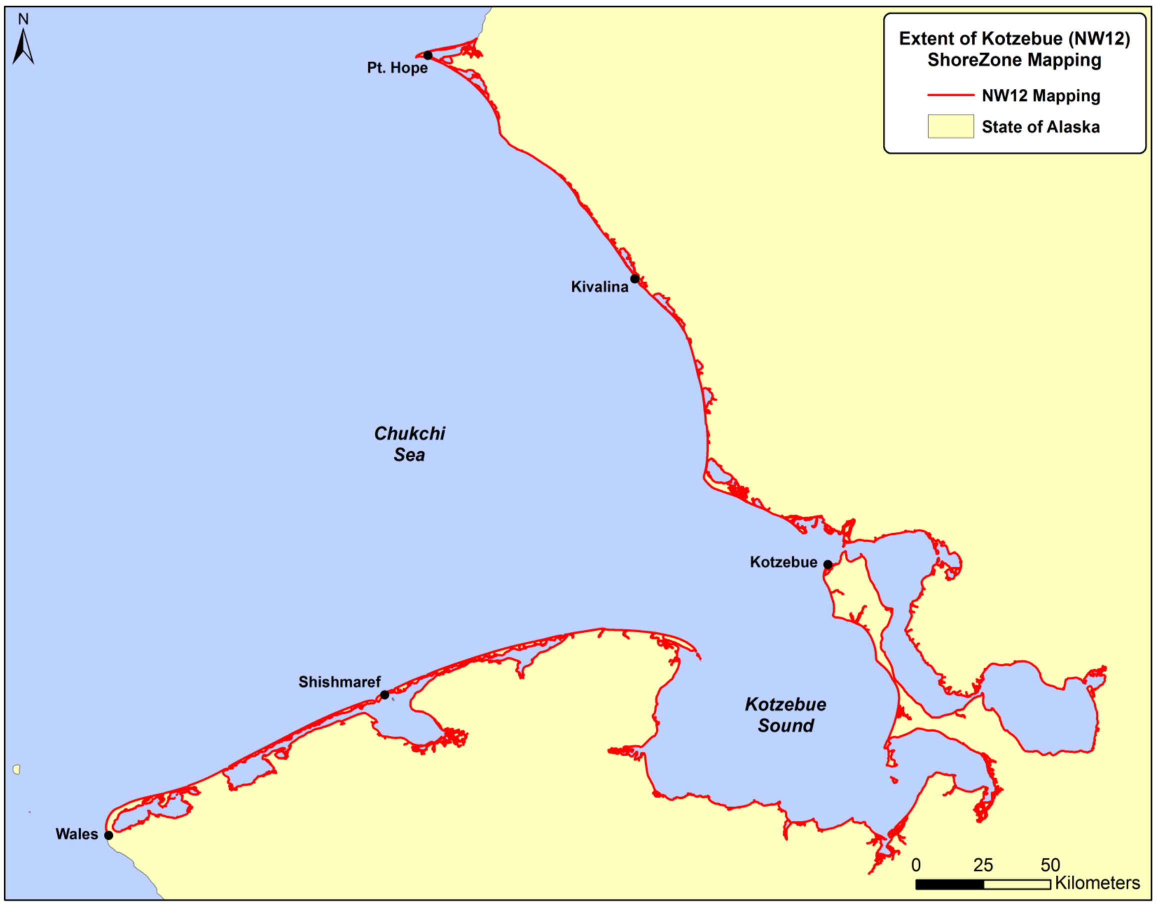
CORI Project: 12-27 **September 2013**

ShoreZone Coastal Habitat Mapping
Data Summary Report

Northwest Alaska Survey Area



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SUMMARY

ShoreZone is a coastal habitat mapping and classification system in which georeferenced aerial imagery is collected specifically for the interpretation and integration of geological and biological features of the intertidal zone and nearshore environment. The mapping methodology is summarized in Harney *et al* (2008).

This data summary report provides information on **geomorphic and biological features** of 4,694 km of shoreline mapped for the 2012 survey of Northwest Alaska. The habitat inventory is comprised of 3,469 along-shore segments (units), averaging 1,353 m in length (note that the AK Coast 1:63,360 digital shoreline shows this mapping area encompassing 3,095 km, but mapping data based on better digital shorelines represent the same area with 4,694 km stretching along the coast).

Organic/estuary shorelines (such as estuaries) are mapped along 744.4 km (15.9%) of the study area. Bedrock shorelines (Shore Types 1-5) are extremely limited along the shoreline with only 0.2% mapped. Close to half of the shoreline is classified as Tundra (44.3%) with low, vegetated peat the most commonly occurring tundra shore type. Approximately a third (34.1%) of the mapped coastal environment is characterized as sediment-dominated shorelines (Shore Types 21-30). Of these, narrow sand and gravel beaches (Shore Type 25) are the most common, mapped along 658.2 km of shoreline (14% of the total study area).

Approximately 37% of all habitat classes mapped are structured by wave energy and another 36% is structured by permafrost processes. Repeatable assemblages of biota that can be recognized from the aerial imagery are termed *biobands*; nine biobands have been mapped in Northwest Alaska to date. Tundra, as represented by the TUN bioband is mapped along 86% of the shoreline. Salt marsh, as indexed by the PUC biobands, is also common and mapped along 77% of the shoreline in this mapping area.

Man-modified shorelines (Shore Types 32 and 33) are comparatively rare (0.1%). The most common type of shore modification observed is landfill found on 64 km of the shoreline. Most anthropogenic features occur near the communities of Kotzebue, Kivalina and Shishmaref.

A Coastal Vulnerability Module that added three vulnerability indices was applied to the Kotzebue shoreline between Pt. Hope and Cape Prince of Wales. These indices are: a *stability index*, a *flood sensitivity index* and a *thaw sensitivity index.* Results indicate that more than 45% of the coast has high flooding sensitivity (>50m storm surge inundation) and about 40% of the coast has high thaw settlement sensitivity (>25% thaw lake in backshore).

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1 INTRODUCTION

1.1 Overview of the ShoreZone Coastal Habitat Mapping Program

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

ShoreZone imagery provides a useful baseline, while mapped resources (such as shoreline sediments, eelgrass and wetland distributions) are an important tool for scientists and managers. 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 in Alaska continues to grow through the efforts of a network of partners, including scientists, managers, GIS specialists, and web specialists in federal, state, and local 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. Harney et al 2008), and applications are developed that use ShoreZone data to examine modern questions regarding the coastal environment and nearshore habitats (Harney 2007, 2008). As of September 2013, mapped regions include close to 58,500 km of coastline Alaska and 40,000 km of coastline in British Columbia, Washington and Oregon (Figures1, 2 and 3).

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

- natural resource 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 mapping methodology and the definition of 2008 standards are available in the ShoreZone Coastal Habitat Mapping Protocol for the Gulf of Alaska (Harney et al 2008). This and other ShoreZone reports are available for download from the ShoreZone website at www.ShoreZone.org.

1.2 ShoreZone Mapping of Northwest Alaska Imagery

The field surveys conducted in Northwest Alaska in 2012 collected aerial video and digital still photographs of the coastal and nearshore zone during zero-meter tide levels and lower. The imagery and associated audio commentary are used to map the geomorphic and biological features of the shoreline according to the ShoreZone Coastal Habitat Mapping Protocol (Harney *et al* 2008) with some updates for periglacial shorelines included in the DRAFT revision (Harper and Morris 2011).

The purpose of this report is to provide a summary of the physical (geomorphic) and biological data mapped in Northwest Alaska (Figure 3).

The along-shore length of shoreline mapped in the database is **4,694 kilometers** in 3,469 along-shore segments (units), averaging 1,353 m in length. Physical and biological data are summarized with illustrations in Sections 2 and 3, respectively.

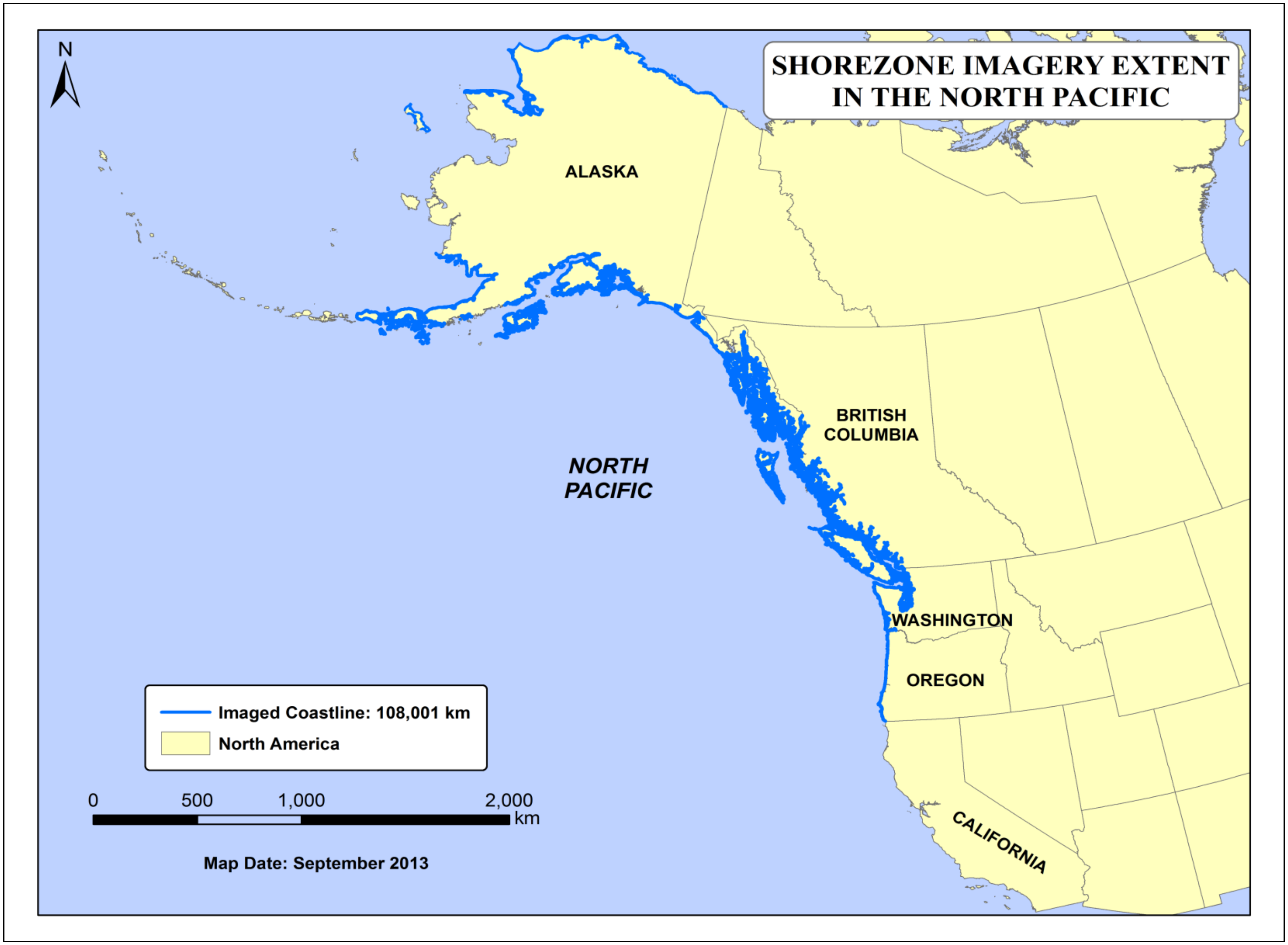

Figure 1. Extent of ShoreZone imagery in Alaska, British Columbia, and Washington State and Oregon (108,001 km).

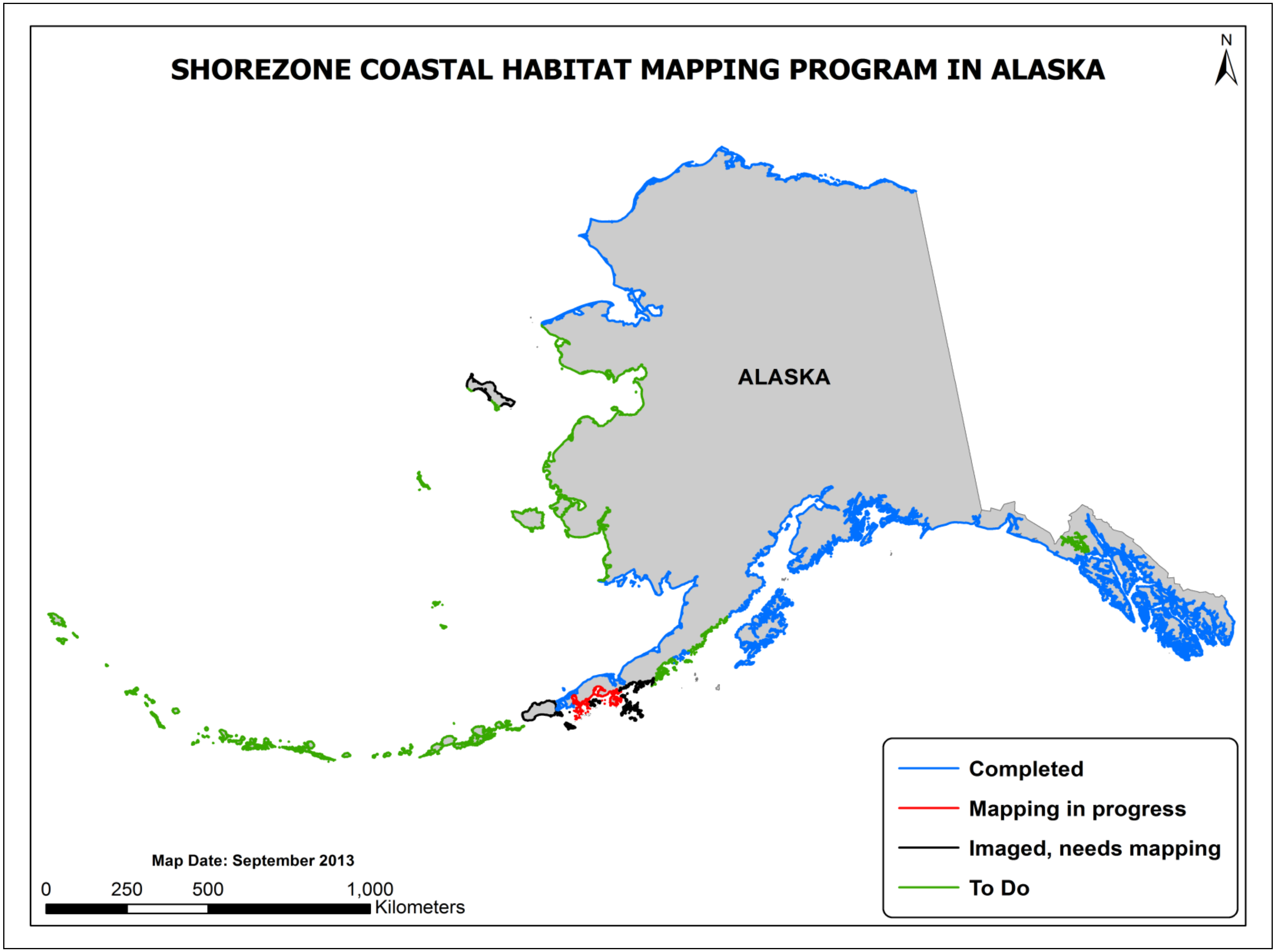

Figure 2. Extent of ShoreZone imagery and coastal habitat mapping in the State of Alaska (as of September 2013).

