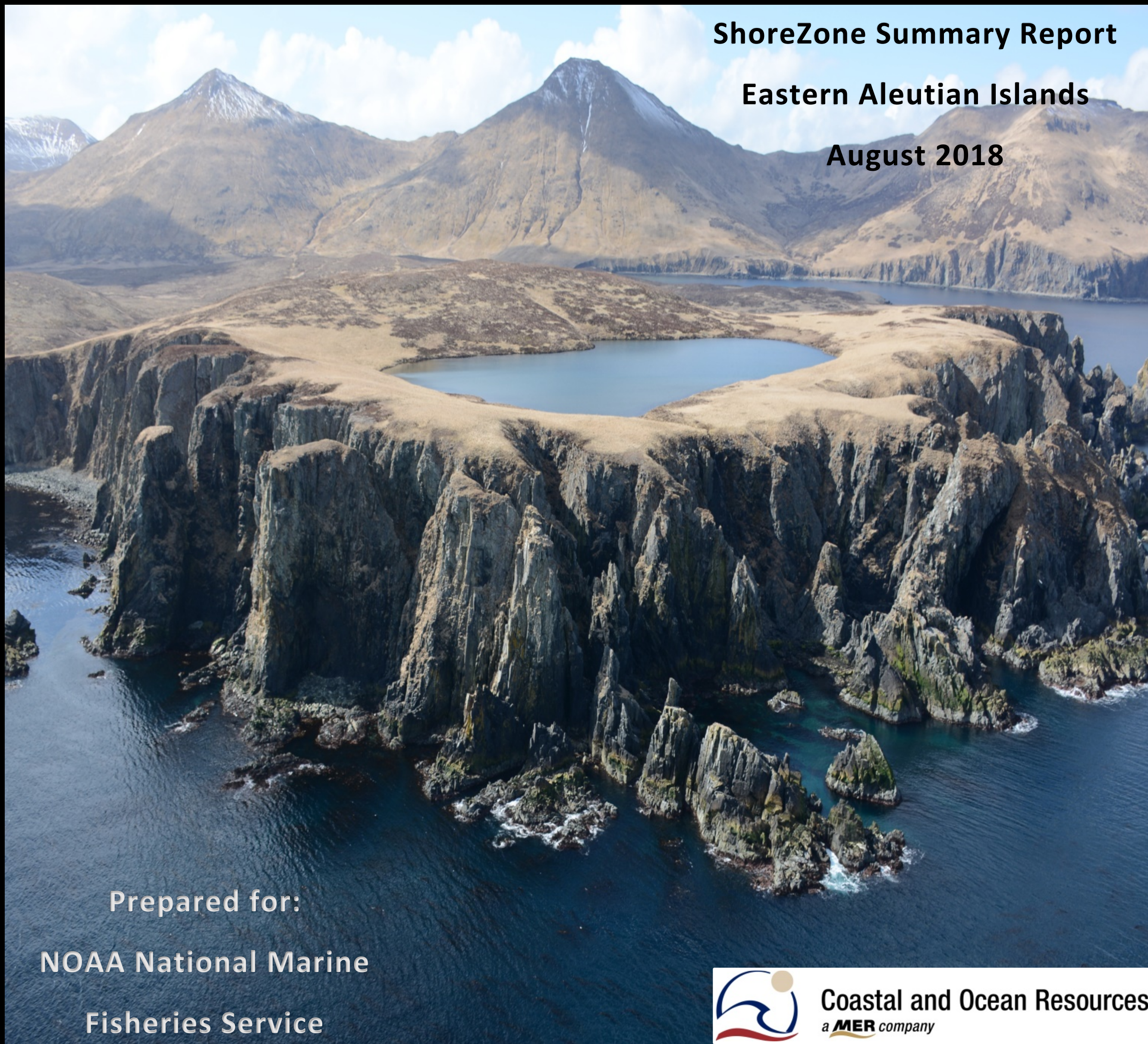
ShoreZone Summary Report

Eastern Aleutian Islands

August 2018

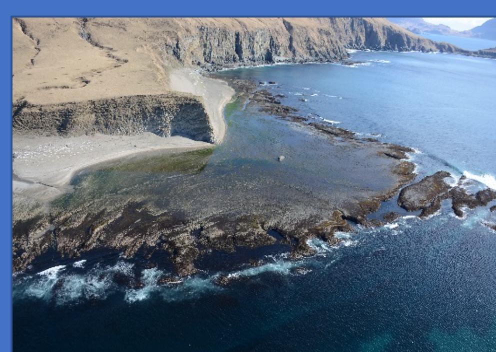


Prepared for:

NOAA National Marine Fisheries Service

Coastal and Ocean Resources
a MER company

ShoreZone

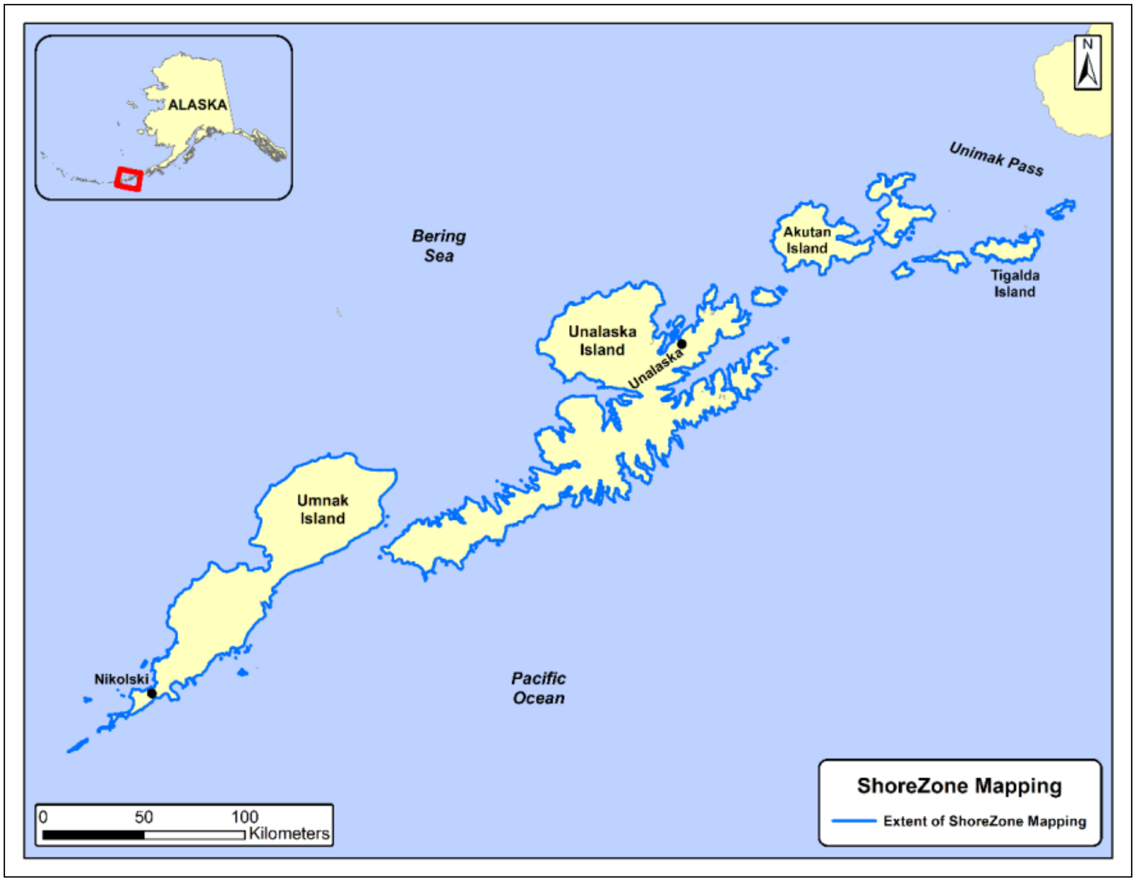


Coastal and Ocean Resources

MCORI Project: 16-18 **August 2018**

ShoreZone Habitat Mapping Summary Report

Eastern Aleutian Islands Survey Area



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Coastal and Ocean Resources, 2018. ShoreZone Habitat Mapping Summary Report for the Eastern Aleutian Islands survey area. Produced for the NOAA National Marine Fisheries Service, Alaska Region, Juneau, Alaska, 50p.

