ShoreZone Summary Report

Eastern Aleutian Islands

June 2017

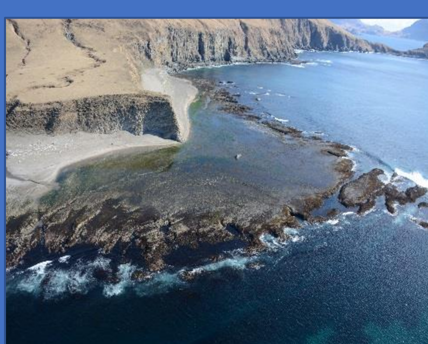
Prepared for:

Prince William Sound

Oil Spill Recovery Institute

ShoreZone

Coastal and Ocean Resources



On the cover:

Cape Kalekta, Unalaska Island

Cape Izigan, Unalaska Island

Chernofski Harbor, Unalaska Island

Coastal and Ocean Resources

MCORI Project: 16-07 **June 2017**

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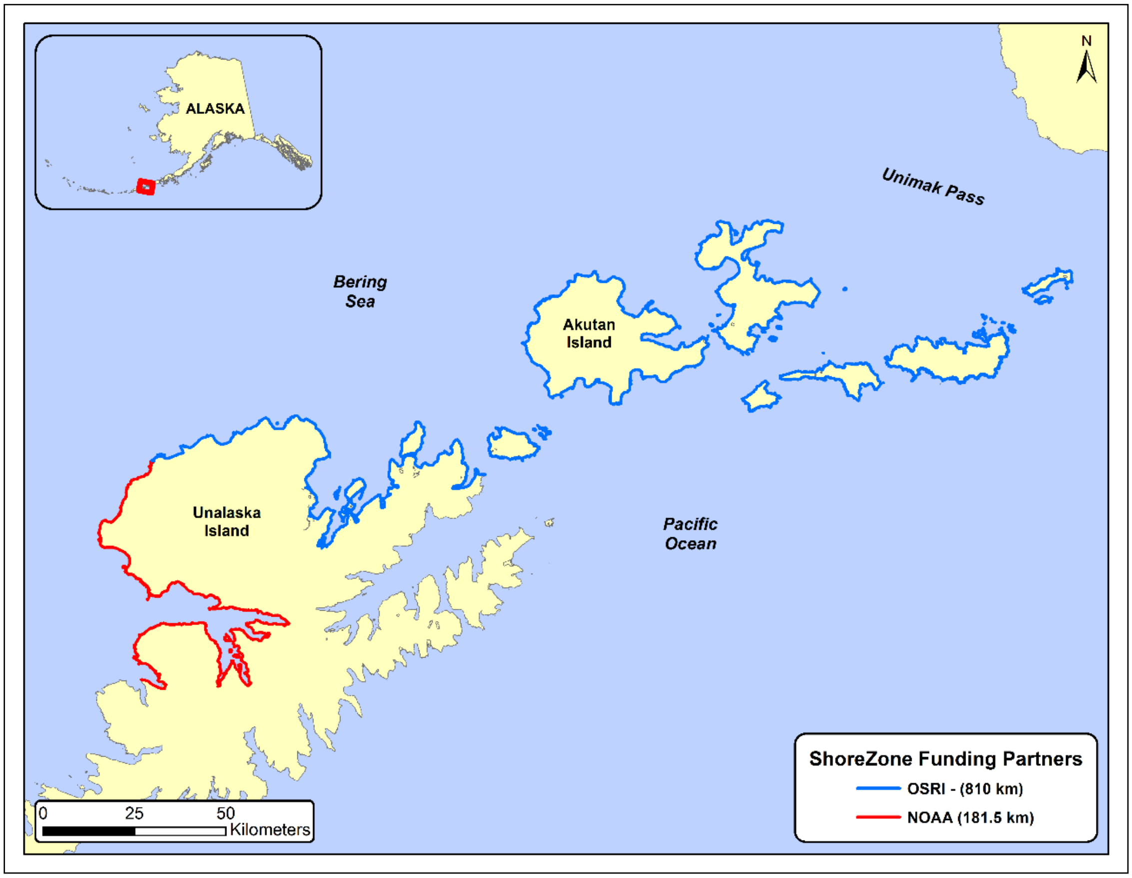

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The suggested citation for this report is:
Coastal and Ocean Resources, 2017. ShoreZone Mapping Summary: Eastern Aleutian Islands. A Regional Summary Report for Prince William Sound Oil Spill Recovery Institute, Cordova, Alaska, 52 p.

SUMMARY

ShoreZone is a coastal habitat mapping system in which georeferenced aerial imagery is acquired specifically for the classification of geomorphological and biological features of the intertidal zone and nearshore environment. The mapping methods are described in a series of protocol documents, the most recent being Cook *et al*. (2017).

This report summarizes the data collected on geomorphological and biological features from the 2016 coastal imaging survey of the Eastern Aleutian Islands. This report only includes a portion of that particular survey.

Several additions were implemented to the physical mapping protocols in 2016: the addition of the Coastal Vulnerability Index that evaluates the effects of storm waves on coastal flooding and erosion and the redefinition of the Shoreline Stability Index and Flood Zone Width in the Coastal Vulnerability Module. Changes to the biological mapping protocols were implemented in 2015, including: updated metrics for the biobands including length, width and percent cover for each band and the redefinition of bioband codes to clarify and expand the current suite of biobands classified with ShoreZone.

Eastern Aleutian Islands Area Quick Facts

993 km of shoreline mapped.

5,360 shoreline units created.

Units averaged **185 m** in length.

50% of the shoreline is classified as **Sediment** shore type.

51% of the shoreline is classified with a high Oil Residence Index value.

12 intertidal biobands were classified, with **Barnacle (BARN)** being the most common (58%).

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1 OVERVIEW OF SHOREZONE

ShoreZone is an imaging and habitat classification system for the coastal nearshore margin including the shallow subtidal, intertidal shoreline and supratidal fringe. One objective of ShoreZone is to produce an integrated searchable inventory of the physical and biological attributes of coastal habitats. ShoreZone imagery and habitat attributes can provide a useful baseline from which to study change over time, while the attributes mapped (such as shoreline sediments, wetland distribution and biotic communities) provide an important resource for scientists and managers. The ShoreZone mapping system provides a decision support tool for many potential uses including: community planning, facilities citing, conservation planning, research and fisheries management, emergency planning and response, search and rescue, education and habitat modeling.

The ShoreZone system was developed in the 1980s and 1990s to map coastal habitats in British Columbia and Washington State (Howes 2001; Berry *et al.* 2004). In 2001 ShoreZone was implemented in Alaska beginning with Cook Inlet, Outer Kenai, Katmai, and portions of the Kodiak Archipelago (Harper and Morris 2004). ShoreZone has since expanded to a spatially continuous database of over 71,600 km of coastal Alaska and 45,000 km of British Columbia, Washington and Oregon (see Figure 1). Figure 2 shows the extent of the shoreline mapped in the Eastern Aleutian Islands. This is the section of shoreline covered by this summary report.

The field survey conducted around the Eastern Aleutian Islands in April 2016 acquired aerial video and digital still images of the coast during minus tides (zero-meter tide levels and lower). The imagery and associated audio commentary were used to map the physical and biological attributes of the shoreline according to Harper and Morris (2014) and the most recent ShoreZone coastal habitat mapping protocols of Cook *et al*. (2016). The purpose of this report is to provide a summary of the physical and biological data imaged and classified in the Eastern Aleutian Islands (Figure 2).

The length of shoreline mapped is 993 kilometers in 5,360 along-shore segments (units), averaging 185 m in length. The digital shoreline used for the ShoreZone mapping was compiled from multiple sources to create the best available representation of the current shoreline. The primary source was the Continuously Updated Shoreline Product (CUSP) shapefile available from NOAA (April 2016) and the secondary source was the Alaska_63,360 shapefile.

Figure 1. Extent of ShoreZone imagery in Alaska, British Columbia, Washington State and Oregon as of June 2017.

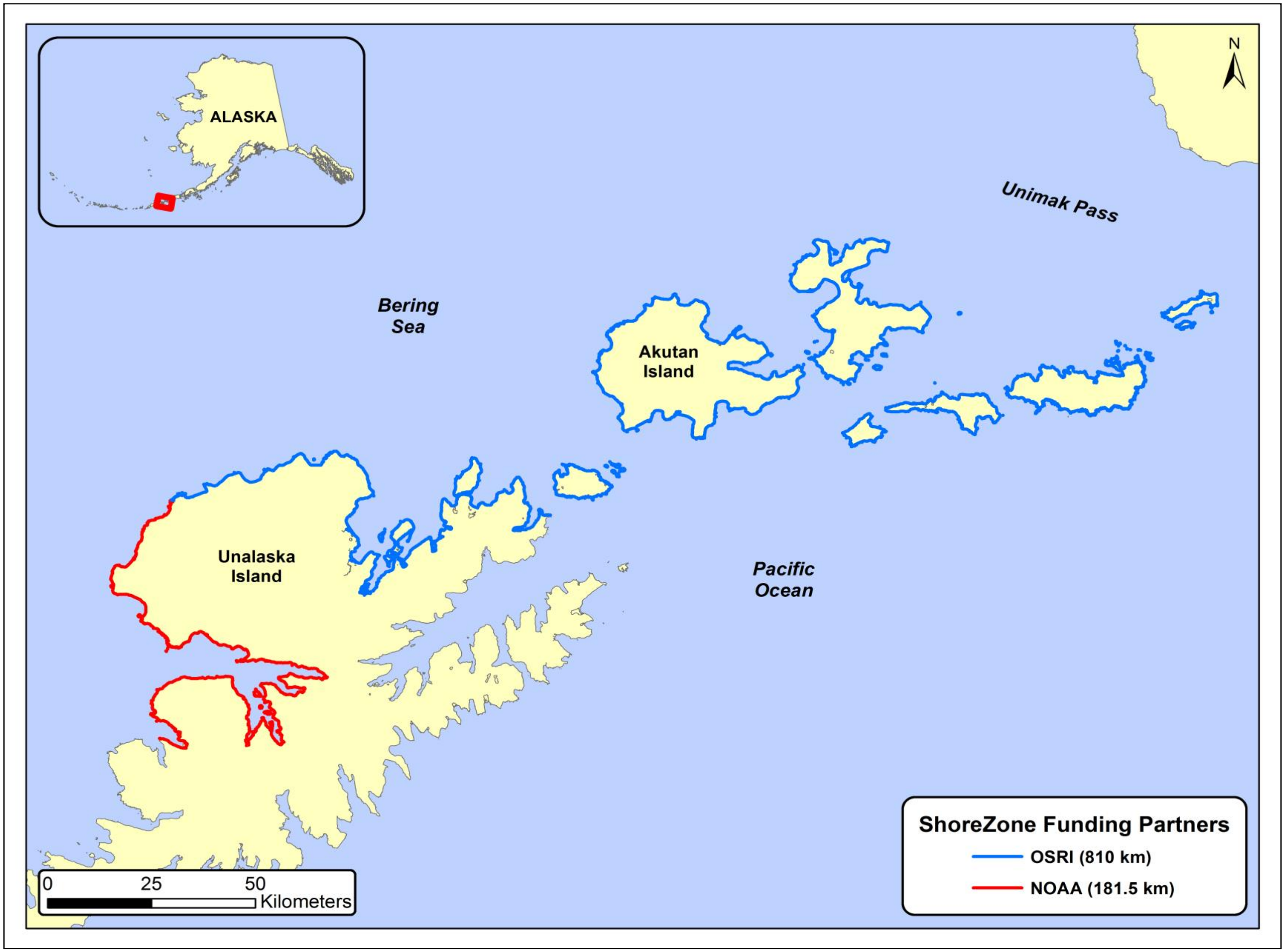

Figure 2. Extent of mapping in the Eastern Aleutian Islands area.

2 PHYSICAL ATTRIBUTE DATA SUMMARY

2.1 Shore Type Classification

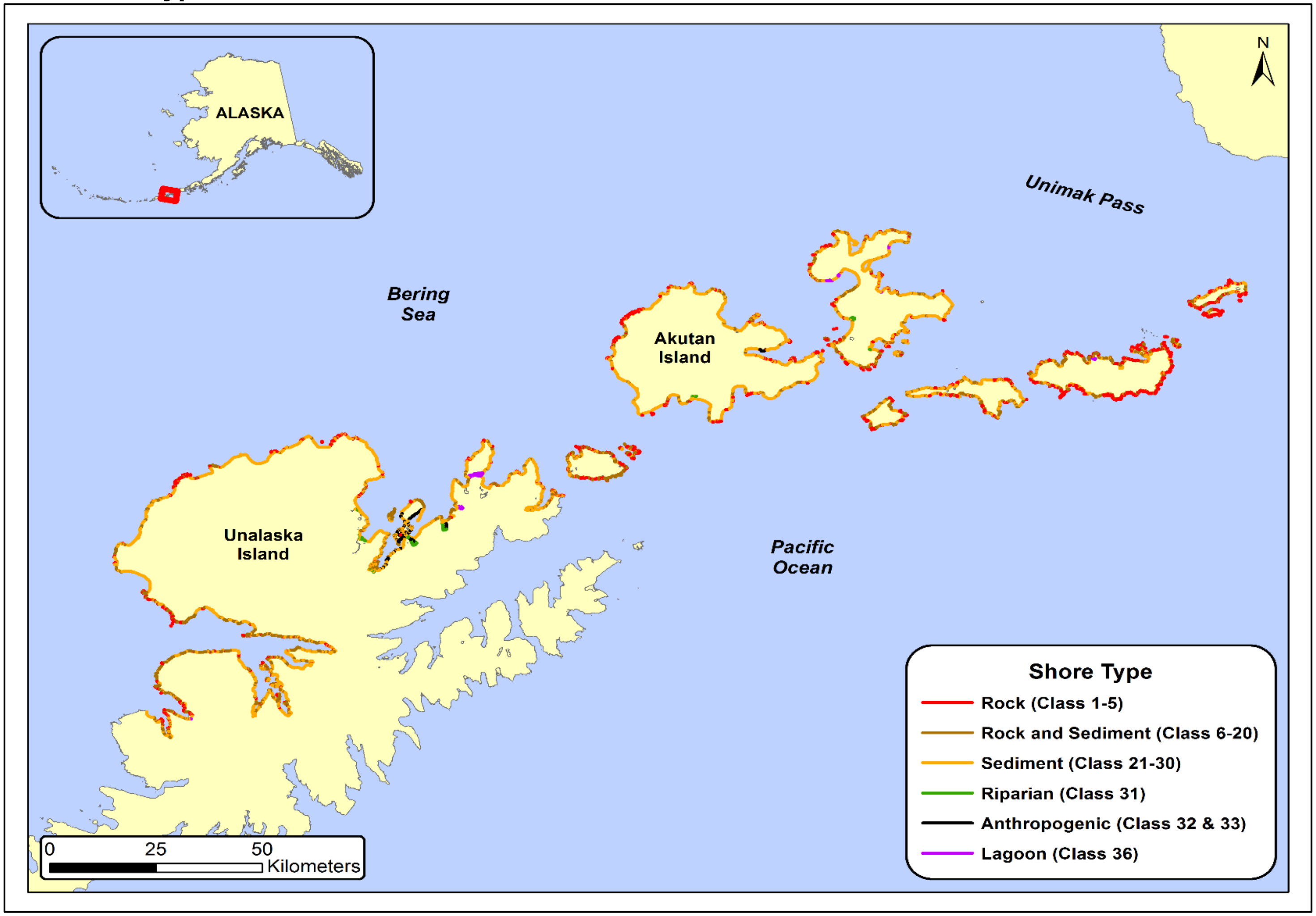

Figure 3. Map of the Shore Type groups in the Eastern Aleutian Islands area.

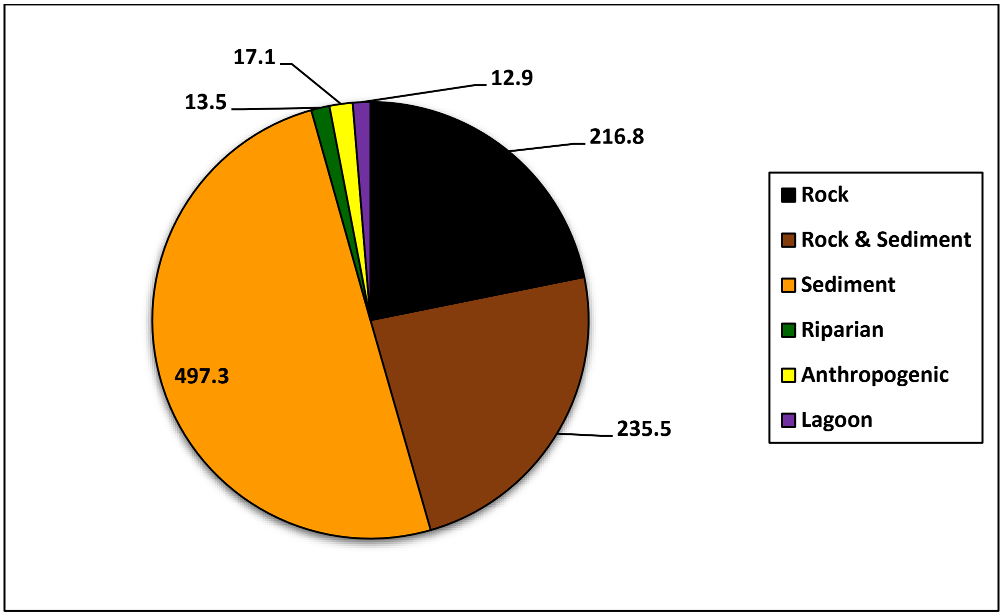

Figure 4. Grouped Shore Type by shoreline length (km).

