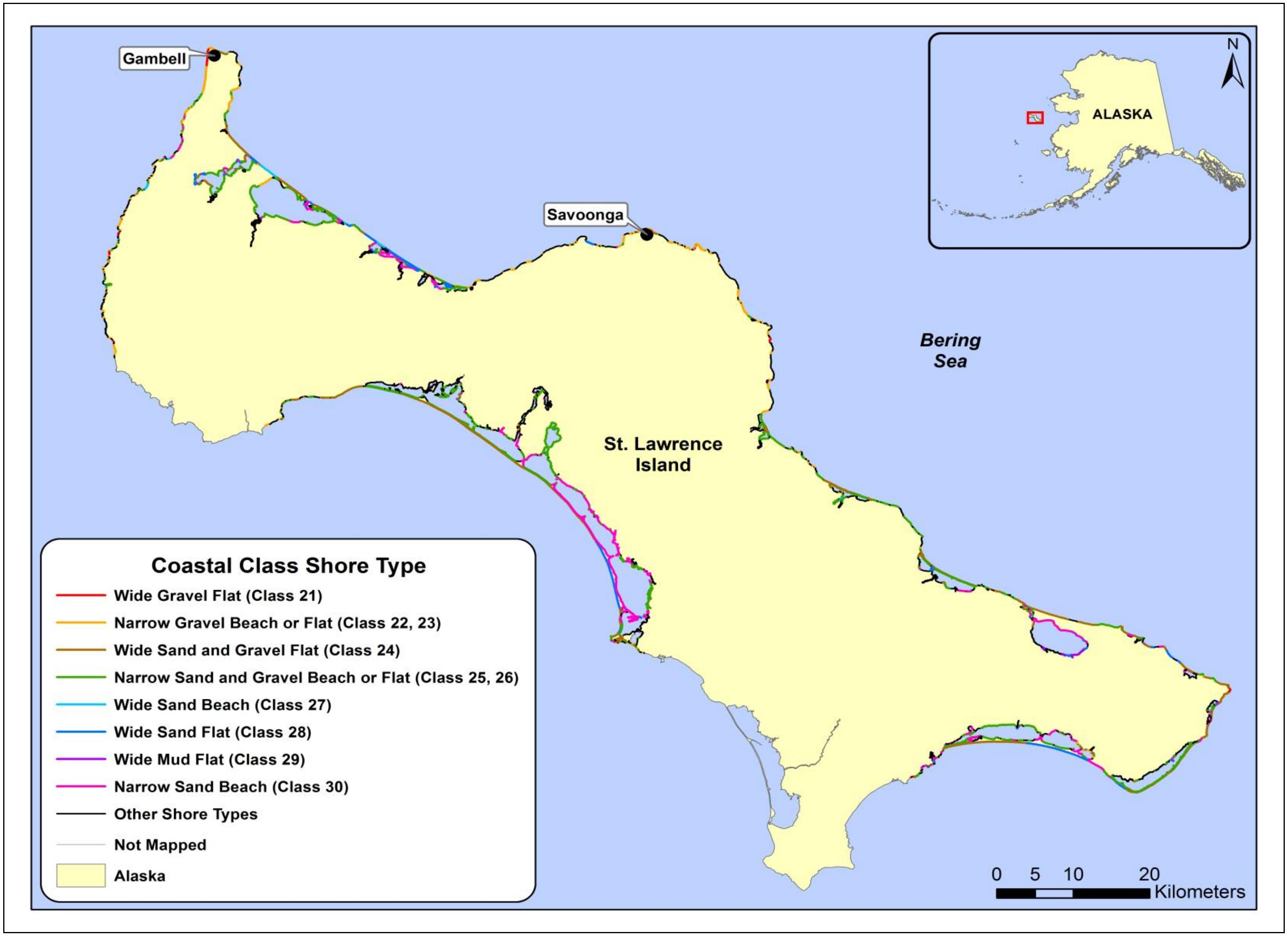


Figure 5. Map of the distribution of sediment shorelines (Shore Types, grouped by geomorphology) in the study area. Data are summarized in Table 2.

Table 3. Summary of Shore Types by ESI Class

Environmental Sensitivity Index (ESI)		Sum of Unit Length (km)	# of Units	% Occurrence (by length)
ESIClass	Description			
1A	Exposed rocky shores; Exposed rocky banks	15.3	41	1.4
1C	Exposed rocky cliffs with boulder talus base	13.5	28	1.2
2A	Exposed wave-cut platforms in bedrock, mud, or clay	2.5	12	0.2
3A	Fine- to medium-grained sand beaches	62.8	106	5.7
3C	Tundra cliffs	3.3	7	0.3
4	Coarse-grained sand beaches	60.6	132	5.5
5	Mixed sand and gravel beaches	325.9	550	29.8
6A	Gravel beaches (granules and pebbles)	31.8	50	2.9
6B	Gravel beaches (cobbles and boulders)	105.2	296	9.6
7	Exposed tidal flats	0.0	1	0.0
8A	Sheltered scarps in bedrock, mud, or clay; sheltered rocky shores (impermeable)	17.8	27	1.6
8B	Sheltered, solid, man-made structures; sheltered rocky shores (permeable)	0.3	3	0.0
8E	Peat Shorelines	0.9	6	0.1
9A	Sheltered tidal flats	75.5	202	6.9
9B	Vegetated low banks	16.2	28	1.5
10A	Salt- and brackish-water marshes	198.1	283	18.1
10E	Inundated low-lying tundra	111.6	113	10.2
Totals:		***1,095.4***	***1,994***	***100.0%***

*Note: Other ESI Classes not observed.

2.2 Anthropogenic Shore Modifications

Shore-protection features and coastal access construction such as seawalls, rip rap, docks, dikes, and wharves are enumerated in ShoreZone mapping data. When the Shore Modification section of the dataset is examined, it shows that 0.4% of the shoreline on St. Lawrence Island has been modified. 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 4) is shown in Figure 6.

Table 4. Summary of Shore Modifications

Shore Modification	# of Occurrences	Shoreline Length (km)	% of Shoreline
Landfill	25	3.3	0.30
Wooden bulkhead	1	0.0	0.00
Boat ramp	7	0.5	0.05
Totals:	***33***	***3.8***	***0.35%***

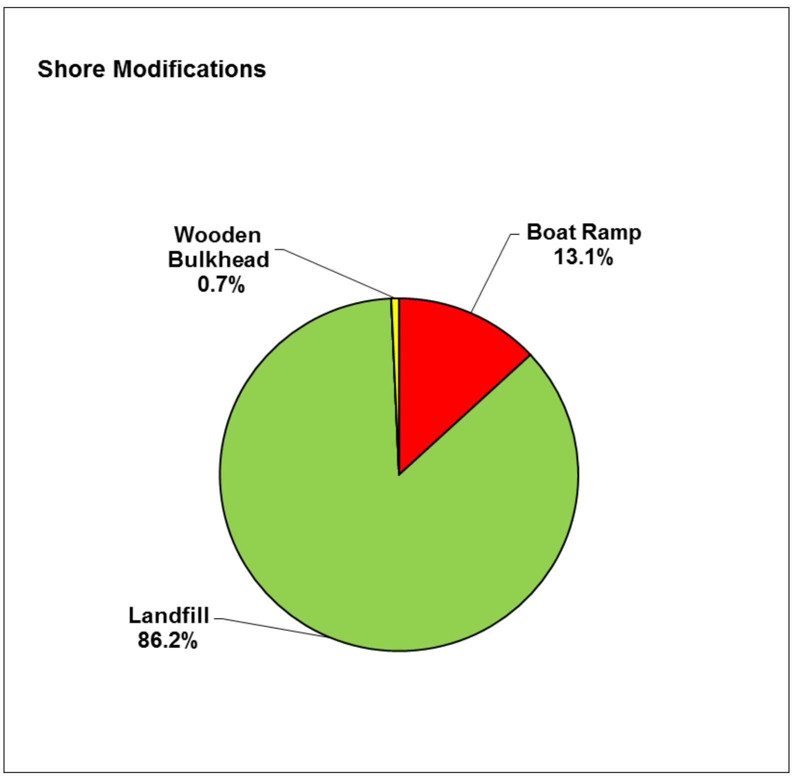


Figure 6. Occurrence of Shore Modification types over 3.8 km of shoreline.

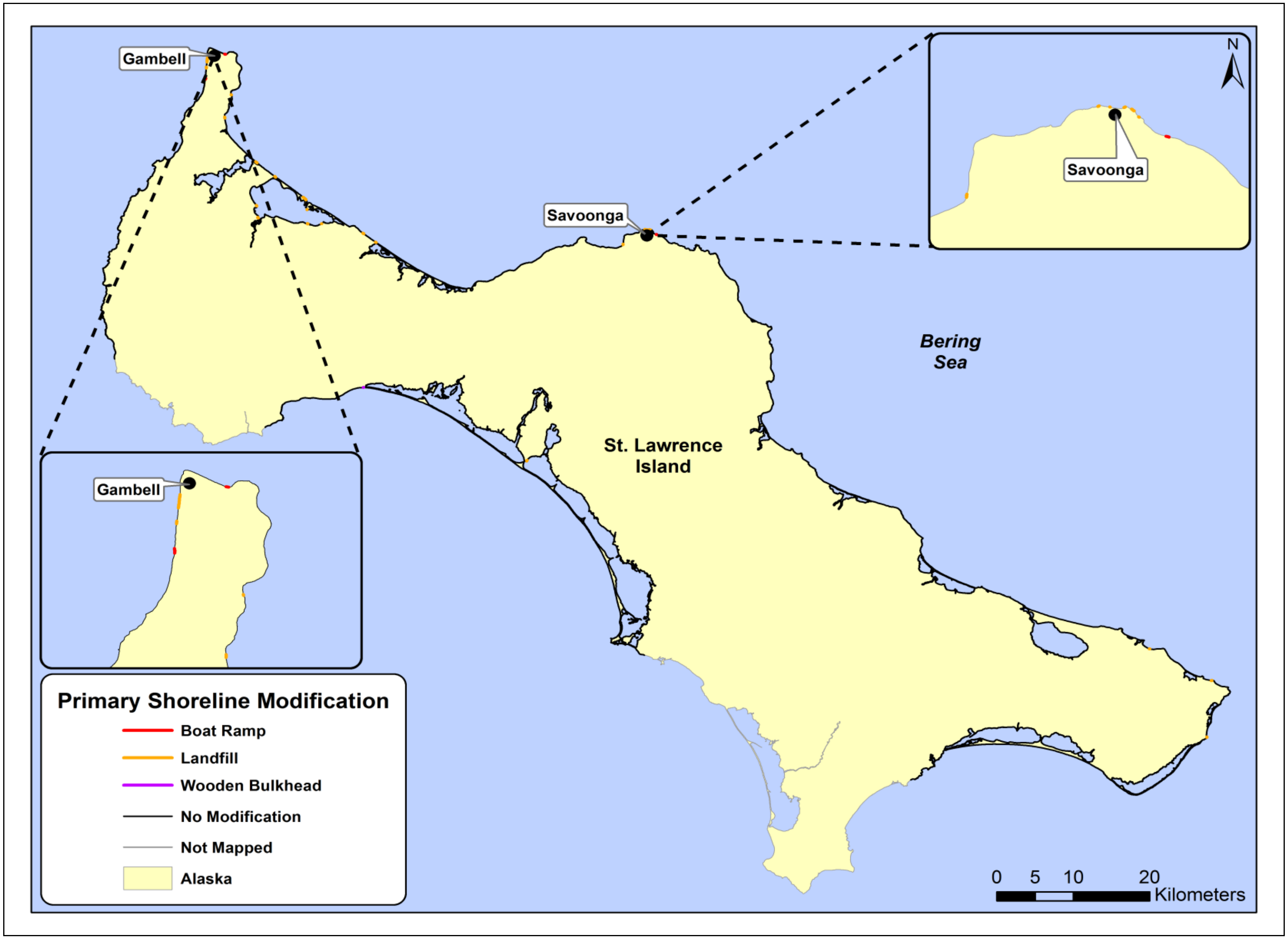


Figure 7. Map of the distribution of units in which shore modification features were observed in the study area. Data are summarized in Table 4.

2.3 Oil Residence Index (ORI)

The Oil Residence Index (ORI) is a rating between 1 and 5 that reflects the estimated persistence of spilled oil on a shoreline. A value of 1 reflects relatively short oil residence (days to weeks), while a value of 5 reflects potentially long oil residence times (months to years). An ORI value is applied to each across-shore component on the basis of sediment texture and wave exposure (Table A-6), as well as to each along-shore unit on the basis of shore type and wave exposure (Table A-6). For more information on the assignment of this attribute, refer to the ShoreZone Protocol (Harper and Morris 2014).

The dominance of lower wave exposures and sand-gravel sediment textures results in high Oil Residence Indices for over half of the shore segments: 72% have an ORI of 4 or 5, indicating oil residence times are on the order of months to years (Table 5; Figure 8). All of the protected lagoon shorelines, which are very common, would have lengthy persistence, should a heavy oil reach those shorelines.

Table 5. Summary of Oil Residence Index

Relative Persistence	Oil Residence Index (ORI)	Estimated temporal persistence	Shoreline Length (km)	Shoreline Length (%)
Short	1	Days to weeks	19.6	1.8
	2	**Weeks** to months	120.0	11.0
Moderate	3	Weeks to **months**	169.7	15.5
	4	**Months** to years	170.8	15.6
Long	5	Months to **years**	615.3	56.2
Totals:			***1,095.4***	***100.0%***

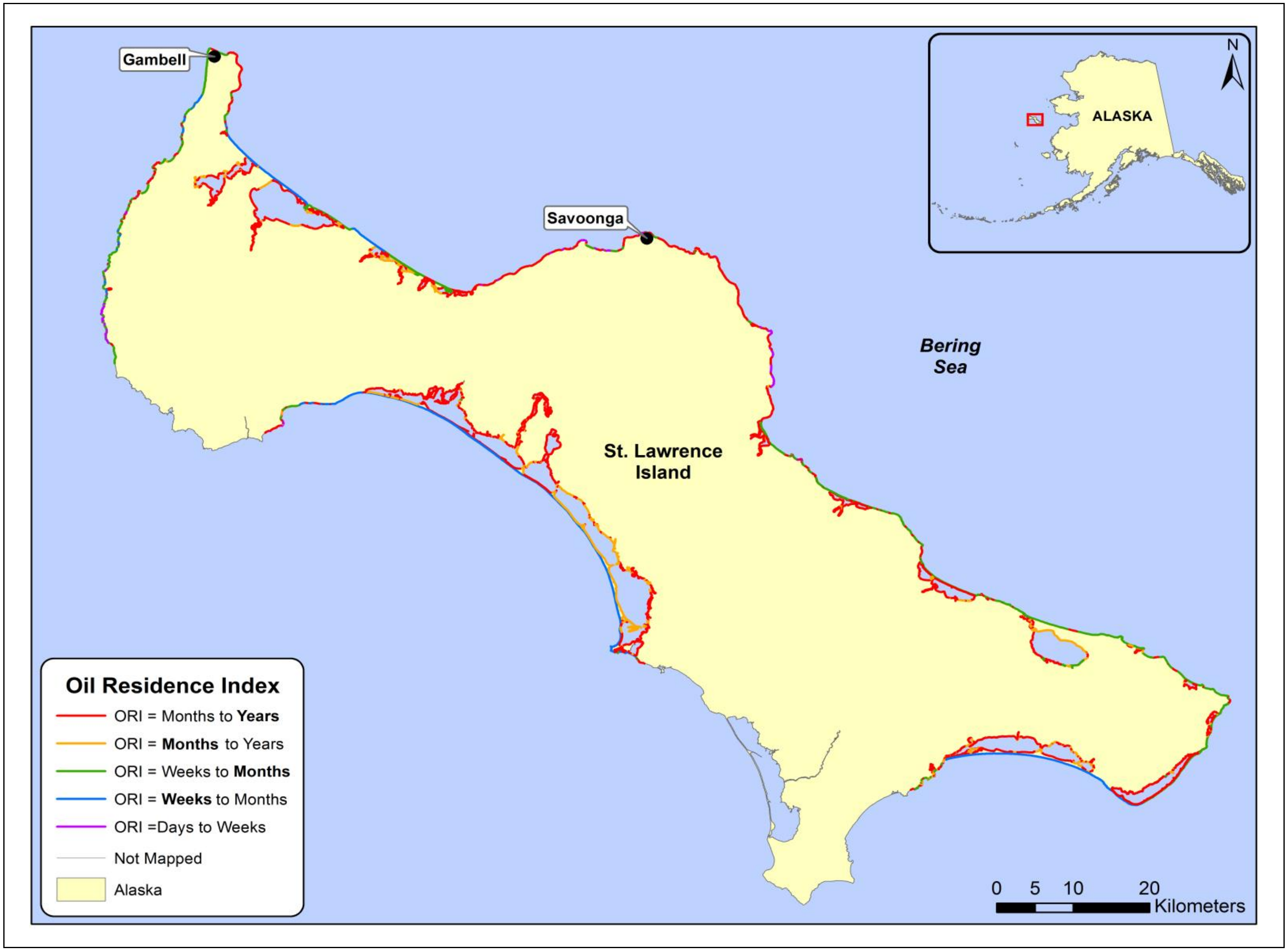


Figure 8. Oil Residence Index (ORI) for shorelines in the study area, based on substrate type and wave exposure (Appendix A, Table A-6).