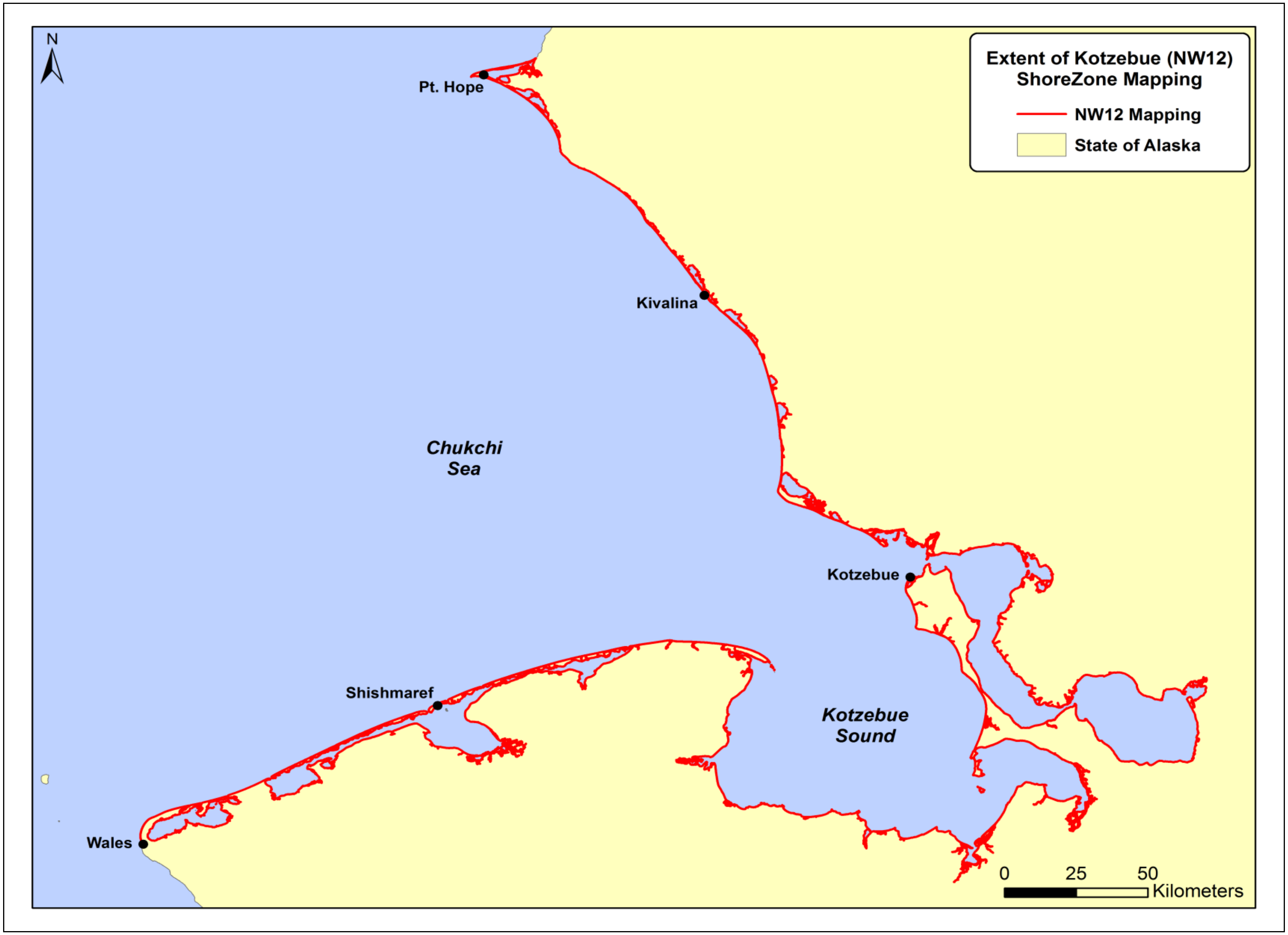

Figure 3. Map of study area in Northwest Alaska (4,694 km)

2 PHYSICAL SHOREZONE DATA SUMMARY

2.1 Shore Types

The principal characteristics of each along-shore segment are used to assign an overall unit classification or “shore type” that represents the unit as a whole. ShoreZone mapping employs two along-shore **unit classification** systems: coastal shore types defined for British Columbia (“Shore Types”) 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 is listed in Table 1. Grouped Shore Types are useful to illustrate mapped distributions (Figure 4) and to summarize data in graphic form (Figure 5). **Bedrock shorelines** (Shore Types 1-5) comprise 10.4 km (0.2%) of mapped shorelines. **Rock and sediment shorelines** (Shore Types 6-20) comprise of 1% of the shoreline (41.5 km). **Sediment-dominated shorelines** (Shore Types 21-30) comprise approximately a third of the entire area (34.1%) along 1,601km of the coast (Figures 6 & 7). Of these, narrow sand and gravel beaches (Shore Type 25) are the most common, mapped along 658.2 km of shoreline (14% of the total study area). Tundra shorelines are the most comprehensive along the coast (close to 44.3%).Organic and Lagoon shorelines constitute the remaining coast with 15.9% and 4.5% respectively.

The NOAA Environmental Sensitivity Index (ESI Class) is a shoreline classification system developed to categorize coastal regions on the basis of their oil-spill sensitivity. The ESI system uses wave exposure and principal substrate type to assign alongshore coastal units a ranking of 1-10 to indicate the relative degree of sensitivity to oil spills (1=least sensitive, 10=most sensitive) as well as a general shore type (Peterson *et al* 2002; 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 2.

Table 1. Summary of Shore Types

Substrate Type	Shore Type No.	Shore Type Description	Sum of Unit Length (km)	# of Units	% Occurrence (by length)	Cumulative Occurrence (%, km)
Rock	3	Rock Cliff	10.4	42	0.2	**0.2% 10.4km**
Rock & Sediment	8	Cliff with gravel beach	28.2	80	0.6	**1.0% 41.5km**
	13	Cliff w gravel/sand beach	12.7	21	0.3	
	14	Ramp w gravel/sand beach	0.4	2	0.0	
	18	Cliff with sand beach	0.1	1	0.0	
Sediment	21	Gravel flat, wide	0.2	1	0.0	**34.1% 1601.1km**
	22	Gravel beach, narrow	47.5	86	1.0	
	24	Sand & gravel flat or fan	171.5	142	3.7	
	25	Sand & gravel beach, narrow	658.2	930	14.0	
	26	Sand & gravel flat or fan	127.3	137	2.7	
	27	Sand beach	13.2	7	0.3	
	28	Sand flat	235.6	144	5.0	
	29	Mudflat	32.2	24	0.7	
	30	Sand beach	315.3	237	6.7	
Organics	31	Organics/Estuarine	744.4	349	15.9	**15.9% 744.4km**
Man-made	32	Man-made, permeable	4.1	8	0.1	**0.1% 5.3km**
	33	Man-made, impermeable	1.2	2	0.0	
Lagoon	36	Lagoon	210.0	135	4.5	**4.5% 210.0km**
Tundra	37	Inundated Tundra	843.4	198	18.0	**44.3% 2081.8km**
	38	Ground Ice Slumps	159.0	231	3.4	
	39	Low Vegetated Peat	1079.5	682	23	
Totals:			***4,694.0***	***3,469***	***100.0***	***100%***

*Note: Other Shore Types not observed.

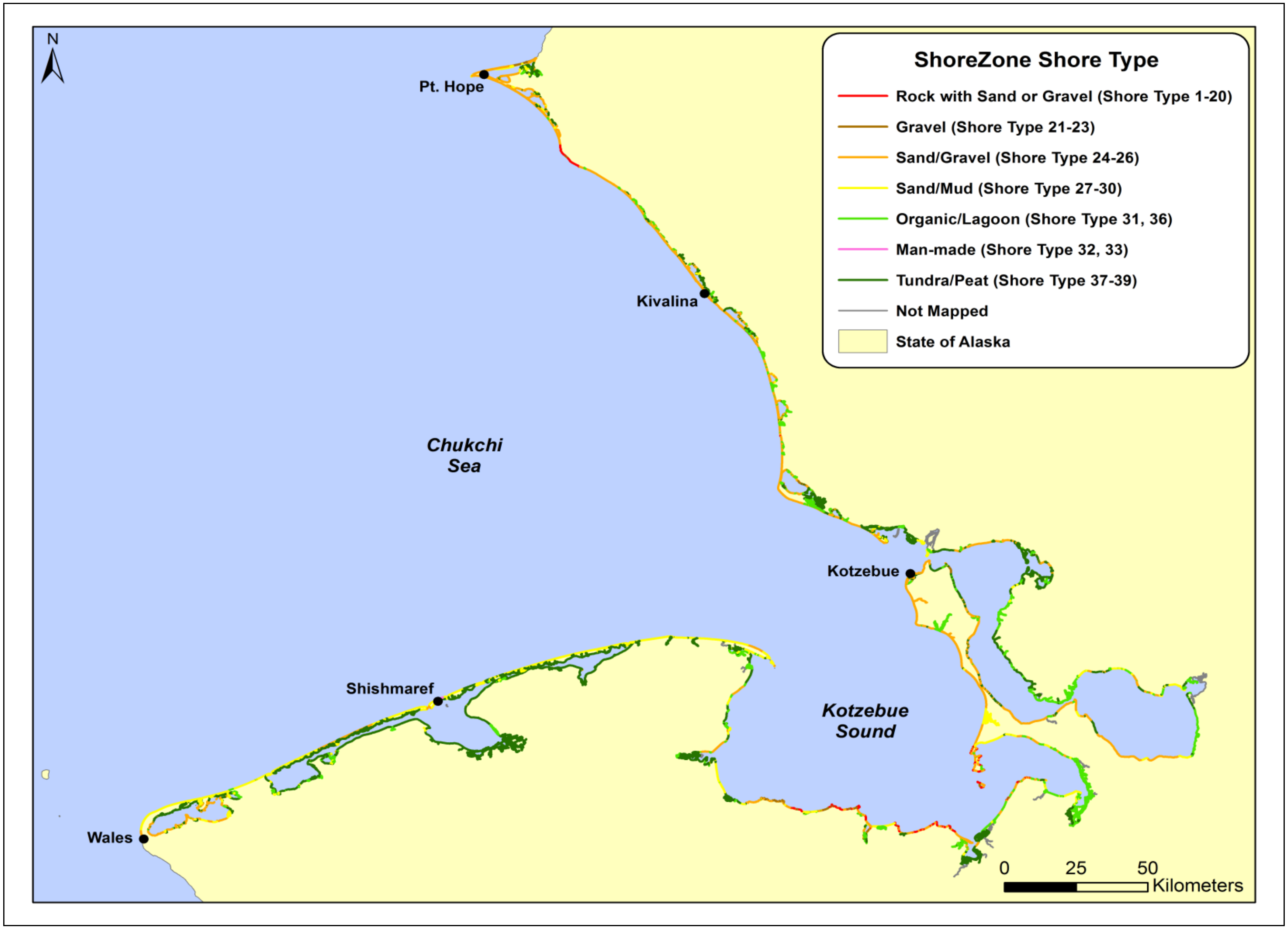

Figure 4. Map of the distribution of principal substrate types (on the basis of grouped Shore Types) in the study area. Data are listed by individual class and summarized by grouped classes in Table 1.

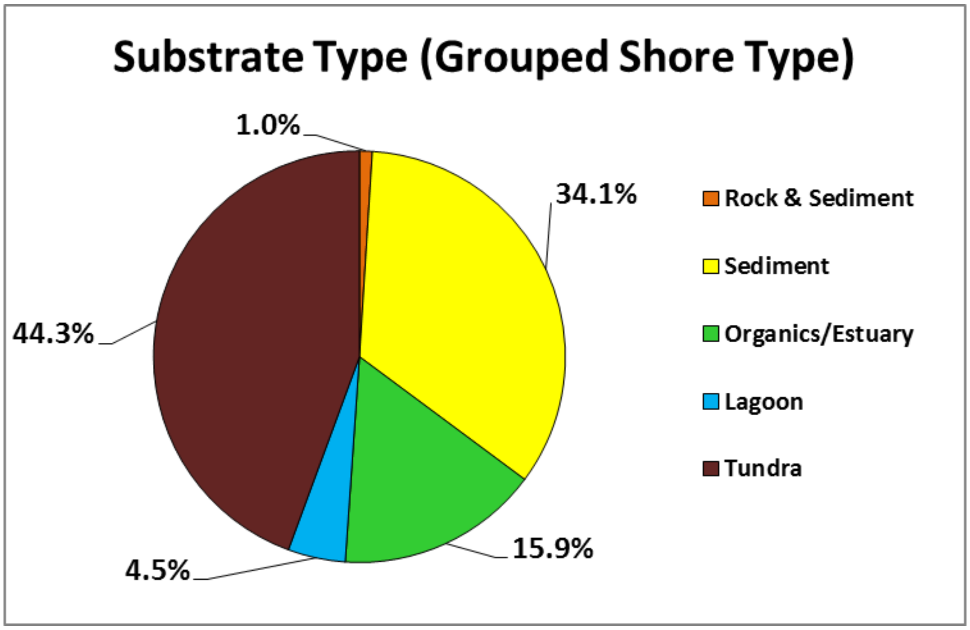

Figure 5. Relative abundance of principal substrate types (on the basis of grouped Shore Types) in the study area. Data are summarized in Table 1.

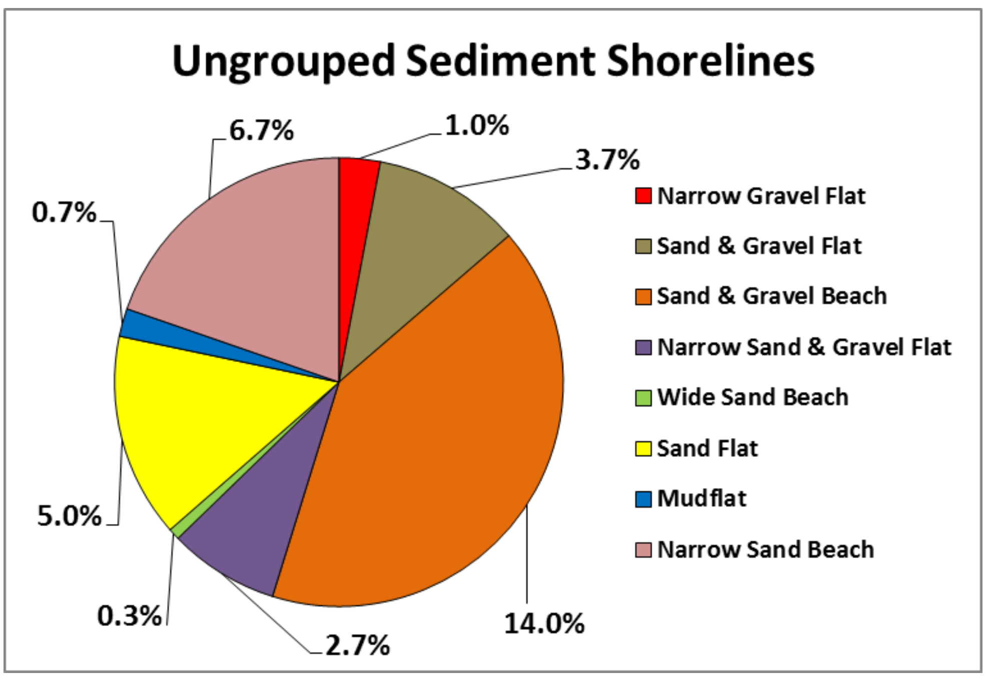

Figure 6. Relative abundance of sediment shorelines (Shore Types 21-30) in the study area.

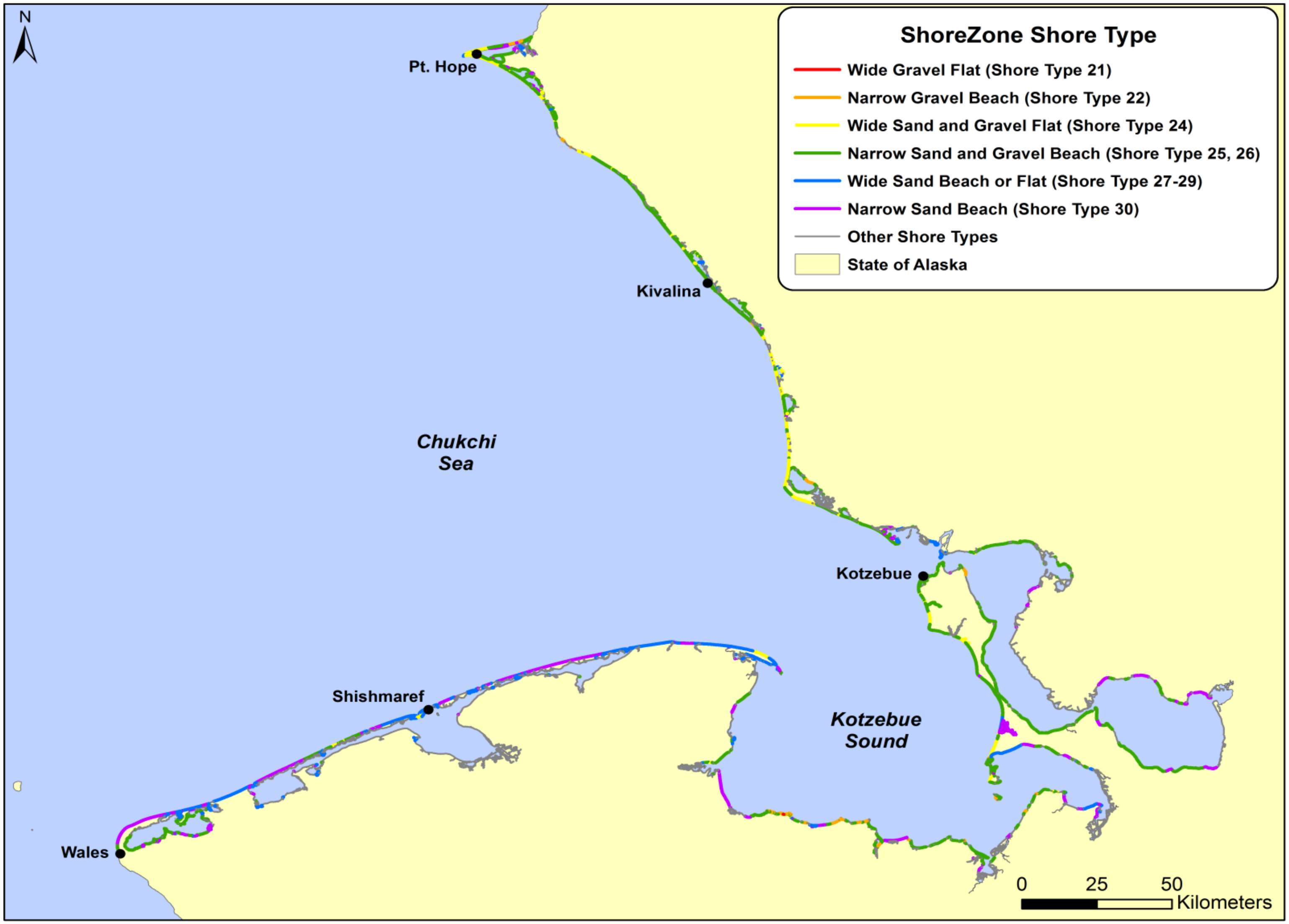

Figure 7. Map of the distribution of sediment shorelines (Shore Types, grouped by geomorphology) in the study area. Data are summarized in Table 1.