The Shore Type classification is used to define along-shore coastal units based on the geomorphic features and attributes such as substrate size, substrate texture, across-shore width, and slope (after Howes *et al* 1994). The principal characteristics of each along-shore unit are used to assign one of 39 overall unit classifications called "Shore Type". Sediment shorelines (50%) and Rock and Sediment shorelines (24%) dominated the Eastern Aleutian Islands area. The rest of the shoreline is comprised of Rock, Anthropogenic, Riparian, Current and Lagoon Shore Types (see Figures 3 and 4 for distribution and summary statistics). The description for each of these Shore Types is given in Table 1. Photographic examples of the major Shore Types mapped in the Eastern Aleutian Islands area are in Appendix A.

Table 1. Summary of Shore Types for the Eastern Aleutian Islands survey area.

Substrate Type	Shore Type No.	Shore Type Description	Sum of Unit Length (km)	# of Units	% Occurrence (by length)	Cumulative Occurrence (%, km)
Rock	1	Rock Ramp, wide	3	24	<1	**22% 217 km**
	2	Rock Platform, wide	18	103	2	
	3	Rock Cliff	141	953	14	
	4	Rock Ramp, narrow	43	288	4	
	5	Rock Platform, narrow	11	72	1	
Rock & Sediment	6	Ramp w gravel beach, narrow	7	40	1	**24% 236 km**
	7	Platform w gravel beach, wide	24	127	2	
	8	Cliff with gravel beach	46	316	5	
	9	Ramp with gravel beach	77	490	8	
	10	Platform with gravel beach	9	66	1	
	11	Ramp w gravel & sand beach,	2	8	<1	
	12	Platform with G&S beach, wide	33	144	3	
	13	Cliff with gravel/sand beach	5	42	1	
	14	Ramp with gravel/sand beach	21	146	2	
	15	Platform with gravel/sand beach	9	40	1	
	16	Ramp w sand beach, wide	<1	3	<1	
	17	Platform w sand beach, wide	<1	4	<1	
	18	Cliff with sand beach	1	8	<1	
	19	Ramp w sand beach, narrow	<1	1	<1	
Sediment	21	Gravel flat, wide	6	20	1	**50% 497 km**
	22	Gravel beach, narrow	222	1160	22	
	23	Gravel flat or fan	0	1	0	
	24	Sand & gravel flat or fan	24	90	2	
	25	Sand & gravel beach, narrow	183	854	18	
	26	Sand & gravel flat or fan	14	70	1	
	27	Sand beach	3	6	0	
	28	Sand flat	23	59	2	
	29	Mudflat	<1	1	0	
	30	Sand beach	20	69	2	
Organics	31	Organics/Estuarine	14	44	1	**1% 13 km**
Man-made	32	Man-made, permeable	15	74	2	**2% 17 km**
	33	Man-made, impermeable	2	8	<1	
Lagoon	36	Lagoon	13	29	1	**1% 13 km**
Totals:			***993***	***5,360***	***100***	***100%***

Note: This table only includes Shore Types observed in the Eastern Aleutian Islands survey are

2.2 Environmental Sensitivity Index (ESI)

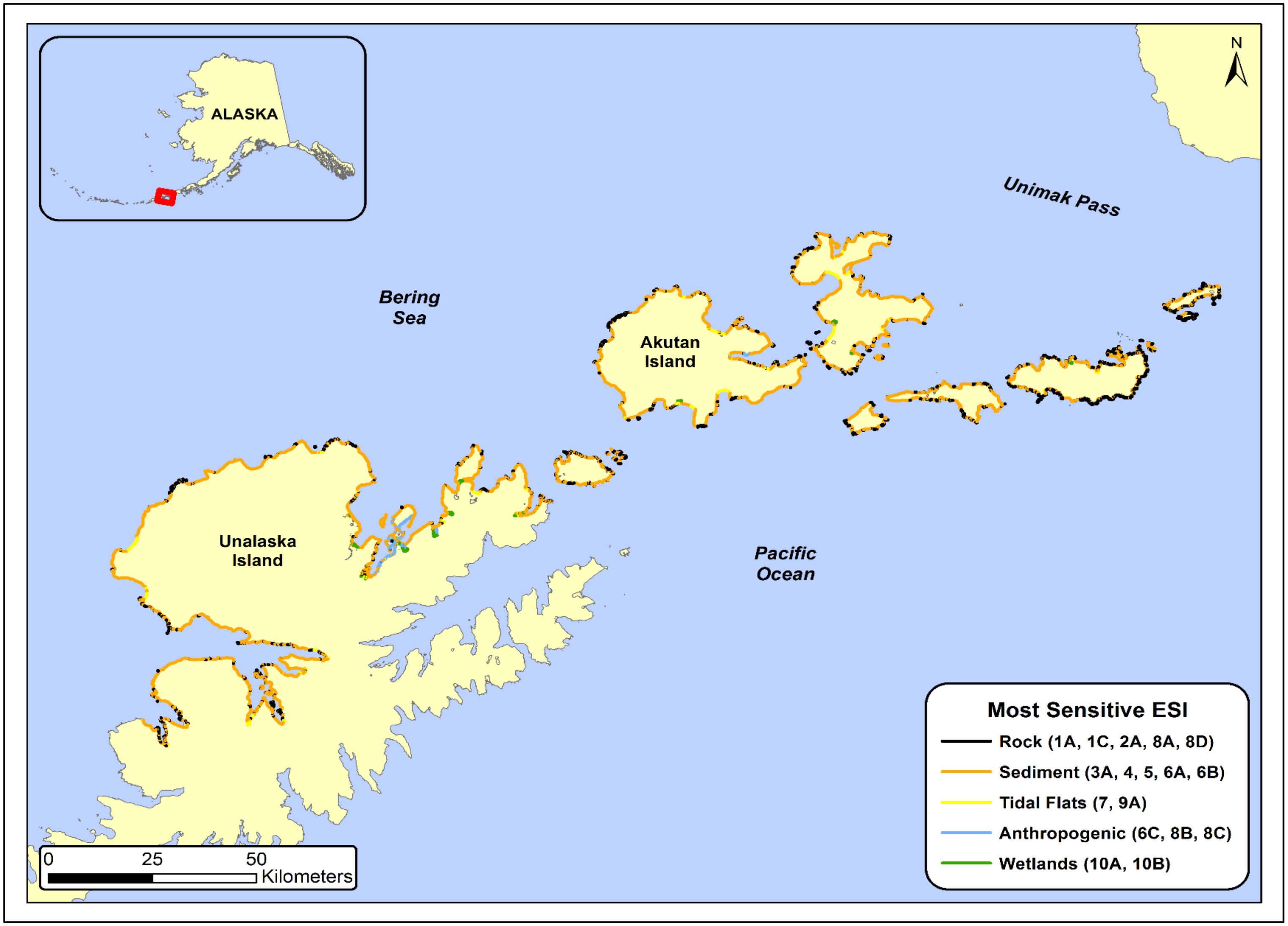

Figure 5. Distribution of the grouped most sensitive ESI categories.

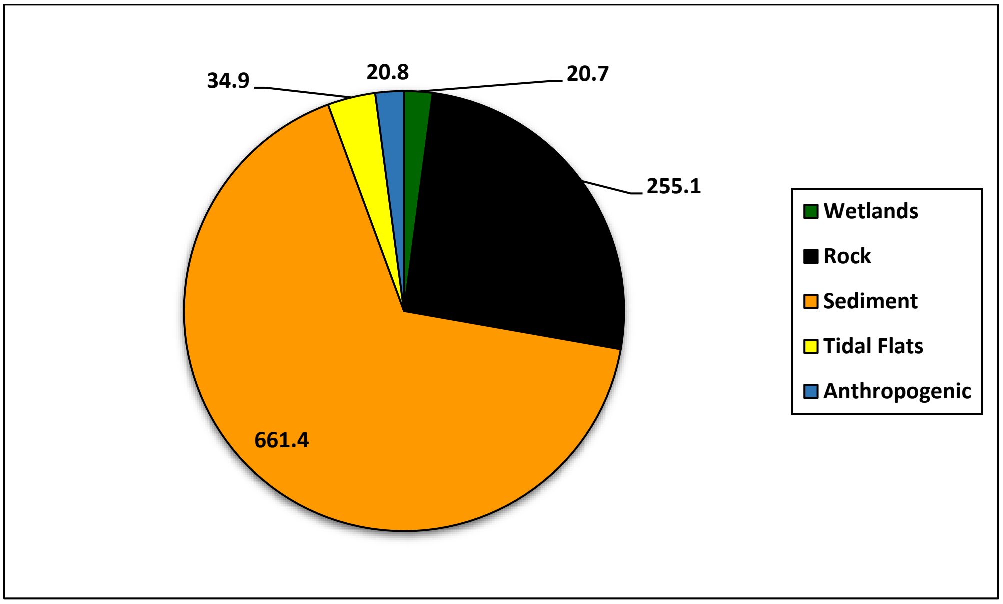

Figure 6. Grouped most sensitive ESI categories by shoreline length (km).

The NOAA Environmental Sensitivity Index (ESI) is a shoreline classification system developed to characterize coastal regions based on sensitivity to potential oil spills (Petersen *et al*. 2002). The ESI system uses wave exposure and principal substrate type to assign a rank of 1 to 10 (with 10 being the most sensitive to oil) to alongshore units. Up to three ESI numbers can be assigned to each ShoreZone unit (high, mid and low intertidal) if applicable. The highest ESI number for each unit, which is the most sensitive, is used in this analysis. The Eastern Aleutian Islands area is dominated by the grouped Sediment category (67% of shoreline length). The rest of the shoreline with regards to ESI was grouped in these categories respectively: Rock, Tidal Flats, Wetlands, Anthropogenic and Peat (Figures 5 and 6). The summary of Shore Type by ESI class can be seen in Table 2.

Table 2. Summary of Shore Types by ESI Class for the Eastern Aleutian Islands survey area.

Environmental Sensitivity Index (ESI)		Sum of Unit Length (km)	# of Units	% of Total Shoreline Length
No.	Description			
1A	Exposed rocky shores; Exposed rocky banks	152	1014	15
1C	Exposed rocky cliffs with boulder talus base	14	91	1
2A	Exposed wave-cut platforms in bedrock, mud, or clay	64	390	6
3A	Fine- to medium-grained sand beaches	20	71	2
4	Coarse-grained sand beaches	4	17	<1
5	Mixed sand and gravel beaches	261	1214	26
6A	Gravel beaches (granules and pebbles)	35	256	3
6B	Gravel beaches (cobbles and boulders)	342	1876	34
6C	Rip rap	3	20	<1
7	Exposed tidal flats	25	65	3
8A	Sheltered scarps in bedrock, mud, or clay; sheltered rocky shores (impermeable)	22	142	2
8B	Sheltered, solid, man-made structures; sheltered rocky shores (permeable)	4	20	<1
8C	Sheltered Rip Rap	14	61	1
8D	Sheltered rocky rubble shores	3	25	<1
9A	Sheltered tidal flats	10	37	1
10A	Salt- and brackish-water marshes	19	55	2
10B	Freshwater marshes	2	6	<1
	Totals:	***993***	***5,360***	***100***

Note: ESI Classes not observed in this survey area were not included in the table.

2.3 Oil Residence Index (ORI)

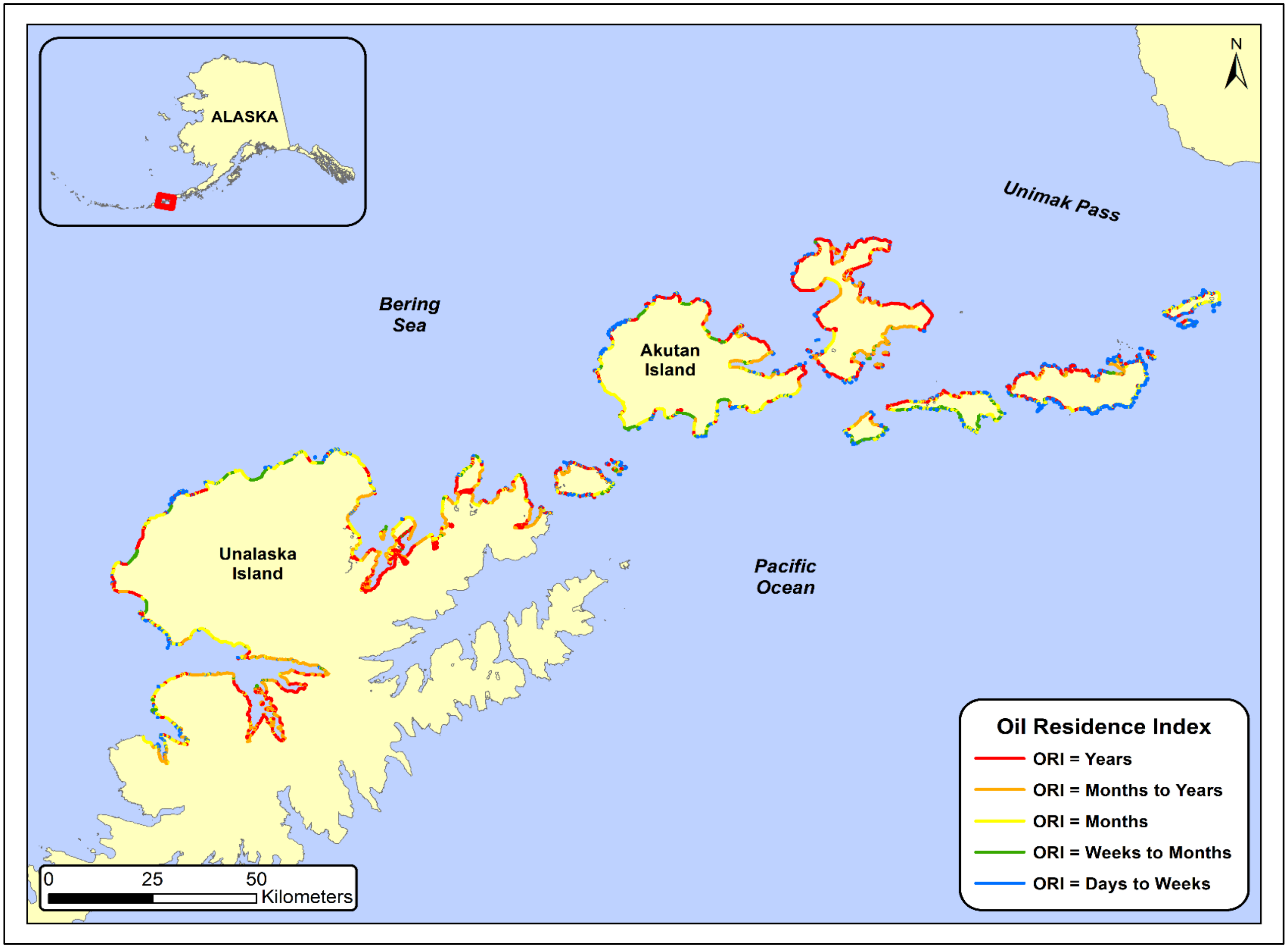

Figure 7. Distribution of the Oil Residence Index (ORI) categories.