2.4 ShoreZone Coastal Vulnerability Module

The Coastal Vulnerability Module (CVM) for ShoreZone is intended to provide users with a spatial picture of where and how shorelines are likely to be sensitive to climate change, specifically sea level rise. For example, shorelines with very low gradients will become increasingly flooded by storm surges.

The Coastal Vulnerability Module provides a measure of coastal sensitivity to climate change in terms of three indices that are based on observed coastal geomorphology of the shoreline (Appendix B). The three indices are:

> ***Coastal Stability Index*** that provides a measure of stability (retreating or prograding) for both clastic/sediment shorelines or for wetland shorelines (see Table B-1).
>
> ***Flooding Sensitivity Index*** that provides an estimate of the degree of observed flooding of immediate backshore areas (see Table B-2).
>
> ***Thaw Sensitivity Index*** that provides an estimate of thaw lake or water coverage in the backshore that is an indirect indicator of thaw settlement potential (see Table B-3).

These indices are complemented by an inventory of descriptive coastal features of mass-wasting/wetland morphology (Appendix B, Table B-4) that are potentially of interest to coastal planners and managers.

Coastal Vulnerability St. Lawrence Island

The ShoreZone Coastal Vulnerability Module was applied to the shoreline on St. Lawrence Island, comprising of 887.6 km (PH53 shoreline). The CVM was only applied to soft sediment shoreline; low gradient shorelines which are likely to become inundated due to sea level rise. Data for the three vulnerability indices are shown in Tables 6, 7, 8, and 9.

Figure 9 provides an overview of the distribution of stability classes for the region.

There are several features related to coastal vulnerability that stand out:

- A map of wetland observations (Fig. 10) indicates areas with wetland morphology (33% of the shoreline).

- The mapping data show that approximately 16% of the shoreline is likely to experience storm surge inundation greater than 50 m horizontally (Fig. 11, 12). This provides a clear metric of the sensitivity to both storm surges and sea level rise.

- Approximately 12% of the shoreline contains thaw lakes covering more than 25% of the backshore (Fig. 13, 14). These are areas that are already undergoing thaw lake coalescence and thaw settlement and are vulnerable from both climate warming and storm-surge inundation and melting.

Table 6. Coastal Stability Index

		Stability Class	Occurrences (km)	Occurrence (%)	Subtotals (%)
CLASTIC	CE4	Erosional	8.9	1.0	
	CE3		21.1	2.4	
	CE2		22.3	2.5	
	CE1		44.0	5.0	
	CS	Stable	237.1	26.7	
	CA1	Accretional	196.0	22.1	
	CA2		30.8	3.5	
	CA3		3.7	0.4	63.5
WETLAND	WE2	Erosional	20.6	2.3	
	WE1		71.6	8.1	
	WS	Stable	198.6	22.4	
	WA1	Accretional	31.8	3.6	36.4
Bedrock	R	Not applicable	0.9	0.1	0.1
Anthropogenic	A	Seawall	0.0	0.0	
Other	X	Provisional	0.0	0.0	
Total:			***887.6***	***100.0***	***100.0***

Table 7. Flooding Sensitivity Index

	Flooding Class	Occurrence (km)	Occurrences (%)
F4	Major	27.1	3.1
F3	↑	111.9	12.6
F2	↑	437.9	49.3
F1	Minor	309.8	34.9
X		0.9	0.1

Table 8. Thaw Sensitivity Index

	Thaw Sensitivity Class	Occurrence (km)	Occurrences (%)
T4		25.3	2.8
T3	High	77.5	8.7
T2	↑	136.9	15.4
T1	Low	647.0	72.9
X		0.9	0.1

Table 9. Coastal Mass-Wasting and Wetland Features

Category	Feature	Occurrence (km)	Occurrences (%)
Mass Wasting	Ground ice slumps	5.6	0.6
	Block slumps	5.6	0.6
	Debris flows/solifluction	23.8	2.7
	Ice Wedges	0.0	0.0
Wetlands	Lagoonal complex	143.6	16.2
	Deltaic complex	26.9	3.0
	Marsh clones	0.0	0.0
	Associated mudflats	7.3	0.8
	Submerged morphology	93.2	10.5
	Relict river morphology	11.9	1.3
	Relict shoreline morphology	8.4	0.9
Other		71.4	8.0
None	No relevant features	488.9	55.1
Not Applicable	Coastal Hazards not applicable	0.9	0.1

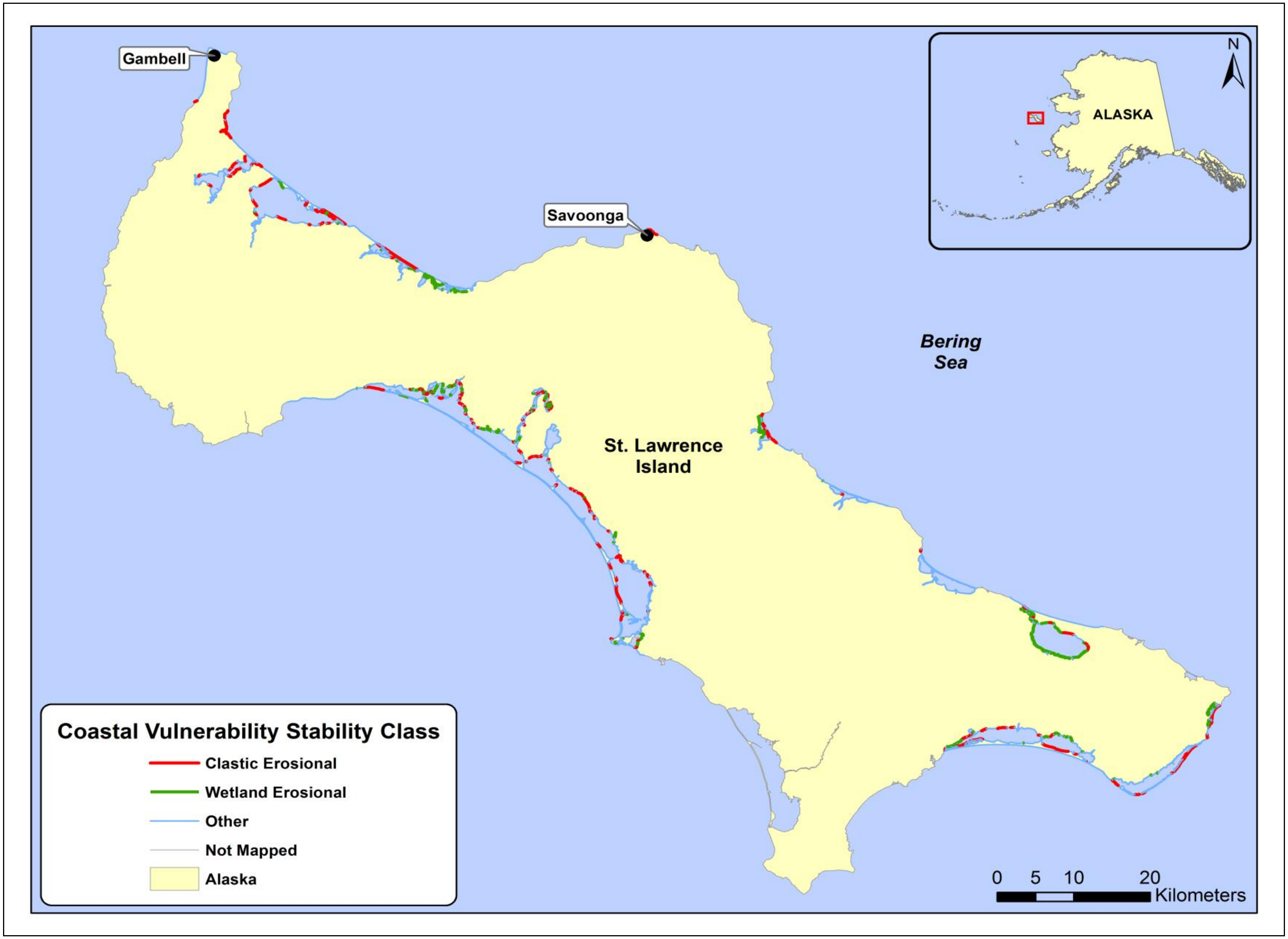


Figure 9. Map of the distribution of stability class regarding coastal vulnerability in the study area.

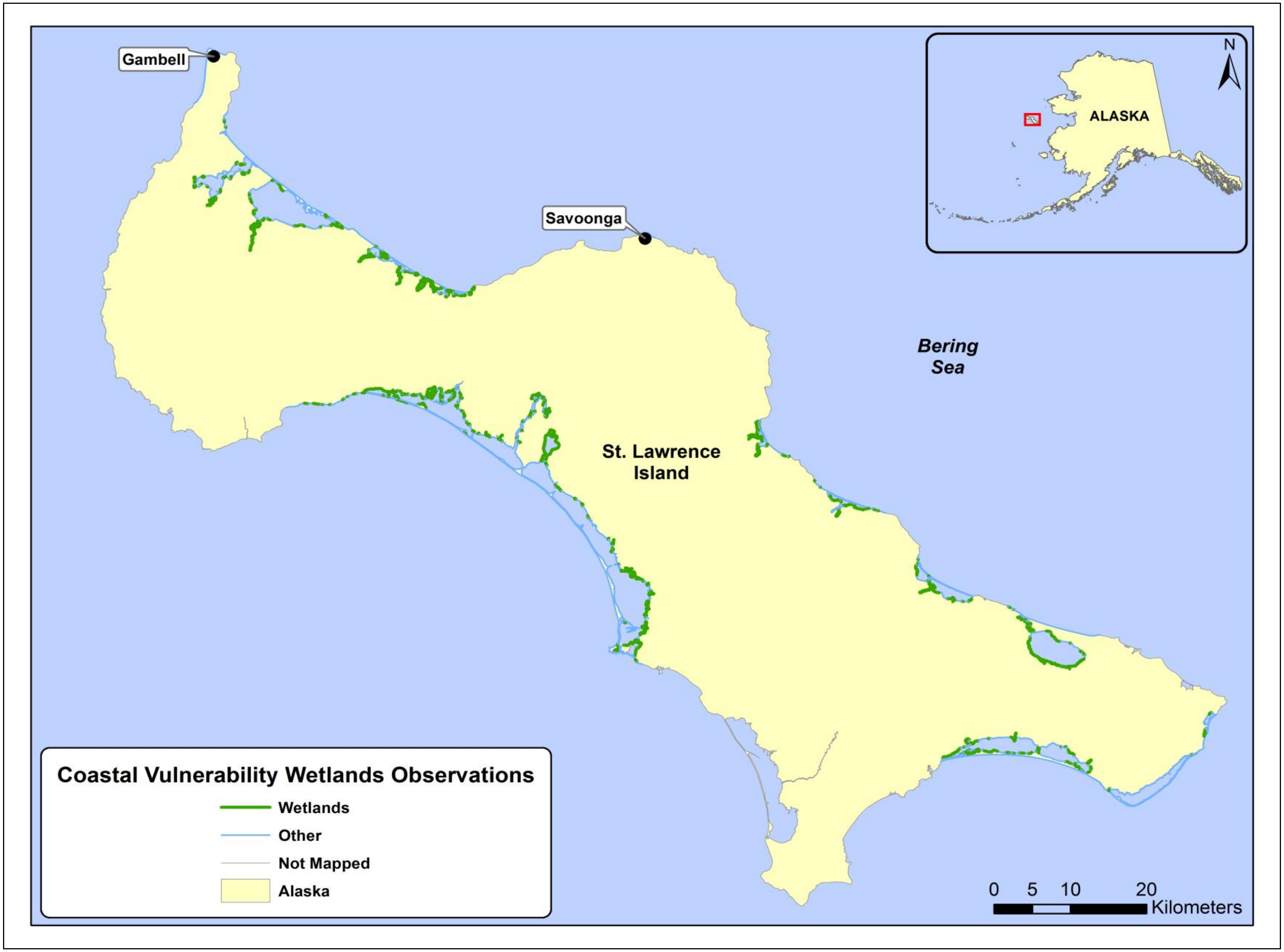


Figure 10. Map of the distribution of wetland observations in the study area.

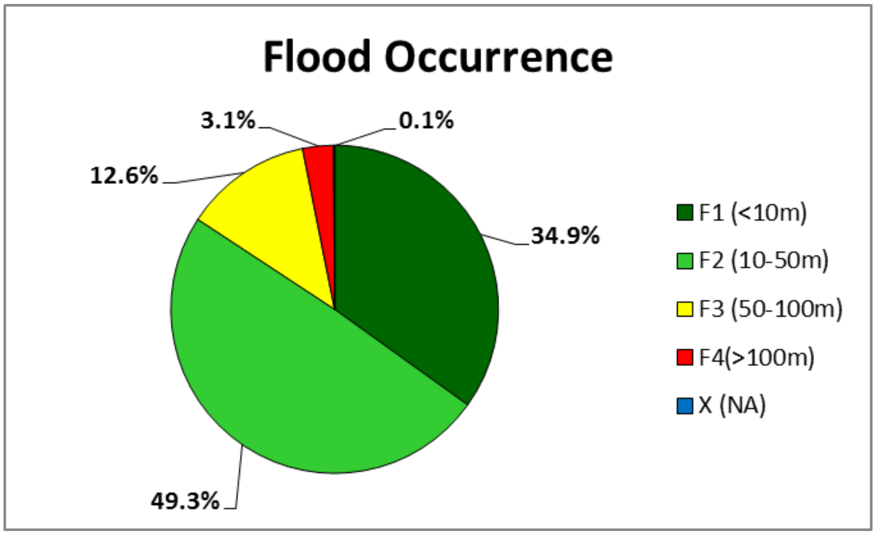


Figure 11. Relevant flood occurrence regarding coastal vulnerability in study area. Distances indicate potential storm surge inundation.