Table 2. Summary of Shore Types by ESI Class

Environmental Sensitivity Index (ESI)		Sum of Unit Length (km)	# of Units	% Occurrence (by length)
No.	Description			
1A	Exposed rocky shores; Exposed rocky banks	3.1	21	0.1
1B	Exposed, solid man-made structures	5.1	11	0.1
1C	Exposed rocky cliffs with boulder talus base	31.7	44	0.3
3A	Fine- to medium-grained sand beaches	308.3	276	6.6
3B	Scarps and steep slopes in sand	0.5	1	0.0
3C	Tundra cliffs	123.7	192	2.6
4	Coarse-grained sand beaches	30.3	33	0.6
5	Mixed sand and gravel beaches	1048.1	1220	22.3
6A	Gravel beaches (granules and pebbles)	34.9	54	0.7
6B	Gravel beaches (cobbles and boulders)	19.4	48	0.4
6C	Rip Rap (man-made)	3.4	6	0.1
7	Exposed tidal flats	125.4	72	2.7
8A	Sheltered scarps in bedrock, mud, or clay; sheltered rocky shores (impermeable)	9.2	21	0.2
8B	Sheltered, solid, man-made structures; sheltered rocky shores (permeable)	4.8	15	0.1
8C	Sheltered rip rap	1.0	2	0.1
8E	Peat shorelines	1032.2	675	22.0
9A	Sheltered tidal flats	159.8	102	3.4
9B	Vegetated low banks	184.1	136	3.9
10A	Salt- and brackish-water marshes	726.4	338	15.5
10E	Inundated low-lying tundra	860.9	202	18.3
	Totals:	***4,694.0***	***3,469***	***100.0%***

*Note: Other ESI Classes not observed.

2.2 Anthropogenic Shore Modifications

Shore-protection features and coastal access constructions such as seawalls, rip rap, docks, dikes, and wharves are enumerated in ShoreZone mapping data. Overall, shorelines classified as man-modified (having more than 50% of the unit altered by human activities, assigned Shore Types 32 and 33) occur along 4.1 km (0.1%) of shoreline in the study area, mostly near the communities of Kotzebue, Kivalina and Shishmaref. These shore types are mapped only where the intertidal modification is more than 50% of the shoreline.

The ShoreZone system also inventories the shore modification that may be present in the backshore. The types of shore modification features (such as land fill 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 3) is shown in Figure 8.

Table 3. Summary of Shore Modifications

Shore Modification	# of Occurrences	Shoreline Length (km)	% of Man-Modified Shoreline
Wooden bulkhead	4	2.7	3.3%
Boat ramp	7	4.1	5.0%
Concrete bulkhead	4	4.6	5.7%
Landfill	54	63.9	79.0%
Riprap	11	5.7	7.0%
Totals:	***80***	***60.4***	***100.0%***

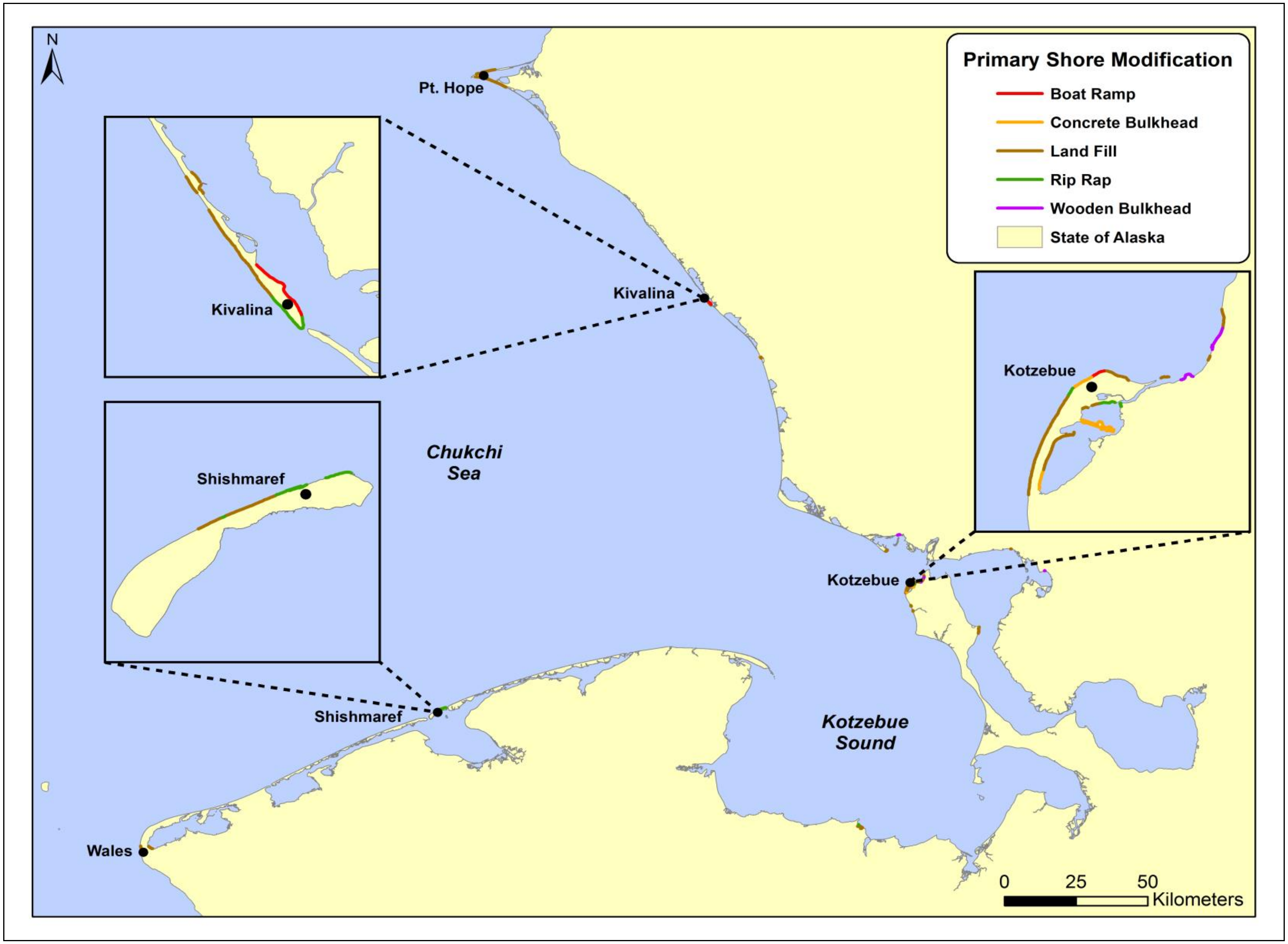

Figure 8. Map of the distribution of units in which shore modification features were observed in the study area. Data are summarized in Table 3.

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-7). For more information on the assignment of this attribute, refer to the ShoreZone Protocol (Harney *et al* 2008).

The dominance of lower wave exposures and sand-gravel sediment textures results in high Oil Residence Indices for most shore segments: 70.5% have an ORI of 5, indicating oil residence times are on the order of months to years (Table 4; Figure 9).

Table 4. Summary of Oil Residence Index

Relative Persistence	Oil Residence Index (ORI)	Estimated temporal persistence	Shoreline Length (km)	Shoreline Length (%)
Short	1	Days to weeks	4.6	0.1%
	2	**Weeks** to months	461.2	9.8%
Moderate	3	Weeks to **months**	399.1	8.5%
	4	**Months** to years	518.6	11.0%
Long	5	Months to **years**	3310.9	70.5%
		Totals:	***4,694.0***	***100.0%***

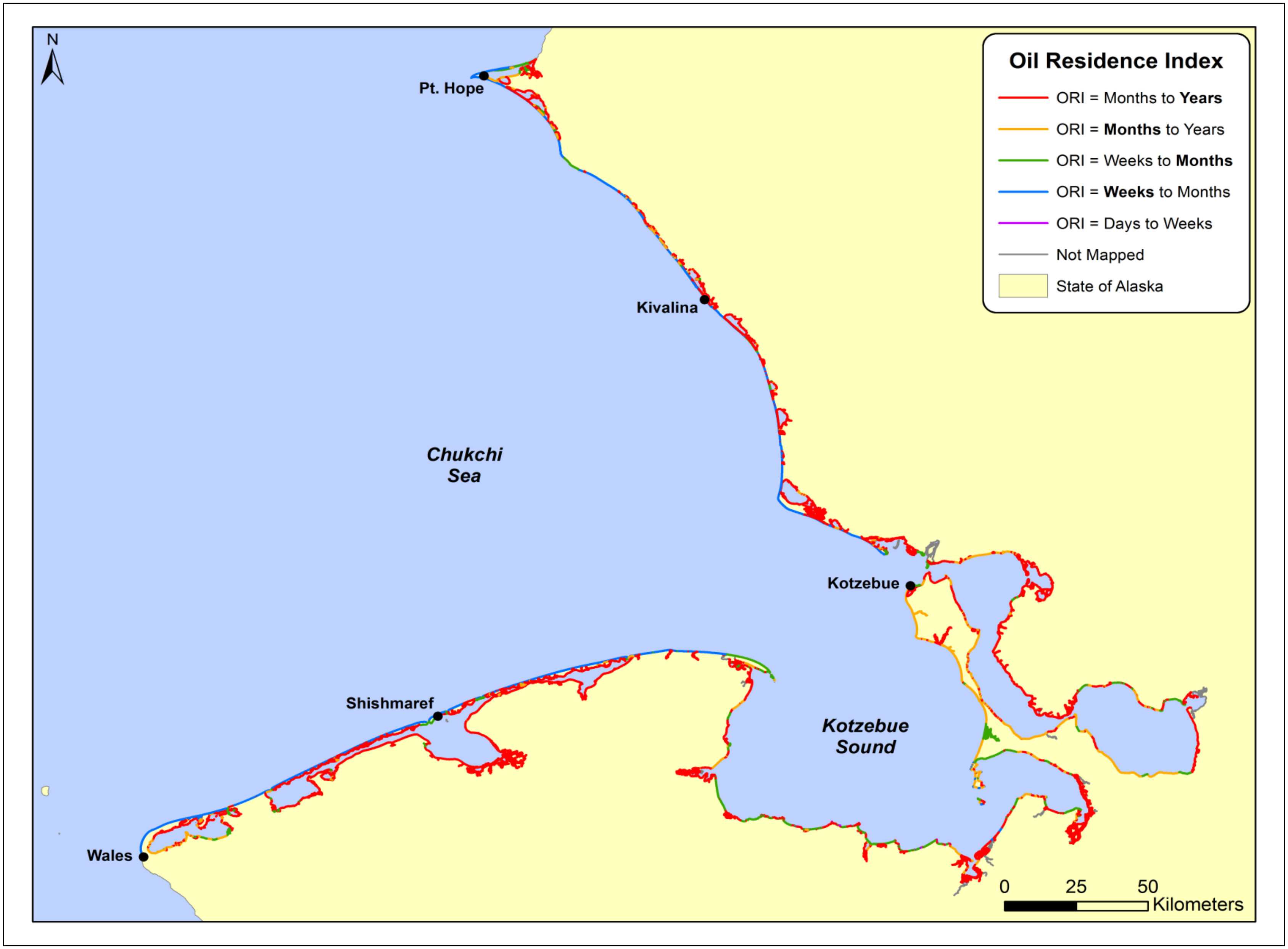

Figure 9. Oil Residence Index (ORI) for shorelines in NW Alaska, based on substrate type and wave exposure (Appendix A, Table A-7).

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.

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 in Northwestern Alaska

The ShoreZone Coastal Vulnerability Module was applied to the shoreline between Pt. Hope and Cape Prince of Wales, a shoreline length of 4,694 km. Data for the three vulnerability indices are shown in Tables 5, 6, 7, and 8.

Figure 10 provides an overview of the distribution of stability classes for the region, and Figure 11 provides an overview of the distribution of mass-wasting and wetland morphologies for the region.

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

- The mapping data show that approximately 46% of the shoreline is likely to experience storm surge inundation greater than 50m (Fig. 12, 13). This provides a clear metric of the sensitivity to both storm surges and sea level rise.

- Approximately 40% of the shoreline contains thaw lakes covering more than 25% of the backshore (Fig. 14, 15). 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.

- A map of submerged wetland morphology (Fig. 16) indicates wetlands that have already been inundated and submerged due to thaw settlement. While not widely distributed (10% of the shoreline), they do indicate that change is occurring rapidly.

Table 5 Coastal Stability Index

		Stability Class	Occurrences (km)	Occurrence (%)	Subtotals (%)
CLASTIC	CE4	Erosional	50.7	1.1	
	CE3		227.7	4.8	
	CE2		293.0	6.2	
	CE1		266.6	5.7	
	CS	Stable	374.0	8.0	
	CA1	Accretional	283.8	6.0	
	CA2		154.8	3.3	
	CA3		40.8	0.9	36.0
WETLAND	WE2	Erosional	880.1	18.7	
	WE1		818.6	17.4	
	WS	Stable	544.5	11.6	
	WA1	Accretional	687.7	14.6	62.3
Bedrock	R	Not applicable	59	1.3.0	
Anthropogenic	A	Seawall	4.9	0.1	
Other	X	Provisional	8.2	0.2	
		Total:	***4,694.4***		

Table 6 Flooding Sensitivity Index

	Flooding Class	Occurrence (km)	Occurrences (%)
F4	Major	1,584	33.8
F3	↑	566.3	12.1
F2	↑	1,056	22.5
F1	Minor	1,422	40.3

Table 7 Thaw Sensitivity Index

	Thaw Sensitivity Class	Occurrence (km)	Occurrences (%)
T4	High	1,249.4	26.6
T3	↑	643.8	13.7
T2	Low	560.9	11.9
T1		2,165	46.1
X		74.7	1.6

Table 8 Coastal Mass-Wasting and Wetland Features

Category	Feature	Occurrence (km)	Occurrences (%)
Mass Wasting	Ground ice slumps	120.9	2.6
	Block slumps	78.2	1.7
	Debris flows/solifluction	440.9	9.4
	Ice Wedges		
Wetlands	Lagoonal complex	1,103.0	23.5
	Deltaic complex	788.9	16.8
	Marsh clones	24.2	0.5
	Associated mudflats	26.0	0.6
	Submerged morphology	531.8	11.3
	Relict river morphology	84.2	1.8
	Relict shoreline morphology	64.1	1.4
Other		155.2	3.3
None	No relevant features	1,222.8	26.0
Not Applicable	Coastal Hazards not applicable	54.2	1.2

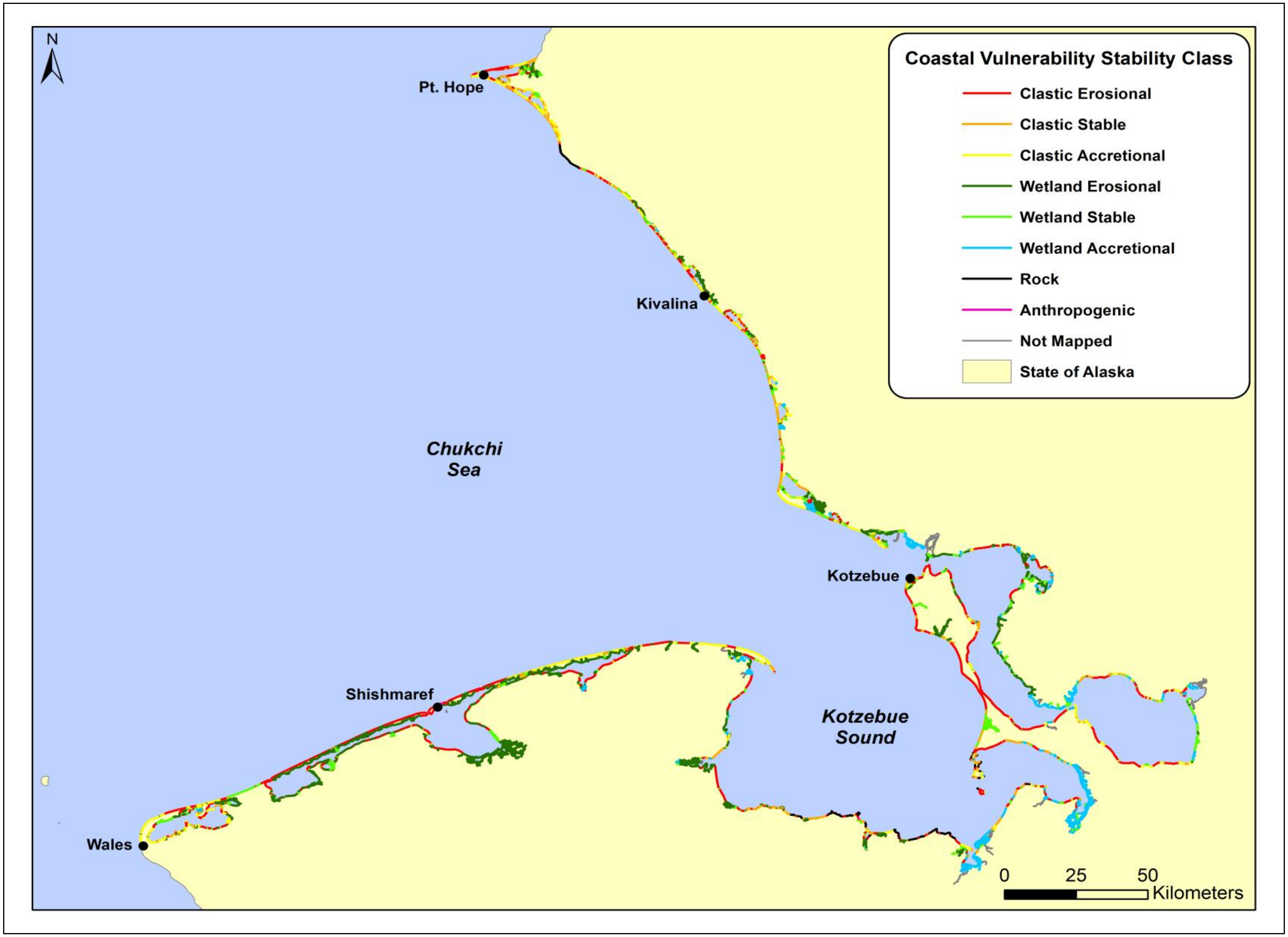

Figure 10. Map of the distribution of stability class regarding coastal vulnerability in the study area.