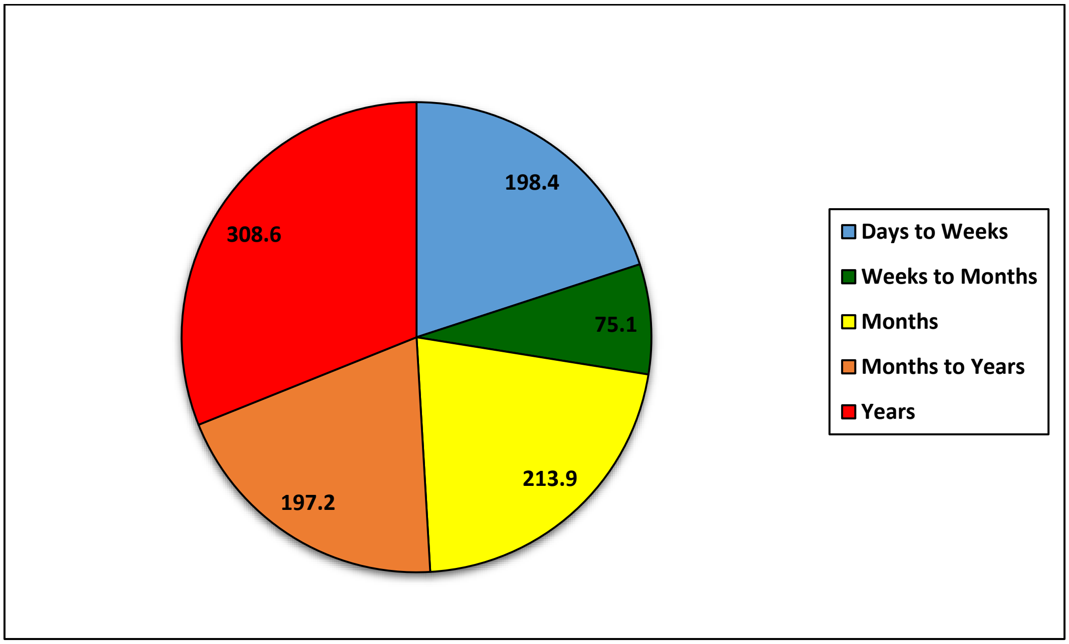

Figure 8. Oil Residence Index (ORI) categories by shoreline length (km).

The Oil Residence Index (ORI) is a rating between 1 and 5: a value of 1 reflects relatively short oil residence (days to weeks) while a value of 5 reflects potentially very long oil residence times (many years). An ORI value is applied to each alongshore unit and to each across-shore component based on sediment texture and wave exposure. Lower wave exposures and sand-gravel sediment textures results in high ORI values for 51% of the shore segments in the Eastern Aleutian Islands area, indicating oil residence times are on the order of months to years (see Figures 7 and 8 for distribution and summary statistics).

2.4 ShoreZone Coastal Vulnerability

2.4.1 Flood Zone Width

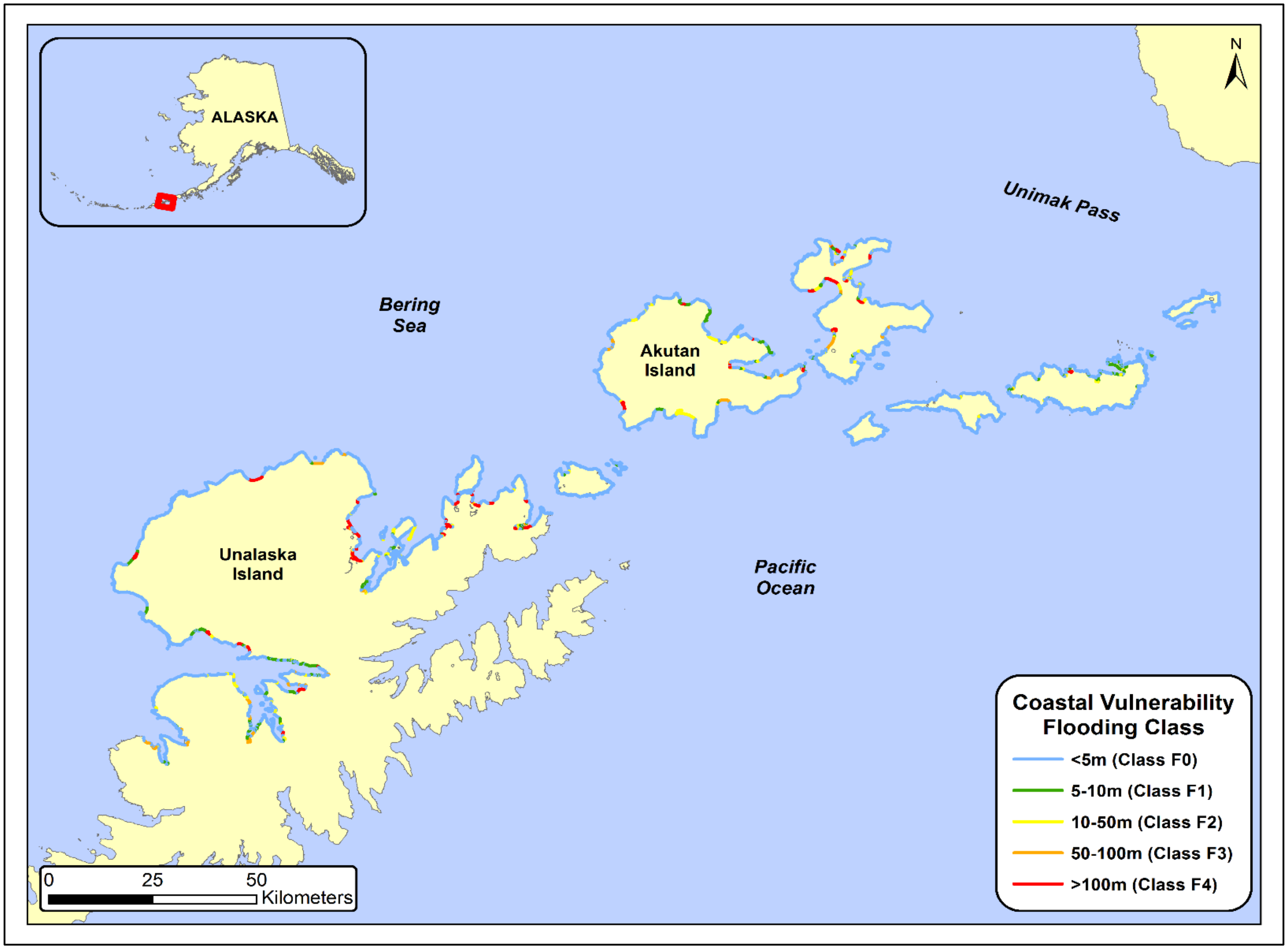

Figure 9. Distribution of the Coastal Vulnerability Flooding Class.

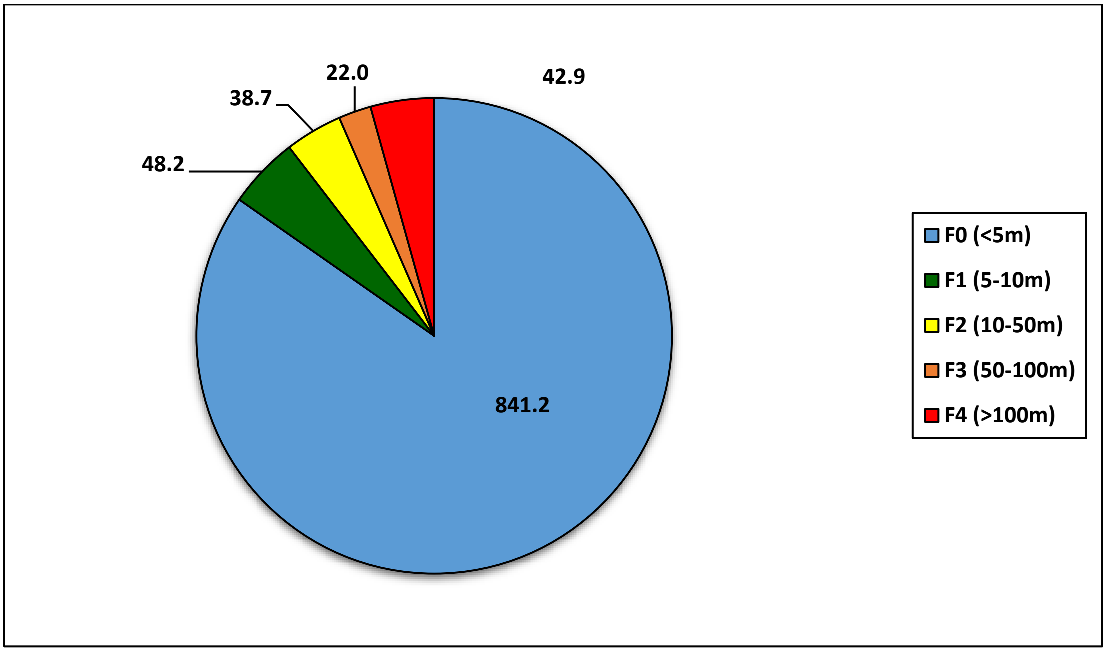

Figure 10. Flooding Class categories by shoreline length (km).

The Coastal Vulnerability Module (CVM) includes a classification of flooding sensitivity based on the across shore profile and photographic evidence of historical flooding such as an unambiguous marine debris line. The Flooding Class is an estimate of vulnerability to inundation of the terrestrial area beyond the supratidal. The distance to the debris line is measured and used to classify the flooding potential. Flat shorelines with very low gradients that show evidence of historical flooding have a higher risk of being inundated by storm surges. Potential for damage due to flooding is generally low in the study area, with 85% of the shoreline at a low risk of flooding <5m from MHW (see Figures 9 and 10 for distribution and summary statistics). The flooding class is a parameter of the Coastal Vulnerability Index (see Page18).

2.4.2 Shoreline Stability Index

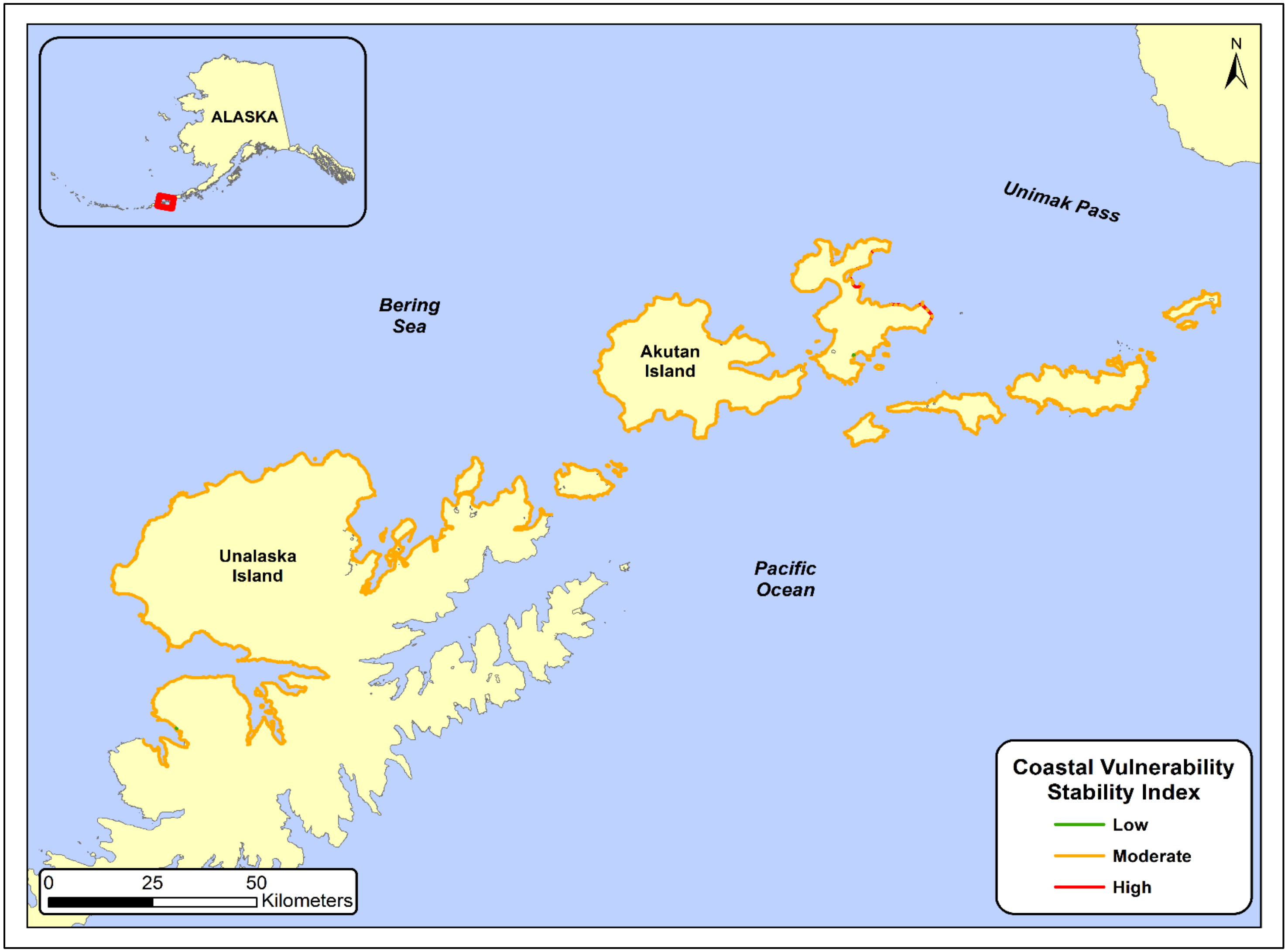

Figure 11. Distribution of the Coastal Vulnerability Shoreline Stability Index

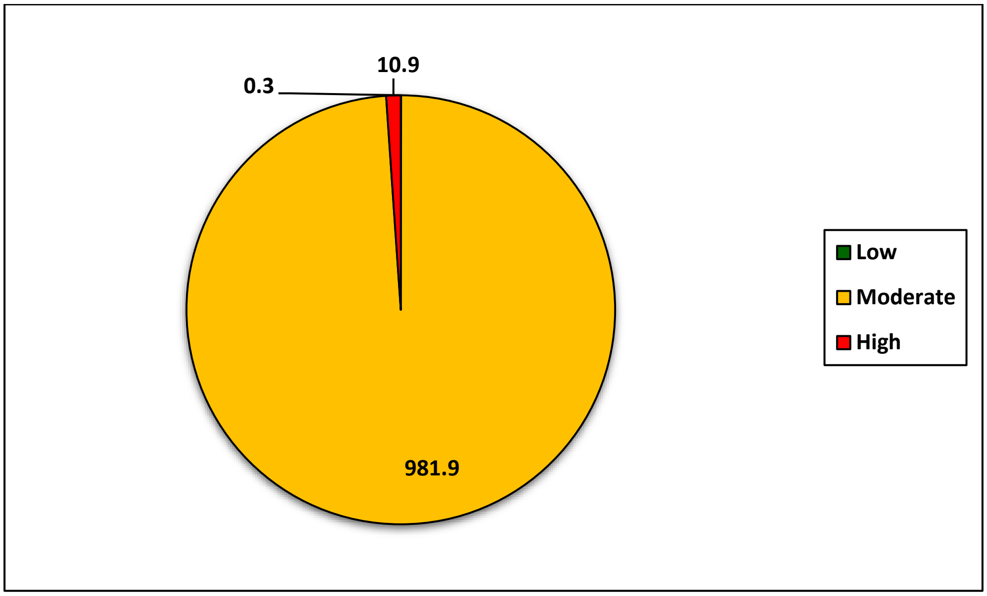

Figure 12. Shoreline Stability Index categories by shoreline length (km).

The Shoreline Stability Index is a ranking of the vulnerability of shoreline units to erosion. This is based on erosional or accretional forms within the unit. In the Eastern Aleutian Islands area, most of the shoreline units (99% shoreline length) were mapped as stable (see Figures 11 and 12 for distribution and summary statistics). The shoreline erosion index is a parameter of the Coastal Vulnerability Index (see Page 18). The stability index categories are: 1= Very high (>2 m/yr, erosional), 2= High (1 to 2 m/yr, erosional), 3= Moderate (1 to -1 m/yr, stable), 4= Low (1 to 2 m/yr, accretional), 5= Very low (>2 m/yr, accretional).