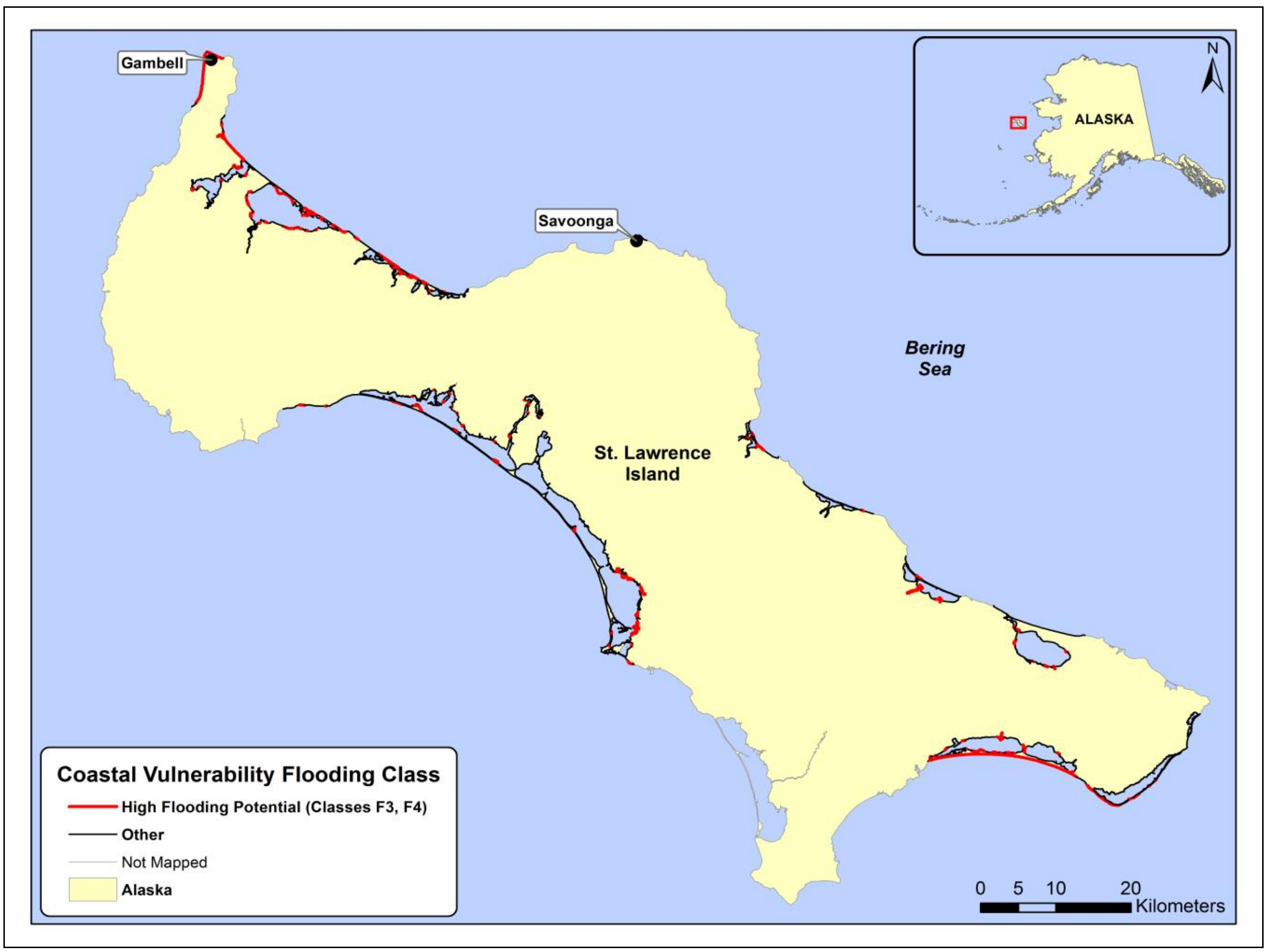


Figure 12. Map showing the occurrence of high inundation areas (>50m inundation).

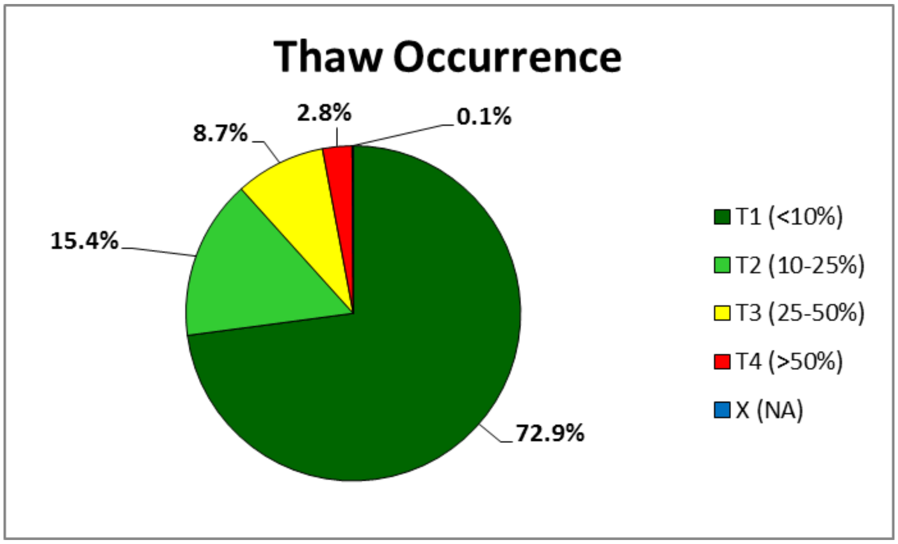


Figure 13. Relevant thaw occurrence regarding coastal vulnerability in study area. Percentages indicate the occurrence of ponds or lakes in the backshore.

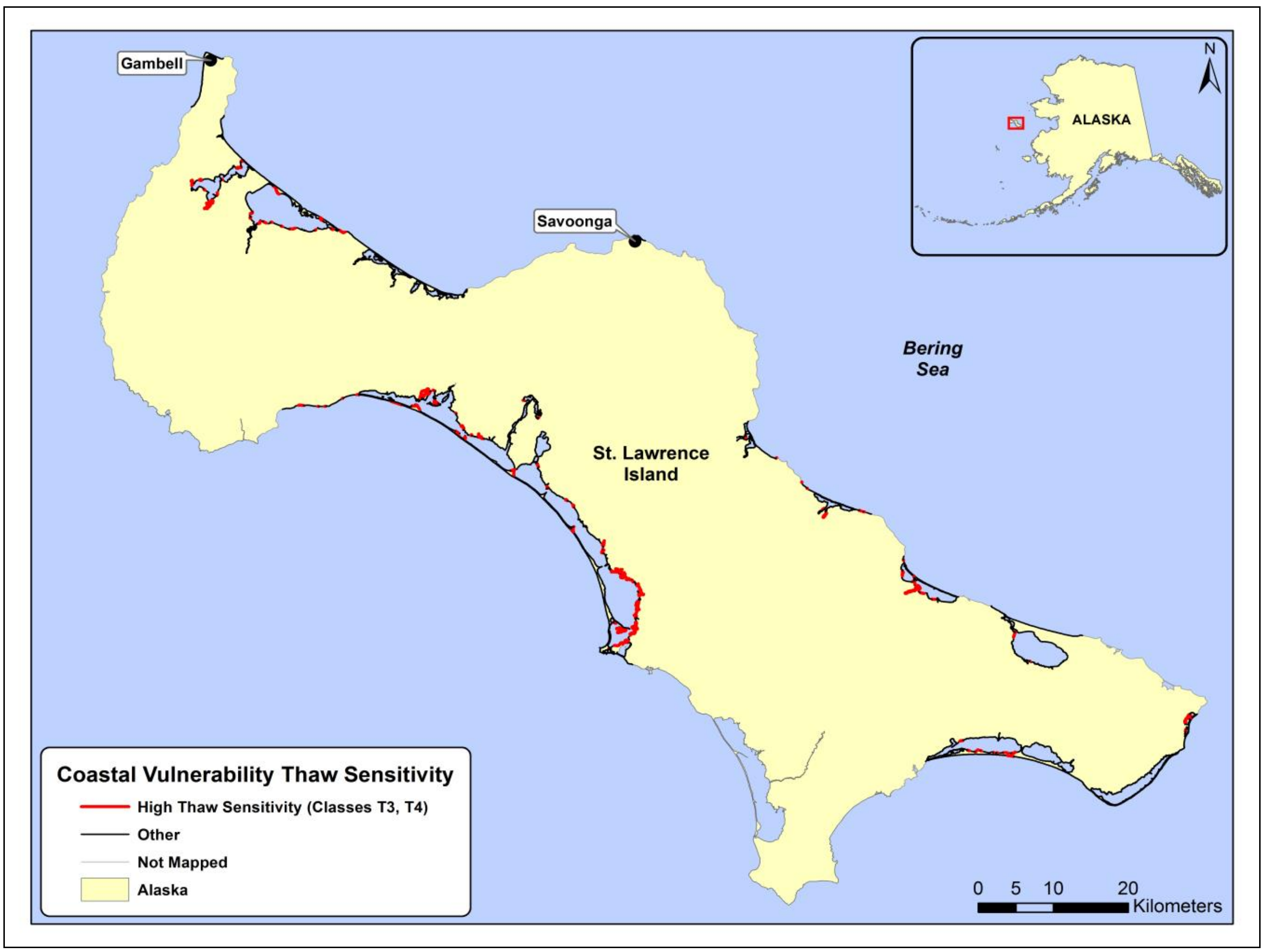


Figure 14. A map showing the occurrence shorelines with a high density of thaw lakes (>25%).

3 BIOLOGICAL SHOREZONE DATA SUMMARY

Biological ShoreZone mapping is based on the observation of patterns of biota in the coastal zone, with data recorded on the occurrence and extent of species assemblages (called **biobands**). The observations of presence, absence and relative distribution of the biobands are recorded in the mapping within each alongshore unit. Based on those observations, an interpreted classification of **biological wave exposure** and **habitat class** is assigned.

In the St. Lawrence Island project area, much of the shoreline is composed of mobile sediment beaches and few intertidal biobands are present to use as indicators of wave exposure categories. For this reason, the biological mappers used the wave exposure category which had been classified by the physical Mappers (EXP_OBSER) to assign the 'biological' exposure.

3.1 Biobands

A **bioband** is an observed assemblage of coastal biota, found on the shoreline at characteristic wave energies, substrate conditions and typical across-shore elevations. Biobands are spatially distinct, with alongshore and across-shore patterns of color and texture that are visible in aerial imagery (Figures 15 and 16). Biobands are described across the shore, from the high supratidal to the shallow nearshore subtidal and are named for the dominant species or group that best represents the entire bioband.

Some biobands are named for a single *indicator* species (such as the Eelgrass bioband (ZOS)), while others represent an assemblage of co-occurring species (such as the Red Algae bioband (RED)). Indicator species are the species that are most commonly observed in the band. For descriptions of all the biobands in mapping throughout Alaska, including lists of indicator and associate species, refer to Appendix A, Table A-16.

The distribution of each bioband observed in every unit is recorded in the database. Bioband occurrence is recorded as *patchy* or *continuous* for all biobands except for the Splash Zone bioband (VER), which is recorded from an estimate of the across-shore width (*narrow, medium* or *wide*). A distribution of *patchy* is defined as 'visible in less than half (approximately 25-50%) of the along-shore unit length' and *continuous* is defined as 'visible in more than half (50-100%) of the unit's along-shore length' (refer to Appendix A, Table A-16 for full definitions).

Figure 15. Dune Grass (GRA) and Salt Marsh (PUC) biobands with adjacent Tundra (TUN) around small estuary/lagoon feature (Seevoo Point, photo bs13_sq_00938.jpg).

Figure 16. Tundra (TUN) with a few patches of Dune Grass (GRA) in the supratidal with Rockweed (FUC) in the intertidal and Soft Brown Kelps (SBR) in the nearshore subtidal (Kavalghak Bay, photo bs13_sq_07194.jpg).

The occurrence of each bioband mapped in the St. Lawrence Island project area included in this summary report is summarized in Table 10 and Figure 17.

The Tundra (TUN) bioband was the most common bioband mapped in the project area and was recorded in 71% of the units (within the marine limit). The Tundra bioband is defined as occurring in the supratidal zone on periglacial coasts. Vegetation in the Tundra band includes a low turf of dwarf willows, herbs, grasses and sedges which can intermingle with upper edge of Dune Grass (GRA), Salt Marsh (PUC) or Sedge (SED) biobands on low elevation coastal plains.

Dune Grass (GRA) and Salt Marsh (PUC) were the next most commonly mapped bioband, with 51% of the coast having either patchy or continuous GRA recorded and 31% of the coast with mostly patchy PUC. Dune Grass was observed both on the higher energy outer coast beaches as well as along a narrow strip at the lowest edge of salt marshes in lagoons and at river deltas. The Sedge (SED) bioband occurred along 15% of the shoreline, generally co-occuring with the Tundra bioband in the fresh-water influenced estuaries and lagoon systems.

Only small amounts of the biobands associated with stable substrate (Rockweed, Green Algae, and Red Algae) were observed on St. Lawrence Island, which together amounted to 10% of the total mapped shoreline (Table 10 and Figure 19). Benthic kelps (Soft Brown Kelps (SBR) or Dark Borwn Kelps (CHB)) were observed in just over 14% of the shoreline. These benthic kelps likely included Rockweed (FUC) which is usually strictly an intertidal algae but has been known to grow deeper in Arctic regions. It was not possible to distinguish Rockweed from other biobands in the nearshore so they were included with the Soft Brown Kelp (SBR) bioband for this project. The Eelgrass (ZOS) bioband was mapped along 4% of the shoreline. The presence of the indicator species for this bioband, *Zostera marina*, could not be confirmed during this survey; therefore, in the St. Lawrence Island project area the ZOS band is indicating the presence of attached submerged vegetation that is serving the same ecological function as Eelgrass.

Table 10. Bioband Abundances Mapped

Bioband		Continuous		Patchy		Total	% of
Name	Code	km	%	km	%	km	Mapped
Tundra	TUN	721	66	57	5	778	71
Dune Grass	GRA	422	39	137	13	560	51
Sedge	SED	95	9	71	7	166	15
Salt Marsh	PUC	95	9	241	22	336	31
Rockweed	FUC	35	3	40	4	74	7
Green Algae	ULV	30	3	19	2	48	4
Bleached Red Algae	HAL	2	<1	23	2	25	2
Red Algae	RED	9	1	8	1	17	2
Soft Brown Kelps	SBR	80	7	75	7	156	14
Dark Brown Kelps	CHB	<1	<1	2	<1	2	<1
Eelgrass	ZOS	9	<1	25	3	34	4

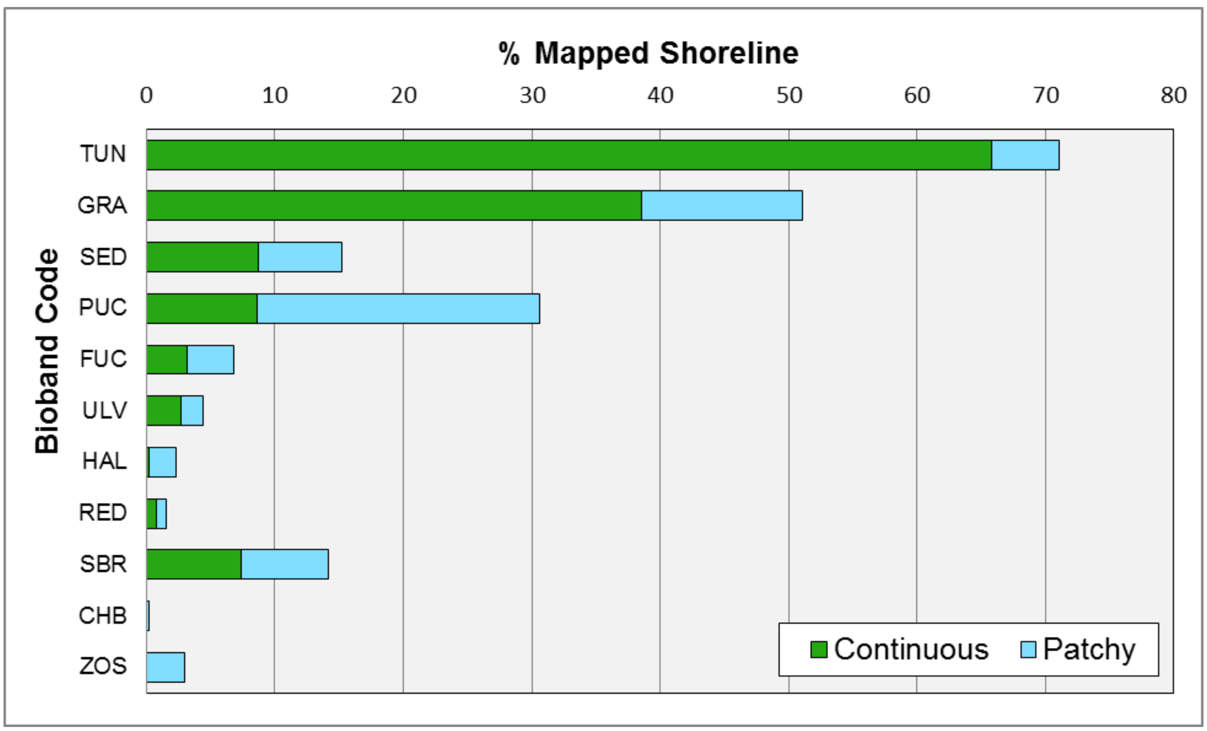


Figure 17. Bioband abundances as a percent of the mapped shoreline in the study area.