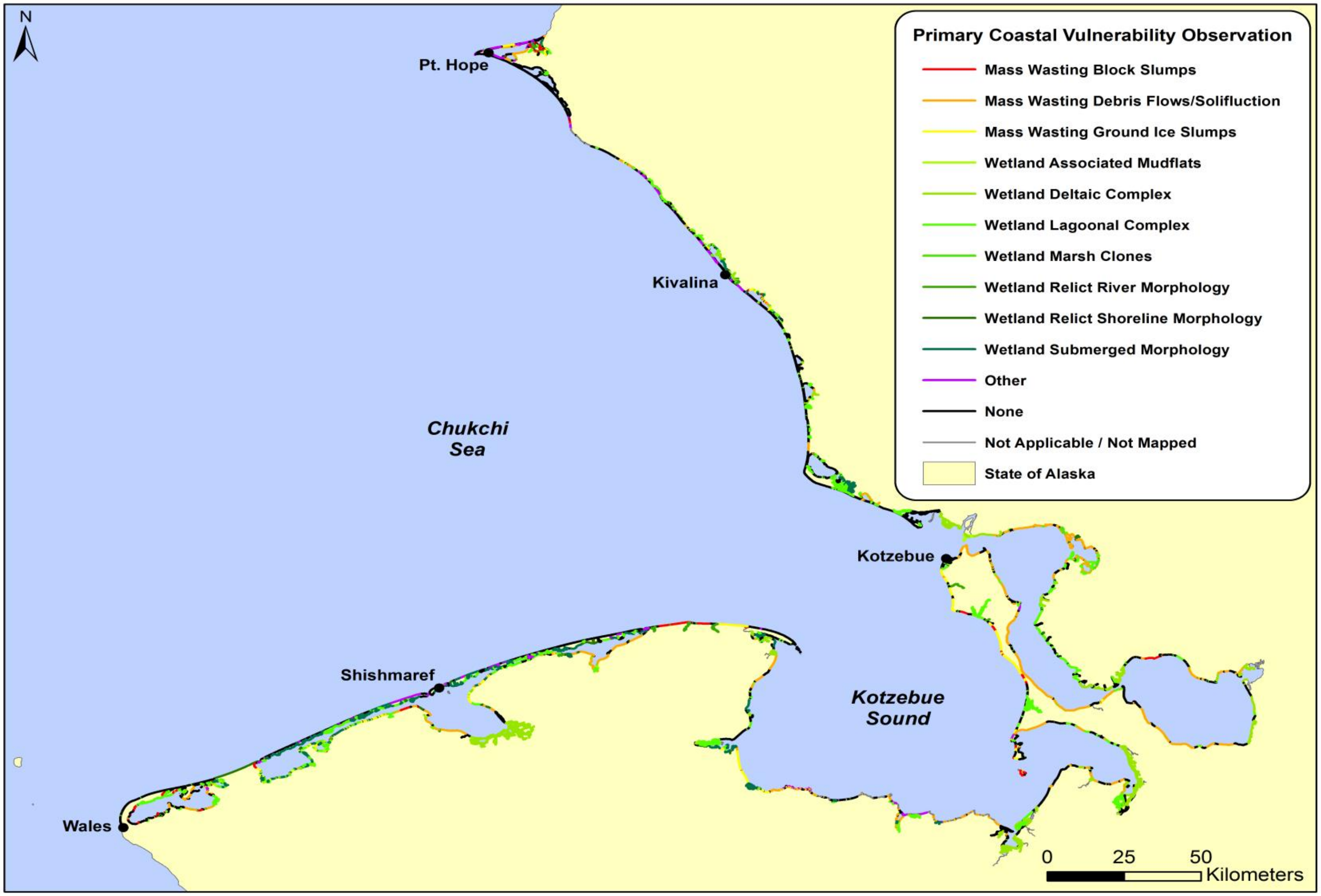

Figure 11. Map of the distribution of primary observations regarding coastal vulnerability in the study area.

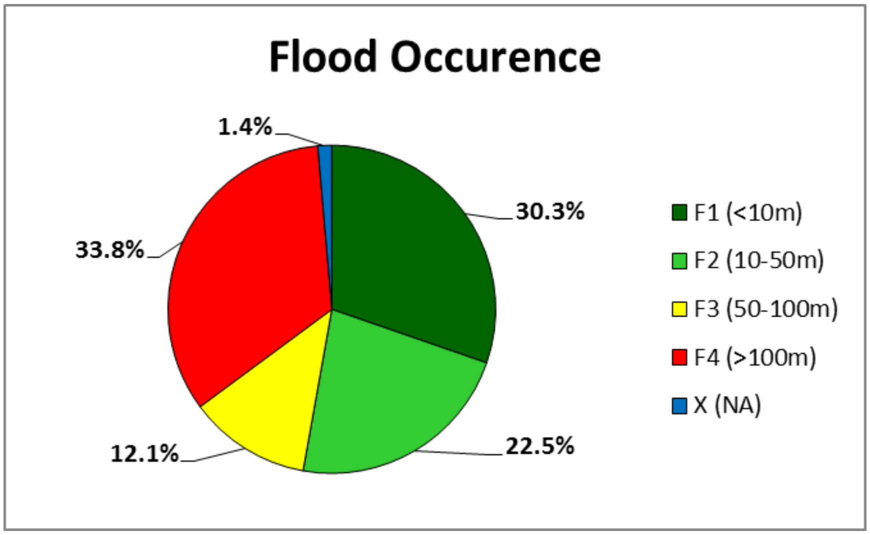

Figure 12. Relevant flood occurrence regarding coastal vulnerability in study area. Distance indicate potential storm surge inundation distances.

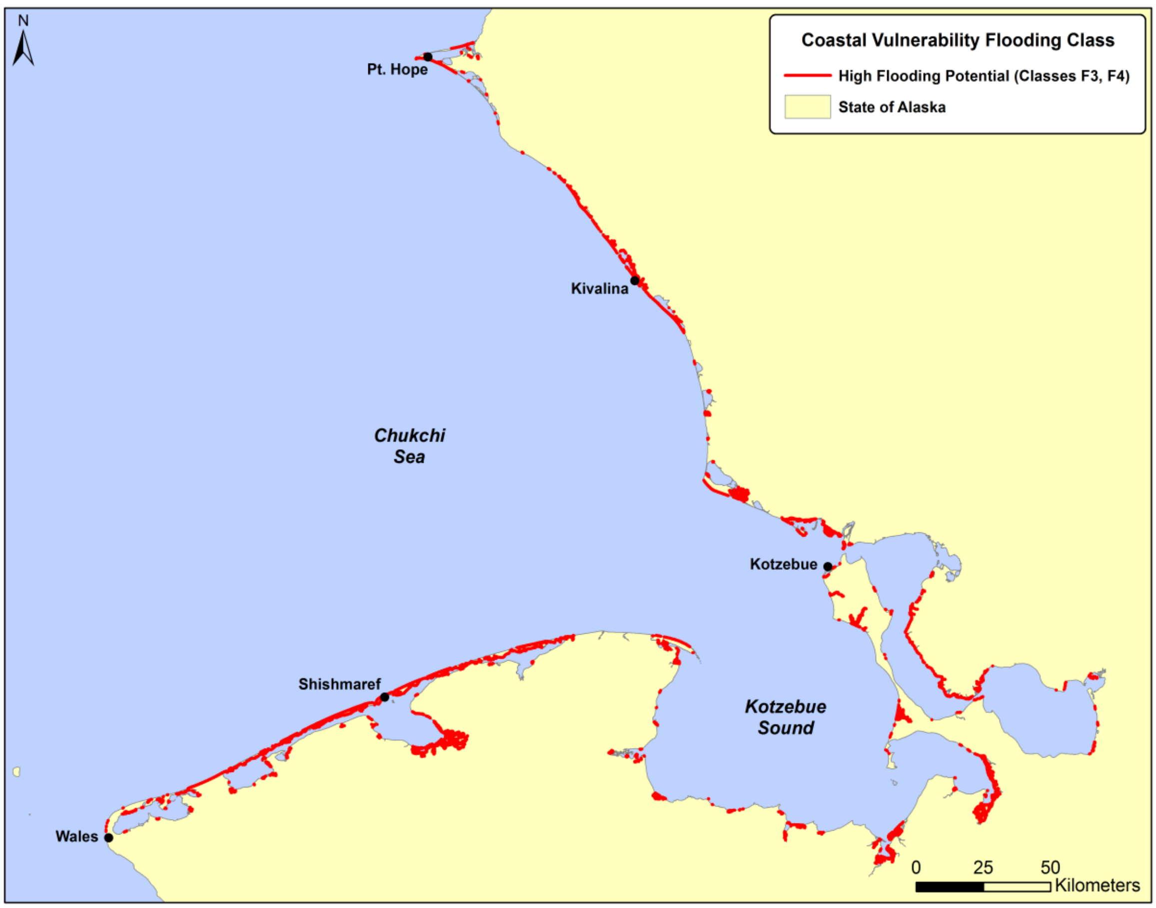

Figure 13. Map showing the occurrence of high inundation areas (>50m inundation).

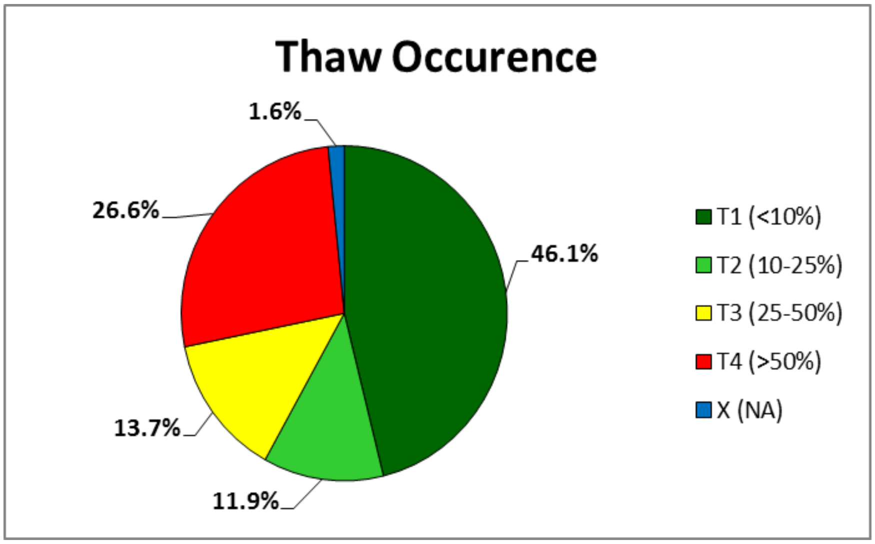

Figure 14. Relevant thaw occurrence regarding coastal vulnerability in study area. Percentages indicate the occurrence of ponds or lakes in the backshore.

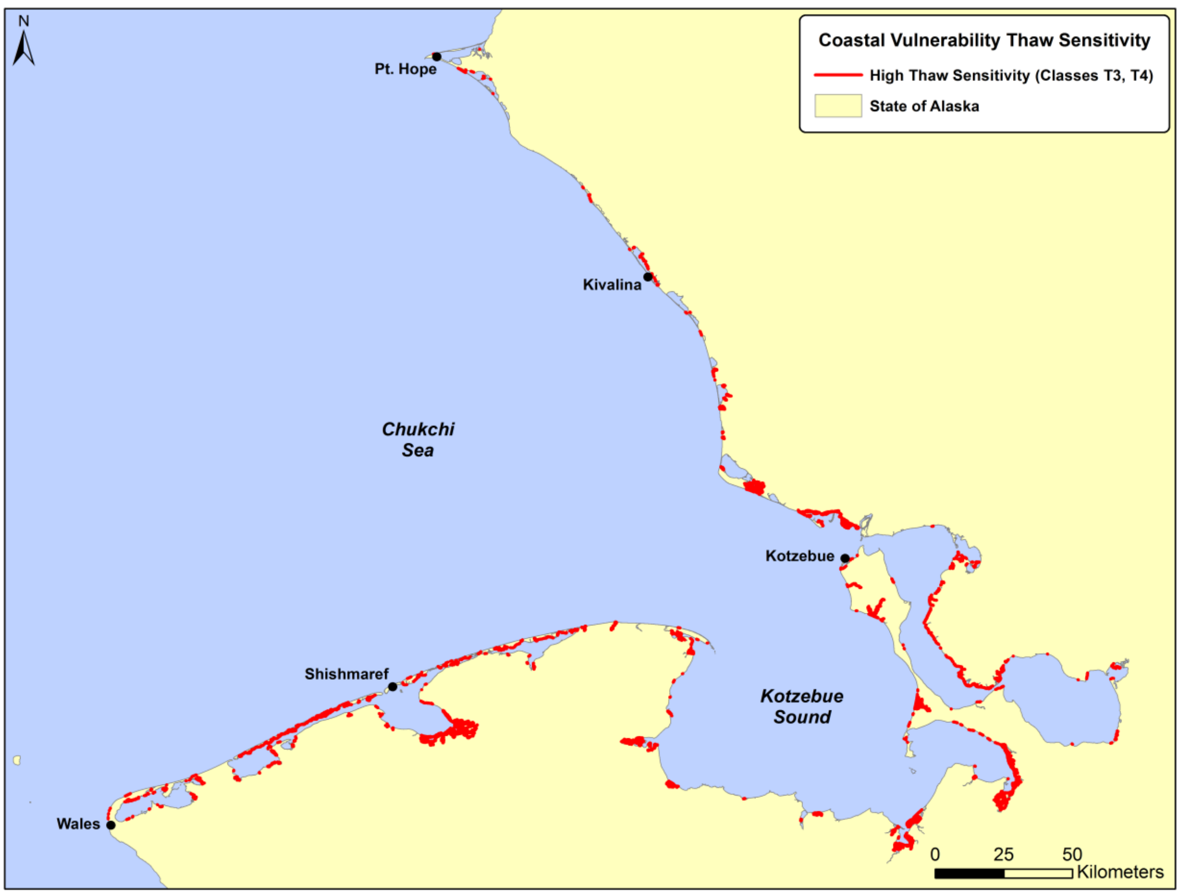

Figure 15. A map showing the occurrence shorelines with a high density of thaw lakes (>25%).