2.4.3 Coastal Vulnerability Observations

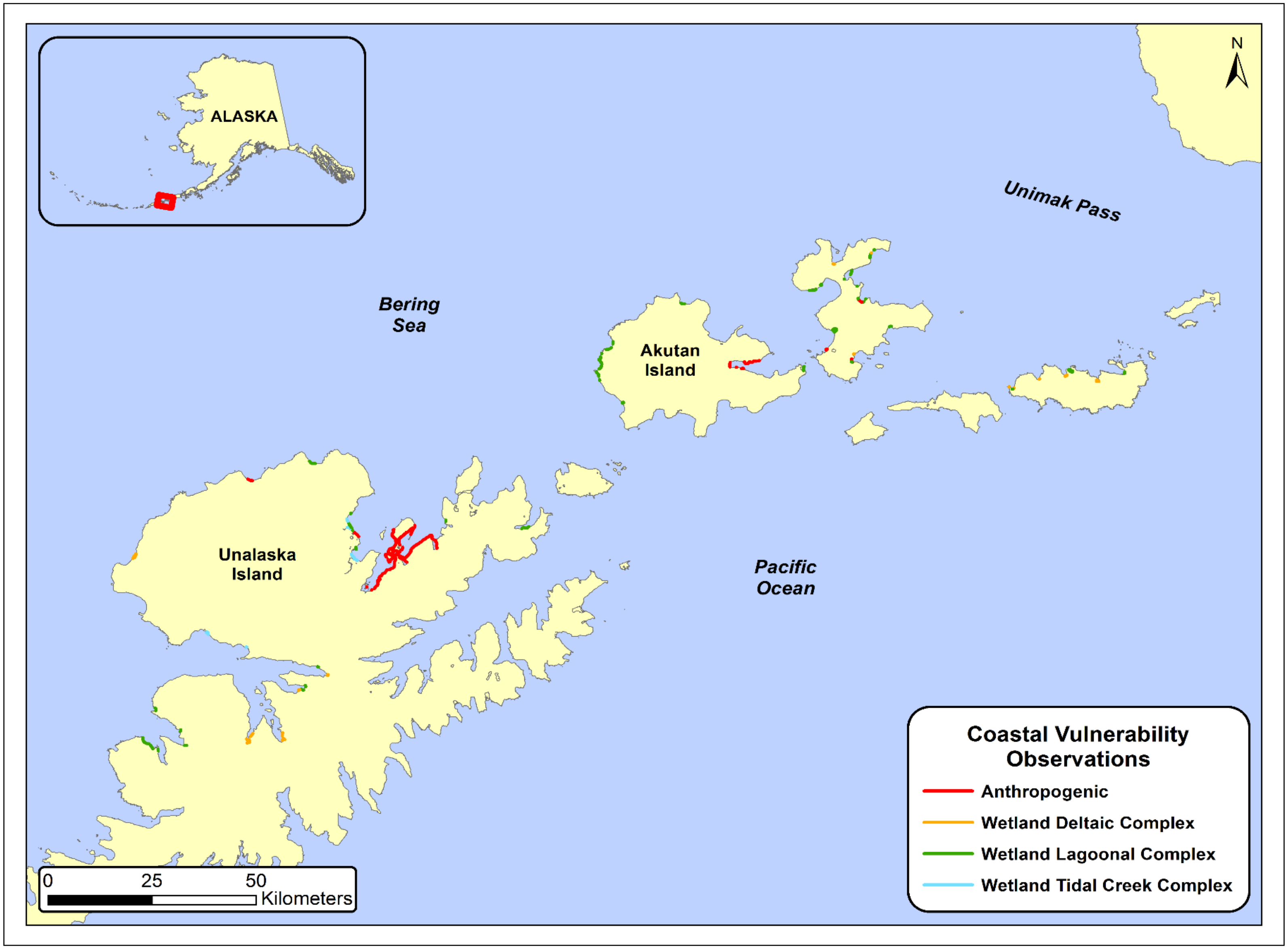

Figure 13. Distribution of the Coastal Vulnerability Observations categories.

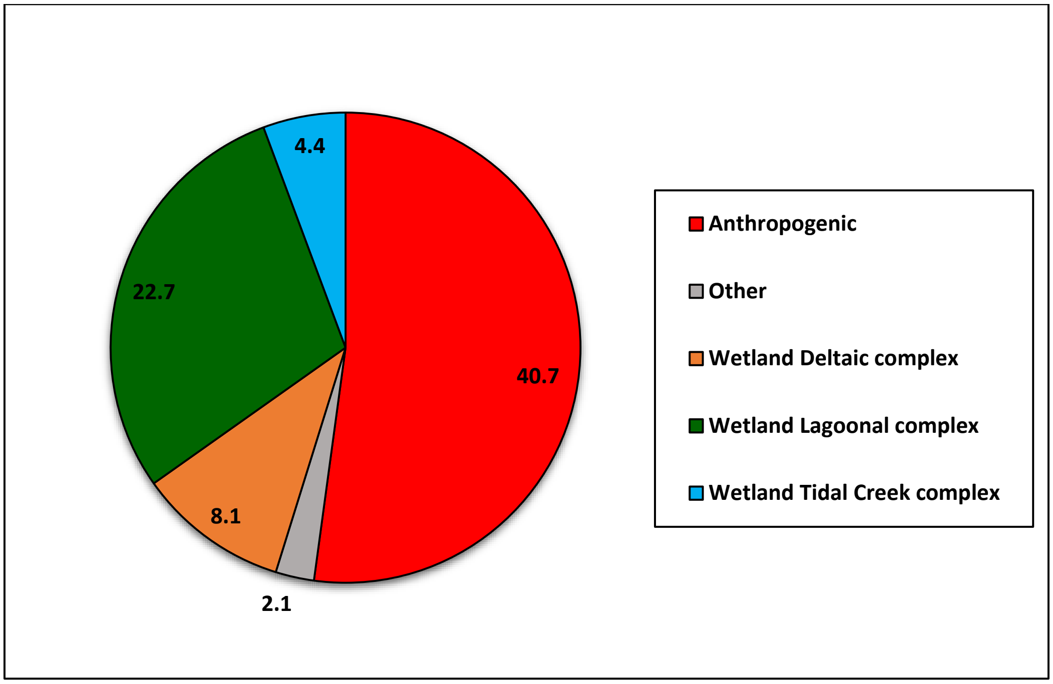

Figure 14. Coastal Vulnerability Observations categories by shoreline length (km). Category 'None' not shown.

The CVM Observations are features important for estimating the frequency and extent of coastal inundation. In the Eastern Aleutian Islands area, apart from the 'None' category, the majority of observations were from Anthropogenic category with 40.7km (see Figures 13 and 14 for distribution and summary statistics). With regards to the Anthropogenic category it is important to point out that these areas are not necessarily areas of vulnerability but areas potentially impacted.

2.4.4 Coastal Vulnerability Index

The methods of Thieler and Hammer-Klose (2000) ((http://woodshole.er.usgs.gov/project-pages/cvi/) were adapted to calculate the Coastal Vulnerability Index (CVI) using five ShoreZone attributes: Shore Type, Max Tide Range, Shoreline Erosion index, Flood Zone Width, and Wave Height. See the most recent ShoreZone protocol for more details (Cook *et al*., 2017). This Index has so far only been calculated in the Kuskokwim Bay area which is very morphologically and dynamically different from the rocky, exposed shoreline of the Aleutian Islands. When the Index was calculated for this survey area, the values did not match the observations of the shoreline on those more exposed coasts. It would appear the various attributes need to be weighted in order to adapt the algorithm for use on a steep, rocky, exposed coast. We will use the classification completed for this portion of the Eastern Aleutians, as well as the further mapping that is underway in this area to refine the Index and determine the appropriate weighting. Until that is completed, the CVI Value and Rank will be left blank in the geodatabase but will be calculated and delivered with the remaining portion of the Eastern Aleutians.

2.5 Anthropogenic Shore Modifications

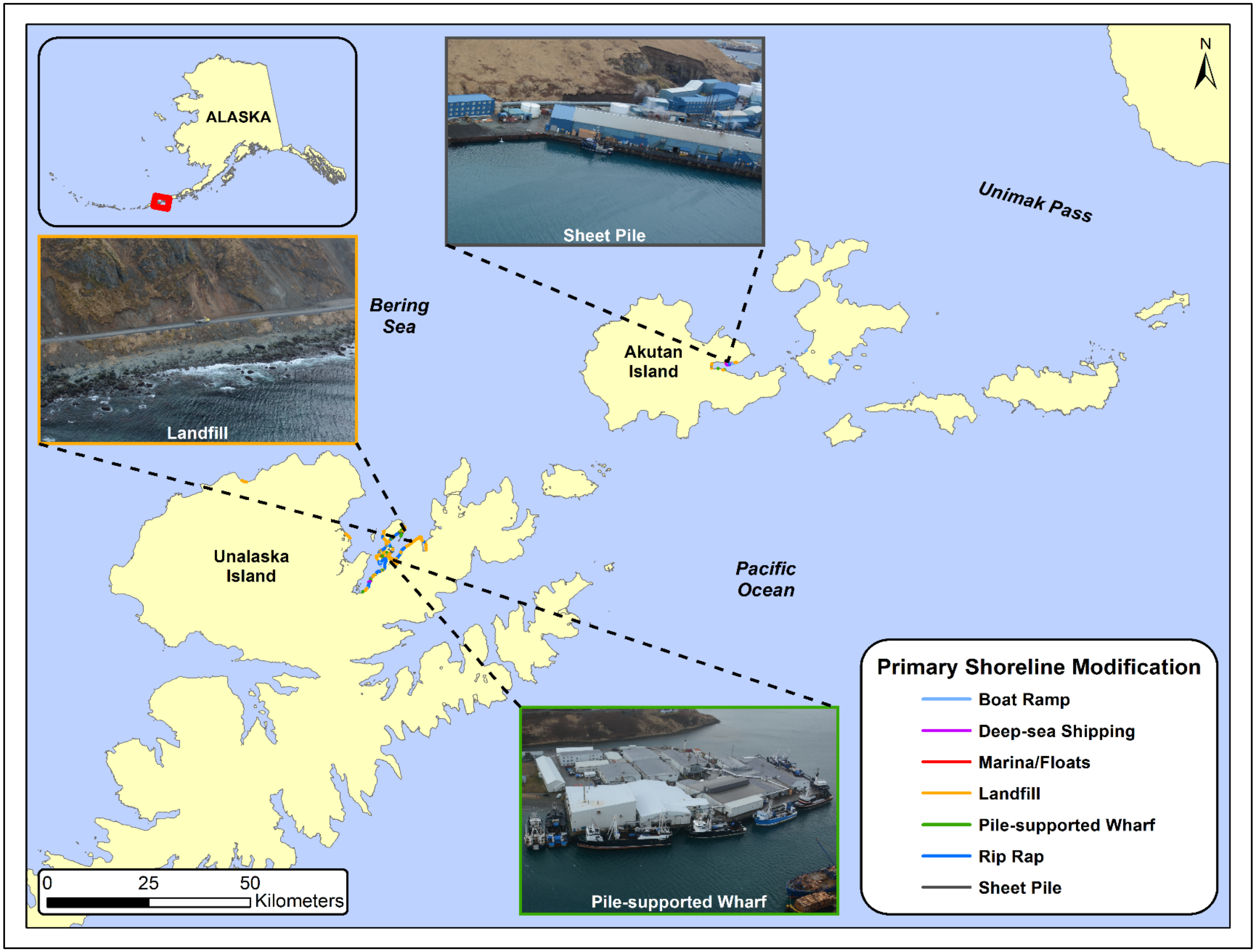

Figure 15. Distribution of Shore Modifications

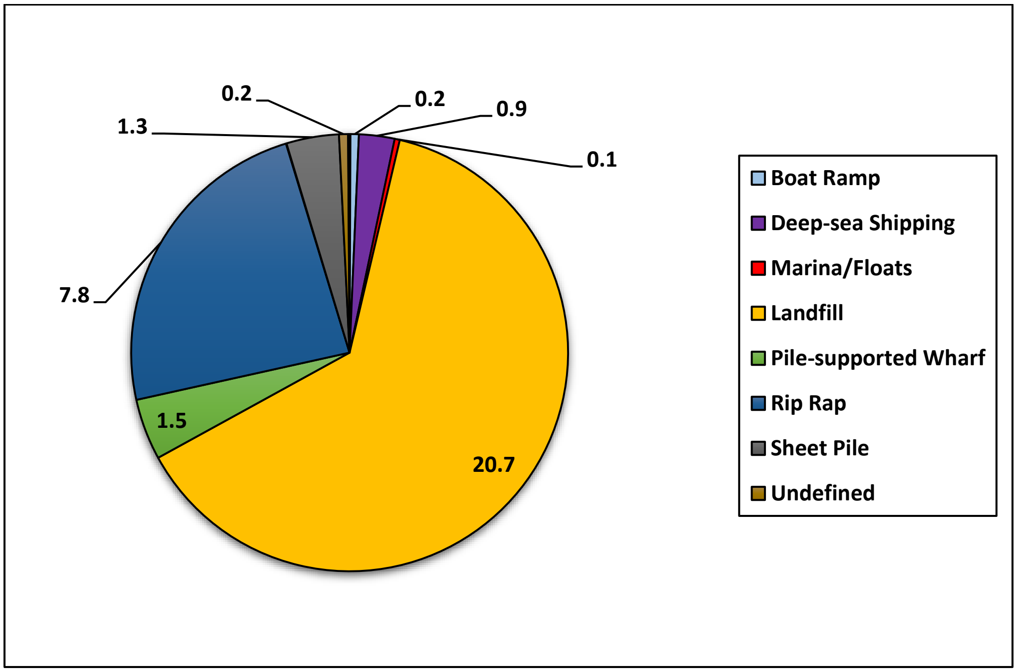

Figure 16. Shore Modifications by shoreline length (km) of each modification type.

Anthropogenic features such as landfill, boat ramps and sheet pile are included in the ShoreZone classification. A total of 32.7 kilometers of shoreline exhibits shore modifications in the Eastern Aleutian Islands study area. 63% of that shoreline was classified as Landfill and 24% was classified as Rip Rap (Figures 15 and 16). Photo examples for Shore Types 32 & 33 can be found in Appendix A of this report.

3 BIOLOGICAL ATTRIBUTE DATA SUMMARY

3.1 Biobands

Biobands represent assemblages of coastal biota found on the shoreline at characteristic wave exposures, 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 (see Appendix A, Table A-2 for examples from this portion of the Eastern Aleutians). Full descriptions of all biobands, including indicator and associated species can be found in the ShoreZone protocol (Cook et al. 2017). It is important to note that a nested bioband classification was developed and applied to all ShoreZone mapping completed after January 1st, 2015, including the area covered in this report. Changes to the bioband definitions include the application of a consistent naming convention and new four digit codes for each bioband. A number of new biobands were added, and some were split to better describe the banding that has been observed as ShoreZone continues to move into new and unique areas.

The specific elevation or zone of the intertidal determines how the bioband attributes are described. For example, biobands found in the supratidal (A Zone) and subtidal (C Zone) are described by percent of alongshore length of unit and a width category. The intertidal (B zone) biobands are described by percent of alongshore length of the unit and percent cover of the zone.

Biobands mapped in this portion of the Eastern Aleutians survey area are summarized in Tables 3 and 4. The most commonly occurring intertidal biobands in the survey areas were Barnacles, Filamentous and Foliose Red Algae, Dark Brown Kelps and Winter Laver, with all being found in almost half the units. The most common Splash Zone bioband was Black Lichen, occurring in 64% of the units while the Dune Grass bioband was common in 37% of units. The most common subtidal biobands found were Dark Brown Kelps (41%), Dragon Kelp (27%) and Bull Kelp (24%). All the most common biobands were typically associated with more exposed rock-dominated shorelines, which is a good description of the majority of the Aleutian Islands. Distribution maps, statistics and observations about some specific biobands are found following Tables 3 and 4.

Table 3. Percent cover of the zone for the intertidal biobands in the Eastern Aleutians survey area.

Bioband		Zone	Number of Units							Total Number of Units With Bioband Present*	% of Total Units with Bioband Present
			Percent Cover Category (Intertidal Zone)								
Name	Code		<5%	5-25%	26-50%	51-75%	76-95%	>95%	Bioband Present, Percent Cover Not Assessed		
Barnacle	BARN	Upper to Mid-Intertidal (B)	98	2677	315	37	2	0	2	3131	58
Rockweed	ROCK		59	685	57	2	0	1	0	804	15
Blue Mussels	BLMU		19	102	2	1	0	0	0	124	2
Green Algae	GRAL		109	1715	138	6	1	0	1	1970	37
Winter Laver	WILA		35	2038	256	11	0	1	3	2344	44
Filamentous and Foliose Red Algae	FFRA		57	2340	207	8	1	1	1	2615	49
Brown Bladed Algae	BRBA	Lower Intertidal (B)	39	795	172	23	2	0	23	1054	20
Soft Brown Kelps	SOBK		19	132	35	3	0	0	0	189	4
Dark Brown Kelps	DABK		61	1896	551	33	3	0	2	2546	48
Intertidal/Subtidal Vegetation	INSV		0	26	2	0	0	0	0	28	<1
Anemones	ANEM		8	1	0	0	0	0	0	9	<1
Coralline Red Algae	CORA		84	1272	52	2	0	0	3	1413	26

*Please note that Total Number of Units is used to describe the distribution of biobands rather than length (in kilometers) because biobands are usually not continuous along the entire length of a unit. A calculation could be performed to estimate length of a bioband over a region using the percent length metric in the dataset.

Table 4. Width category of supratidal and subtidal biobands in the Eastern Aleutians survey area.