Bioband Distributions

Only a few supratidal biobands make up most of the biota observed on the permafrost-dominated Arctic coasts of St. Lawrence Island. Those biobands are: Tundra (TUN), Salt Marsh (PUC), Dune Grass (GRA) and Sedges (SED). Almost all of the shoreline on St. Lawrence Island has at least one of these biobands. The distribution of Salt Marsh and Sedges are mapped in Figure 18. The Salt Marsh was most common along the exposed sandy beaches serving as barriers to the protected lagoons, although it was also found inside the lagoons on the northern side of the island. The Sedges bioband was only found along the inner portions of the lagoons on the south side of the island. These lagoons tended to have narrower entrances and more freshwater input than the northern lagoons. Dune Grass and Tundra were ubiquitous in the survey area and showed no real pattern of distribution and were therefore not included in the map.

St. Lawrence Island was dominated by mobile bare beaches, but where hard substrate was found there was generally attached vegetation although in the intertidal it tended to be small and occur in cracks and crevices where it would not be removed by ice scour during the winter. Figure 19 shows the distribution of Rockweed (FUC) and Soft Brown Kelps (SBR) which were the two most common bands found attached to hard substrate in the intertidal and subtidal, respectively. This figure also shows the distribution of the Eelgrass (ZOS) band which, as mentioned previously, is composed of submerged nearshore vegetation that appears to be rooted. It was mostly found in the lagoons on the northern side of the island where there appeared to be more salt water influence. It is not known whether the distribution of eelgrass (*Zostera marina*) extends to St. Lawrence Island so the mapping of this bioband should not be taken to indicate the presence of that species.

Further descriptions of the characteristics of all the biobands can be found in Appendix A, Table A-16.

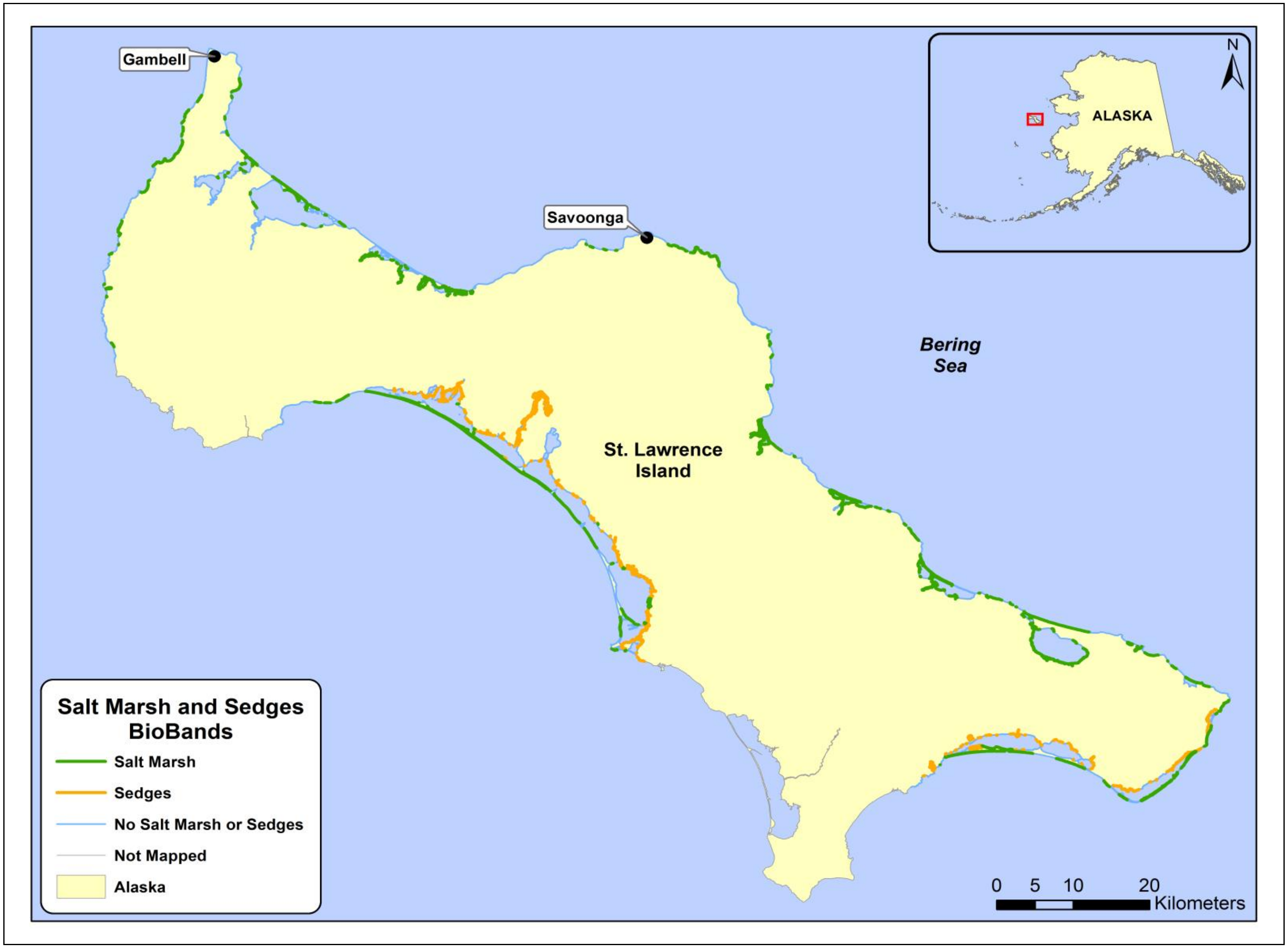


Figure 18. Distribution of units in the project area with Salt Marsh and Sedges biobands.

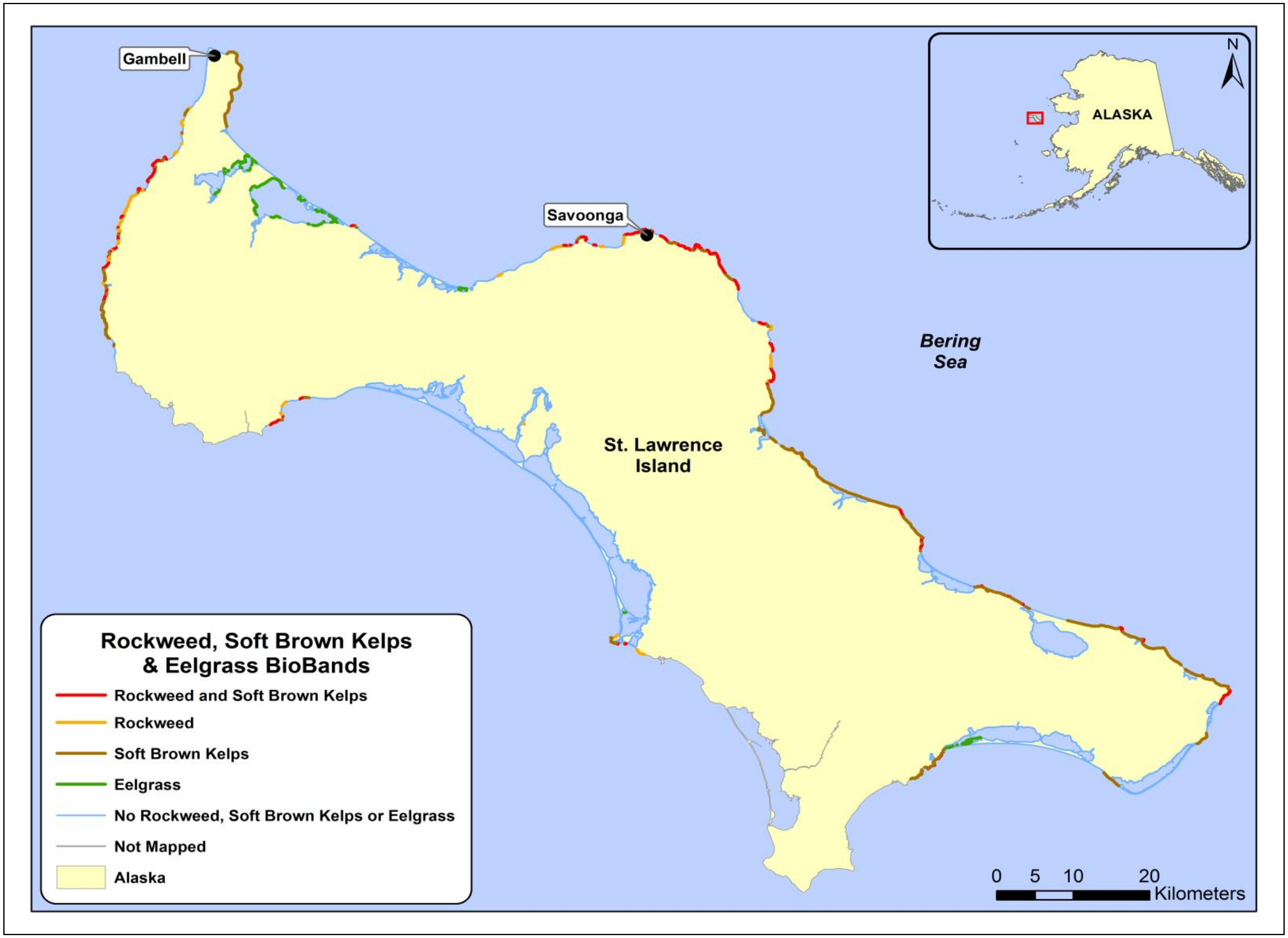


Figure 19. Distribution of units in the project area with Rockweed (FUC), Soft Brown Kelp (SBR) and Eelgrass (ZOS) biobands.

3.2 Biological Wave Exposure

Biological wave exposure categories range from Very Protected (VP) to Very Exposed (VE) and are usually defined in ShoreZone on the basis of a typical set of biobands. When present, the observation and relative abundance of biota in each alongshore unit is used to determine the classification for the biological wave exposure. The assemblages of biota observed are then used as a proxy for the energy conditions at that site. The six biological wave exposure categories are the same as those used in the physical mapping (Appendix A, Tables A-4 and A-9).

Attached intertidal and nearshore biobands are mostly absent on St. Lawrence Island, therefore physical mappers' estimate of wave energy (EXP_OBSER) was deemed to be equivalent to the biological wave exposure for the whole project area. The physical wave exposure is based on fetch window estimates and coastal geomorphology.

The physical wave exposure, as transcribed to the biological exposure attribute for all units, was also then used in the look up matrix for determining the Oil Residence Index (ORI) (Table A-7).

The occurrence of the wave exposure categories mapped in the St. Lawrence Island project area is summarized in Table 11 and Figure 20. Most of the shoreline in the study area was classified with a wave exposure of Semi-protected (SP) or lower (65%). Fourteen percent of the area was mapped as Exposed (E) and 22% was mapped in the Semi-Exposed (SE) category. A summary map of the biological wave exposure categories distribution is shown in Figure 22. Most of the high energy shoreline occurs on barrier beaches which are in close proximity to sheltered lagoon and salt marsh. This results in a spatially-complex mixture of coastal habitats, where wave energy conditions vary considerably over short distances.

Species assemblages used as indicators of wave energy categories for shoreline with biota in the Gulf of Alaska ShoreZone mapping are listed in Appendix A Table A-16. For more information about biobands, biological wave exposure, habitat class definitions and examples from other bioareas in Alaska, see data summary reports for Southeast Alaska and the current ShoreZone protocols. These reports are available for download from the ShoreZone website at http://alaskafisheries.noaa.gov/shorezone/

Table 11. Summary of Wave Exposure [1]

Biological Wave Exposure		Length (km)	% of Mapped
Name	Code		
Exposed	E	157	14
Semi-Exposed	SE	237	22
Semi-Protected	SP	40	4
Protected	P	532	49
Very Protected	VP	130	12
Totals		**1,095**	**100**

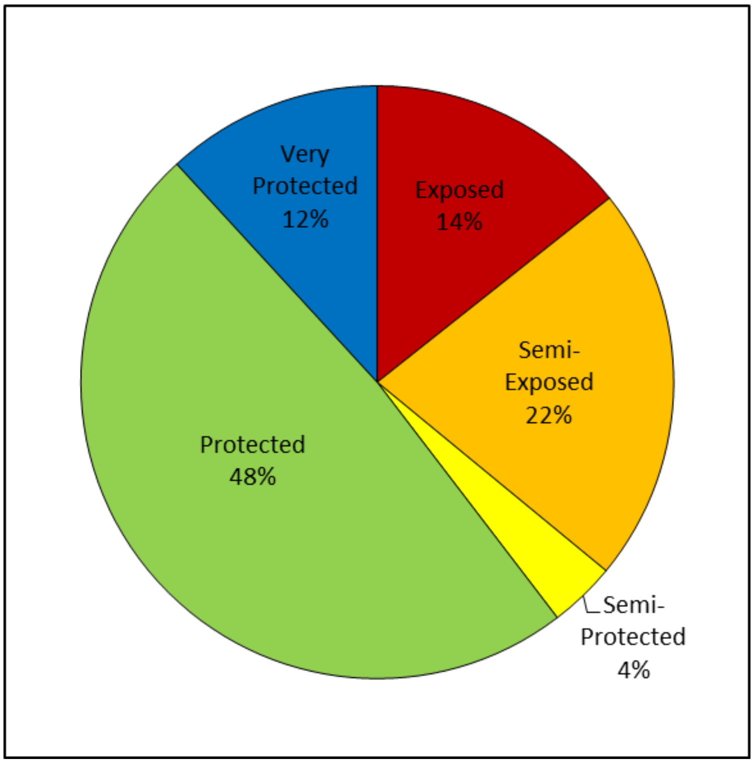


Figure 20. Summary of wave exposures mapped in the study area [2].

[1] and [2] in the St. Lawrence Island project area the physical mapper estimate of wave energy (EXP_OBSER) was used to assign biological wave exposure.