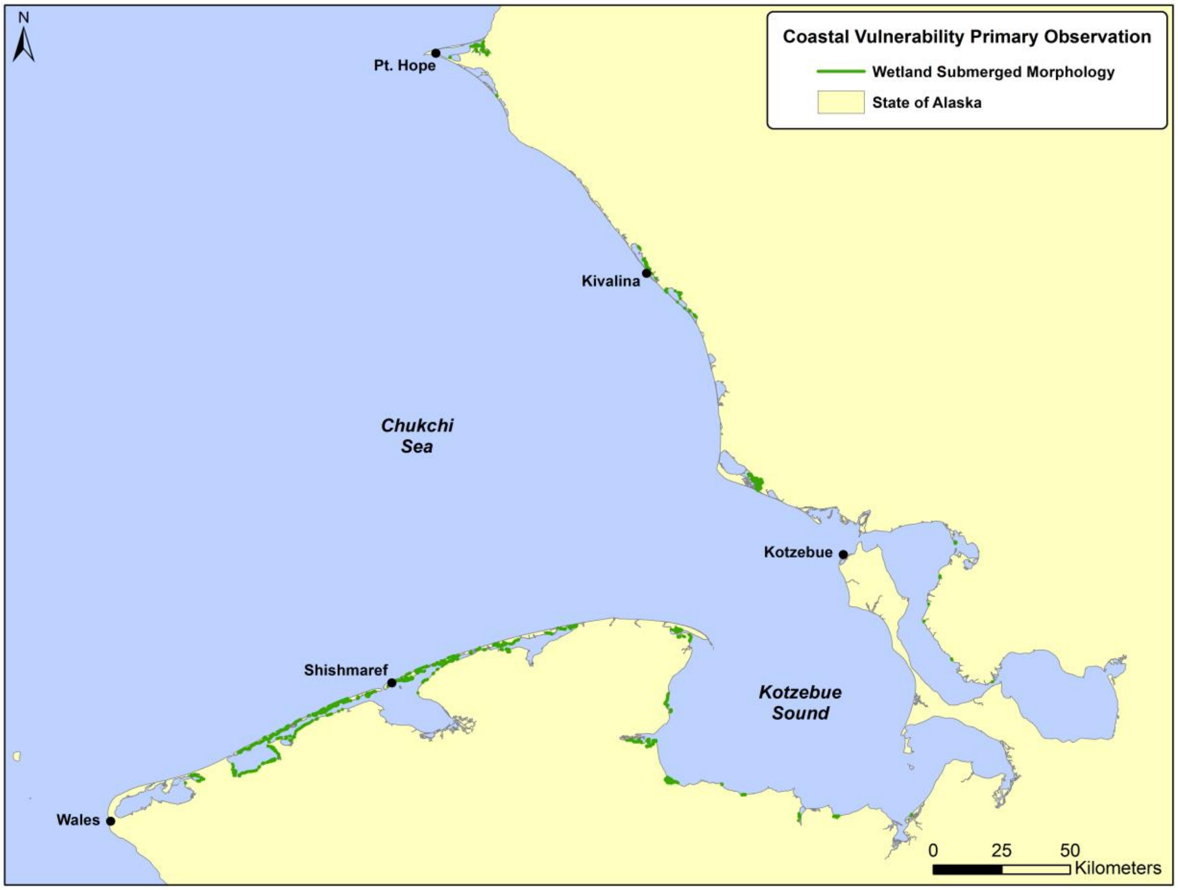

Figure 16. A map showing the locations of wetland morphologies that have been submerged. While these areas are not widely distributed, they are indicative of locations where thaw settlement has occurred.

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 Northwest Alaska 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 units which are bare of biobands, 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 17 and 18). 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-18.

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-19 for definitions for bioband occurrence.

Figure 17. Dune Grass (GRA) and Salt Marsh (PUC) biobands with adjacent Tundra (TUN) around small estuary/lagoon feature. (Goodhope Bay, south shore Kotzebue Sound, photo nw12_kz_03780.jpg).

Figure 18. Dune Grass (GRA) bioband on high energy washover beach, with extensive Salt Marsh (PUC) and Sedges (SED) in the backshore, inside the lagoon behind the beach. (northeast of Shishmaref, Bering Land Bridge National Preserve, photo nw12_kz_05764.jpg).

The occurrence of each bioband mapped in the Northwest Alaska project area included in this summary report is summarized in Table 9 and Figure 19.

The Tunda (TUN) bioband was nearly ubiquitous throughout the project area and was recorded at over 85% of the units (map not shown). The Tundra bioband is defined as occurring in the supratidal zone, in units classified as Tundra form (U) 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 Salt Marsh (PUC) or Sedges (SED) bioband on low elevation coastal plains.

Dune Grass (GRA) was the most next most commonly mapped bioband, with almost 70% of the coast having either patchy or continuous GRA recorded (Table 9). 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. Salt Marsh (PUC) and Sedges (SED) biobands were the next most common, and were recorded at 77% and 42% of the coast, respectively.

Although the Eelgrass (ZOS) bioband was not mapped on the shoreline, extensive areas of drift swash lines of eelgrass were observed during the field program, at stations along the southwest shore of Kotzebue Sound. A large eelgrass bed is known from other studies in the offshore shallow banks in south Kotzebue Sound, sheltered from the open Chukchi Sea by the curving spit at Cape Espenberg. Other patches of drift eelgrass were observed during the shore station survey, inside lagoons on the Bering Land Bridge Preserve coast, so it is possible that patches of eelgrass are present in those larger lagoons, however, no confirmed aerial observations of rooted eelgrass was photographed during the aerial surveys.

Only small amounts of biobands associated with stable substrate (Barnacle, Rockweed, Green Algae, and Red Algae) were observed in the Kotzebue project area, which together amounted to less than 5% of the total mapped shoreline (Table 9 and Figure 19). No areas of benthic kelps or canopy kelps were observed.

Within some of the larger lagoons, in particular in the freshwater-dominated areas of Selewik Lake at the eastern end of the project, areas of ‘pondweed’ where observed growing in the nearshore. These rooted vascular plants are likely a mixture of the filamentous plant *Stuckenia filiformis* and the tall, leafy *Potamogeton alpinus.* Both species are listed in Whiting *et al* (2011) as common in brackish water of the Noatak, Kobuk and Selawik River delta. Approximately 100 units have the presence of ‘pondweed’ noted in the ‘BIO_UNIT_COMMENT’ field (Appendix A, Table A-8).

Table 9. Bioband Abundances Mapped in Northwest Alaska

Bioband		Continuous		Patchy		Total	% of
Name	**Code**	**km**	**%**	**km**	**%**	**km**	**Mapped**
Tundra	**TUN**	3,981	85	47	1	4,028	86
Dune Grass	**GRA**	2,275	48	969	21	3,243	69
Salt Marsh	**PUC**	3,030	65	578	12	3,608	77
Sedges	**SED**	1,067	23	885	19	1,953	42
Biofilm	**BFM**	0	0	7	0	7	0
Barnacle	**BAR**	1	0	0	0	1	0
Rockweed	**FUC**	11	0	6	0	16	0
Green Algae	**ULV**	52	1	129	3	181	4
Red Algae	**RED**	9	0	7	0	16	0

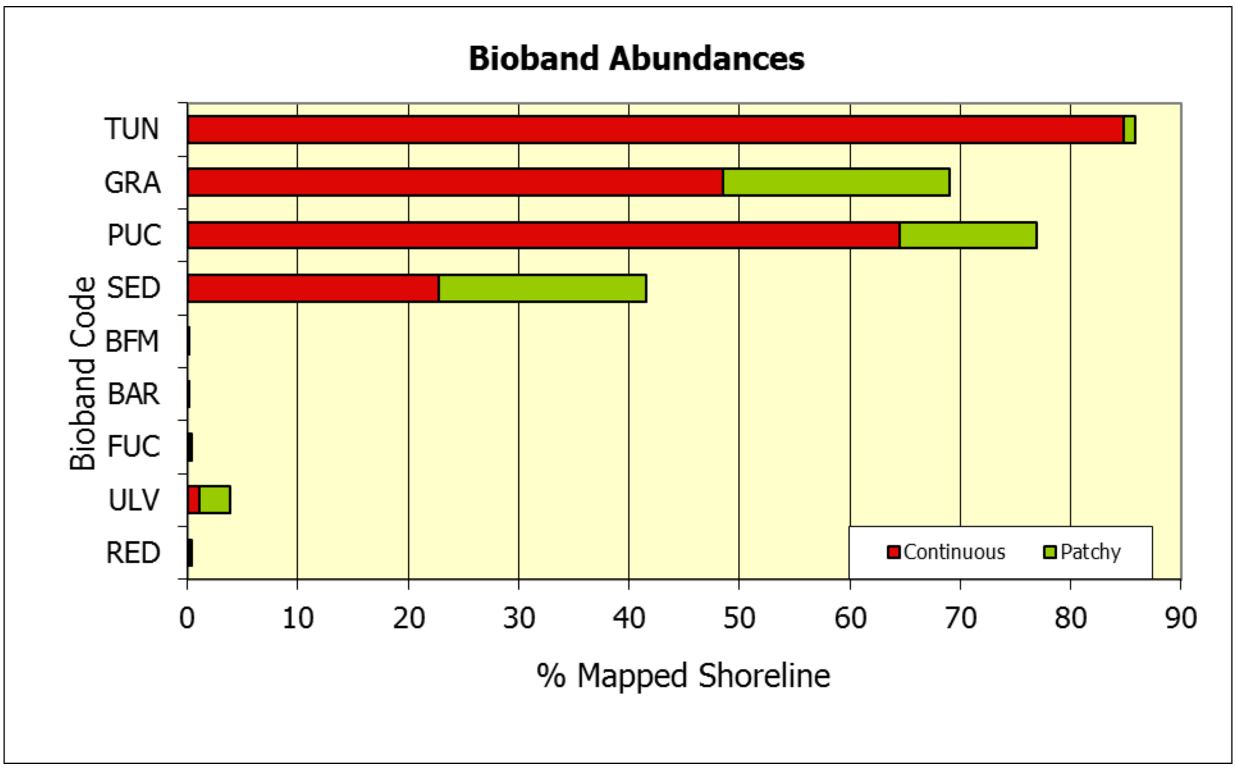

Figure 19. Bioband abundances mapped in project area.

Bioband Distributions

Overall only a few supratidal biobands make up most of the biota observed on the permafrost-dominated Arctic coasts of the Kotzebue Sound and Chukchi Sea. Those biobands are: Tundra (TUN), Salt Marsh (PUC), Dune Grass (GRA) and Sedges (SED).

Distribution of Salt Marsh, Dune Grass and Sedges Biobands.

Almost all of the shoreline in the Northwest Alaska project area has at least one of the Salt Marsh (PUC), Dune Grass (GRA) or Sedges (SED) biobands. Elsewhere in Alaska ShoreZone, these biobands usually are mapped in only a small percentage of the shoreline length, and when they co-occur, they are one of the indicators of 'estuarine' features. The high proportion of these typical 'estuarine' biobands in Northwest Alaska highlights the large amount of salt marsh in the region (Figure 20).

Mapped combinations of these bands are illustrated in Figure 20, as:

- All three bands occurring together: Salt Marsh (PUC), Dune Grass (GRA), and Sedges (SED
- Two most commonly mapped occurring together: Salt Marsh (PUC) and Dune Grass (GRA)
- Any other combination of Salt Marsh (PUC), Dune Grass (GRA) or Sedges (SED).

Each of these three biobands is dominated by rooted vascular plants, with the Salt Marsh bioband having the most diverse species composition, as it can include a mixture of different salt-tolerant grasses, herbs and sedges. The Sedges (SED) band, usually a monoculture of sedges (*Carex spp*.), was slightly more common along the most freshwater dominated sections of the Selwik Lake area on the eastern edge of the project area (Figure 20).

Further descriptions of the characteristics of these biobands can be found in Appendix A, Table A-18.

Figure 20. Distribution of units in the project area with selected combinations of the Dune Grass, Salt Marsh and Sedges biobands.

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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-5 and A-10).

In the Northwest Alaska project area classified for this project, attached intertidal and nearshore biobands are mostly absent. In units where no attached biota was visible, the physical mappers' estimate of wave energy (EXP_OBSER) was deemed to be equivalent to the biological wave exposure. 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 units without attached biota, 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 Northwest Alaska project area is summarized in Table 10 and in Figure 21. Most of the shoreline in the study area was classified with a wave exposure of Semi-protected (SP) or lower (79%). Twelve percent of the area was mapped as Exposed (E) and 9% 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-11. 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 10. Summary of Wave Exposure in Northwest Alaska [1].

Biological Wave Exposure			
Name	**Code**	**Length (km)**	**% of Mapped**
Exposed	E	548	12
Semi-Exposed	SE	444	9
Semi-Protected	SP	941	20
Protected	P	2,762	59
		4,694	100

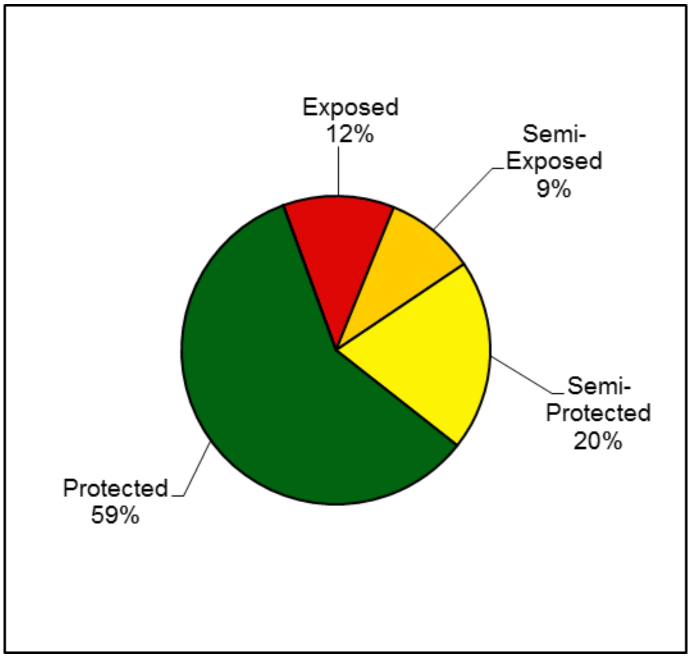

Figure 21. Summary of wave exposures mapped in the project area [2].

[1] and [2] In the Kotzebue area, where attached intertidal biota are largely absent on bare beaches, the physical mapper estimate of wave energy (EXP_OBSER) is used to assign biological wave exposure.

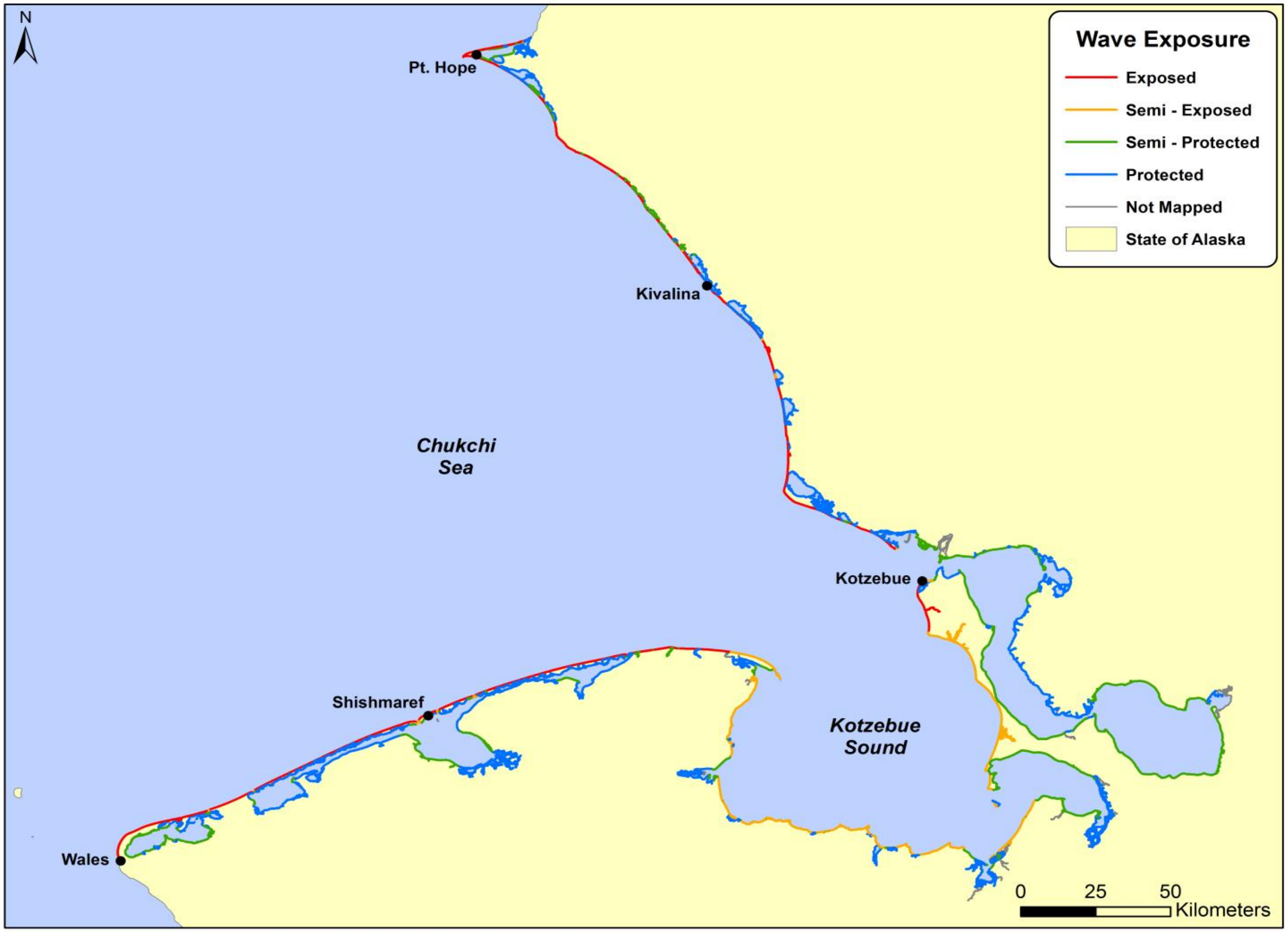

Figure 22. Distribution of wave exposure categories mapped in the project area. (Note that for the Northwest Alaska project, most exposure categories are assigned from the physical exposures).

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 (Figure 23 and Appendix A, Table A-9). 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. For example, the 'Southeast Alaska – Sitka' bioarea (Figure 23) has a full range of wave exposures, dense nearshore canopy kelps and a diverse array of coastal morphologies.