Eastern Aleutian Islands Area Summary

2,295 km of shoreline mapped

10,862 shoreline units created

Average unit length is **211 m**

43% of the intertidal is classified as **Sediment-dominated** and **33%** is classed as **Rock and Sediment-dominated**

44% of the shoreline has a high Oil Residence Index value (residence of months to years)

2% of the shoreline has a **Shoreline Modification** of some type

15 intertidal biobands were classified, with **Barnacle** and **Filamentous and Foliose red Algae** being the most common (**over 50%** of units each)

8 supratidal biobands were classified, with **Black Lichen** being the most common (**66%** of units)

8 subtidal biobands were classified, with **Bladed Brown Algae** being the most common (**44%** of units)

Unalaska

Sedanka Island

Unalaska Bay, Unalaska Island

Akutan Island

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1 INTRODUCTION

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 a georeferenced, 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, predicted oil residence and biotic communities) provide an important resource for scientists and managers. The ShoreZone mapping system provides a decision support tool with 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 75,000 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 around the Eastern Aleutian Islands and is the section of shoreline covered by this summary report.

The ShoreZone imaging survey conducted in 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 the most recent ShoreZone coastal habitat mapping protocol (Cook *et al*. 2017). The purpose of this report is to provide a summary of the physical (Section 2) and biological (Section 3) data imaged and classified the Eastern Aleutian Islands survey area.

The length of shoreline mapped is 2,295 kilometers in 10,862 along-shore segments (units), averaging 211 m in length. The digital shoreline used for the ShoreZone habitat 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.