Bioband		Zone	Width Category (m)				Total Number of Units With Bioband Present*	% of Total Units with Bioband Present
Name	Code		<1 m	1-5 m	>5 m	Bioband Present, Width Category Not Assessed		
Splash Zone	SPZO	Splash Zone (A)	51	450	261	0	762	14
Lichens	LICH		0	0	0	76	76	1
Black Lichen	BLLI		293	2013	1143	0	3449	64
Yellow Lichen	YELI		3	359	137	0	499	9
White Lichen	WHLI		13	108	0	0	121	2
			<10 m	10-30 m	>30 m	Bioband Present, Width Category Not Assessed		
Dune Grass	DUGR	Supratidal (A)	1773	94	57	51	1975	37
Grasses	GRAS		160	30	12	8	210	4
Salt Marsh	SAMA		0	1	0	5	6	<1
Wetland Vegetation	WEVE		57	3	17	15	92	2
Eelgrass	EELG	Subtidal (C)	1	2	1	5	9	<1
Brown Bladed Algae	BRBA		66	14	4	722	806	15
Soft Brown Kelps	SOBK		11	4	1	186	202	4
Dark Brown Kelps	DABK		44	21	7	2148	2220	41
Urchin Barren	URBA		29	43	89	49	210	4
Brown Canopy Kelp	BRCA		23	18	31	99	171	3
Dragon Kelp	DRKE		428	475	407	144	1454	27
Bull Kelp	BUKE		172	351	455	290	1268	24

*Please note that Total Number of Units is used to describe the distribution of biobands rather than length (in kilometers) because biobands are usually not continuous along the entire length of a unit. A calculation could be performed to estimate length of a bioband over a region using the percent length metric in the dataset.

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Dune Grass (DUGR) was the most commonly occurring supratidal, non-splash zone bioband and was found in 37% of units (see Figures 17 and 18 for distribution graph and map). It is likely the distribution of this bioband was underestimated due to the timing of the Eastern Aleutians survey. The survey was conducted in early April 2016, before the Dune Grass had begun to green up, so it was still a light beige color (see example photo in Table A-2) and it was difficult to distinguish from terrestrial grasses growing near the beach, which is why the two biobands are shown together in the distribution map in Figure 18. The Grasses bioband was also used when the vegetation in the splash zone was grazed down by the feral cattle populations that inhabit many of the Eastern Aleutian Islands, making it difficult to be certain whether the bioband was Dune Grass. Another bioband that was likely underestimated, even more so than Dune Grass, was Salt Marsh (SAMA) as many of the species that comprise that bioband are annuals and had only just started to emerge when the imaging survey took place. The distribution of Salt Marsh is also shown in Figure 18. Dunegrass occurs exclusively in the supratidal zone and can be anything from a fringe at the top of a sand/gravel beach to a wide meadow covering dunes. The fringing band was most common in the Eastern Aleutians survey area, often growing at the base of cliffs and talus slopes on the more exposed coastline.

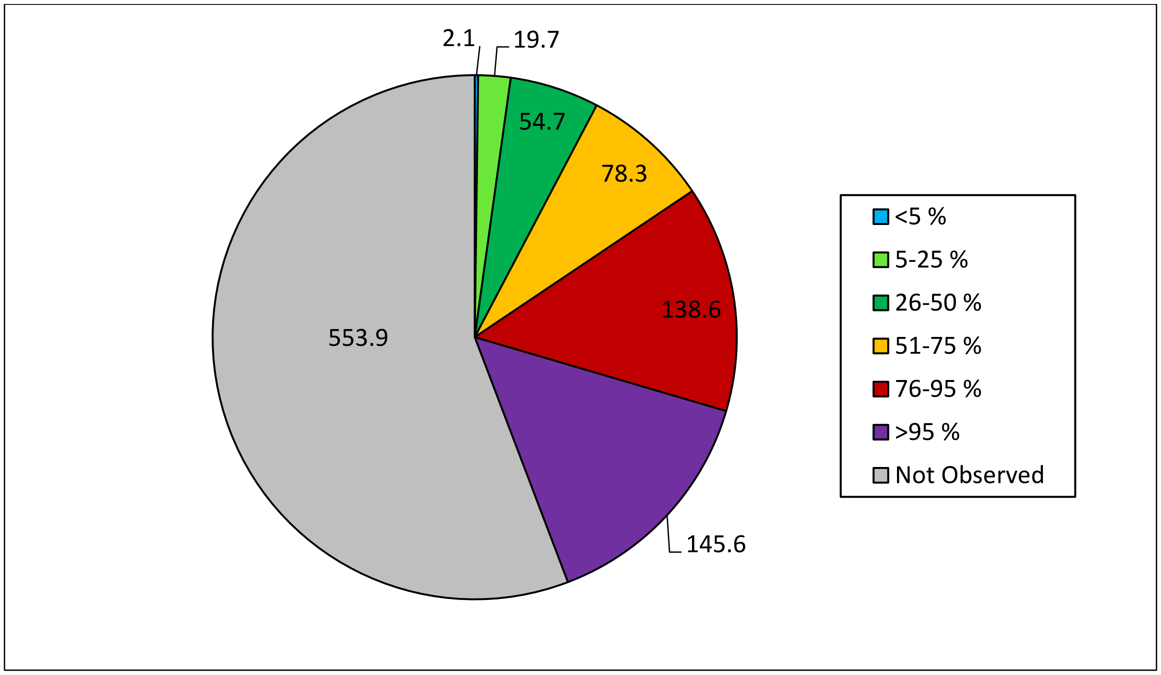

Figure 17. Distribution of the supratidal Dune Grass (DUGR) bioband by percent alongshore length category and shoreline length (km).

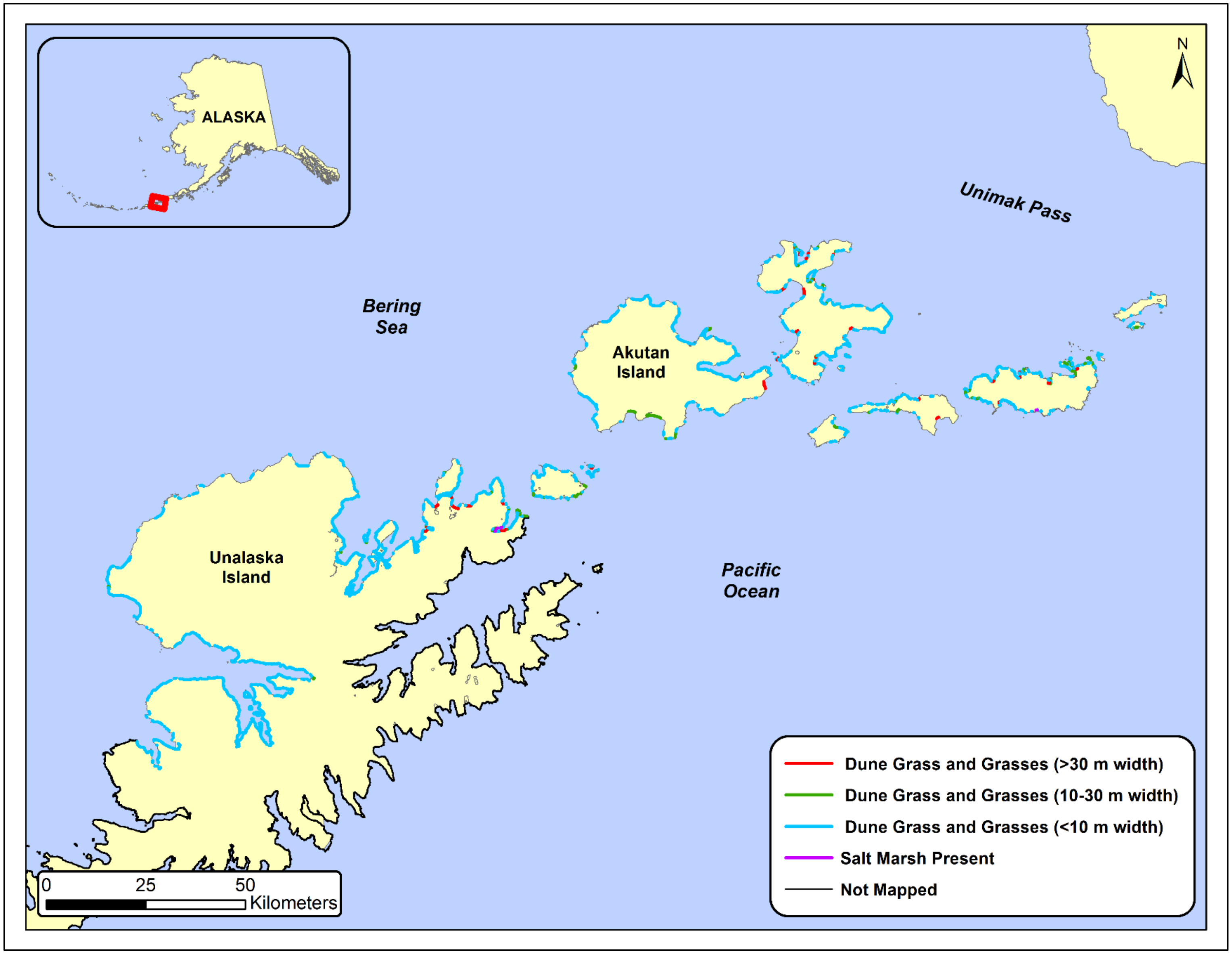

Figure 18. Distribution of the Dune Grass (DUGR) and Grasses (GRAS) biobands by width category and the presence of Salt Marsh (SAMA) in the supratidal (A zone).

There are three biobands that describe Bladed Kelps in the nested bioband tables (see the most recent ShoreZone protocol (Cook *et al*. 2017)), and those are Brown Bladed Algae (BRBA) at the secondary level with Dark Brown Kelps (DABK) and Soft Brown Kelps (SOBK) nested underneath at the more specific tertiary level. These three biobands are combined together on the distribution map (Figure 20) as the difference between Dark Brown Kelps and Soft Brown Kelps was difficult to determine in some areas. This was possibly due to the survey being early in the growing season for these kelps so the kelps were either eroded from winter storms or not fully grown for the year. Often the distinction between Dark Brown and Soft Brown Kelps is down to the exposure, but when the exposure was in the low Semi-Exposed or changing from Semi-Exposed to Semi-Protected (as was common in this survey area) that difference is not clear-cut, so the less specific Brown Bladed Algae (BRBA) bioband was used by mappers. Any of the Bladed Kelp biobands can occur in the low intertidal or subtidal zones, so the distribution maps show units where either was recorded.

Urchin Barrens (URBA) are subtidal patches where the lack of predators such as Sea Otters has allowed sea urchins to proliferate. These urchins graze down the kelp and expose the underlying substrate which is often covered by coralline red algae and invertebrates. The coralline red community can be quite important in the Aleutians. Urchin Barrens generally co-occur with Bladed Kelp biobands which is why that bioband was also included on Figure 20. The distribution of Urchin Barrens by width category can be seen in Figure 19. Interestingly, Urchin Barrens were only observed on the Bering Sea side of the islands which could be due to the differing oceanographic characteristics and/or differing exposures and nearshore habitat characteristics of the two water masses.

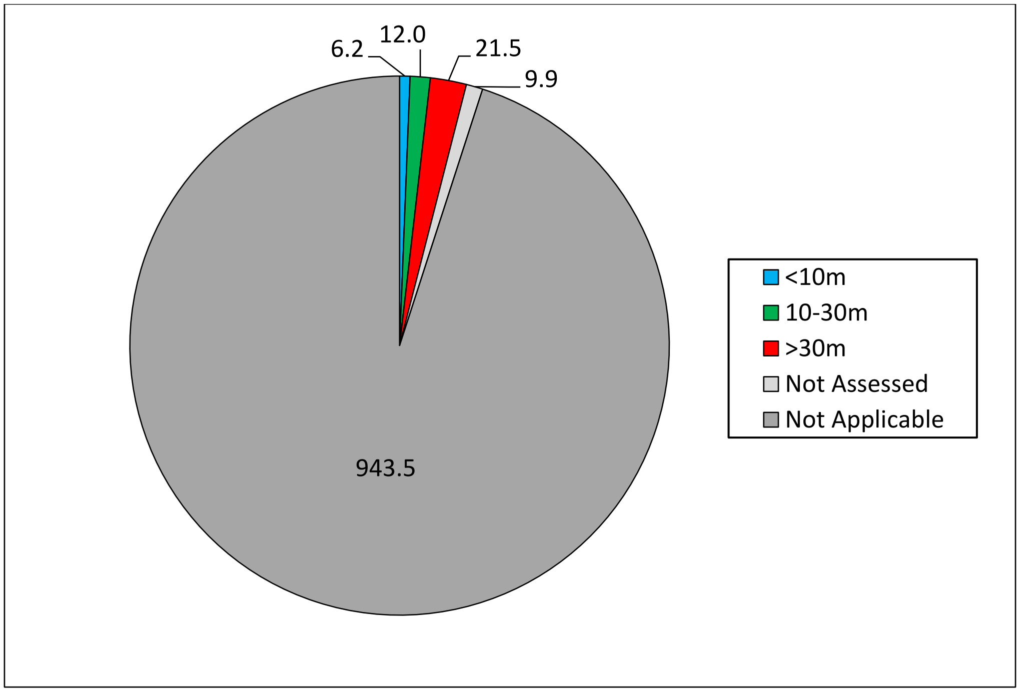

Figure 19. Distribution of the Urchin Barren (URBA) bioband by width category and shoreline length (km).

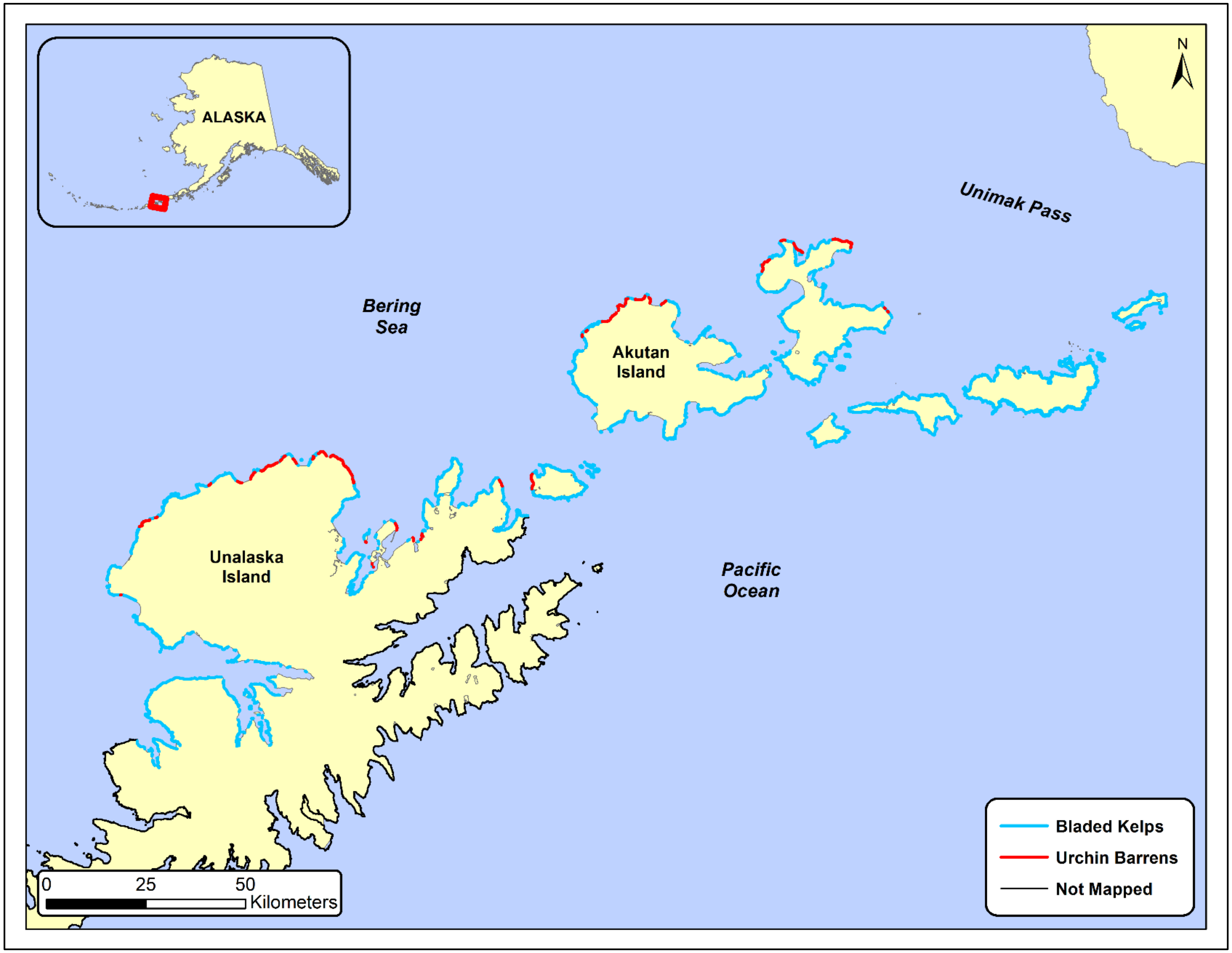

Figure 20. Distribution of the Bladed Brown Kelps (BRBA), Dark Brown Kelp (DABK) and Soft Brown Kelp (SOBK) Biobands (referred to as Bladed Kelps on the map) in the intertidal or subtidal (B or C zones) and the Urchin Barren (URBA) bioband. Please note that Bladed Kelps generally co-occur with Urchin Barrens.