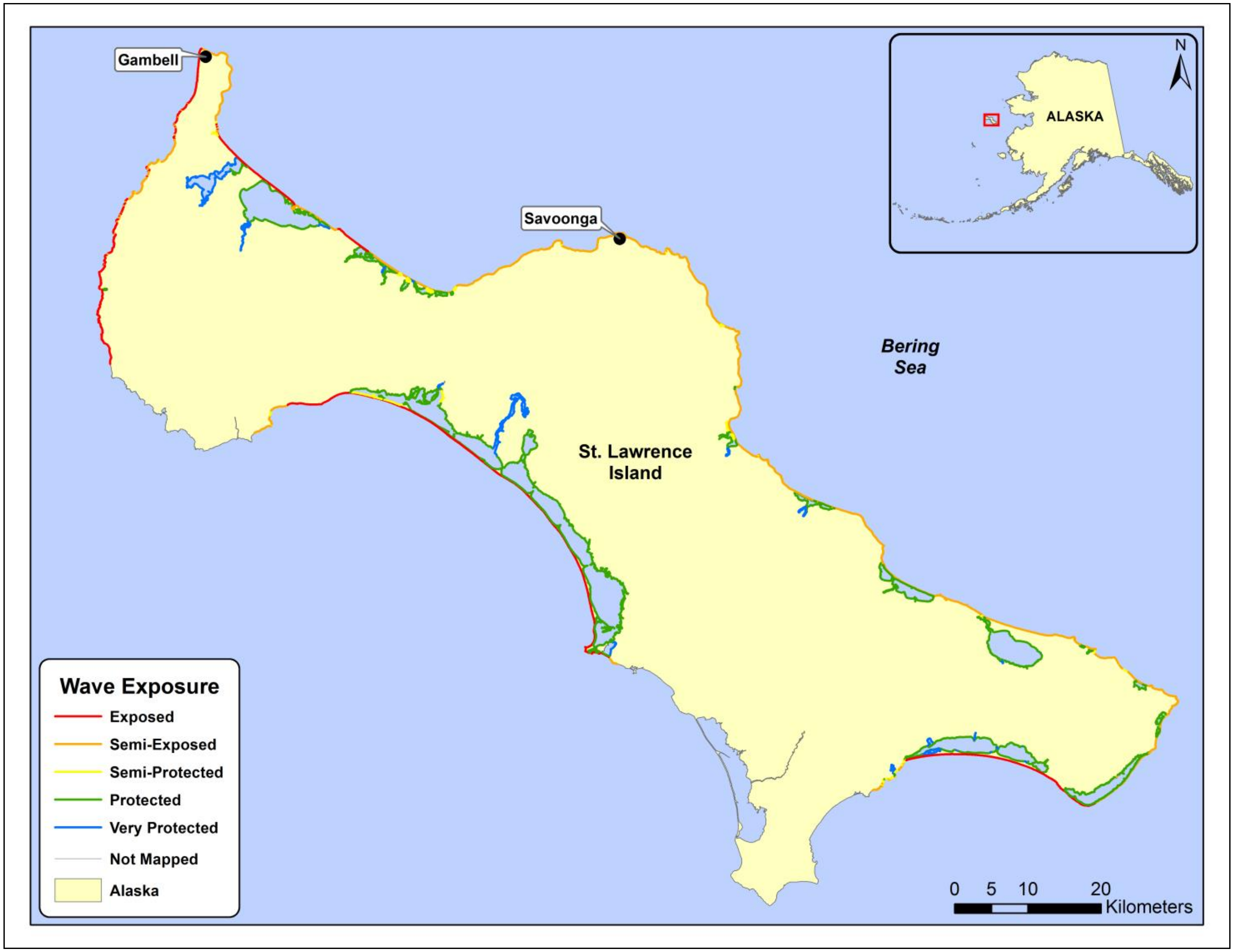


Figure 21. Distribution of wave exposure categories mapped in the study area (note that for the St. Lawrence Island project all exposure categories were assigned from the physical exposures).

3.3 BioAreas

As ShoreZone biological mapping has been completed throughout Alaska, differences in the coastal habitats classified have been observed. To recognize these broad-scale trends in coastal habitats, as well as the region-specific species assemblages mapped, a number of **bioareas** have been defined in Alaska Appendix A, Table A-8). A similar approach was applied in British Columbia to recognize the eco-regional differences and seven bioareas have been defined there for the ShoreZone mapping.

Bioareas in Alaska have been delineated on the basis of observed differences in the distribution of coastal habitat classification, the distribution of biobands (and in particular, those biobands in the lower intertidal), and in some areas, the distribution of nearshore canopy kelp biobands.

St. Lawrence Island is part of the Kotzebue (KOTZ) bioarea (Figure 22) which is characterized by high energy, mobile sediment barrier beaches and large backshore lagoons. Extensive areas of salt marsh are also present on low energy shoreline away from the open coast. The upper intertidal Tundra (TUN) bioband is ubiquitous and much of the shoreline also has Salt Marsh (PUC) and Dune Grass (GRA) biobands. Sedge (SED) bioband is also common in the more ponded lagoons but few other biobands are observed and their extent is limited.

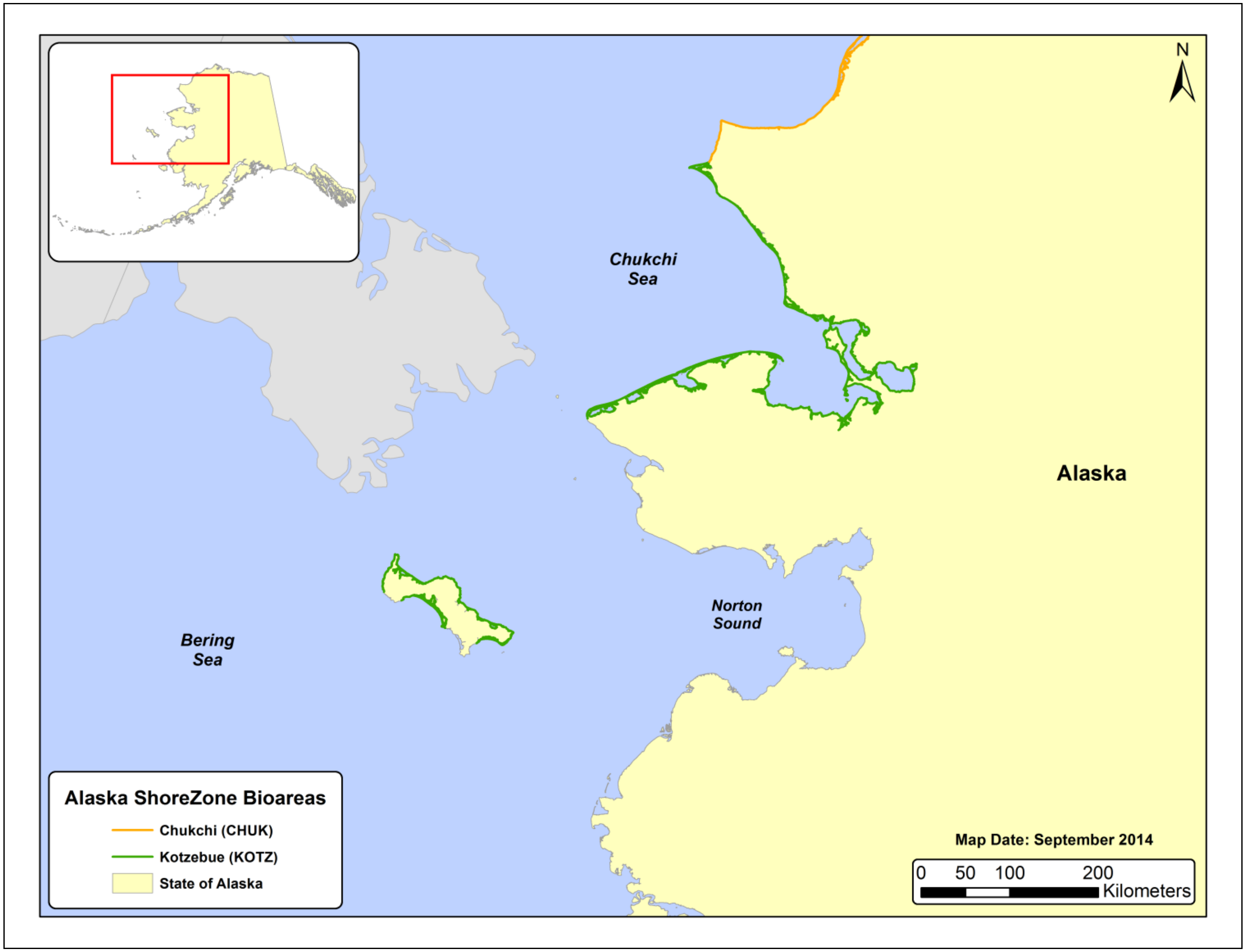


Figure 22. Bioareas identified in the region around the St. Lawrence Island survey area. Bioareas are delineated on the basis of observed regional differences in the distribution of biota and coastal geomorphology.

3.4 Habitat Class

Habitat Class is a summary classification that combines both physical and biological characteristics observed for a particular shoreline unit. The classification is based on wave exposure and geomorphic characteristics, and is intended to provide a single attribute to summarize the detail attributes which describe the biophysical features of the unit.

The habitat class is determined from the biological wave exposure [3] in combination with the 'dominant structuring process' and geomorphic features of the site are used to assign the unit's Habitat Class. Wave energy is the most common structuring process, and less commonly observed habitats are those structured by current, estuarine/fluvial processes or anthropogenic structures.

In wave energy-structured habitat classes, the combination of wave exposure and substrate type determines the degree of substrate mobility, which in turn determines the presence and abundance of attached biota. Where the substrate is mobile, biota is sparse or absent, and where the substrate is stable, epibenthic biota can be abundant.

The three categories of wave energy-structured habitat classes, based on substrate mobility, are as follows:

- **Immobile** or stable substrates, such as bedrock or large boulders, enabling a well-developed epibenthic assemblage to form;
- **Partially Mobile** mixed substrates such as a rock platform with a beach or sediment veneer where the development of a full bioband assemblage is limited by the partial mobility of the sediments;
- **Mobile** substrates such as sandy beaches where coastal energy levels are sufficient to frequently move sediment, thereby limiting the development of epibenthic biota.

Habitat classes determined by dominant structuring processes other than wave energy have limited occurrence along the coast and, except for the anthropogenic shorelines, are often highly valued habitats. These habitat classes are:

- **Estuary** complexes, with freshwater stream flow, delta form at the stream mouth and fringing wetland biobands including Salt Marsh (PUC), Dune Grass (GRA) and often Sedges (SED);
- **Current-Dominated** channels where high tidal currents support assemblages of biota typical of higher energy sites than would be found at the site if wave energy was the structuring process (these units are usually associated with lower wave exposure conditions in adjacent shore units);

[3] In the St. Lawrence Island area, where attached intertidal biota are largely absent on bare beaches, the physical mapper estimate of wave energy (EXP_OBSER) was used to assign biological wave exposure.

- **Glacier** ice, where saltwater glaciers form the intertidal habitat;
- **Anthropogenic** features where the shoreline has undergone human modification (e.g., areas of rip rap or fill, marinas and landings), excluding archaeological sites;
- **Lagoons**, which have enclosed coastal ponds of brackish or salty water (note that Lagoons in the biological classification are mapped only as a secondary habitat class, see Table A-12 for further definition of secondary habitat class).
- **Permafrost,** where units are structured by permafrost and may be inundated tundra, eroding tundra sea cliffs or other periglacial features.

Approximately 81% of the habitat class categories mapped were structured by wave energy, mostly in the mobile class (Table 12 and Figure 23). Of the non-wave energy structured habitats, the Permafrost habitat was most common and accounts for 15% of the shoreline mapped on St. Lawrence Island. Note that the biological permafrost habitat class and physical periglacial coastal class differ slightly due to specific biological habitat mapping rules (Appendix A, Table A-11). In this case, there is a 5% discrepancy between periglacial and estuary classifications. Furthermore, the Estuary habitat class was only mapped along 5% of the shoreline of St. Lawrence Island (Figure 24), although this habitat class was more common in the mainland portion of the KOTZ bioarea. Many of the KOTZ bioarea estuaries are along fringing wetlands that have numerous ponds of standing water and drainage channels (likely brackish) but may be some distance from truly ‘fluvial’ processes. The ‘rule of thumb’ for Estuary habitat class in this bioarea was therefore modified to identify salt marshes of this nature, which are separate from ‘tundra-dominated’ classes but not necessarily directly associated with ‘fluvial processes’.

Backshore lagoons were classified as ‘secondary habitat class: lagoon’ on 9% of St. Lawrence Island (Figure 25). Lagoons are characterized by brackish standing water, with limited drainage and usually have salt marsh biobands.

Further descriptions and definitions of the habitat class categories are listed in Appendix A, Tables A-10 and A-11.

Table 12. Summary of Occurrence of Habitat Classes

Dominant Structuring Process	Habitat Class		Kotzebue project area	
	Exposure Category	Substrate Mobility	Length (km)	% of Mapping
Wave Energy	Exposed (E)	Immobile & Partially Mobile	32	3
	Semi-exposed (SE)	Immobile & Partially Mobile	93	9
	Semi-protected (SP)	Immobile & Partially Mobile	5	<1
	Protected (P)	Immobile & Partially Mobile	24	2
	Very Protected (VP)	Partially Mobile	1	<1
	E, SE, SP, P	Mobile	722	66
Fluvial/Estuarine processes	Estuary		50	5
Current dominated	Current Channel		<1	<1
Periglacial	Permafrost		167	15
Man-modified	Anthropogenic		<1	<1
Lagoon *	Lagoon		100	9
	Totals		**1095**	**100**

* Lagoons are classified as *secondary habitat class* (Appendix A, Table A – 10 and A – 11) and are not included in the total shoreline length.

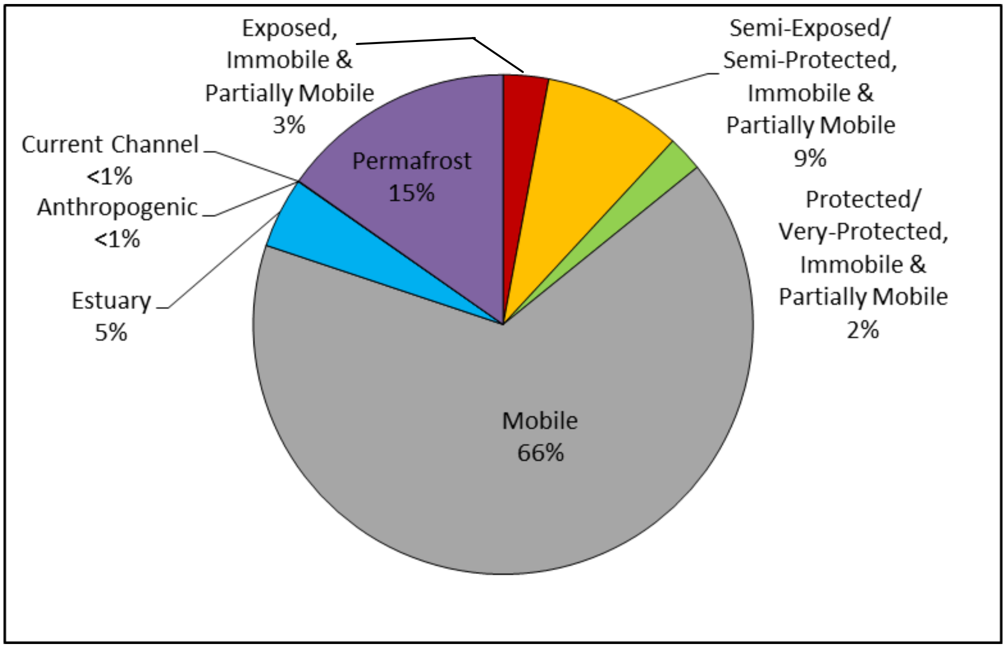


Figure 23. Summary of Habitat Class categories mapped in the study area.