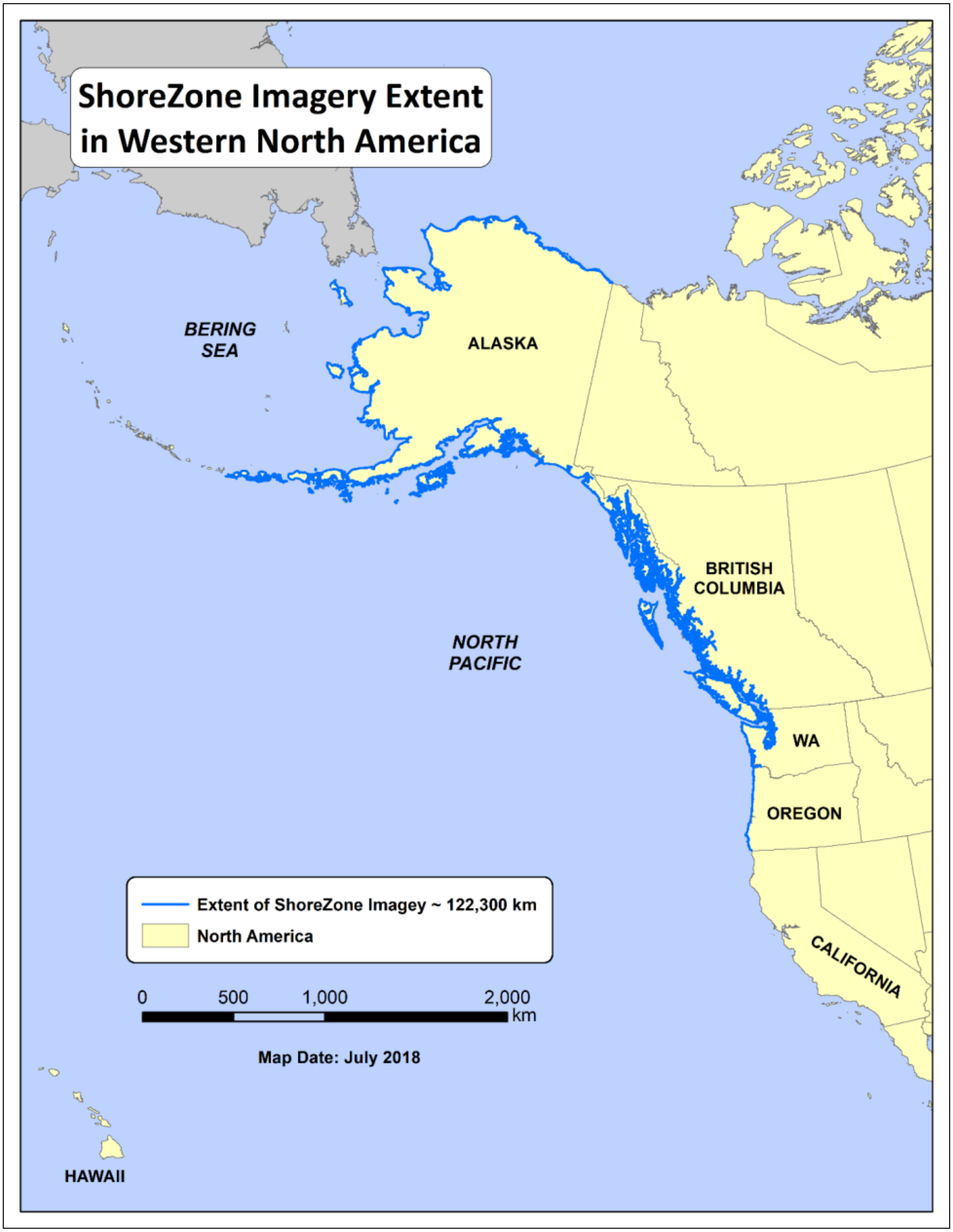

Figure 1. Extent of ShoreZone imagery in Alaska, British Columbia, Washington State and Oregon as of July 2018.