The Coralline Red Algae (CORA) bioband was found in 26% of the units in the survey area (see Figures 21 and 22 for distribution statistics and map). This low intertidal bioband is typically found on rocky substrate in Semi-Exposed or Exposed habitats and is often the understory to large bladed kelps. Because of the understory nature of this red algae it can be assumed to be present over a greater area than is visible from the aerial imagery. It is therefore not surprising that the majority of the observations of Coralline Red Algae fall into the lower (<5%, 5-25%) percent cover categories (Figure 21), although it tended to be found along a greater percent length of the unit, as seen in Figure 22.

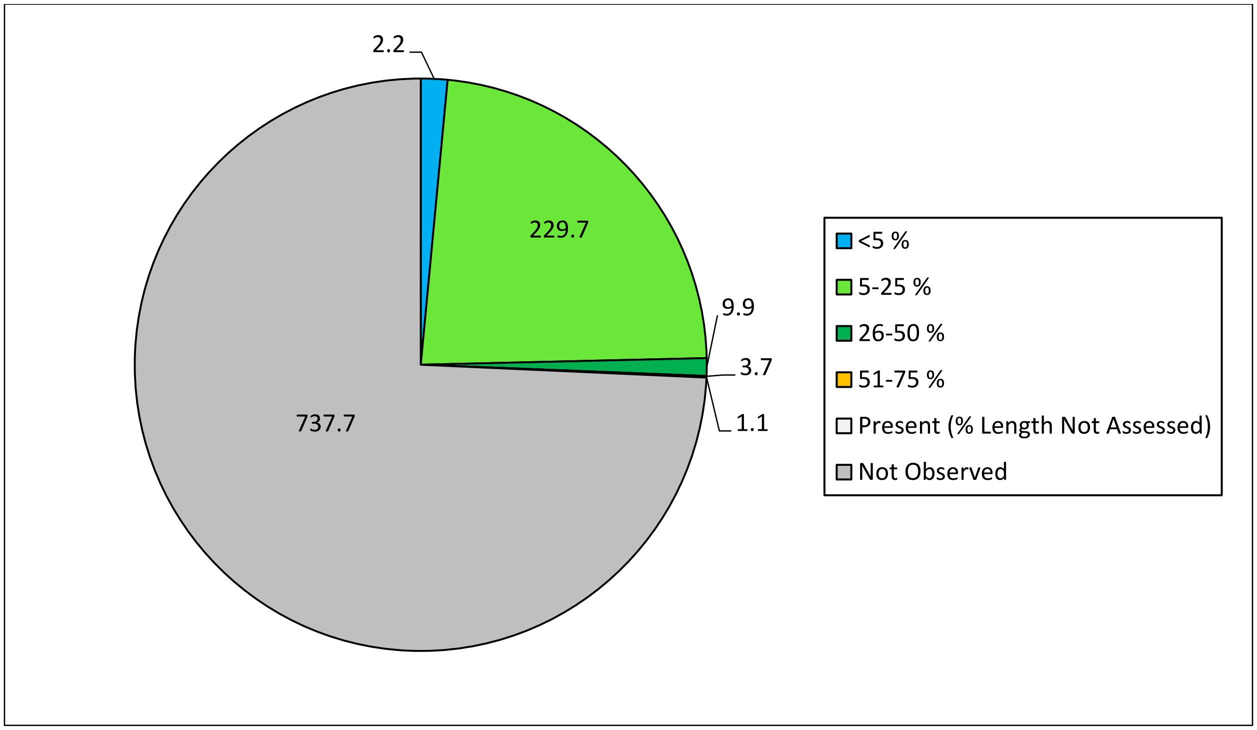

Figure 21. Distribution of the intertidal Coralline Red Algae (CORA) bioband by percent cover category and shoreline length (km).

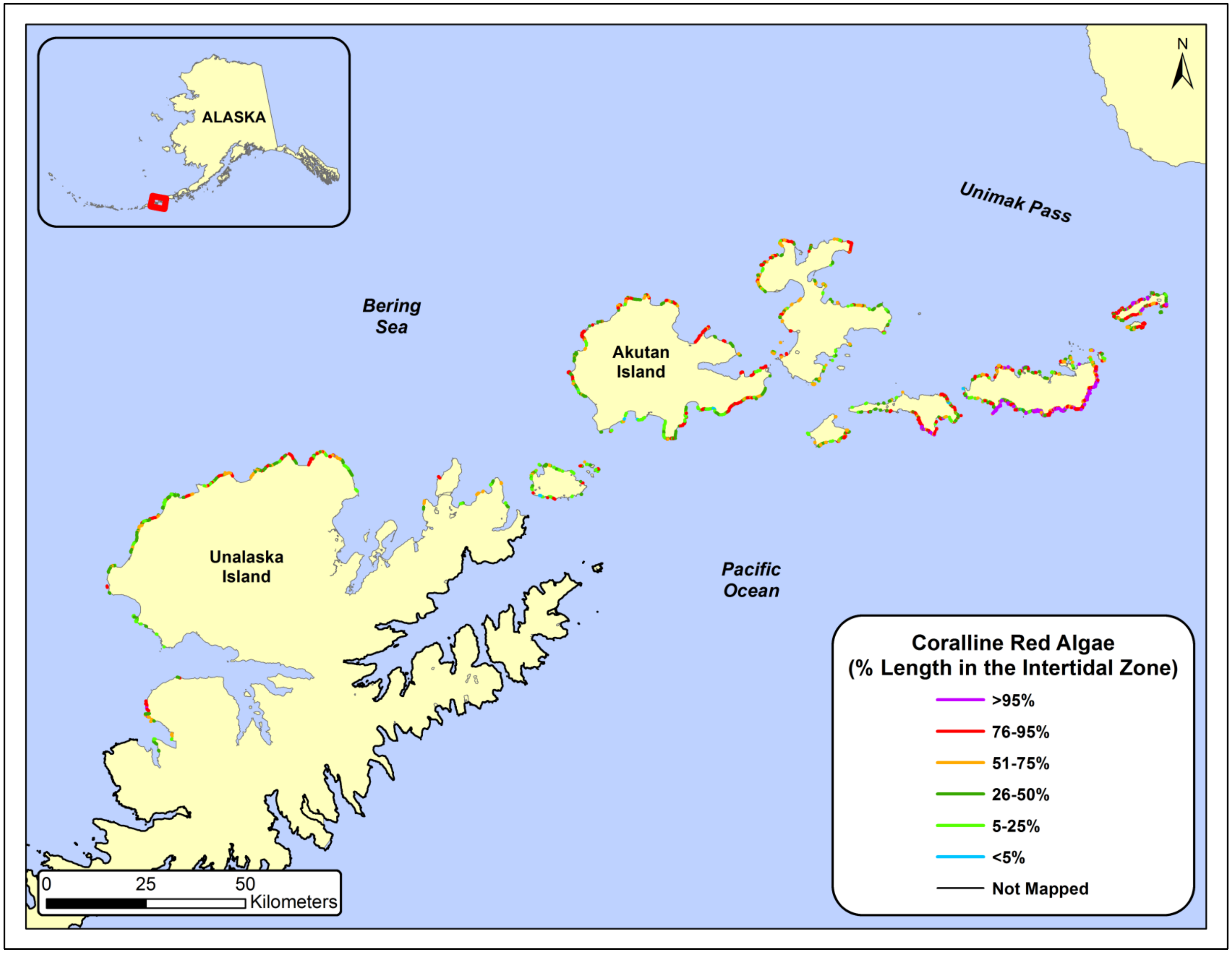

Figure 22. Distribution of the Coralline Red Algae (CORA) bioband by percent alongshore length of the unit in the intertidal (B zone).

There were two canopy kelps observed in this portion of the Eastern Aleutians survey area, Bull Kelp (BUKE) and Dragon Kelp (DRKE) (see Table A-2 for photographic examples). Canopy kelps form valuable habitat for other algae, fish and invertebrates and are an important part of a healthy coastline. Bull Kelp can handle more exposed parts of the coast while Dragon Kelp tended to be in areas that were Semi-Exposed down to Protected areas. Where the two canopy kelps co-occur, the Dragon Kelp is generally found inshore of the Bull Kelp bed. See Figure 23 to 25 for statistics on the width categories of the kelp beds and distribution map of their presence. The Bull Kelp tended to form more sparse beds in this survey area, possibly because the imaging survey was conducted earlier in the growing season and the beds may not yet have recovered from winter storms. Canopy kelps, Bull Kelp in particular, was more common on the Pacific Ocean side of the islands with Dragon Kelp being more common between the islands where the exposure is lower.

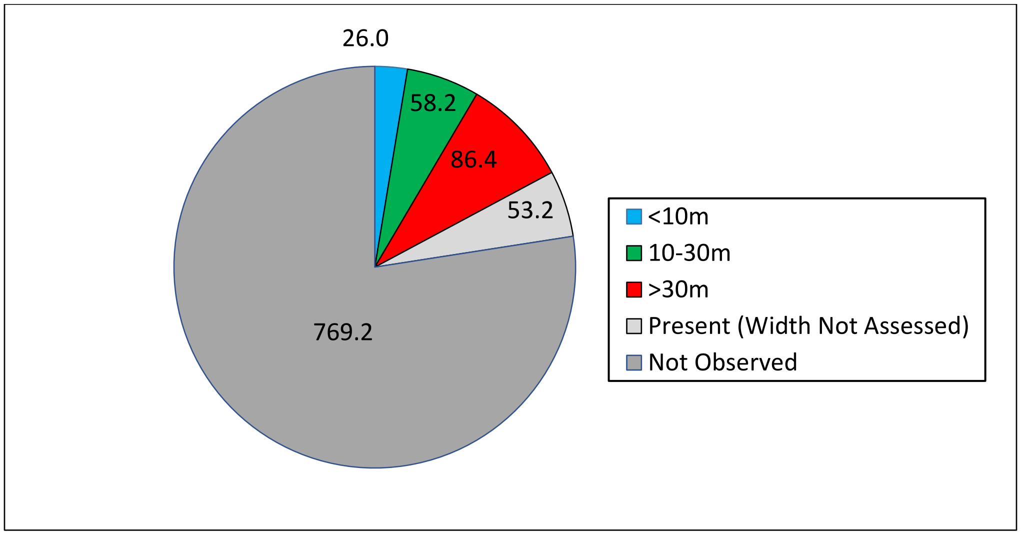

Figure 23. Distribution of the subtidal Bull Kelp (BUKE) bioband by width category and shoreline length (km).

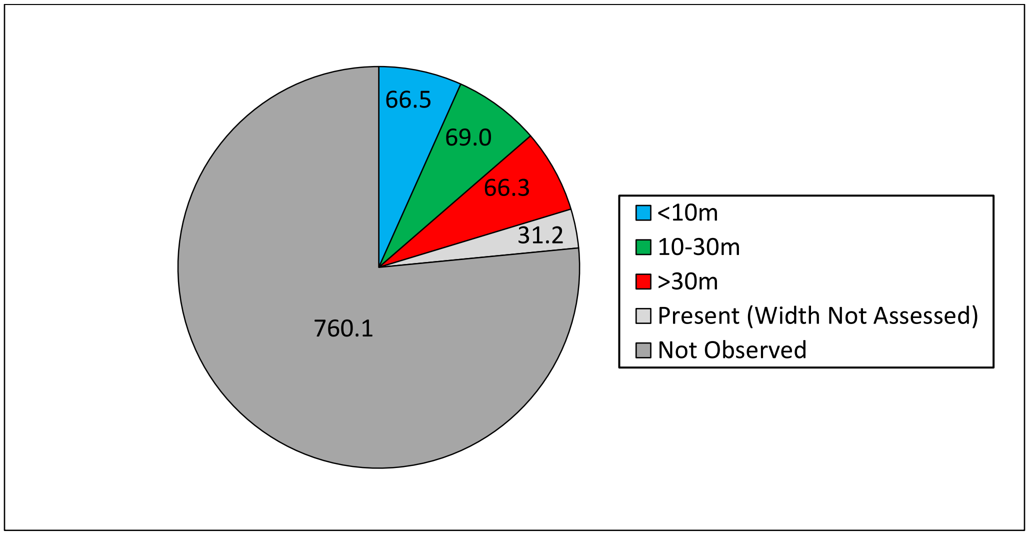

Figure 24. Distribution of the subtidal Dragon Kelp (DRKE) bioband by width category and shoreline length (km).

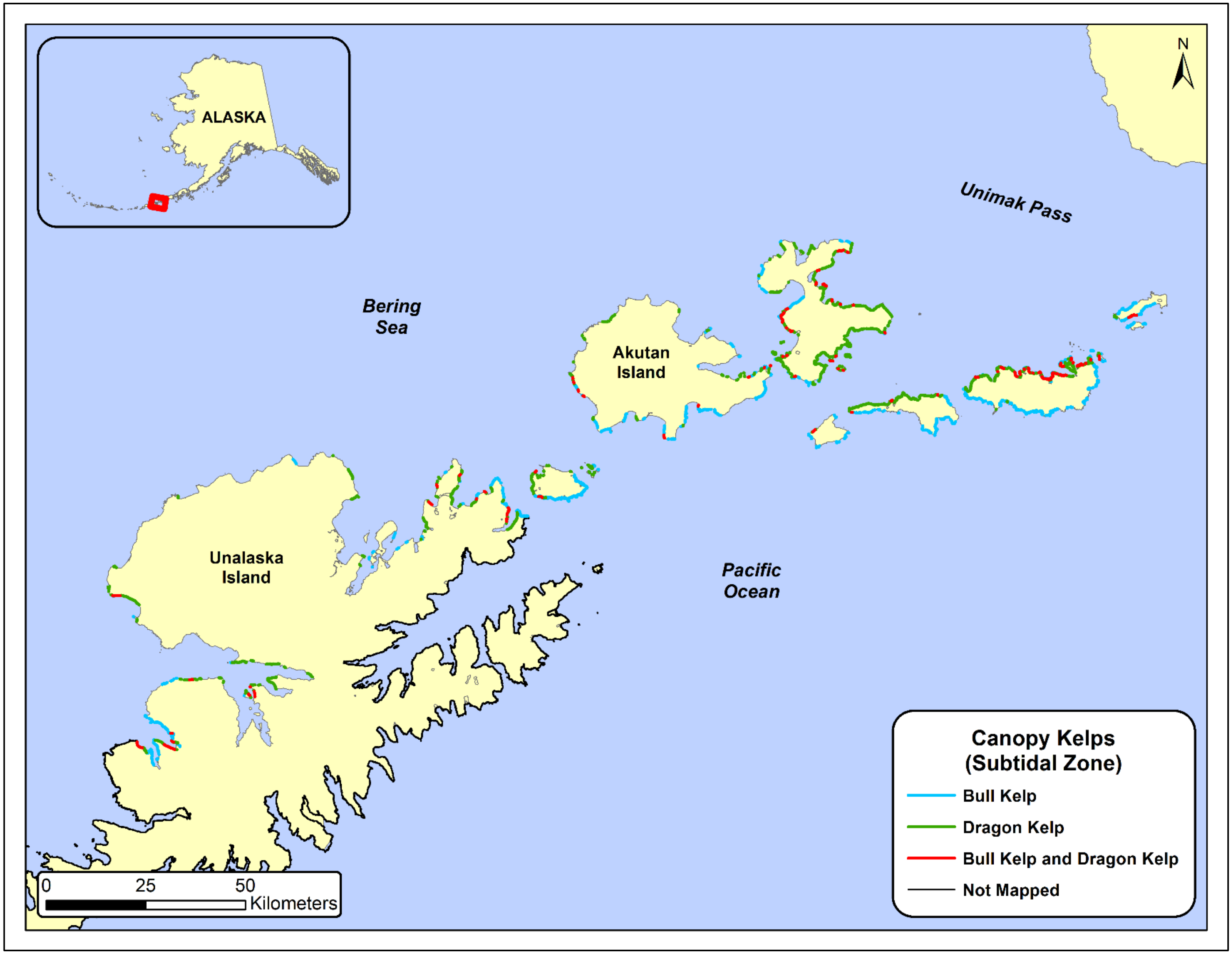

Figure 25. Distribution of the canopy kelp biobands, Bull Kelp (BUKE) and Dragon Kelp (DRKE) in the survey area.