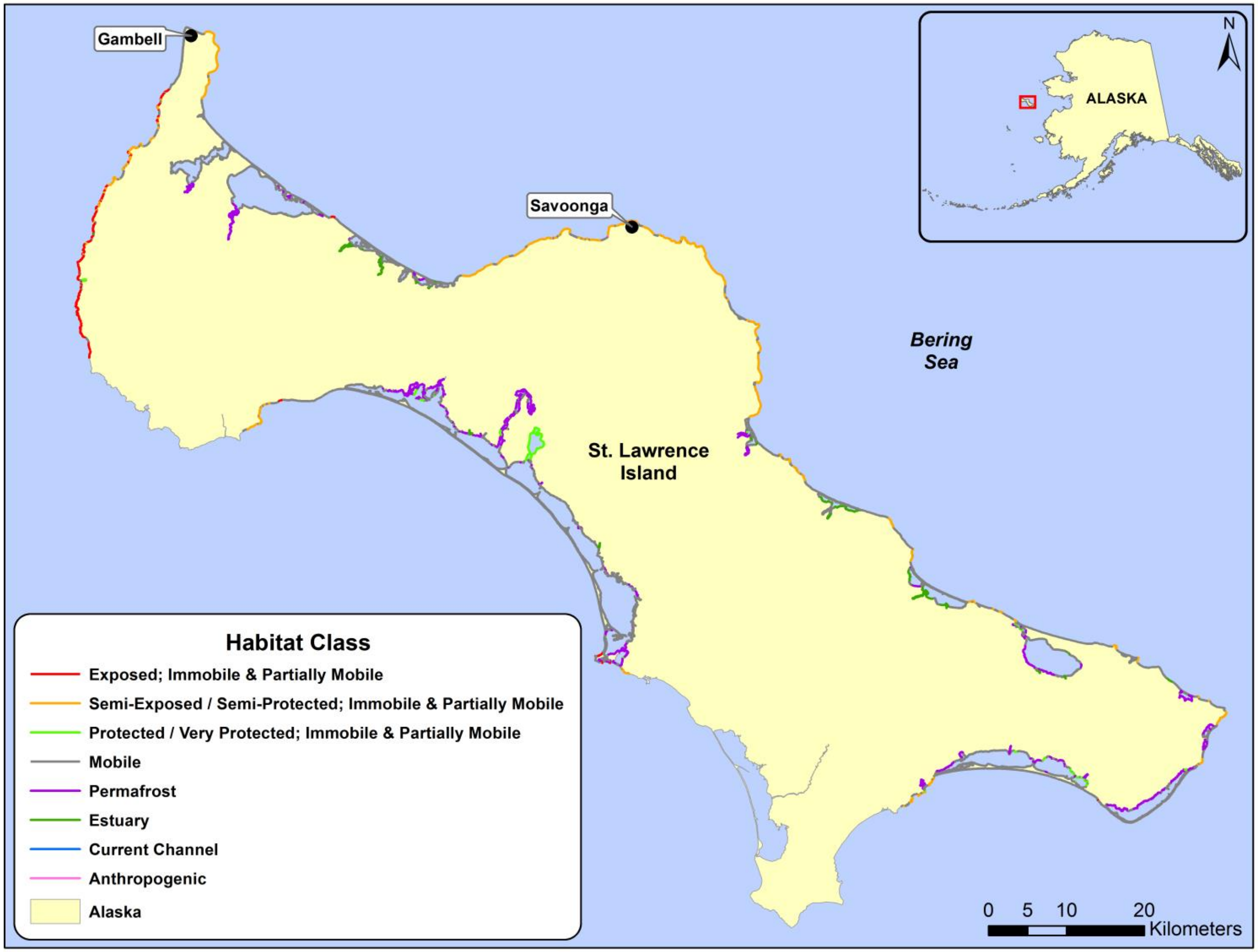


Figure 24. Distribution of Habitat Classes by 'dominant structuring process' for study area.

Figure 25. Lagoon secondary habitat class, in backshore behind high energy barrier beach near Tikugha Point, by Kangee Camp (Photo bs13_sq_03456.jpg).

4 CONCLUSIONS & RECOMMENDATIONS

4.1 Conclusions

1. This ShoreZone project covers close to 1,095 km on St. Lawrence Island. The system will allow for the searching of a wide variety of attributes that are captured in the ShoreZone dataset. One can examine all the information for a small site or one can look for the distribution of a single attribute of large region.

2. The attributes in ShoreZone provides an important tool for habitat capability modelling for a wide variety of species. For example, ShoreZone has been used in British Columbia and Alaska for identifying high probability sites for invasive green crabs (Harney 2007). ShoreZone attributes of substrate, exposure and associations with marshes and eelgrass were used to identify and map these sites. This same query could now be applied to the St. Lawrence Island dataset.

3. Co-registered imagery, when fully implemented on the website, will allow users of ShoreZone to examine actual photos and video that were used to interpret the cataloged data.

4.2 Recommendations

1. We are often asked how ShoreZone might be used as a monitoring tool. In general, ShoreZone does not provide sufficient resolution of attributes to be used in change detection. However, it is an excellent tool for selecting sites that can be used for monitoring; the ShoreZone information allows interpolation of results from such sites to much broader sections of coast.

2. Another frequent question is: how often should ShoreZone be updated? As climate change affects the coastal zone, shorelines may move in position but usually the shoreline habitat does not change – that is, a low-energy, eroding cliff shoreline is still a low-energy, eroding cliff habitat even though the shoreline position has changed. It may be that changes in technology may drive the need for updating more than environmental change. In 2003, ShoreZone was still using film and a few hundred photos per day were being collected. But in 2013, digital technology allows thousands of georeferenced photos to be collected in a day. Given that technology is changing so rapidly, it may be that changes in imagery acquisition or delivery will provide a more compelling reason to update the ShoreZone project.

5 REFERENCES

Berry, H.D., J.R. Harper, T.F. Mumford, Jr., B.E. Bookheim, A.T. Sewell and L.J.Tamayo 2004. Washington State ShoreZone Inventory User's Manual, Summary of Findings, and Data Dictionary. Reports prepared for the Washington State Dept. of Natural Resources Nearshore Habitat Program.

Harney, J.N. 2007. Modeling Habitat Capability for the Non-Native European Green Crab (*Carcinus maenas*) Using the ShoreZone Mapping System in Southeast Alaska, British Columbia, and Washington State. Report prepared for NOAA National Marine Fisheries Service (Juneau, AK). 75 p.

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

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

Harper, J.R. and M.C. Morris 2014. Alaska ShoreZone Coastal Habitat Mapping Protocol. Report prepared by Nuka Research and Planning LCC of Seldovia for the Alaska Bureau of Ocean Energy Management (BOEM), Anchorage, AK, 144 p.

Howes, D.E. 2001. British Columbia biophysical ShoreZone mapping system – a systematic approach to characterize coastal habitats in the Pacific Northwest. Puget Sound Research Conference, Seattle, Washington, Paper 3a, 11p.

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

Petersen, J., J. Michel, S. Zengel, M. White, C. Lord, C. Plank. 2002. Environmental Sensitivity Index Guidelines. Version 3.0. NOAA Technical Memorandum NOS OR&R 11. Hazardous Materials Response Division, Office of Response and Restoration, NOAA Ocean Service, Seattle, Washington 98115 89p + App.

6 ACKNOWLEDGMENTS

We would like to thank NOAA National Marine Fisheries Service, Alaska Region for their continued support on this project.

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

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

APPENDIX A DATA DICTIONARY

Appendix Table	Description
A-1	Data dictionary for UNIT table
A-2	Classification of shore types employed in ShoreZone mapping
A-3	Environmental Sensitivity Index (ESI) Shore Type classification
A-4	Exposure matrix used for estimating observed physical exposure (EXP_OBSER) on the basis of fetch distance
A-5	Oil Residence Index (ORI) definitions
A-6	Oil Residence Index (ORI) look-up matrix based on exposure (columns) and substrate type (rows)
A-7	Data dictionary for BIOUNIT table
A-8	Definition of BIOAREAS
A-9	Exposure Codes used in *Biounit* Table
A-10	Habitat Class Codes
A-11	Habitat Class Definitions
A-12	Data dictionary for across-shore component table (XSHR)
A-13	'Form' Code Dictionary
A-14	'Material' Code Dictionary
A-15	Data dictionary for the BIOBAND Table
A-16	Bioband Definitions
A-17	Data dictionary for the PHOTO Table

Table A-1. Data dictionary for UNIT table

Field Name	Description
UnitRecID	Automatically-generated number field; the database "primary key" for unit-level relationships
PHY_IDENT	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	2-digit coastal region number (see reference maps and GIS materials)
AREAS	2-digit coastal area number (see reference maps and GIS materials)
PHY_UNIT	4-digit physical along-shore unit number; segmented during physical mapping and delineated on paper maps and in GIS
SUBUNIT	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	Single-letter description of Unit type: a (L)ine [unit] or (P)oint feature [variant]
BC_CLASS	Coastal class or "shore type" of the unit based primarily on substrate type, across-shore width, and slope (Table A-2)
ESI	Environmental Sensitivity Index shore unit classification (Table A-3)
LENGTH_M	Along-shore length in meters; calculated after digitizing using ArcGIS and updated using database query
GEO_MAPPER	Last name of the physical mapper
GEO_EDITOR	Last name of the physical mapper who QA/QCs the work (10% of all units are reviewed by an editor)
GEO_MAP_DATE	the mapping date
VIDEOTAPE	Title of the videotape (DVD imagery) used for mapping; naming convention for Oregon is ORG11_OR_02, in which ORG11 is the region and year, OR is the team, 02 is tape
HR	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	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	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	Estimate of wave exposure as observed by the physical mapper, as a function of the relative fetch (Table A-4), with a consideration of geomorphology.
ORI	Oil Residence Index indicates a possible residence time of heavy oils stranded on the shore. It is largely determined by wave exposure (or energy) levels and shore substrate types (see Tables A-5 and A-6)
SED_SOURCE	Estimated sediment source for the unit: (A)longshore, (B)ackshore, (F)luvial, (O)ffshore, (X) not identifiable
SED_ABUND	Code indicating the relative sediment abundance within the shore-unit, (A)bundant, (M)oderate, (S)carce

[continued]

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

Field Name	Description
SED_DIR	One of the eight cardinal points of the compass indicating dominant sediment transport direction (N, NE, E, SE, S, SW, W, NW). (X) Indicates transport direction could not be discerned from imagery.
CHNG_TYPE	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	Name of a prominent geographic feature near the unit (from nautical chart or gazetteer)
UNIT_COMMENTS	Text field used for miscellaneous comments and notes during physical mapping
SHORE_PROB	Comment on nature of difference between digital shoreline and observed shoreline
SM1_TYPE	2-letter code indicating the *primary* type of shore modification occurring within the unit: BR = boat ramp; CB = concrete bulkhead; DK = dyke; LF = landfill; SP= sheet pile; RR = rip rap and WB = wooden bulkhead
SM%	Estimated % occurrence of the primary shore modification type in tenths (i.e. "2" = 20% occurrence with the unit alongshore)
SM2_TYPE	2-letter code indicating the *secondary* type of shore modification occurring within the unit
SM2%	Estimated % occurrence of the *secondary* type of shore modification occurring within the unit
SM3_TYPE	2-letter code indicating the *tertiary* type of shore modification occurring within the unit
SM3%	Estimated % occurrence of the *tertiary* seawall type in tenths (i.e., "2" = 20% occurrence within the unit)
SMOD_TOTAL	Total % occurrence of shore modification in the unit in tenths
RAMPS	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	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	Estimated number of recreational slips at docks of the unit; based on small boat length ~<50'
DEEPSEA_SLIP	Estimated number of slips for ocean-going vessels in the unit; based on ship length ~>100'
ITZ	Sum of the across-shore width of all the intertidal components (B zones) within the unit
EntryDate ModifiedDate	Date and time the unit was physically mapped (or modified)

Table A-2. Classification of shore types employed in ShoreZone mapping
(after 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 Petersen *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; mangroves
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 & very 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

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 Code	Description
UnitRecID	**Unit Record ID:** Automatically-generated number field; the database "primary key" required for relationships between tables
PHY_IDENT	**Physical_Ident** is a unique code to identify each unit, assigned by physical mapper; defined as an alphanumeric string determined by the codes for: Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0), where '12' is Region 12, '03' is Area 3, '0552' is the Unit number, and '0' is the Subunit number.
BIOAREA	**Bioarea:** Geographic division used to describe regional differences in observed biota and coastal habitats (Bioarea codes and descriptions listed in Table A-8)
EXP_BIO	**Biological Wave Exposure:** A classification of the wave exposure category within the Unit, assigned by the Biological mapper, based on observed indicator species and biobands (Table A-9)
HAB_CLASS	**Habitat Class**: Code for a classification of overall habitat category within the Unit, assigned by the biological mapper. Based on the Biological Exposure (EXP_BIO) and the geomorphic features of the shoreline (Table A-10 and A-11).
HAB_CLASS_LTRS	**Habitat Class** in alphabetic code: translation in the HAB CLASS lookup table (Table A-11)
HAB_OBS	**Habitat Observed**: Original Habitat code categories used to classify Habitat Type; not used in current protocol but kept for backward-compatibility with earlier projects; replaced by HAB_CLASS
BIO_SOURCE	**Biomapping Source:** The source data used to interpret coastal zone biota: (V)ideotape, (V2) - lower quality video imagery, (S)lide, (I)nferred
HAB_CLASS2	**Secondary Habitat Class**: Code for a classification of secondary Lagoon-type habitat within the Unit, assigned by the biological mapper. Based on the Biological Exposure (EXP_BIO) and lagoon habitat types (Table A-10 and A-11)
HC2_SOURCE	**Secondary Habitat Class Source:** Source used to interpret the Secondary Habitat Class (HAB_CLASS2) as: OBS(erved) as viewed from video, L(oo)KUP refering to 'Form' Code Lo or Lc in XSHR table
HC2_Note	**Secondary Habitat Class Comment:** comment field for Secondary Habitat Class (HAB_CLASS2)
RIPARIAN_PERCENT	**Riparian Percent Overhang:** Estimate of the percentage of alongshore length of the intertidal zone, in which the shoreline is shaded by overhanging riparian vegetation; all substrate types (Expanded definition in Table A-10)
RIPARIAN_M	**Riparian Overhang Meters:** Calculated portion of the unit length, in meters, of riparian overhang in the intertidal (B) zone, using LENGTH_M field of UNIT table, and RIPARIAN_PERCENT of BIOUNIT table; all substrate types.
BIO_UNIT_COMMENT	**Biological Comments**: regarding the along-shore unit as a whole. Included as deliverable data, as note format.
BIO_MAPPER	**Biological Mapper:** The initials of the biological mapper that provided the biological interpretation of the imagery
PHOTO	Still Photo in Unit: **Yes/No tick box** to indicate if high resolution photo is available for the Unit. (see BIOSLIDE table)
DateAdded DateModified	**Date/Time Mapped or Modified:** Date and time the unit was physically mapped (or modified)

Table A-8. Definitions of the BIOAREA attribute in BIOUNIT table.