The new Kotzebue bioarea 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 most of the shoreline also has Salt Marsh (PUC) and Dune Grass (GRA) biobands. Sedge (SED) bioband is also common but few other biobands are observed and their extent is limited.

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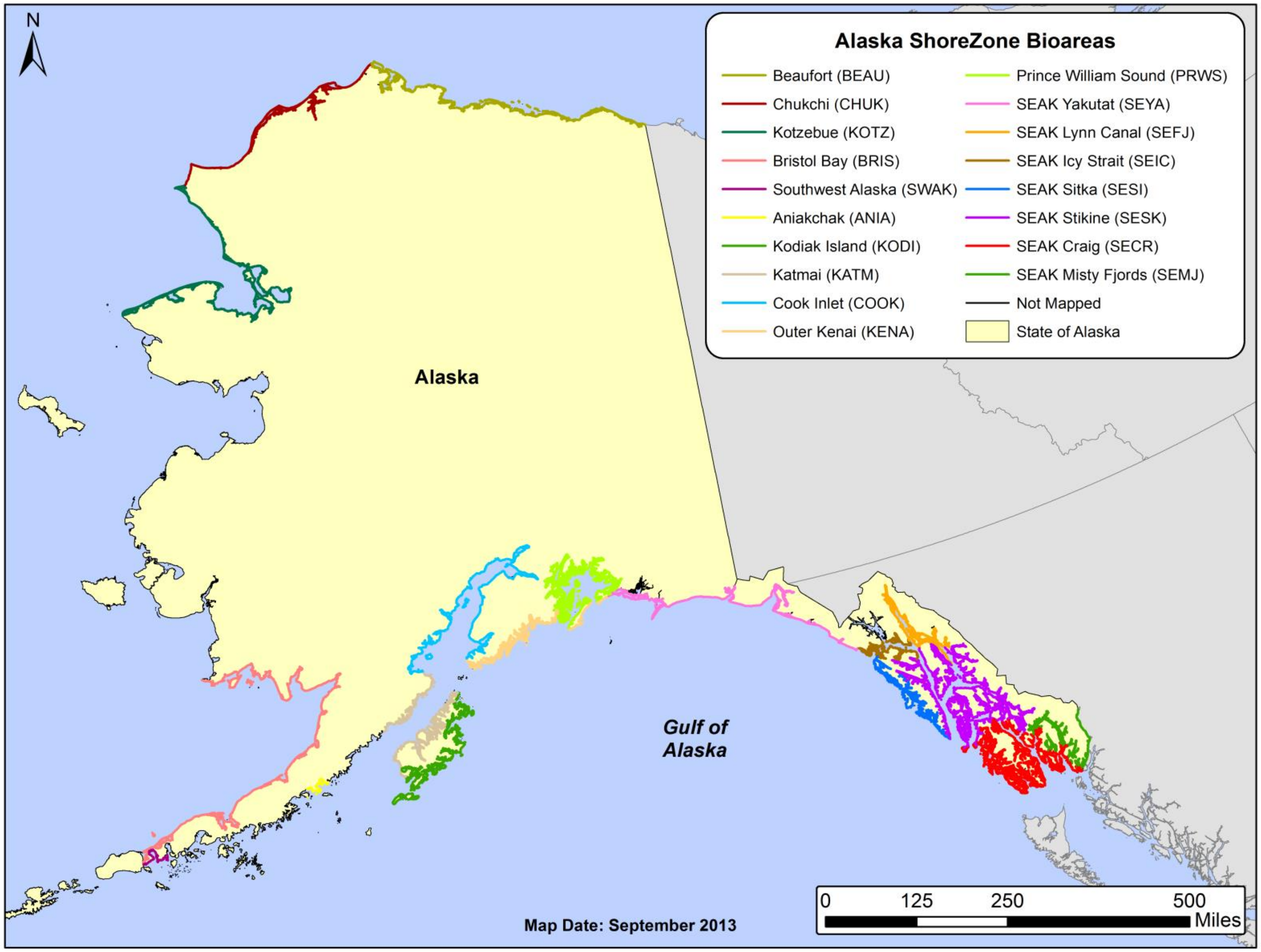

Figure 23. Bioareas identified in coastal Alaska ShoreZone mapping to date. Bioareas are delineated on the basis of observed regional differences in the distribution of biota and coastal geomorphology.

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 Kotzebue area, where attached intertidal biota are largely absent on bare beaches, the physical mapper estimate of wave energy (EXP_OBSER) is 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 37% of habitat class categories mapped are structured by wave energy, mostly in the mobile classes. (Table 11 and Figure 24) Of the non-wave energy structured habitats, the Permafrost habitat is one of the most often observed, and accounts for 36% of the shoreline mapped in Northwest Alaska. Estuary classes are recorded in 28% of the shoreline, and are part of the extensive salt marsh complexes (Figure 25).

Many of the Northwest Alaska area 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 the Northwest Alaska area was modified to identify salt marshes of this nature, which are separate from ‘tundra-dominated’ classes but not necessarily directly associated with ‘fluvial processes’ (Figure 26).

Backshore lagoons were classified as ‘secondary habitat class: lagoon’ on 17% of the Northwest Alaska project area coast (Figure 27). 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-12 and A-13.

Table 11. Summary of Occurrence of Habitat Classes in Kotzebue Project Area.

Dominant Structuring Process	Habitat Class		Kotzebue project area	
	Exposure Category	Substrate Mobility	Length (km)	% of Mapping
Wave Energy	Exposed (E)	Immobile & Partially Mobile	6	<1
	Semi-exposed (SE)	Immobile & Partially Mobile	70	2
	Semi-protected (SP)	Immobile & Partially Mobile	51	1
	Protected (P)	Partially Mobile	98	2
	E, SE, SP, P	Mobile	1,486	32
Fluvial/Estuarine processes	Estuary		1,292	28
Periglacial	Permafrost		1,681	36
Man-modified	Anthropogenic		10	<1
Lagoon *	Lagoon		791	17

* Lagoons are classified as *secondary habitat class* Appendix A, Table A – 12.

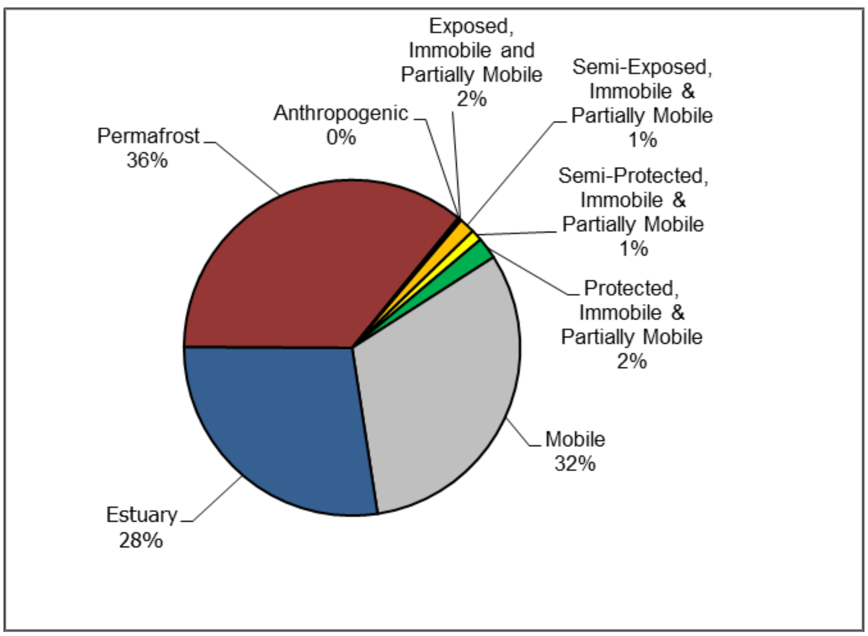

Figure 24. Summary of Habitat Class categories mapped in the project area

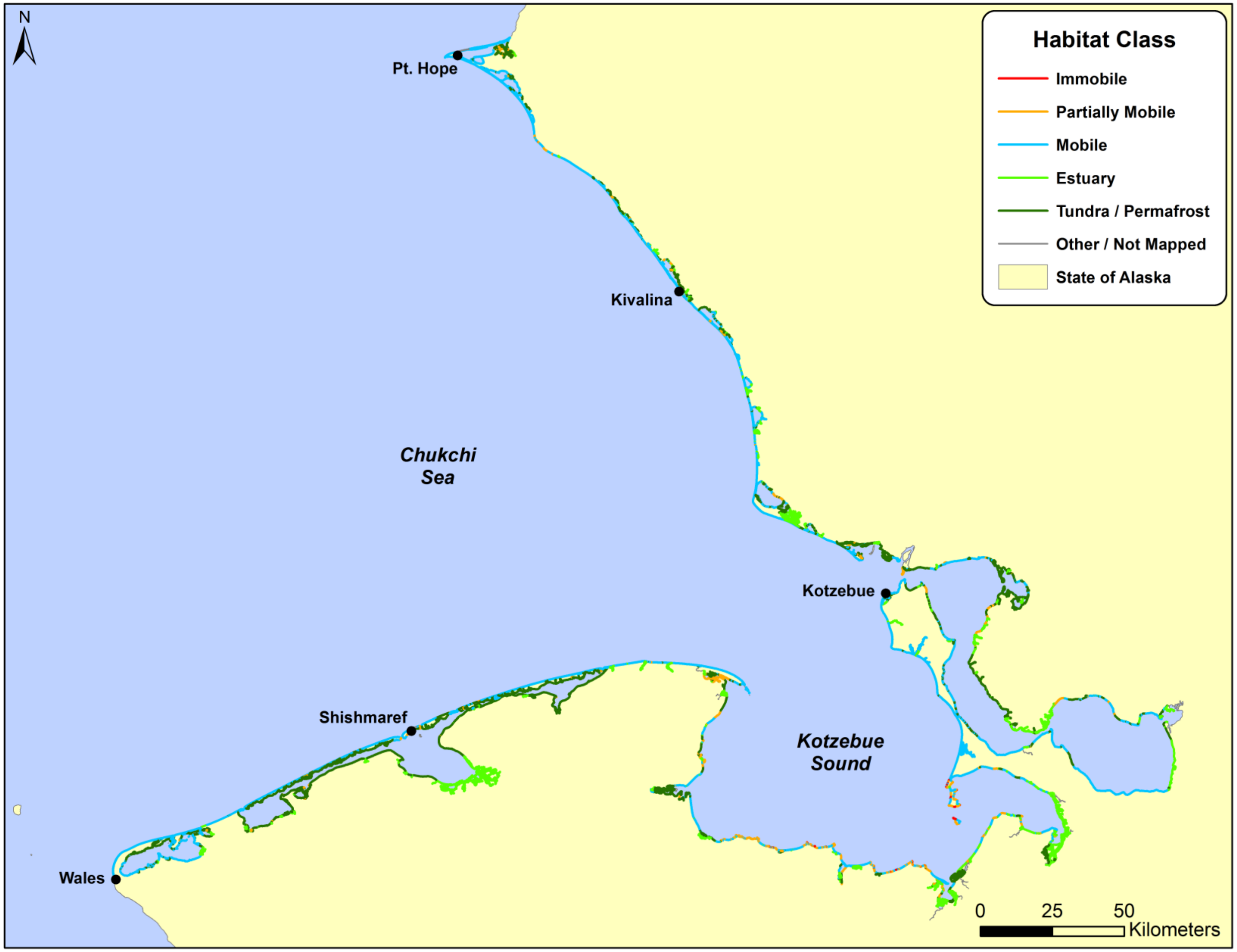

Figure 25. Distribution of Habitat Classes by 'dominant structuring process' for project area.

Figure 26. **Estuary** habitat class for salt marsh near Kiwalik Lagoon, Spafarief Bay, southeast Kotzebue Sound. (Photo nw12_kz_10957.jpg)

Figure 27. **Lagoon** secondary habitat class, in backshore behind high energy barrier beach. Near Cape Seppings, north of Kivalina. (Photo nw12_kz_14496.jpg).

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5 ACKNOWLEDGMENTS

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We also thank the staff of Coastal and Ocean Resources Inc. and Archipelago Marine Research Ltd. for their efforts in the field and in the office.

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, Inc. At the time of publication, that person is Dr. John Harper.

Table	Description
A-1	Definitions for fields and attributes in the UNIT table.
A-2	Definitions of the BC_CLASS attribute, in the UNIT table. (after Howes *et al* [1994] “BC Class” in British Columbia ShoreZone)
A-3	Shore Types Associated with Structuring Processes Other than Wave Action.
A-4	Definitions of the ESI (Environmental Sensitivity Index) attribute, from the UNIT table (after Peterson *et al* [2002]).
A-5	Definitions for estimating the OBSERVED PHYSICAL EXPOSURE attribute, (EXP_OBSER) in the UNIT table.
A-6	Definition of the OIL RESIDENCE INDEX (ORI) attribute in the UNIT table.
A-7	OIL RESIDENCE INDEX (ORI) Component lookup matrix based on exposure (columns) and substrate type (rows).
A-8	Definitions of the attributes in the BIOUNIT table.
A-9	Definitions of the BIOAREA attribute in BIOUNIT table.
A-10	List of the BIOLOGICAL WAVE EXPOSURE codes, in BIOUNIT table.
A-11	Definitions of BIOLOGICAL WAVE EXPOSURES, by bioband, and by indicator and associate species assemblages (EXP_BIO attribute in BIOUNIT table).
A-12	Expanded descriptions for HABITAT CLASS, SECONDARY HABITAT CLASS, and RIPARIAN fields of the BIOUNIT table.
A-13	Codes for HABITAT CLASS and SECONDARY HABITAT CLASS attributes, in the BIOUNIT table.
A-14	Definitions of fields and attributes in the XSHR (Across-shore) component table (after Howes *et al* 1994).
A-15	Definitions of FORM attributes, in XSHR (Across-shore) table (after Howes *et al* 1994).
A-16	Definitions of the MATERIALS attributes, in XSHR (Across-shore) table. (after Howes *et al* 1994).
A-17	Definitions for fields in the BIOBAND table.
A-18	Definitions for BIOBAND attribute for Southeast Alaska, in BIOBAND table.
A-19	Definitions for Occurrences of Biobands, in the BIOBAND table.
A-20	Definitions for fields in the PHOTOS table.

Appendix A

Table A-1. Definitions for Fields and Attributes in the UNIT table.

Field Name	Description
UnitRecID	**Unit Record ID:** An automatically-generated number field; the database "primary key" for unit-level relationships
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.
REGION	**Region:** assigned during mapping, makes up first two digits of the PHY_IDENT. (See PHY_IDENT description for example.)
AREAS	**Area:** assigned during mapping, makes up the third and fourth digits of the PHY_IDENT. (See PHY_IDENT description for example.)
PHY_UNIT	**Unit:** Four digit **along-shore unit number**; assigned during mapping, unique within Region/Area mapping section. (See PHY_IDENT description for example.)
SUBUNIT	**Subunit:** assigned during mapping, is '0' for unit line features. Subunit field is used to identify Point features (if any, also called 'Variants') within Units, and are numbered sequentially (1, 2, 3…) according to the order occurring within the unit. (See PHY_IDENT description for example.)
TYPE	**Unit Type:** A single-letter description for Unit as either: a (L)ine (linear unit) or (P)oint feature (variant). Related to SUBUNIT attribute, where each numbered SUBUNIT 'variant' would be TYPE 'P'
SHORE_TYPE	**Shore Type:** Code number for Coastal Class classification for the unit. Definitions of codes in Tables A-2 and A-3. Determined by the Physical mapper and based on: overall substrate type, sediment size (if sediment is present), across-shore width, and across-shore slope for the unit; derived from the Howes *et al* (1994).
ESI	**Environmental Sensitivity Index** Classification for the shore unit, using unit-wide interpretation of ESI. Definitions in Table A-4, after Peterson *et al* [2002].
LENGTH_M	**Unit Length**: Along-shore unit high waterline, in meters; calculated in ArcGIS, from digitized shoreline
GEO_MAPPER	**Physical Mapper Name:** Last name of the physical mapper
GEO_EDITOR	**Physical Mapper Reviewer:** Last name of the physical mapper who QA/QCs the work (10% of all units are reviewed by a different Physical mapper than did original mapping)
VIDEOTAPE	**Videotape Name:** Unique code for title of the videotape used for mapping; Naming convention example is SE07_SO_08, where first four characters identify the main survey region and year, (where SE07 is 'Southeast Alaska 2007'), two letter code for survey team (where SO is 'Sockeye') and two digit code '08' is for consecutively numbered tape.
HR	**Hour**: From the first two digits of the 6-digit UTC time burned on video image, identifying video frame at which the unit starts; with the unit start frame at center of viewing screen
MIN	**Minute**: From the third and fourth digits of the 6-digit UTC time burned on video image at which unit starts; with the unit start frame at center of viewing screen
SEC	**Seconds**: From the last two digits of the 6-digit UTC time burned on video image at which unit starts; with the unit start frame at center of viewing screen
EXP_OBSER	**Physical wave exposure:** Estimate of wave exposure as observed by the physical mapper, estimated from observed fetch and coastal processes; categories listed in Table A-5.