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 wave exposure at that site. For definitions of the Biological Wave Exposures and the exposure ranges of the biobands, see the most recent ShoreZone protocol (Cook *et al*. 2017).

The distribution of the wave exposure categories mapped in the Eastern Aleutian survey area are summarized in Figure 26 and a distribution map of the categories is shown in Figure 27. Most of the coastline was in the higher exposure categories of Semi-Exposed or Exposed (66%) with the rocky coast on the outside of the islands having the highest exposures. The Bering Sea side of the islands had more stretches of Semi-Exposed than the Pacific Ocean side of the islands and there were differences in the distribution of biobands on those two sides as well.

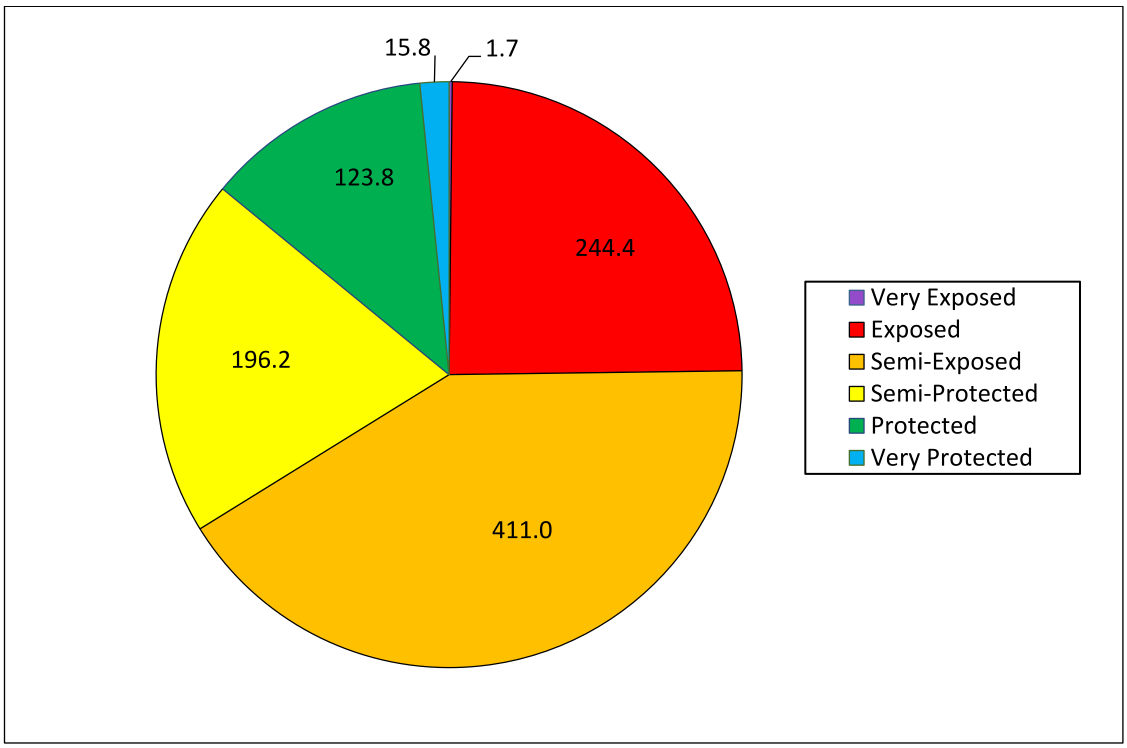

Figure 26. Distribution of biological wave exposures mapped in the Eastern Aleutians survey area by shoreline length (km).

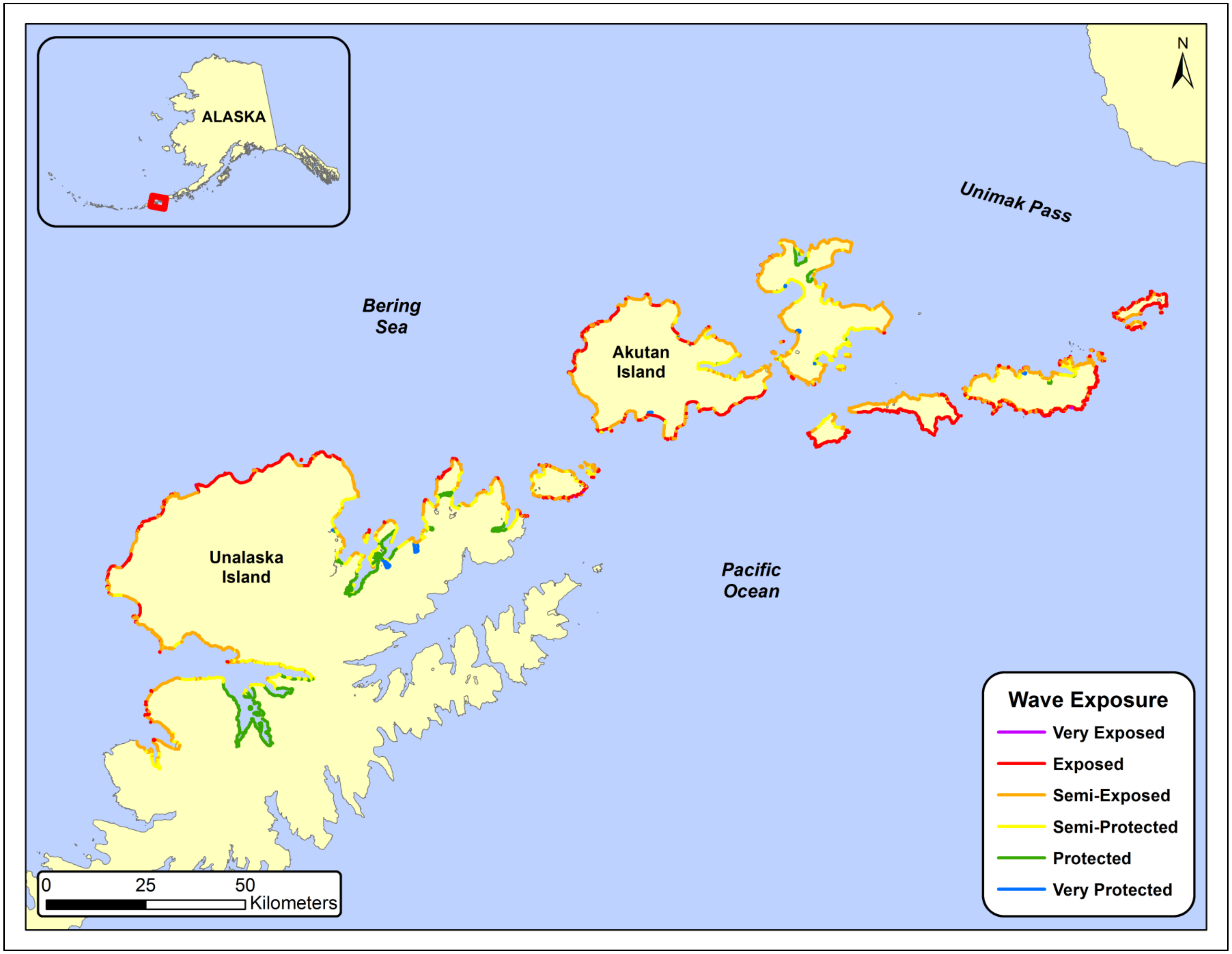

Figure 27. Distribution of the Biological Wave Exposure in the Eastern Aleutians survey area.

3.3 Habitat Class

Habitat Class is a classification based on wave exposure and geomorphic characteristics observed on an alongshore unit. The habitat class is intended to provide a single attribute to characterize the biophysical features of each unit. The habitat class is assigned by the biological mapper and weighted according to the dominant structuring process. Wave exposure is the most common structuring process, and less commonly observed habitats are those structured by current, estuarine/fluvial processes, and anthropogenic structures. For habitat classes structured by wave exposure, substrate mobility determines the presence of epibenthic biota. Where the substrate is highly mobile, biota is sparse or absent, and where the substrate is stable, biota can be abundant. For further definitions and explanations of Habitat Class codes please see the most recent ShoreZone protocol (Cook *et al*. 2017).

The distribution of habitat class categories mapped for the Eastern Aleutian Islands are summarized in Figures 28 and 29. Partially mobile substrate is the dominant shoreline type (59%). Estuaries are not very common in this area with only 1.5% of the shoreline in that classification. The estuary habitat class is associated with spawning and nursery habitats for fish as well as breeding and foraging grounds for birds and other wildlife. However, given the lack of any major river systems in the Eastern Aleutian Islands, it is not surprising this habitat class in rare. The Lagoon and Anthropogenic habitat classes each occurred in approximately 1% of units. This is also to be expected in the Aleutians where there are few villages or settlements.

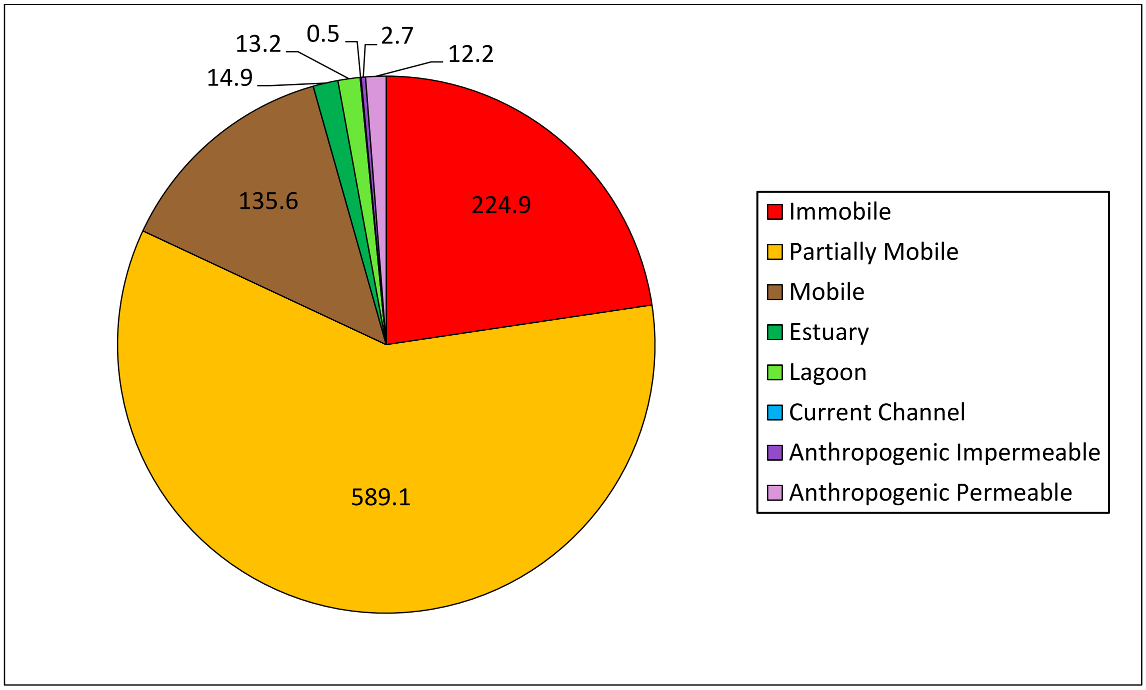

Figure 28. Distribution of Habitat Class categories in the Eastern Aleutians survey area by shoreline length (km).

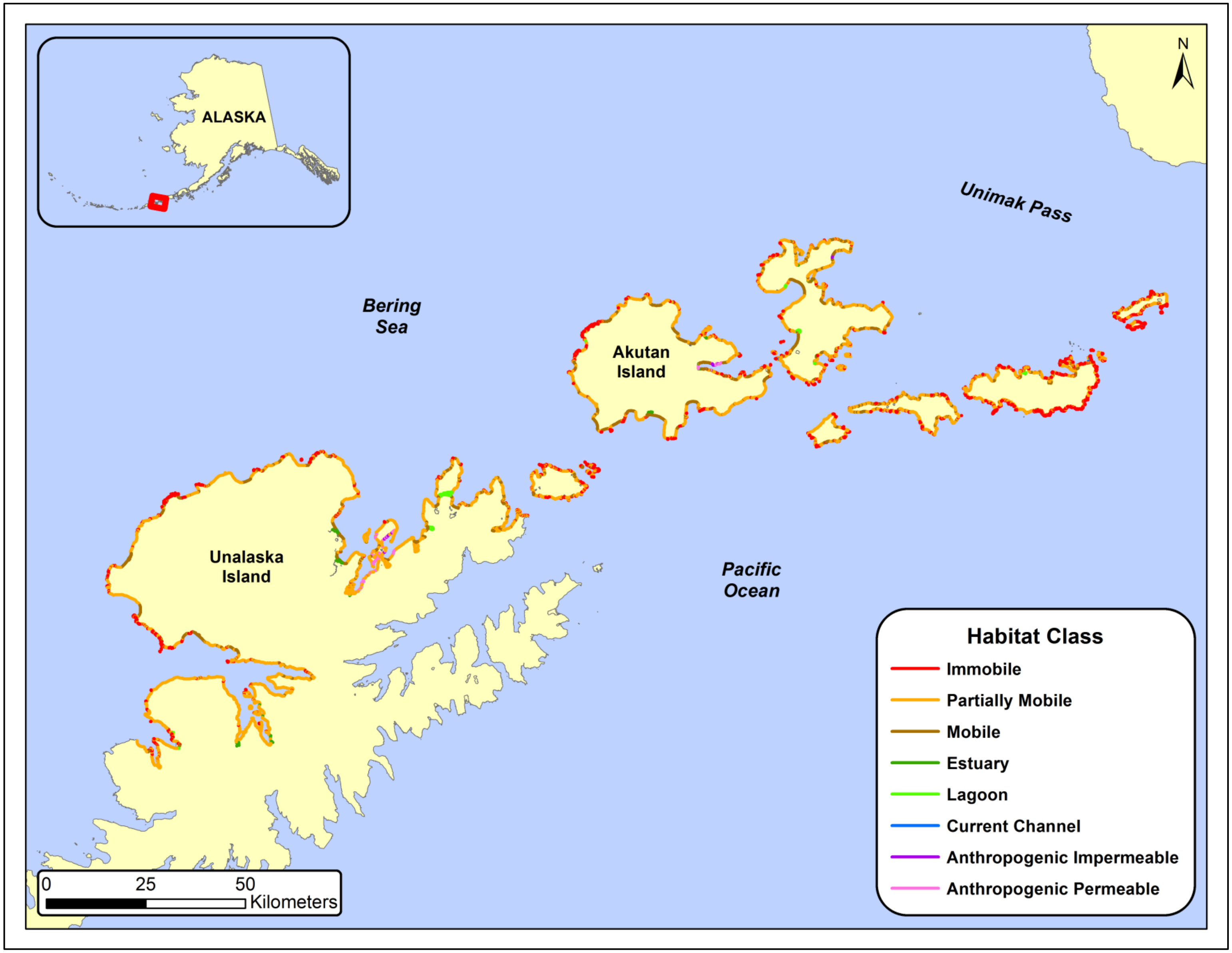

Figure 29. Distribution of Habitat Class categories in the Eastern Aleutians survey area.

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5 ACKNOWLEDGMENTS

We would like to thank the Prince William Sound Oil Spill Recovery Institute and NOAA National Marine Fisheries Service, Alaska Region for funding the projects represented in this summary report. The ShoreZone program is also supported by The Nature Conservancy and we are grateful for their continued support.

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

Protocols for data access and distribution are established by the program partner agencies. Please see www.ShoreZone.org for a list of partner agencies and related web sites. Video imagery can be viewed and digital stills downloaded online at www.ShoreZone.org. Any hardcopies or published data sets utilizing ShoreZone products shall clearly indicate their source. For questions regarding the protocols or information in this report, please contact Sarah Cook, the ShoreZone Program Manager at Sarah@coastalandoceans.com (Tel: 250-658-4050). For data requests or analytical support contact Kalen Morrow at Kalen@coastalandoceans.com.

APPENDIX A

Photographic Examples of Shore Types and Biobands

Table A-1. Examples of the Shore Types in the Eastern Aleutian Islands area (Page 39).
Table A-2. Examples of the most common Biobands in the Eastern Aleutian Islands area (Page 47).

Table A-1. Examples of the Shore Types in the Eastern Aleutian Islands area.

Photo ai16_ua_02459: Example of Shore Type 3; Rock Cliff.
Unalaska Bay, Unalaska Island.

Photo ai16_ua_05465: Example of Shore Type 4; Rock Ramp.
Tigalda Island.

Photo ai16_ua_07225: Example of Shore Type 8; Cliff with gravel beach.
Akun Head, Akun Island.

Photo ai16_ua_20395: Example of Shore Type 9; Ramp with gravel beach.
Hot Springs Bay, Akutan Island.