Bioarea Name	Bioarea Code	Bioarea Suffix *	Geographic Extent	Characteristics
Outer Kenai	KENA	8	Kenai Coast, Alaska, including Kenai Fjords National Park, from Cape Elizabeth at the east entrance of Cook Inlet to Port Bainbridge at the west entrance of Prince William Sound.	Rugged coastline, dominated by extremely steep shores and Very Exposed wave energy. Fjord heads with tidewater glaciers. Absence of Dragon Kelp and Giant Kelp biobands.
Cook Inlet	COOK	9	Cook Inlet, Alaska, from Cape Douglas on the southwest entrance Cook Inlet, north to Anchorage, including Turnagain Arm and Kachemak Bay, to Cape Elizabeth at the southeast entrance of Cook Inlet.	Sediment-dominated, wide, low-slope shorelines, moderate to lower wave exposures. Affected by silt-laden freshwater input, absence of Giant Kelp and Dragon Kelp. Very wide complexes of salt marshes and estuaries.
Kodiak Island	KODI	10	Kodiak archipelago, Gulf of Alaska side, from Tugidak Island and Akhiok at the southwest end of the archipelago, to Shuyak Island at the northeast end of the islands.	Diversity of habitats and wave exposures, from Very Protected estuaries to Exposed rock cliffs. Fully marine and open to Gulf of Alaska. Lush lower intertidal brown algae, red algae and canopy kelps, in particular at north end. Southwest coast has wide rock platforms with surfgrass beds and sediment dominated offshore islands.
Katmai / Shelikof Strait side of Kodiak Island	KATM	11	Katmai National Park and Preserve, Alaska Peninsula, Shelikof Strait, includes the northwest side of the Kodiak archipelago.	Moderate to high wave exposures, affected by outflow from Cook Inlet, and separated from open Gulf of Alaska by Kodiak archipelago. Limited diversity of lower intertidal browns and canopy kelps, with diversity of red algae characterizing higher exposure sites. Includes both coasts of Shelikof Strait.
Aniakchak	ANIA	11	Aniakchak National Monument and Preserve, Alaska Peninsula, Shelikof Strait, southwest of Katmai National Park.	High wave exposure, wide bedrock platforms and mobile sediment beaches. Included in KATM bioareas for species descriptions, pending further delineation of bioarea boundaries. Likely transitional to Aleutian bioareas.
Southeast Alaska -- Yakutat	SEYA	12	The Yakutat region, on the Gulf of Alaska coast. Extends from the outer edge of the Copper River delta, near Cordova, south through Yakutat Bay, to Icy Point, just north of Cross Sound.	Exposed west-facing coast, open to Gulf of Alaska. Mobile, high-energy sediment beaches dominant. Limited canopy kelp distribution.
Southeast Alaska – Lynn Canal (fjord)	SEFJ	12	Lynn Canal from Point Howard at the southwest edge, at SEIC boundary, north to Skagway, and the east side of Lynn Canal south. Includes Juneau, Douglas Island, Taku Inlet and Port Snettisham with the southeast edge to the south tip of Glass Peninsula, Hugh Point on Admiralty Island.	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.

* Suffix applied to bioband codes for four lower intertidal biobands (HAL, RED, SBR, CHB) to distinguish between regional differences in species composition of these bands in different bioareas.

[continued]

Table A-8. Definitions of the BIOAREA attribute in BIOUNIT table (continued).

Bioarea Name	Bioarea Code	Bioarea Suffix *	Geographic Extent	Characteristics
Southeast Alaska – Icy Strait	SEIC	12	The Icy Strait region, of northern SE Alaska. The north extend is at Icy Point, at SEYA boundary, south to Cape Spencer and the north shore Cross Sound, east to the southwest entrance of Lynn Canal at Point Howard. Includes entire south shore Icy Strait, from Point Lucan at west to False Bay, northeast Chichagof Island.	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.
Southeast Alaska – Sitka	SESI	12	The Sitka area includes the northwest sides of Chichagof and Baranof Islands. The northern boundary is at Point Lucan in Icy Strait, including Yakobi and Kruzof Islands with the southern boundary at the southern tip of Baranof Island at Cape Ommaney.	Fully marine, west coast, includes diversity of species, exposure and habitat categories, from Exposed to Very Protected. Giant Kelp abundant, Dragon Kelp limited distribution.
Southeast Alaska – Misty Fjords	SEMJ	12	Misty Fjords area includes all fjords in the southeast region of Southeast Alaska, including Behm Canal, George Inlet, Carroll Inlet, Thorne Arm, Boca de Quadra and the western side of Portland Inlet.	Fjord landscape, bedrock-dominated, low wave exposures. Low species diversity. Absence of Giant Kelp and Dragon Kelp.
Southeast Alaska – Craig	SECR	12	The Craig area includes islands in the southwest region of Southeast Alaska, including areas around Ketchikan as well as Prince of Wales Island, Dall Island and all surrounding archipelagos, from southern Coronation Island, south to Dixon Entrance.	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.
Southeast Alaska -- Stikine	SESK	12	The Stikine area encompasses central Southeast Alaska. Northern extent includes east Chichagof Island from False Bay, west Admiralty Island and south from Tracy and Endicott Arms. Includes east Baranof, Kuiu and Kupreanof Islands as well as the Stikine River and surrounding Islands, Etolin and Wrangell. Southern boundary crosses Coronation and Warren Islands and northwest Prince of Wales Island	Glacial silty water affected, diversity of shoreline habitats and substrate types, moderate and lower wave exposures. Dragon Kelp dominant canopy kelp.
Prince William Sound	PRWS	13	All of Prince William Sound from Orca Inlet at Cordova on the east, to the south end of Montague Island, and across to Port Bainbridge on the west.	Diverse habitat, with high Semi-Exposed to Very Protected wave exposures. Differences between conditions in eastern and western Sound, with interaction of circulation complexities. Numerous tidewater glaciers and effects of Copper River. Absence of Giant Kelp and Dragon Kelp.

* Suffix applied to bioband codes for four lower intertidal biobands (HAL, RED, SBR, CHB) to distinguish between regional differences in species composition of these bands in different bioareas.

Table A-8. Definitions of the BIOAREA attribute in BIOUNIT table. (continued)

Bioarea Name	Bioarea Code	Bioarea Suffix *	Geographic Extent	Characteristics
Chukchi Sea coast	CHUK	14	Chukchi Sea coast from Point Barrow, to Point Hope	Low tundra cliffs and flats, permafrost dominated shore; barrier beach lagoon systems
Beaufort Sea coast	BEAU	15	Point Barrow to Canadian border	Tundra cliffs and flats, extensive offshore barrier sand islands, permafrost dominated shore
Bristol Bay	BRIS	16	False Pass, Bechevin Bay to Cape Newenham	Wide sand and mud flats, braided stream and river mouths, dominated by mobile beaches, with few areas of immobile substrate.
Southwest Alaska Peninsula	SWAK	17	Southwest Alaska Peninsula from Unimak Island, northeast to include all survey area from 2011 of Cold Bay and Sand Point teams. Northeast boundary to be determined, and may be extended to include Aniakchak (ANIA). Offshore Shumagin and Sanak Islands groups included in SWAK.	Wide high energy beaches and rock platforms on mainland peninsula and offshore islands. Some lower wave exposures lagoons with eelgrass. Nearshore kelps include Dragon Kelp.
Kotzebue Sound and St. Lawrence Island	KOTZ	18	Point Hope on Chukchi Sea south including Cape Krusenstern, east including Hotham Inlet, Selawik Lake and Baldwin Peninsula, south Kotzebue Sound, west through Cape Espenberg and southwest to Cape Prince of Wales. Also includes all of St. Lawrence Island.	Wide high energy bare beaches - large tidal lagoon complexes, extensive salt marsh. Much of the coast is sediment dominated with some rock and gravel sections on St. Lawrence Island. Selawik Lake section includes large areas of near-freshwater marsh and shallow nearshore.

* Suffix applied to four lower intertidal biobands (HAL, RED, SBR, CHB) to distinguish between regional differences in species composition of these bands in different bioareas.

Table A-9. *Biological Wave Exposure* Codes

Biological Wave Exposure	
Name	**Code**
Very Exposed	VE
Exposed	E
Semi-Exposed	SE
Semi-Protected	SP
Protected	P
Very Protected	VP

Table A-10. Expanded descriptions for HABITAT CLASS, SECONDARY HABITAT CLASS, and RIPARIAN fields of the BIOUNIT table.

Attribute	Description
HAB_CLASS	**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 and the associated biological wave exposure 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 biological mapper observes and records the biobands in the unit, if any, and determines the Biological Exposure Category (EXP_BIO). The Habitat Class is determined on the basis of presence/absence of biobands, exposure category, geomorphology, and spatial distribution of biota within the unit. Within the database, an alpha code provides a summary indicator of habitat. (Table A-11), in which the matrix includes all combinations of Dominant Structuring Process, with associated substrate mobility and general geomorphic type on the vertical axis, and Biological Exposure on the horizontal axis.
HAB_CLASS2	The '**Secondary Habitat Class**' was added as an attribute in the BioUnit Table during biological mapping of the Kodiak Archipelago in Alaska 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. Backshore lagoons are also a coastal feature in Oregon. 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.
RIPARIAN_PERCENT	As an attribute in the BIOUNIT table, the **Riparian_Percent** value is intended to be an index for the potential habitat for upper beach spawning fishes. The value recorded in the **Riparian_Percent** field is an estimate of the percentage of the unit's total alongshore length in which riparian vegetation (trees and shrubs) shades the upper intertidal zone. Shading of the highest high water line is a good estimate of riparian shading; therefore, shading of wetland herbs and grasses is not included in the estimate, nor is any shading of the splash zone alone. Shading must be visible in the upper intertidal zone, and the shading vegetation must be woody trees or shrubs. Riparian overhanging vegetation is also an indicator of lower wave exposures, in which the splash zone is narrow. Shading may occur in on sediment-dominated or in rocky intertidal settings.

Table A-11. Codes for HABITAT CLASS and SECONDARY HABITAT CLASS attributes, in the BIOUNIT table.

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.	VE_I	E_I	SE_I	SP_I	P_I	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'.	VE_P	E_P	SE_P	SP_P	P_P	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.	VE_M	E_M	SE_M	SP_M	P_M	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.	VE_E	E_E	SE_E	SP_E	P_E	VP_E
Current energy		Current-Dominated	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.	VE_C	E_C	SE_C	SP_C	P_C	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.	VE_G	E_G	SE_G	SP_G	P_G	VP_G
Anthropogenic		Anthropogenic – Impermeable	Impermeable modified Habitats are intended to specifically note units classified as Coastal Class 33. These Habitat Classes are mapped to specifically inventory modified shoreline.	VE_X	E_X	SE_X	SP_X	P_X	VP_X
		Anthropogenic – Permeable	Permeable modified Habitats are intended to specifically note shore units classified as Coastal Class 32. These Habitat Classes are mapped to specifically inventory modified shoreline.	VE_Y	E_Y	SE_Y	SP_Y	P_Y	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.	VE_L	E_L	SE_L	SP_L	P_L	VP_L
Periglacial		Permafrost	Units consist of forms structured permafrost at the coast, such as inundated tundra, tundra sea cliffs or other periglacial features	19 VE_T	29 E_T	39 SE_T	49 SP_T	59 P_T	69 VP_T

Habitat Class codes in shaded boxes are very infrequent or do not occur.

Table A-12. Data dictionary for across-shore component table (XShr)
(after Howes *et al* 1994)

Field Name	**Description**
UnitRecID	Automatically-generated number field; the database “primary key” for unit-level relationships
XshrRecID	Automatically-generated number field; the database “primary key” for across-shore relationships
PHY_IDENT	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	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	Code indicating the across-shore position (tidal elevation) of the component: (A) supratidal, (B) intertidal, (C) subtidal
COMPONENT	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	Principal geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix1	Veneer indicator field; blank = no veneer; “v” = veneer
Mat1	Material (substrate and/or sediment type) that best characterizes Form1, described by a specific set of codes (Table A-12)
FormMat1Txt	Automatically-generated field that is the translation of codes used in Form1 and Mat1 into text
Form2	Secondary geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix2	Veneer indicator field; blank = no veneer; “v” = veneer
Mat2	Material (substrate and/or sediment type) that best characterizes Form2, described by a specific set of codes (Table A-12)
FormMat2Txt	Automatically-generated field that is the translation of codes used in Form2 and Mat3 into text
Form3	Tertiary geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix3	Veneer indicator field; blank = no veneer; “v” = veneer
Mat3	Material (substrate and/or sediment type) that best characterizes Form3, described by a specific set of codes (Table A-12)
FormMat3Txt	Automatically-generated field that is the translation of codes used in Form3 and Mat3 into text
Form4	Fourth-order geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix4	Veneer indicator field; blank = no veneer; “v” = veneer
Mat4	Material (substrate and/or sediment type) that best characterizes Form4, described by a specific set of codes (Table A-12)
FormMat4Txt	Automatically-generated field that is the translation of codes used in Form4 and Mat4 into text
WIDTH	Mean across-shore width of the component (e.g. A1) in meters
SLOPE	Estimated across-shore slope of the mapped geomorphic Form in degrees; must be consistent with Form codes (Table A-11)
PROCESS	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	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-13. '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
l	breached dyke
m	marina
n	ferry terminal
o	log booms
p	port facility
q	aquaculture
r	boat ramp
s	seawall
t	landfill, tailings
u	tide gates
w	wharf
x	outfall or intake
y	intake
z	beach access

B = Beach

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

C = Cliff

stability/geomorph	
a	active / eroding
p	passive (vegetated)
c	cave
slope	
i	inclined (20°-35°)
s	steep (>35°)

Cliff cont.

height	
l	low (<5m)
m	moderate (5-10m)
h	high (>10m)
modifiers (optional)	
f	fan, apron, talus
g	surge channel
t	terraced
r	ramp

D = Delta

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

E = Dune

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

F = Reef

(no vegetation)	
f	horizontal (<2°)
i	irregular
r	ramp
s	smooth

I = Ice

g	glacier

L = Lagoon

o	open
c	closed

M = Marsh

c	tidal creek
d	dead marsh by salt intrusion
e	levee
f	drowned forest
h	high
l	mid to low (discontinuous)
o	pond
s	brackish, supratidal
t	tidal swamp, shrub/scrub

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-14. '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	dead trees (fallen, not cut)
o	organic litter
p	peat
t	trees (living)

C = Clastic

a	angular blocks (>25cm diameter)
b	boulders (rounded, subrounded,>25cm)
c	cobbles
d	diamicton (a poorly-sorted sediment mixture containing a range of particle sizes in a mud matrix)
f	fines/mud (mix of silt/clay, <0.0.63 mm diameter)
g	gravel (unsorted mix pebble, cobble, boulder >2 mm)
k	clay (compact, finer than fines/mud, <4 μm diameter)
p	pebbles
r	rubble (boulders>1 m diameter)
s	sand (0.063 to 2 mm diameter)
$	silt (0.0039 to 0.063 mm)
x	angular fragments (mix of 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

SEDIMENT TEXTURE

(Simplified from Wentworth grain size scale)

GRAVELS

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

SAND

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

FINES ("MUD")

includes silt and clay

silt	0.0039 to 0.063 mm
clay	<0.0039 mm

TEXTURE CLASS BREAKS

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

SHORE MODIFICATIONS

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

'Percent of unit length' for Shore Modification recorded to nearest ten percent, with default value for Shore Modification = 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 is used, they are ranked in order of relative volume. A surface layer can be described by prefix *v* for veneer (e.g. vCs/R). Grayed items are not used in the Alaska ShoreZone program.