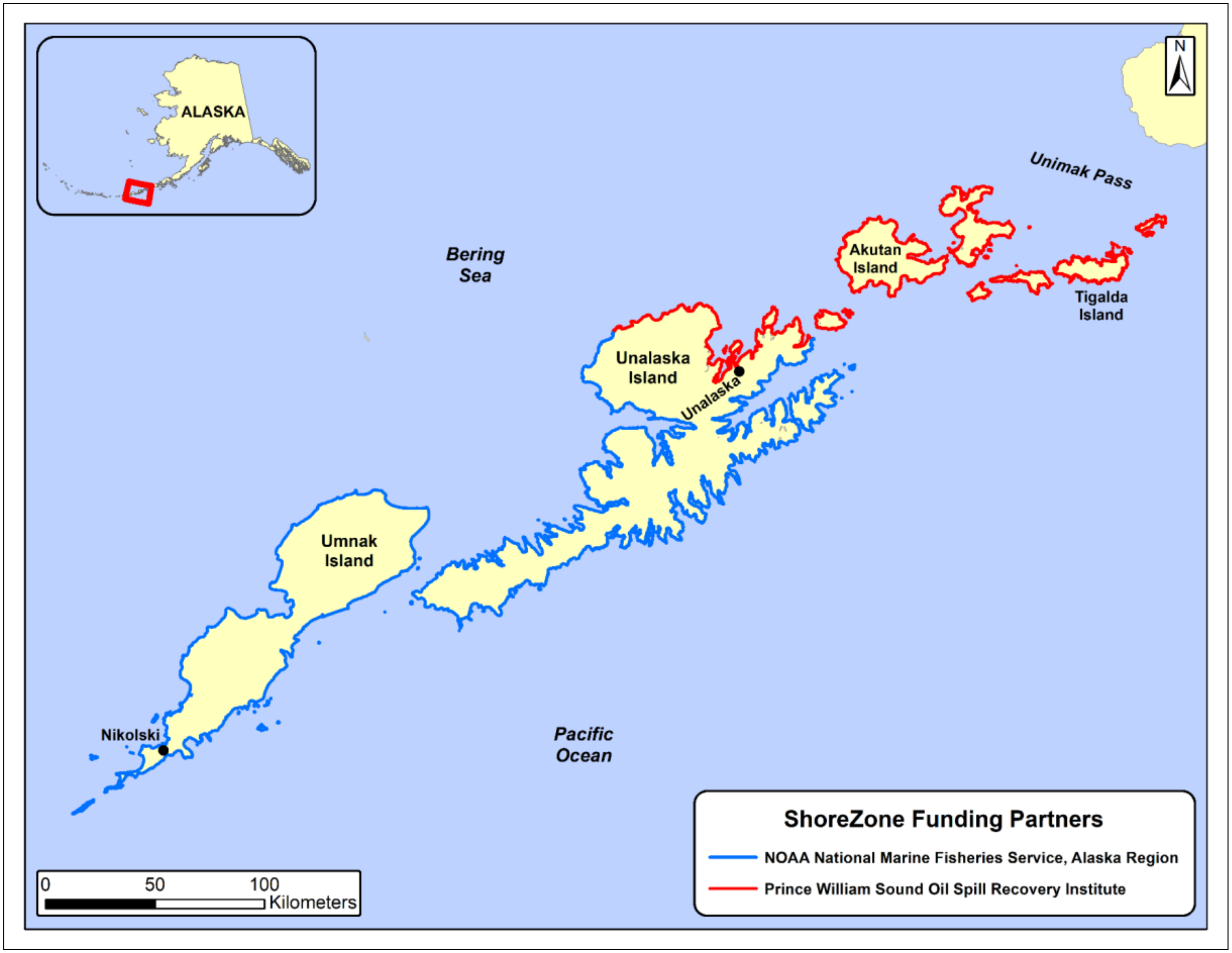

Figure 2. Extent of mapping and funding in the Eastern Aleutian Islands survey area.