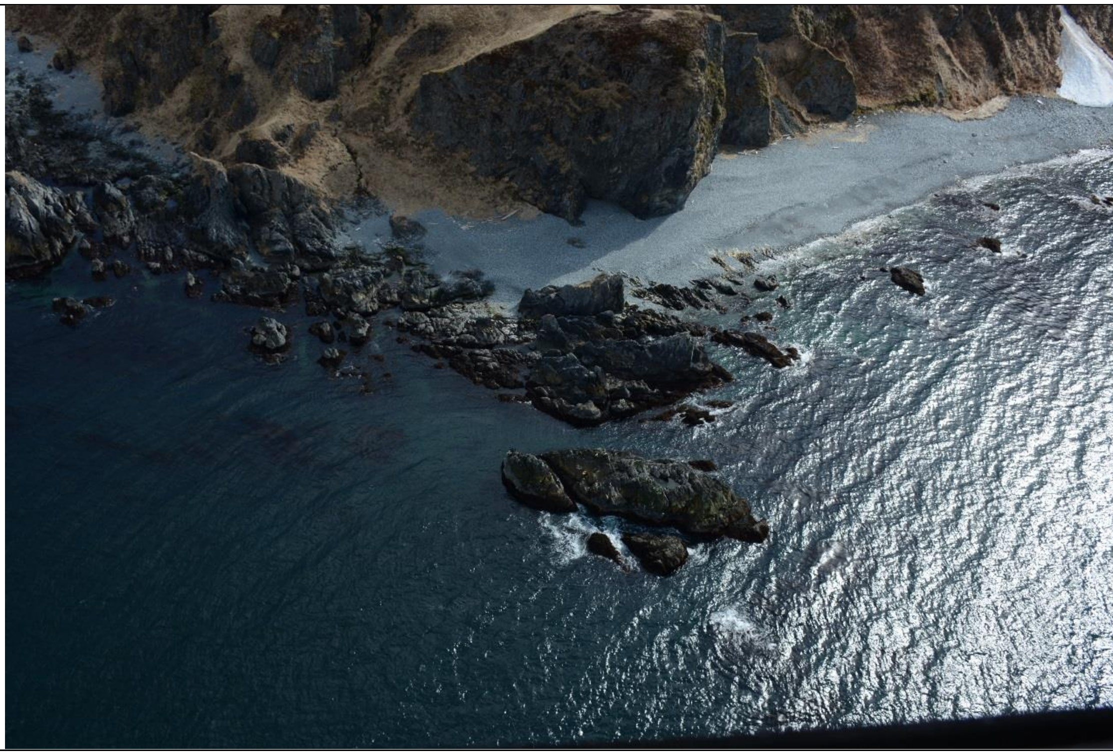

Photo ai16_ua_17073: Example of Shore Type 12; Platform with gravel/sand beach.
Makushin Bay, Unalaska Island.

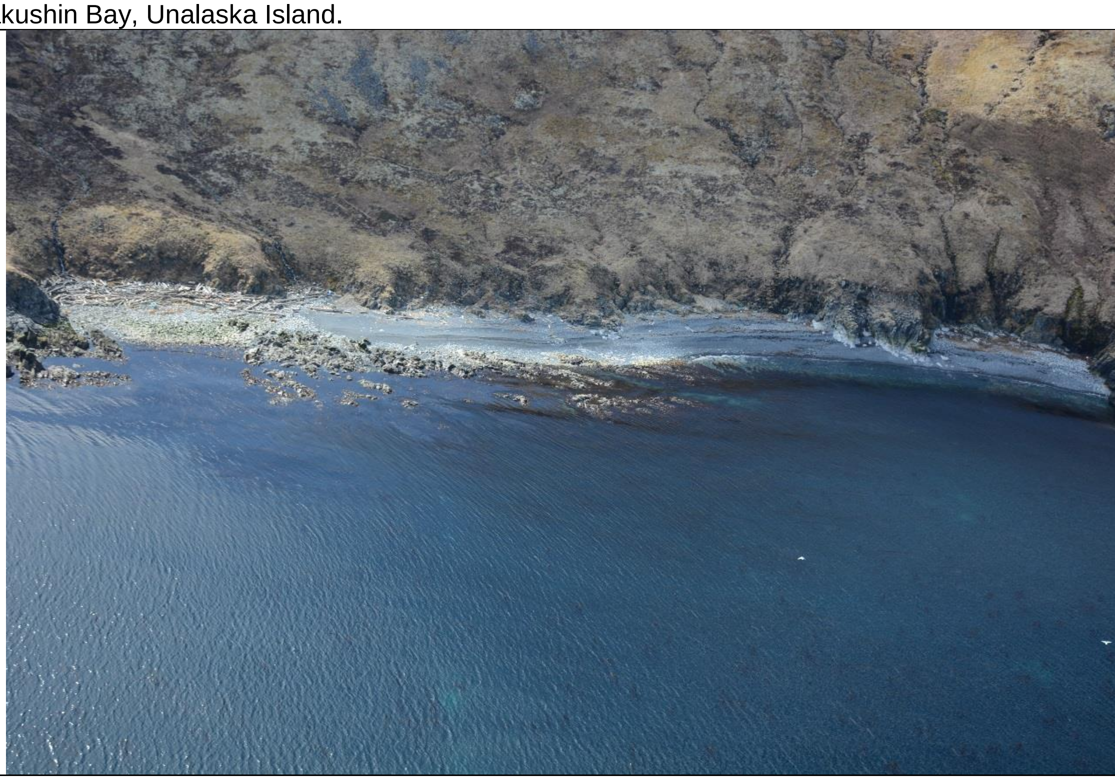

Photo ai16_ua_06189: Example of Shore Type 14; Ramp with gravel/sand beach.
Welcome Bay, Tigalda Island.

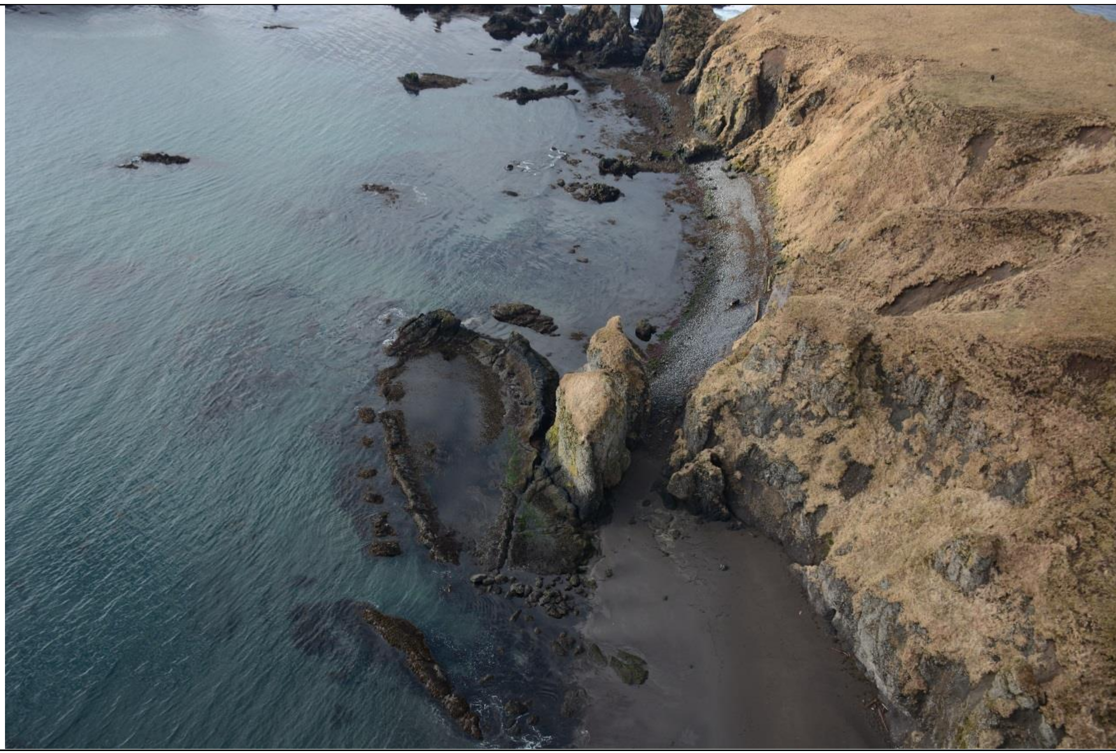

Photo ai16_ua_04694: Example of Shore Type 16; Ramp with sand beach.
Easy Cove.

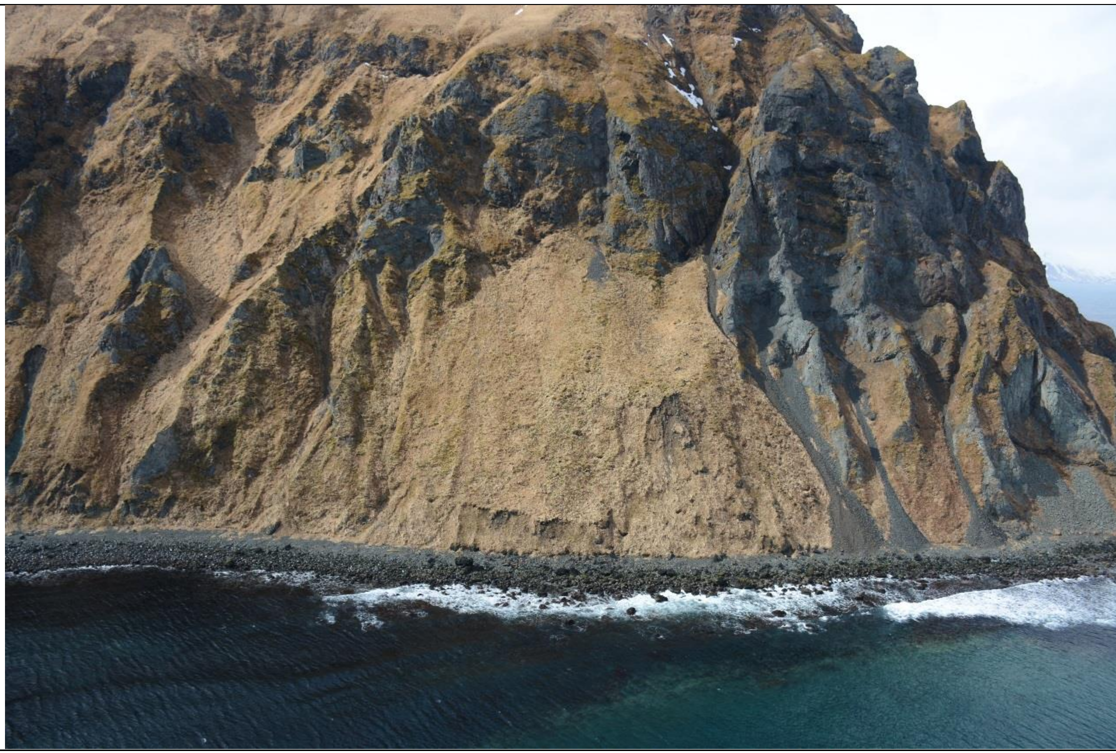

Photo ai16_ua_02549: Example of Shore Type 22; Gravel beach, narrow.
Unalaska Bay, Unalaska Island.

Photo ai16_ua_22276: Example of Shore Type 24; Sand & gravel flat or fan.
Cannery Bay, Unalaska Island.

Photo ai16_ua_02057: Example of Shore Type 25; Sand & gravel beach, narrow.
English Bay, Unalaska Island.

Photo ai16_05951: Example of Shore Type 28; Sand flat.
Tigalda Island.

Photo ai16_ua_03591: Example of Shore Type 30; Sand beach.
Unalaska Bay, Unalaska Island.

Photo ai16_ua_03442: Example of Shore Type 31; Organics/fines.
Captains Bay, Unalaska Island.

Photo ai16_ua_02819: Example of Shore Type 32; Permeable man-made structures.
Unalaska, Unalaska Island.

Photo ai16_ua_02943: Example of Shore Type 33; Impermeable man-made structures.
Dutch Harbor, Unalaska Island.

Photo ai16_ua_02623: Example of Shore Type 36; Lagoon.
Unalaska Bay, Unalaska Island.

Table A-2. Examples of the most common Biobands in the Eastern Aleutian survey area.

Photo ai16_ua_05143: Good example of the Black Lichen (BLLI) bioband which is a black band in the supratidal zone, usually cause by the lichen *Verrucaria* sp. South side Tigalda island.

Photo ai16_ua_00271: Good example of the Dune Grass (DUGR) bioband. Beaver Inlet, Unalaska Island.

Photo ai16_ua_12642: Good example of the olive green Winter Laver (WILA) bioband in the high intertidal zone. North side of Umnak Island.

Photo ai16_ua_10951: Good example of the Barnacle (BARN) bioband in the high intertidal zone. Umnak Island.

Photo ai16_ua_06625: Good example of the mixed Green Algae (GRAL) and Filamentous and Foliose Algae (FFRA) biobands that are common on partially mobile coasts in this survey area. Akun Bay, Akun Island.

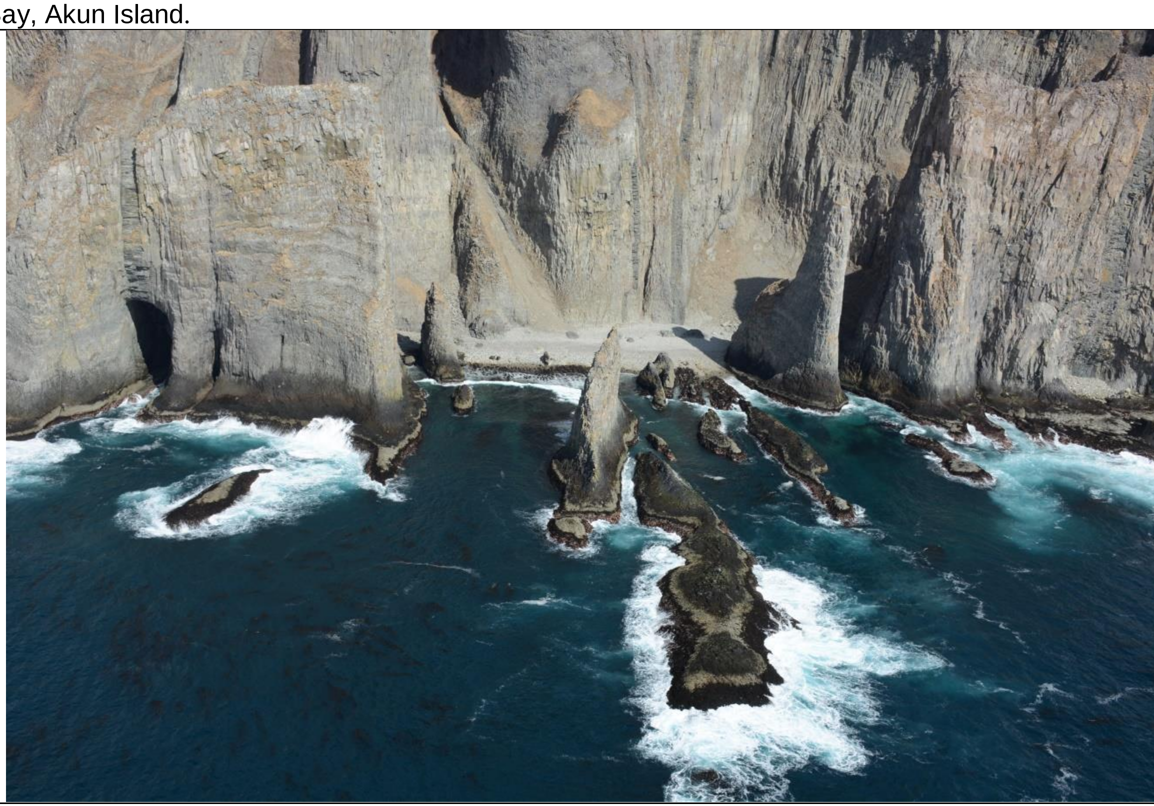

Photo ai16_ua_15105: Good example of the Dark Brown Kelps (DABK) bioband in the lower intertidal zone. South side of Unalaska Island.

Photo ai16_ua_22524: Good example of the Brown Bladed Algae (BRBA) bioband in the lower intertidal. North side of Unalaska Island.

Photo ai16_ua_11080: Good example of the bright pink Coralline Red Algae (CORA) bioband. Akutan Island.

Photo ai16_ua_12770: Example of the Urchin Barren (URBA) bioband in the subtidal. North side of Umnak Island.

Photo ai16_ua_04769: Good example of a Dragon Kelp (DRKE) bioband in the nearshore. Trident Bay, Akun Island.

Photo ai16_ua_07539: Good example of the Bull Kelp (BUKE) bioband in the nearshore. Akutan bay, Akun Island.