Table A-15. Data Dictionary for the *Bioband* Table

Field	Description
UnitRecID	Automatically-generated number field; the database “primary key” required for relationships between tables
XshrRecID	Automatically-generated number field; the database “primary key” required for relationships between tables
PHY_IDENT	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	Unique alphanumeric identifier of component made up of: REGION, AREA, PHYS_UNIT, SUBUNIT, ZONE and COMPONENT fields
VER	Bioband for Splash Zone (black lichen **VER***ucaria*) in supratidal (Table A-16)
MSH	Bioband code for Shrub Meadow, upper salt marsh shrub fringe (Table A-16)
MAG	Bioband code for High Grass Meadow, upper salt marsh grass meadow (Table A-16)
GRA	Bioband code for Dune **GRA**ss in supratidal (Table A-16)
AMM	Bioband code for European Beach Grass (**AMM**ophilia spp) (Table A-16)
SED	Bioband for **SED**ges in supratidal (Table A-16)
TRI	Bioband for Salt Marsh grasses, including ***TRI****glochin* and other salt tolerant grasses, herbs and sedges, in supratidal. Same bioband included in Washington ShoreZone. (Table A-16)
BAR	Bioband for **BAR**nacle (*Balanus/Semibalanus*) in upper intertidal (Table A-16)
FUC	Bioband for Rockweed, the **FUC***us*/barnacle in upper intertidal (Table A-16)
ULV	Bioband for Green Algae, including mixed filamentous and foliose greens (**ULV***a* sp*., Cladophora, Acrosiphonia*) in mid-intertidal (Table A-16)
BMU	Bioband for **B**lue **MU**ssel (*Mytilus trossulus*) in mid-intertidal (Table A-16)
MUS	Bioband for California **MUS**sel/gooseneck barnacle assemblage (*Mytilus californianus/Pollicipes polymerus*) in mid-intertidal (Table A-16)
HAL	Bioband for Bleached Red Algae, including mixed filamentous and foliose reds in mid-intertidal (Table A-16)
OYS	Bioband code for **OYS**ter, primarily cultured on mud flats, mid-intertidal (Table A-16)
RED	Bioband for **RED** Algae, including mixed filamentous and foliose reds (*Odonthalia, Neorhodomela, Mazzaella,* coralline algae) in lower intertidal (Table A-16)
ALA	Bioband for ribbon kelp, **ALA***ria* spp. (Table A-16)
SBR	Bioband for **S**oft **BR**own Kelps, including unstalked large-bladed laminarians, in lower intertidal and nearshore subtidal (Table A-16)
CAL	Bioband for infaunal mud flat shrimp (***CAL****lianassa*), in sand/mud flats in larger estuaries. Same bioband included in Washington ShoreZone. (Table A-16)
CHB	Bioband for Dark Brown Kelps, including stalked bladed dark **CH**ocolate-**B**rown kelps in lower intertidal and nearshore subtidal (Table A-16)
SUR	Bioband for **SUR**fgrass (*Phyllospadix*) in lower intertidal and nearshore subtidal (Table A-16)
ZOS	Bioband for **ZOS***tera* (Eelgrass) in lower intertidal and subtidal (Table A-16)
ZOS2	*Zostera* occurrence data taken from EPS mapping data of some of the Oregon estuaries
MAC	Bioband for Giant Kelp (**MAC***rocystis spp*) in nearshore subtidal (Table A-16)
NER	Bioband for Bull Kelp (**NER***eocystis luetkeana*) in nearshore subtidal (Table A-16)
NER2	Nereocystis occurrence data taken from ODFW mapping data.

Table A-16. Southwest Alaska Bioband Definitions

Zone	Bioband		Color	Indicator Species	Physical Description	Biological Wave Exposure	Associate Species
	Name	**Code**					
A supratidal	**Splash Zone**	**VER**	Black or bare rock	*Verrucaria* sp. Encrusting black lichens Bare rock substrate	Visible as a dark stripe, on bare rock, marking the upper limit of the intertidal zone. This band is recorded by width: Narrow (N), Medium (M) or Wide (W)	Very Exposed to Very Protected	*Littorina* sp.
A supratidal	**Shrub Meadow**	**MSH**	Pale green	*Picea sitchensis* *Deschampsia caespitosa*	A narrow strip at the uppermost marsh edge, next to the tree line; usually a transition to spruce forest, including small spruce, shrubs and mixed grasses, sedge and herbs.	Very protected to Protected	*Heracleum lanatum* *Achillea millefolium* *Rumex maritimus* *Grindelia integrifolia* *Hordeum brachyantherum*
A supratidal	**High Grass Meadow**	**MAG**	Pale grassy green or beige	*Deschampsia caespitosa* *Trifolium wormskjoldii*	Mixed grassy meadow, on uppermost salt marsh, interfingers with Salt Marsh (TRI) or Sedge (SED) at lower elevation transition.	Very protected to Protected	*Distichlis spicata* *Juncus gerardii* *Juncus leuceurii* *Agrostis alba*
A supratidal	**Dune Grass**	**GRA**	Pale blue-green	*Leymus mollis*	Native dune grass found in small patches in undisturbed sand dunes and in salt marsh. This band is often associated with driftwood log line on beaches or as clumps in upper salt marsh elevations	Exposed to Protected	*Lathyrus japonica* *Juncus lesueurii*
A supratidal	**European Beach Grass**	**AMM**	Beige-green	*Ammophila* spp	Outer coastal sand dunes, forming clumps and stabilizing active dunes.	Exposed to Semi Exposed	*Hypochaeris radicata* *Lupinus littoralis* *Fragaria chiloensis* *Aira praecox* *Aira caryophyllea*
A supratidal	**Sedges**	**SED**	Bright green to yellow-green	*Carex lyngbyei*	Appears in wetlands around lagoons and estuaries. Always associated with freshwater. This band often seen as patches, usually at upper elevation of TRI band	Semi Protected to Very Protected	*Carex* spp.
A supratidal	**Salt Marsh**	**TRI**	Light, bright, or dark green, with red-brown	*Triglochin maritimum* *Distichlis spicata* *Deschampsia caespitosa.* *Plantago maritima* *Scirpus americanus* *Salicornia virginica*	Appears around estuaries, marshes, and lagoons. Always associated with freshwater. Separated as 'high marsh' and 'low marsh' as gradation of assemblages according to elevation/salt water inundation. TRI can be sparse grasses and herbs on coarse sediment or a wetter, peaty meadow with assemblage of herbs, grasses and sedges	Semi Exposed to Very Protected	*Carex* spp. *Potentilla pacifica* *Spergularia marina* *Juncus* spp *Eleocharis* sp *Atriplex patula*
upper B intertidal	**Barnacle**	**BAR**	Grey-white to pale yellow	*Balanus glandula* *Chthamalus* spp *Semibalanus cariosus*	Visible on bedrock or large boulders. Can form an extensive band in higher exposures where not overtopped by algal canopy.	Exposed to Protected	*Hildenbrandia* spp *Endocladia muricata* *filamentous green algae* *Porphyra* sp. *Fucus distichus*

Table A-16 (continued) Southwest Alaska Bioband Definitions

Zone	Bioband		Color	Indicator Species	Physical Description	Exposure	Associate Species
	Name	Code					
upper B intertidal	**Rockweed**	**FUC**	Golden-brown	*Pelvetiopsis* spp *Fucus* spp *Mastocarpus* spp	Appears on bedrock cliffs and boulder, cobble or gravel beaches. Commonly occurs at the same elevation as the barnacle band.	Semi Exposed to Protected	*Balanus glandula* *Mazzaella cornucopiae* *Semibalanus cariosus* *Ulva sp.* *Endocladia muricata*
B intertidal	**Green Algae**	**ULV**	Green	*Ulva sp.* *Enteromorpha* spp	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.	Exposed to Protected	*Filamentous red algae*
B intertidal	**Blue Mussel**	**BMU**	Black or blue-black	*Mytilus trossulus* *M. galloprovinicialis*	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.	Very Exposed to Protected	*Balanus glandula* *Semibalanus cariosus* Filamentous red algae
B intertidal	**California Mussel**	**MUS**	Grey-blue	*Mytilus californianus* *Pollicipes polymerus*	Dominated by a complex of California mussels (*Mytilus californianus*) and gooseneck barnacles (*Pollicipes polymerus*), with thatched barnacles (*Semibalanus cariosus*).	Very Exposed to Semi Exposed	*Postelsia palmaeformis* *Semibalanus cariosus* *M. trossulus*
B intertidal	**Bleached Red Algae**	**HAL**	Olive, golden or yellow-brown	*Mazzaella* spp *Ondonthalia* spp *Other foliose & filamentous red algae*	Common on bedrock platforms, and cobble or gravel beaches. Distinguished from the RED band only by color, and often is same species as RED	Exposed to Semi Protected	Other filamentous and foliose red algae Filamentous green algae
B intertidal	**Oyster**	**OYS**	Dark beige to brown		Generally inconspicuous and of limited extent, areas of oyster aquaculture on mudflats, in particular in Coos Bay	Very protected to Protected	Filamentous brown algae Filamentous green algae
B intertidal	**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. *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.	Very Exposed to Semi Protected	Other foliose and filamentous red algae *Pisaster ochraceus* *Nucella* sp. *Katharina tunicata* Large brown kelps of the CHB bioband
B & C intertidal, subtidal	**Alaria**	**ALA**	Dark brown or red-brown	*Alaria marginata*	Common on bedrock cliffs and platforms, and on boulder/cobble beaches. This often single-species band has a distinct smooth, shiny, ribbon-like texture.	Exposed to Semi Protected	Foliose red algae *Saccharina* sp. *Laminaria* sp.

Table A-16 (continued) Southwest Alaska Bioband Definitions

Zone	Bioband Name	Bioband Code	Color	Indicator Species	Physical Description	Exposure	Associate Species
B & C intertidal, subtidal	**Soft Brown Kelps**	**SBR**	Yellow-brown, olive brown or brown.	*Saccharina latissima.* *Sargassum muticum*	This band is defined by non-floating large bladed browns kelps and appears to be of limited distribution on the Oregon coast.	Semi Exposed to Very Protected	Other filamentous brown algae and bladed kelps
B & C intertidal, subtidal	**Mud Flat Shrimp**	**CAL**	mottling on sand flats, burrows	*Neotrypaea californiensis* *Upogebia pugettensis*	On sand/mud flats in larger estuaries, where textured surface of flats indicates presence of infauna	Protected to Very Protected	bivalves and worms
B & C intertidal, subtidal	**Dark Brown Kelps**	**CHB**	Dark chocolate brown	*Laminaria setchelli* *Lessoniopsis littoralis* *Saccharina sessile (smooth)* *Egregia menziesii*	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.	Very Exposed to Semi Exposed	*L. sinclairii.* *Costaria costata* *Alaria sp.* Filamentous and foliose red algae Coralline red algae
B & C intertidal, subtidal	**Surfgrass**	**SUR**	Bright green (may bleach to beige at upper extent)	*Phyllospadix scouleri* *Phyllospadix torreyi.*	Appears in tide pools 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 across-shore profile, where wave energy is dissipated by wave run-up across the broad intertidal zone.	Semi Exposed to Semi Protected	Foliose and coralline red algae
B & C intertidal, subtidal	**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.	Semi Protected to Very Protected	*Porphyra sp.*
B & C intertidal, subtidal	**Eelgrass**	**ZOS2**			Data taken from an existing EPS report and associated shape files. It was not mapped in ShoreZone and only for slected estuaries.		
C subtidal	**Giant Kelp**	**MAC**	Golden-brown	*Macrocystis* spp	Canopy-forming giant kelp, long stipes with multiple floats and fronds. If associated with NER, it occurs inshore of the bull kelp.	Semi Exposed to Protected	*Nereocystis luetkeana*
C subtidal	**Bull Kelp**	**NER**	Dark brown	*Nereocystis luetkeana*	Distinctive canopy-forming kelp with many long strap-like blades growing from a single floating bulb atop a long stipe. Can form an extensive canopy in nearshore habitats. Often indicates higher current areas if observed at lower wave exposures.	Very Exposed to Semi Protected	*Egregia menziesii* *Macrocystis* spp
C subtidal	**Bull Kelp**	**NER2**			Data taken from ODFW mapping. Not mapped in ShoreZone. For selected coastal sections only		

Table A-17. Data Dictionary for the Photos Table

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

APPENDIX B

Coastal Vulnerability Module

Code and Category Descriptions

The Coastal Vulnerability Module (CVM) for ShoreZone is intended to provide users with a spatial picture of where and how shorelines are likely to be sensitive to climate change, specifically sea level rise. For example, shorelines with very low gradients will become increasingly flooded by storm surges.

Coastal Vulnerability Module provides a measure of coastal sensitivity to climate change in terms of three indices that are based on observed coastal geomorphology of the shoreline. The three indices are:

> ***Coastal Stability Index*** (Table B-1) that provides a measure of stability (retreating or prograding) for both clastic/sediment shorelines or for wetland shorelines.
>
> ***Flooding Sensitivity Index*** (Table B-2) that provides an estimate of the degree of observed flooding of immediate backshore areas.
>
> ***Thaw Sensitivity Index*** (Table B-3) that provides an estimate of thaw lake or water coverage in the backshore that is an indirect indicator of thaw settlement potential.

These indices are complemented by an inventory of descriptive coastal features of mass-wasting/wetland morphology (Table B-4) that are potentially of interest to coastal planners and managers.

Table B-1 Coastal Stability Index

		Stability Class	Description
CLASTIC	CE4	Erosional	Actively eroding, bare-faced cliff (<10% vegetation cover)
	CE3		Actively eroding, partially vegetated cliff (10 - 90% vegetation cover) cliff
	CE2		Actively eroding, complete vegetated cliff (>90% cover) but veg “disturbed”
	CE1		Retreating barrier island, spit; possibly with outcropping peat
	CS	Stable	Stable slope with tundra vegetation
	CA1	Accretional	Prograding beach with a single storm berm or dune
	CA2		Prograding beach with multiple storm berms or dunes
	CA3		Prograding beach with wide beach ridge plain in backshore
WETLAND	WE2	Erosional	Peat layers in sub-tidal, often with polygon form still evident
	WE1		Eroding peat scarp
	WS	Stable	Stable – no obvious features indicating erosion or accretion
	WA1	Accretional	Prograding wetland – immature wetland Prograding across flats (most common in deltaic wetland complexes)
Bedrock	R	Not applicable	Assumed stable, Coastal Vulnerability Module not applicable
Anthropogenic	A	Seawall	Assumed stable, Coastal Vulnerability Module not applicable
Other	X	Provisional	use for initial testing phase, if unit cannot be assigned to any of above

Table B-2 Flooding Sensitivity Index

	Flooding Class	Description
F4	Major	Flooding >100 m inland from HWL as indicated by the highest logline
F3	↑	Flooding 50-100m inland from HWL as indicated by the highest logline
F2	↑	Flooding 10-50 m inland from HWL as indicated by the highest logline
F1	Minor	Flooding <10 m inland from HWL as indicated by the highest logline
X		Coastal Hazards not applicable (rock, anthropogenic)

Table B-3 Thaw Sensitivity Index

	Thaw Sensitivity Class	Description
T4		Extensive thaw lakes, standing water, >50% standing water in flooding zone
T3	High	Moderate thaw lake density, 25-50% standing water in flooding zone
T2	↑ Low	Minor thaw lake density or standing water, 10-25% standing water in flooding zone
T1		Negligible standing water, <10% standing water in flooding zone
X		Coastal Hazards not applicable (rock, anthropogenic)

Table B-4 Coastal Mass-Wasting and Wetland Features

Category	Feature
Mass Wasting	Ground ice slumps
	Block slumps
	Debris flows/solifluction
	Ice Wedges
Wetlands	Lagoonal complex
	Deltaic complex
	Marsh clones
	Associated mudflats
	Submerged morphology
	Relict river morphology
	Relict shoreline morphology
Other	Add description of relevant feature
None	Unit assessed, no relevant features (none of the above)
Not Applicable	Unit assessed, Coastal Hazards not applicable (rock, etc.)