[continued]

Table A-1. Definitions for Fields and Attributes in the UNIT table. (continued)

Field Name	Description
ORI	**Oil Residency Index:** Code indicating the potential persistence of oil within the shore unit. Based on unit substrate type and biological wave exposure categories. Definitions and lookup matrix in Tables A-6 and A-7
SED_SOURCE	**Sediment Source:** Code to indicate estimated sediment source for the unit: (A)longshore, (B)ackshore, (F)luvial, (O)ffshore, (X) not identifiable
SED_ABUND	**Sediment Abundance:** Code to indicate the relative sediment abundance within the shore-unit: (A)bundant, (M)oderate, (S)carce
SED_DIR	**Sediment Transport Direction:** 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	**Change Type:** Code indicating the estimated 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	**Shorename:** Name of a prominent geographic feature near the unit (from nautical chart or gazetteer)
UNIT_COMMENTS	**Unit Comments**: Text field for comments and notes during physical mapping
SM1_TYPE	**Primary Shore Modification:** 2-letter code indicating the primary type of shore modification occurring within the unit: BR = boat ramp; CB = concrete bulkhead; LF = landfill; SP= sheet pile; RR = rip rap and WB = wooden bulkhead
SM1_PCT	**Primary Shore Modification Percent Unit Length:** Estimated % occurrence of the primary shore modification type in tenths (i.e. “2” = 20% occurrence with the unit alongshore)
SM2_TYPE	**Secondary Shore Modification:** 2-letter code indicating the secondary type of shore modification occurring within the unit
SM2_PCT	**Secondary Shore Modification Percent Unit Length:** Estimated % occurrence of the secondary type of shore modification occurring within the unit
SM3_TYPE	**Tertiary Shore Modification:** 2-letter code indicating the tertiary type of shore modification occurring within the unit
SM3_PCT	**Tertiary Shore Modification Percent Unit Length:** Estimated % occurrence of the tertiary seawall type in tenths (i.e., “2” = 20% occurrence within the unit)
SMOD_TOTAL	**Total Shore Modification % Unit Length:** Total % occurrence of shore modification in the unit in tenths
RAMPS	**Boat 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	**Piers or Wharves:** 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	**Dock Slips:** Estimated number of recreational slips at docks or marinas within the unit; based on small boat length ~<50’
DEEPSEA_SLIP	**Ship Dock Slips:** Estimated number of slips for ocean-going vessels within the unit; based on ship length ~>100’
ITZ	**Intertidal Zone Width:** Sum of the across-shore width of all the intertidal (B Zone) components within the unit
SLIDE	Still Photo in Unit: **Yes/No tick box** to indicate if high resolution photo is available for the Unit.
EntryDate ModifiedDate	**Date/Time Mapped or Modified:** Date and time the unit was physically mapped (or modified)

Table A-2. Definitions of the Shore Type attribute, in the UNIT table.
(after Howes *et al* [1994] "BC Class" in British Columbia ShoreZone)

Substrate	Sediment	Width	Slope	Shore Type	
				Description	CODE
Rock	n/a	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Rock Ramp, wide	1
			Flat (<5°)	Rock Platform, wide	2
		Narrow (<30 m)	Steep (>20°)	Rock Cliff	3
			Inclined (5-	Rock Ramp, narrow	4
			Flat (<5°)	Rock Platform, narrow	5
Rock & Sediment	Gravel	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Ramp with gravel beach,	6
			Flat (<5°)	Platform with gravel beach,	7
		Narrow (<30 m)	Steep (>20°)	Cliff with gravel beach	8
			Inclined (5-	Ramp with gravel beach	9
			Flat (<5°)	Platform with gravel beach	10
	Sand & Gravel	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Ramp w gravel & sand	11
			Flat (<5°)	Platform with G&S beach,	12
		Narrow (<30 m)	Steep (>20°)	Cliff with gravel/sand beach	13
			Inclined (5-	Ramp with gravel/sand	14
			Flat (<5°)	Platform with gravel/sand	15
	Sand	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Ramp with sand beach,	16
			Flat (<5°)	Platform with sand beach,	17
		Narrow (<30 m)	Steep (>20°)	Cliff with sand beach	18
			Inclined (5-	Ramp with sand beach,	19
			Flat (<5°)	Platform with sand beach,	20
Sediment	Gravel	Wide (>30	Flat (<5°)	Gravel flat, wide	21
		Narrow (<30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Gravel beach, narrow	22
			Flat (<5°)	Gravel flat or fan	23
	Sand & Gravel	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	n/a	-
			Flat (<5°)	Sand & gravel flat or fan	24
		Narrow (<30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Sand & gravel beach,	25
			Flat (<5°)	Sand & gravel flat or fan	26
	Sand/Mud	Wide (>30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Sand beach	27
			Flat (<5°)	Sand flat	28
			Flat (<5°)	Mudflat	29
		Narrow (<30 m)	Steep (>20°)	n/a	-
			Inclined (5-	Sand beach	30
			Flat (<5°)	n/a	-

Table A-3 Shore Type definition for units with 'dominant structuring processes' other than 'wave energy' *

Structuring Processes	Description	Shore Type
Estuarine Processes Dominant	**estuarine** – organics, fines and vegetation dominate the unit; may characterize units with large marshes in the supratidal zone (if the marsh represents >50% of the combined supratidal and intertidal area of the unit), even if the unit has another dominant intertidal feature such as a wide tidal flat or sand beach. This "50% rule" may be ignored and a BC Class 31 applied if a significant amount of marsh (25% or more) infringes on the intertidal zone.	31
Anthropogenic Processes Dominant	***permeable man-made structures*** such as rip-rap, wooden crib structures where a surface oil from a spill will easily penetrate the structure. Man-made structure must comprise >50% of intertidal zone area.	32
	impermeable man-made structures such as concrete seawalls and steel sheet pile. Man-made structure must comprise >50% of intertidal zone area.	33
Current Processes Dominant	***current-dominated*** shore types occur in elongate channels with restricted fetches and where tidal currents are the dominant structuring process. In addition to obvious high currents, channel sides typically includes anomalous vegetation types.	34
Glacial Processes Dominant	***glacial ice*** dominates a few places on the Alaska coast where tide-water glacial are present. These location are characterized by unstable ice fronts	35
Lagoon Processes Dominant	***lagoons*** represent a special coastal feature that has some salt-water influence but may be largely disconnected from other marine processes such as tides and high wave exposure. Lagoons are distinguished from estuaries, which must have fluvial or deltaic landforms. Intertidal zones are often restricted in elevation and narrow. Saltwater influxes may be only episodic.	36
Periglacial Processes Dominant	***inundated tundra*** occurs where thaw-subsidence on low-relief shorelines causes the tundra surface to sink below mean sea level. Often the polygon fracture patterns associated with ice-wedges polygons are evident. Where the shallow ponds coalesce they may transition into lagoons. Usually there is > 25% water within the unit.	37
	ground ice slumps are areas where the thaw of high ice content shores causes mass-wasting is distinct patterns (e.g., ground ice slumps, thermo-erosional falls, solifluction lobes that dominate coastal morphology). Slump processes strongly influence (>50%) of the intertidal zone morphology and texture.	38
	low vegetated peat are areas of low-lying tundra peat banks; usually vegetated in the supratidal zone, but not always vegetated in the intertidal zone. Minimal mineral sediment is present. Usually low energy (shown by an absence of storm wave features). No distinct intertidal zone. Found in permafrost areas, with some occurrence in non-permafrost areas.	39

*** includes new Shore Types 36 through 39, added 2011, to describe permafrost shorelines in Arctic Alaska.**

Table A-4. Definitions of the ESI (Environmental Sensitivity Index) attribute, from the UNIT table. (after Peterson *et al* [2002])

Environmental Sensitivity Index (ESI)	
CODE	**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-5. Definitions for estimating the OBSERVED PHYSICAL EXPOSURE attribute, (EXP_OBSER) in the UNIT table.

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

Codes for exposures: Very Protected = **VP;** Protected = **P;** Semi-Protected =**SP;** Semi-Exposed = **SE;** Exposed = **E;** Very Exposed = **VE**

Table A-6. Definition of the OIL RESIDENCE INDEX (ORI) attribute in the UNIT table.

Persistence	Oil Residence Index (ORI)	Estimated Persistence
Short	1	Days to weeks
Short to Moderate	2	**Weeks** to Months
Moderate	3	Weeks to **Months**
Moderate to Long	4	**Months** to Years
Long	5	Months to **Years**

Table A-7. OIL RESIDENCE INDEX (ORI) Component lookup matrix based on exposure (columns) and substrate type (rows).

Component 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 with pebble, cobble or boulder	1	2	3	4	5	5
sand without pebble, cobble or boulder	2	2	3	3	4	4
mud	999	999	999	3	3	3
peat/organics/vegetation	999	999	999	5	5	5
man-made, permeable	2	2	3	3	5	5

Table A-8. Definitions of the attributes in the 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-9)
EXP_BIO	**Biological Wave Exposure:** A classification of the wave exposure category within the Unit, **In Kotzebue:** assigned by the Biological mapper, based on physical wave exposure category [EXP_ OBSER] when biological indicators were not present.
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-12 and A-13). (**In Kotzbue** EXP_BIO = EXP_OBSER)
HAB_CLASS_LTRS	**Habitat Class** in alphabetic code: translation from number codes in the HAB CLASS lookup table (Table A-13)
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-12 and A-13)
HC2_SOURCE	**Secondary Habitat Class Source:** Source used to interpret the Secondary Habitat Class (HAB_CLASS2) "lagoon": OBServed as viewed from video, LooKUP referring to 'Form' Code (Table A-12 and Table A-13) Lo or Lc in across-shore physical component table (Table A-14 and A-15)
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-12)
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-9. 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-9. 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 affects 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-9. 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 Dragon Kelp.
Kotzebue Sound	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.	Wide high energy bare beaches - large tidal lagoon complexes, extensive salt marsh. Most of coast is sediment dominated. 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-10. List of the BIOLOGICAL WAVE EXPOSURE codes, in BIOUNIT table.

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

Table A-11. Definitions of BIOLOGICAL WAVE EXPOSURES for Gulf of Alaska, by bioband, indicator and associate species *

Exposure	Zone	Indicator Species	Associated Species	Bioband Name	Bioband Code
Very Exposed (VE) & Exposed (E)	Upper Intertidal		*Leymus mollis*	Dune Grass	GRA
		Verrucaria		Splash Zone	VER
			Balanus glandula *Semibalanus balanoides*	Barnacle	BAR
		Semibalanus cariosus		Barnacle	BAR
		Mytilus trossulus		Blue Mussel	BMU
	Lower Intertidal & Nearshore Subtidal				
		Coralline red algae		Red Algae	RED
		Alaria 'nana' morph		Alaria	ALA
		Lessoniopsis littoralis		Dark Brown Kelps	CHB
		Laminaria setchellii		Dark Brown Kelps	CHB
		Nereocystis luetkeana		Bull Kelp	NER
Semi-Exposed (SE)	Upper Intertidal		*Leymus mollis*	Dune Grass	GRA
		Verrucaria		Splash Zone	VER
			Balanus glandula *Semibalanus balanoides*	Barnacle	BAR
			Fucus distichus	Rockweed	FUC
		Semibalanus cariosus		Barnacle	BAR
		Mytilus trossulus		Blue Mussel	BMU
	Lower Intertidal & Nearshore Subtidal	mixed filamentous and foliose red algae		Red Algae	RED
		Alaria 'marginata' morph		Alaria	ALA
		Phyllospadix sp.		Surfgrass	SUR
		Laminaria setchellii		Dark Brown Kelps	CHB
		Saccharina subsimplex		Dark Brown Kelps	CHB
		Saccharina sessile smooth morph		Dark Brown Kelps	CHB
		Alaria fistulosa		Dragon Kelp	ALF
			Macrocystis integrifolia	Giant Kelp	MAC
		Nereocystis luetkeana		Bull Kelp	NER

* Note that only a few of these species and associated biobands occur north of the Alaska Peninsula.

[continued]

Table A-11. Definitions of BIOLOGICAL WAVE EXPOSURES for Gulf of Alaska, by bioband, indicator and associate species (continued) *

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

* Note that only a few of these species and associated biobands occur north of the Alaska Peninsula

Table A-12. 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 wave exposure together with the geomorphology. On the Gulf of Alaska coast, 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. For the Beaufort and Chukchi Sea coasts and Kotzebue Sound where biobands are largely absent and shoreline is dominated by bare intertidal zone, the physical mappers exposure category (EXP_OBSER) is used to assign Habitat Class. Within the database, both a numeric code and an alpha code are used. Both codes for Habitat Class are listed in Table A-14 in which the matrix includes all combinations of Dominant Structuring Process, with associated substrate mobility and general geomorphic type on the vertical axis, and Exposure category on the horizontal axis. Note that a few combinations (e.g., Very Exposed Estuary) are rare or do not occur.
HAB_CLASS2	The '**Secondary Habitat Class**' was added as an attribute in the BioUnit table to highlight backshore lagoon Forms, a common feature observed in the Kodiak region (2006). Since then, **'Lagoon'** was added as a new **Shore Type** (2012) to describe Units on the Arctic coasts. By definition, Units classified as Shore Type 36 Lagoons (see Table A-3) are assigned a Secondary Habitat Class Lagoon as well. **Secondary Habitat Class** 'lagoon' is always associated with a Unit's primary Habitat Class. Although lagoons may include salt marsh, the overall feature is different than in Estuaries. Lagoons usually contain brackish or salt water in a pond with limited drainage. They are often associated with wetlands and may include wetland biobands in the upper intertidal. Single units classified as lagoons may 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 or the Unit is assigned to Shore Type 36.
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-13. 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.	10 VE_I	20 E_I	30 SE_I	40 SP_I	50 P_I	60 VP_I
	Partially Mobile	Rock & Sediment or Sediment	These units describe the combination of sediment mobility observed. That is, a sediment beach that is bare in the upper half of the intertidal with biobands occurring on the lower beach would be classed as 'partially mobile'. This pattern is seen at moderate wave exposures. Units with immobile bedrock outcrops intermingled with bare mobile sediment beaches, as can be seen at higher wave exposures, could also be classified as 'partially mobile'.	11 VE_P	21 E_P	31 SE_P	41 SP_P	51 P_P	61 VP_P
	Mobile	Sediment	These categories are intended to show the 'bare sediment beaches', where no epibenthic macrobiota are observed. Very fine sediment may be mobile even at the lowest wave exposures, while at the highest wave exposures; large-sized boulders will be mobile and bare of epibiota.	12 VE_M	22 E_M	32 SE_M	42 SP_M	52 P_M	62 VP_M
Fluvial/ Estuarine processes		Estuary	Units classified as the 'estuary' types always include salt marsh vegetation in the upper intertidal, are usually associated with a freshwater stream or river which often show a delta form. Estuary units are usually in lower wave exposure categories.	13 VE_E	23 E_E	33 SE_E	43 SP_E	53 P_E	63 VP_E
Current energy		Current-Dominated	Species assemblages observed in salt-water channels are structured by current energy rather than by wave energy. Current-dominated sites are limited in distribution and are rare habitats.	14 VE_C	24 E_C	34 SE_C	44 SP_C	54 P_C	64 VP_C
Glacial processes		Glacier	In a few places in coastal Alaska, saltwater glaciers form the intertidal habitat. These Habitat Classes are rare and include a small percentage of the shoreline length.	15 VE_G	25 E_G	35 SE_G	45 SP_G	55 P_G	65 VP_G
Anthropogenic		Anthropogenic – Impermeable	Impermeable modified Habitats are intended to specifically note units classified as Coastal Class 33. These Habitat Classes are rare and include a small percentage of the shoreline length.	16 VE_X	26 E_X	36 SE_X	46 SP_X	56 P_X	66 VP_X
		Anthropogenic – Permeable	Permeable modified Habitats are intended to specifically note shore units classified as Coastal Class 32. These Habitat Classes are rare and include a small percentage of the shoreline length.	17 VE_Y	27 E_Y	37 SE_Y	47 SP_Y	57 P_Y	67 VP_Y
Lagoon		Lagoon	Units classified as Lagoons in the Secondary Habitat Class contain brackish or salty water that is contained within a basin that has limited drainage. They are often associated with wetlands and may include wetland biobands in the upper intertidal.	18 VE_L	28 E_L	38 SE_L	48 SP_L	58 P_L	68 VP_L
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.
* Note that for mobile bare beaches with no attached biota, as are found on Arctic coasts, the Habitat Class is determined from the ***physical exposure estimate***, in combination with the 'dominant structuring process'.

Table A-14. Definitions of fields and attributes in the XSHR (Across-shore) component table. (after Howes *et al* 1994)

Field Name	Description
UnitRecID	**Unit Record ID:** An automatically-generated number field; the database "primary key" for unit-level relationships
XshrRecID	**Across-shore Record ID:** Automatically-generated number field; the database "primary key" for across-shore relationships
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)
CROSS_LINK	**Crosslink code:** Unique identifier for each across-shore record, consisting of 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	Across-shore **Zone:** Code indicating the across-shore position (tidal elevation) of the Component: (A) supratidal, (B) intertidal, (C) subtidal
COMPONENT	Across-shore **Component:** a 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	**Form1:** The principal geomorphic feature within across-shore Component, described by a specific set of codes (Table A-15)
MatPrefix1	**Material Prefix:** 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-16)
FormMat1Txt	**Form/Material Text:** Automatically-generated field that is the translation of codes used in Form1 and Mat1 into text
Form2	**Form2:** Secondary geomorphic feature within across-shore Component, described by a specific set of codes (Table A-15)
MatPrefix2	**Material Prefix:** 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-16)
FormMat2Txt	**Form/Material Text:** Automatically-generated field that is the translation of codes used in Form2 and Mat2 into text
Form3	**Form3:** Tertiary geomorphic feature within each across-shore component, described by a specific set of codes (Table A-15)
MatPrefix3	**Material Prefix:** 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-16)
FormMat3Txt	**Form/Material Text:** Automatically-generated field that is the translation of codes used in Form3 and Mat3 into text
Form4	**Form4:** Fourth-order geomorphic feature within each across-shore component, described by a specific set of codes (Table A-15)
MatPrefix4	**Material Prefix:** 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-16)
FormMat4Txt	**Form/Material Text:** Automatically-generated field that is the translation of codes used in Form4 and Mat4 into text
WIDTH	**Width:** Estimated mean across-shore width of the component (e.g. A1) in meters
SLOPE	**Slope:** Estimated across-shore slope of the mapped geomorphic Form in degrees; must be consistent with Form codes (Table A-15)
PROCESS	**Coastal Process** dominant in affecting the morphology: (F)luvial, (M)ass wasting (landslides), (W)aves, (C)urrents, (E)olian (wind, as with dunes) (O)ther
COMPONENT_ORI	**Component Oil Residence Index,** based on substrate type and exposure category, where 1 is least persistent, 5 is most persistent (Tables A-6 and A-7)

Table A-15. Definitions of FORM attributes, in XSHR (Across-shore) table. (after Howes *et al* 1994)

A = Anthropogenic

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

B = Beach

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

C = Cliff

stability/geomorphology

- a active/eroding
- p passive (vegetated)
- c cave

slope

- i inclined (20°-35°)
- s steep (>35°)

[continued]

Cliff continued

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 inundated tundra
- e levee
- f drowned forest
- h high
- l mid to low (discontinuous)
- o pond
- s brackish, supratidal

O = Offshore Island

(not reefs)

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

elevation

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

P = Platform

(slope <20°)

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

R = River Channel

- a perennial
- i intermittent
- m multiple channels
- s single channel

T = Tidal Flat

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

U = Tundra

- g ground ice slump
- i inundated
- o isolated thaw ponds
- p plain or level surface
- r ramp

Table A-16. Definitions of the MATERIALS attributes, in XSHR (Across-shore) table. (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)
z	permafrost

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)
z	permafrost

C = Clastic

a	angular blocks (>25cm diameter)
b	boulders (rounded, subrounded,>25cm)
c	cobbles
d	diamicton (poorly-sorted sediment containing a range of particles in a mud matrix)
f	fines/mud (mix of silt/clay, <0.0.63 mm diameter)
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)
t	tephra
x	angular fragments (mix of block/rubble)
v	sediment veneer (used as modifier)
z	permafrost

I – Ice

i	ice

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 diameter

SAND

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

FINES ("MUD")

includes silt and clay

silt	0.0039 to 0.063 mm
clay	<0.0039 mm

TEXTURE CLASS BREAKS

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

SHORE MODIFICATIONS

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

% are 0-10 (default value 0)

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

Table A-17. Definitions for fields in 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-18)
GRA	Bioband code for Dune **GRA**ss in supratidal (Table A-18)
TUN	Bioband code for **TUN**dra in supratidal (Table A-11)
SED	Bioband for **SED**ges in supratidal (Table A-18)
PUC	Bioband for Salt Marsh grasses, including **PUC***cinellia* and other salt tolerant grasses, herbs and sedges, in supratidal (Table A-11)
BAR	Bioband for **BAR**nacle (*Balanus/Semibalanus*) in upper intertidal (Table A-18)
BFM	Bioband for Biofilm (**BFM**) in upper intertidal (Table A-11)
FUC	Bioband for Rockweed, the **FUC***us*/barnacle in upper intertidal (Table A-18)
ULV	Bioband for Green Algae, including mixed filamentous and foliose greens (**ULV***a* sp*., Cladophora, Acrosiphonia*) in mid-intertidal (Table A-18)
BMU	Bioband for **B**lue **MU**ssel (*Mytilus trossulus*) in mid-intertidal (Table A-18)
MUS	Bioband for California **MUS**sel/gooseneck barnacle assemblage (*Mytilus californianus/Pollicipes polymerus*) in mid-intertidal (Table A-18)
HAL	Bioband for Bleached Red Algae, including mixed filamentous and foliose reds (*Palmaria, Odonthalia*, **HAL***osaccion*) in mid-intertidal (Table A-18)
RED	Bioband for **RED** Algae, including mixed filamentous and foliose reds (*Odonthalia, Neorhodomela, Palmaria*) in lower intertidal (Table A-18)
BFM	Bioband for **B**io**F**il**M** mat, in mid to lower intertidal (Table A-18)
ALA	Bioband for ribbon kelp, ALA*ria* spp. (Table A-18)
SBR	Bioband for **S**oft **BR**own Kelps, including unstalked large-bladed laminarians, in lower intertidal and nearshore subtidal (Table A-18)
CHB	Bioband for Dark Brown Kelps, including stalked bladed dark **CH**ocolate-**B**rown kelps in lower intertidal and nearshore subtidal (Table A-18)
SUR	Bioband for **SUR**fgrass (*Phyllospadix*) in lower intertidal and nearshore subtidal (Table A-18)
ZOS	Bioband for **ZOS***tera* (Eelgrass) in lower intertidal and subtidal (Table A-18)
URC	Bioband for **URC**hin Barrens (*Strongylocentrotus fransicanus*) in nearshore subtidal (Table A-18)
ALF	Bioband for Dragon Kelp (**AL***aria* **F***istulosa*) in nearshore subtidal (Table A-18)
MAC	Bioband for Giant Kelp (**MAC***rocystis integrifolia*) in nearshore subtidal (Table A-18)
NER	Bioband for Bull Kelp (**NER***eocystis luetkeana*) in nearshore subtidal (Table A-18)

* Distribution code for biobands observed are listed in Table A-19.

Table A-18. Definitions for BIOBAND attributes for Alaska, in BIOBAND table. *.

Zone	Bioband Name	Bioband Code	Color	Indicator Species	Physical Description	Biological Wave Exposure	Associate Species
A	**Tundra**	**TUN**	Grey green	*Salix spp.* *Vaccinium spp.* *Duponitia fisheri*	Low turf of dwarf shrubs, herbs, grasses, sedges with lichens and mosses, in uppermost supratidal and splash zone. May be inundated in storm surge.	n/a	*Eriophorum sp.* *Dryas integrifolia* *Artemisia spp.* lichens
A	**Splash Zone**	**VER**	Black or bare rock	*Verrucaria* sp. Encrusting black lichens	Visible as a dark stripe, on bare rock, marking the upper limit of the intertidal zone. This band is observed on bedrock, or on low energy boulder/cobble shorelines. This band is recorded by width: Narrow (N), Medium (M) or Wide (W)	VP to VE	*Littorina* sp.
A	**Dune Grass**	**GRA**	Pale blue-green	*Leymus mollis*	Found in the upper intertidal zone, on dunes or beach berms. This band is often the only band present on high-energy beaches.	P to E	
A	**Sedges**	**SED**	Bright green, yellow-green to red-brown.	*Carex lynbyei*	Appears in wetlands around lagoons and estuaries. Usually associated with freshwater. This band can exist as a wide flat pure stand or be intermingled with dune grass. Often the PUC band forms a fringe below.	VP to SP	*Carex* spp.
A	**Salt Marsh**	**PUC**	Light, bright, or dark green, with red-brown	*Puccinellia* sp. *Plantago maritima* *Glaux maritima*	Appears around estuaries, marshes, and lagoons. Usually associated with freshwater. Often fringing the edges of GRA and SED bands. PUC can be sparse *Puccinellia* and *Plantago* on coarse sediment or a wetter, peaty meadow with assemblage of herbs and sedges (including *Potentilla, Spergularia, Achillea, Dodecatheon* and other associated species*).*	VP to SE	*Carex* spp. *Potentilla anserine* *Honckenya peploides* *Salicornia virginica* *Triglochin maritima*
upper B	**Barnacle**	**BAR**	Grey-white to pale yellow	*Balanus glandula* *Semibalanus cariosus*	Visible on bedrock or large boulders. Can form an extensive band in higher exposures where algae have been grazed away.	P to E	*Endocladia muricata* *Gloiopeltis furcata* *Porphyra* sp. *Fucus distichus*
upper B	**Biofilm**	**BFM**	Rusty orange beige, or dark green-black	Bacterial or diatom mat, blue green algal mat	Low turf or stain on sediment. Includes moss-like turf of blue-green algal mat. Usually seen in pools of washover bars and river deltas	P to SE	
upper B	**Rockweed**	**FUC**	Golden-brown	*Fucus distichus*	Appears on bedrock cliffs and boulder, cobble or gravel beaches. Commonly occurs at the same elevation as the barnacle band.	P to SE	*Balanus glandula* *Semibalanus cariosus* *Ulva* sp. *Pilayella* sp.
B	**Green Algae**	**ULV**	Green	*Ulva sp.* *Monostroma sp.* *Cladophora sp.* *Acrosiphonia sp.*	Found on a variety of substrates. This band can consist of filamentous and/or foliose green algae. Filamentous species often form a low turf of dark green.	P to E	*Filamentous red algae*

*Note that four lower intertidal biobands (Red Algae, Bleached Red Algae, Soft Brown Kelps, Dark Brown Kelps) may have slightly different species compositions in different bioareas.

[continued]

Table A-18. Definitions for BIOBAND attributes for Alaska, in BIOBAND table [continued]. *.

Zone	Bioband Name	Bioband Code	Color	Indicator Species	Physical Description	Exposure	Associate Species
B	**Blue Mussel**	**BMU**	Black or blue-black	*Mytilus trossulus*	Visible on bedrock and on boulder, cobble or gravel beaches. Appears in dense clusters that form distinct black patches or bands, either above or below the barnacle band.	P to VE	*Fucus distichus* *Balanus glandula* *Semibalanus cariosus* Filamentous red algae
B	**California Mussel**	**MUS**	Grey-blue	*Mytilus californianus*	Dominated by a complex of California mussels (*Mytilus californianus*) and thatched barnacles (*Semibalanus cariosus*) with gooseneck barnacles (*Pollicipes polymerus*) seen at higher exposures. (Only in southernmost SE Alaska)	SE to VE	*Semibalanus cariosus* *Pollicipes polymerus*
B	**Bleached Red Algae**	**HAL**	Olive, golden or yellow-brown	Bleached foliose or filamentous red algae *Palmaria* sp. *Odonthalia* sp.	Common on bedrock platforms, and cobble or gravel beaches. Distinguished from the RED band by color, although may be similar species. The bleached color usually indicates lower wave exposure than where the RED band is observed.	P to SE	*Halosaccion glandiforme* *Mazzaella* sp. Filamentous green algae
B	**Red Algae**	**RED**	Corallines: pink or white Foliose or filamentous: Dark red, bright red, or red-brown.	*Corallina* sp. *Lithothamnion* sp. *Neoptilota* sp. *Odonthalia* sp. *Neorhodomela* sp. *Palmaria* sp. *Mazzaella* sp.	Appears on most substrates except fine sediments. Lush coralline algae indicates highest exposures; diversity of foliose red algae indicates medium to high exposures, and filamentous species, often mixed with green algae, occur at medium and lower exposures.	P to VE	*Pisaster* sp. *Nucella* sp. *Katharina tunicata* Large brown kelps of the CHB bioband
B & C	**Biofilm**	**BFM**	Rusty orange, beige to dark	bacterial mat	Low, spongy turf on substrate. (Described for Arctic coastlines)	P to SE	
B & C	**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 ribbon-like texture, and may appear iridescent in some imagery.	SP to E	Foliose red algae *Saccharina* sp. *Laminaria* sp.
B & C	**Soft Brown Kelps**	**SBR**	Yellow-brown, olive brown or brown.	*Saccharina latissima* *Cystoseira sp.* *Sargassum muticum*	This band is defined by non-floating large browns and can form lush bands in semi-protected areas. The kelp fronds have a ruffled appearance and can be encrusted with diatoms and bryozoans giving the blades a 'dusty' appearance.	VP to SE	*Alaria sp.* *Cymathere sp.* *Saccharina sessile* (bullate)

*Note that four lower intertidal biobands (Red Algae, Bleached Red Algae, Soft Brown Kelps, Dark Brown Kelps) may have slightly different species compositions in different bioareas.

[continued]

Table A-18. Definitions for BIOBAND attributes for Alaska, in BIOBAND table [continued]*

Zone	Bioband		Color	Indicator Species	Physical Description	Exposure	Associate Species
	Name	Code					
B & C	**Dark Brown Kelps**	**CHB**	Dark chocolate brown	*Laminaria setchelli* *Saccharina subsimplex* *Lessoniopsis littoralis* *Saccharina sessile (smooth)*	Found at higher wave exposures, these stalked kelps grow in the lower intertidal. Blades are leathery, shiny, and smooth. A mixture of species occurs at the moderate wave exposures, while single-species stands of *Lessoniopsis* occur at high exposures.	SE to VE	*Cymathere sp.* *Pleurophycus sp.* *Costaria sp.* *Alaria sp.* *Egregia menziesii* Filamentous and foliose red algae
B & C	**Surfgrass**	**SUR**	Bright green	*Phyllospadix* sp.	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.	SP to SE	Foliose and coralline red algae
B & C	**Eelgrass**	**ZOS**	Bright to dark green	*Zostera marina*	Commonly visible in estuaries, lagoons or channels, generally in areas with fine sediments. Eelgrass can occur in sparse patches or thick dense meadows.	VP to SP	*Pilayella* sp.
C	**Urchin Barrens**	**URC**	Coralline white, underwater	*Strongylocentrotus franciscanus*	Shows rocky substrate clear of macroalgae. Often has a pink-white color of encrusting coralline red algae. May or may not see urchins. (Only in southernmost SE Alaska)	SP to SE	Encrusting invertebrates
C	**Dragon Kelp**	**ALF**	Golden-brown	*Alaria fistulosa*	Canopy-forming kelp, with winged blades on gas-filled center midrib. Usually associated with silty, cold waters near glacial outflow rivers	SP to SE	*Nereocystis luetkeana*
C	**Giant Kelp**	**MAC**	Golden-brown	*Macrocystis integrifolia*	Canopy-forming giant kelp, long stipes with multiple floats and fronds. If associated with NER, it occurs inshore of the bull kelp.	P to SE	*Nereocystis luetkeana* *Alaria fistulosa*
C	**Bull Kelp**	**NER**	Dark brown	*Nereocystis luetkeana*	Distinctive canopy-forming kelp with many long strap-like blades growing from a single floating bulb atop a long stipe. Can form an extensive canopy in nearshore habitats, usually further offshore than *Alaria fistulosa* and *Macrocystis*. Often indicates higher current areas if observed at lower wave exposures.	SP to VE	*Alaria fistulosa* *Macrocystis integrifolia*

*Note that four lower intertidal biobands (Red Algae, Bleached Red Algae, Soft Brown Kelps, Dark Brown Kelps) may have slightly different species compositions in different bioareas.

Table A-19. Definitions for Occurrences of Biobands, in the BIOBAND table. *

Value		Applicable Bioband	Definition
Name	Code		
Patchy	P	All biobands *except* VER	Bioband visible in less than half (approximately 25 – 50%) of the along-shore unit length
Continuous	C	All biobands *except* VER	Bioband visible in more than half (approximately 50-100%) of the along-shore unit length
Narrow	N	VER *only*	Bioband visible at an across-shore width of up to 2 meters
Medium	M	VER *only*	Bioband visible at an across-shore width of between 2 and 5 meters
Wide	W	VER *only*	Bioband visible at an across-shore width of greater than 5 meters

* Note that a Blank or Null value for the bioband indicates that band was not observed within the unit.

Table A-20. Definitions for fields in the PHOTOS table.

Field Name	Description
SlideID	**SlideID**: A unique numeric ID assigned to each slide or photo
UnitRecID	**Unit Record ID**: Automatically-generated number field; the database “primary key” required for relationships between tables, links to Unit table
SlideName	**Photo Name:** A unique alphanumeric name assigned to each slide or photo
ImageName	**Full Photo Name:** Full image name with .jpg extension (required to enable “PhotoLink”)
TapeTime	**Photo Time:** Exact time during aerial video imaging (AVI) survey when digital image was collected; used to link photo to digital trackline and position
SlideDescription	**Photo Comment:** Text field for biological comments regarding the digital photo or slide
Good Example?	**Yes/No** field, which when set to “Yes,” indicates the photo is good representative of a particular biological feature or classification type
ImageType	**Photo Image Type:** Media type of original image: “Digital” or “Slide"
FolderName	**Photo Folder Name:** Name of the folder in which digital images are stored (required to enable “PhotoLink”)
PhotoLink	**Photo Hyperlink:** Enables linkage to photos placed in directories near the database
PHY Good Example?	**Yes/No** field, which when set to “Yes,” indicates the photo is representative of a particular geomorphic feature or classification
PHY SlideComment	**Physical Photo Comment:** Text field for geomorphological comments regarding the digital photo or slide

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.)