2 Physical Attribute Data Summary

2.1 Coastal Class

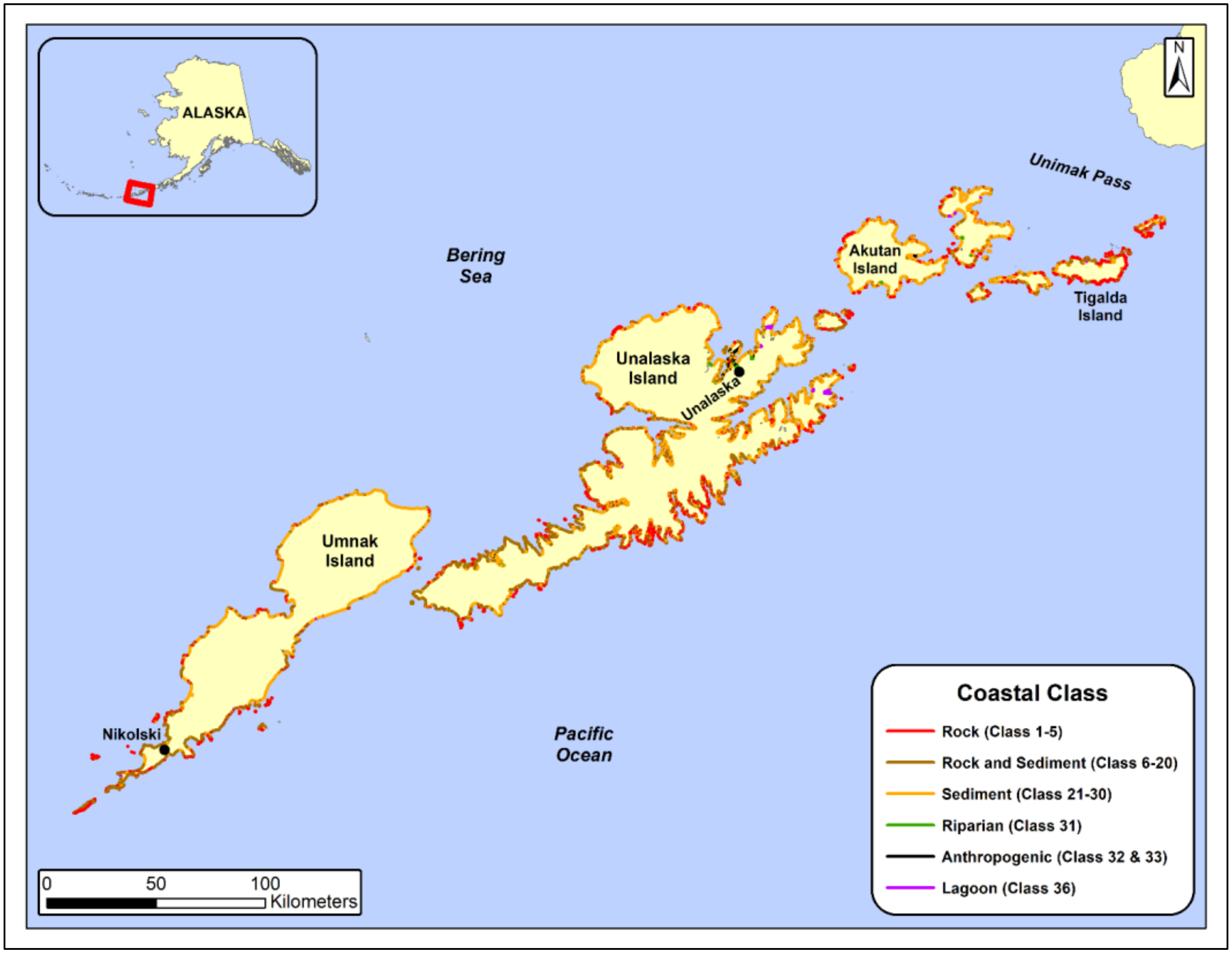

Figure 3. Map of the Coastal Class categories (also known as Shore Type) around the Eastern Aleutian Islands, grouped by type.

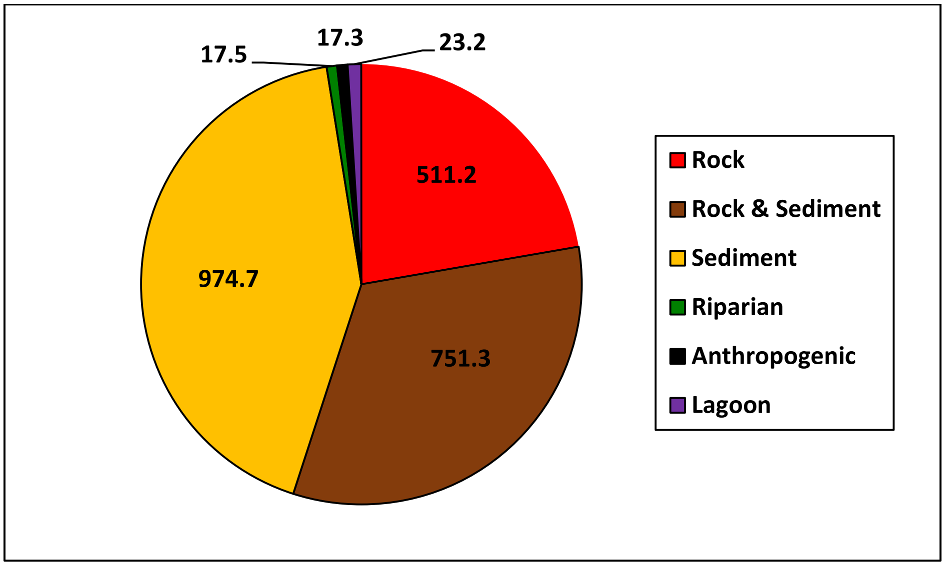

Figure 4. Grouped Coastal Class categories by shoreline length (km).

The Coastal Class is used to define along-shore coastal units based on the dominant process, geomorphic features and other attributes such as substrate size, across-shore width, and slope (Cook *et al*., 2017 after Howes *et al* 1994). The principal characteristics of each along-shore unit are used to assign one of 39 overall unit classifications. Sediment shorelines (42.5%) with Rock and Sediment shorelines (32.7%) dominated the Eastern Aleutian Islands survey area. Rock shorelines followed with 22.3% while Riparian, Anthropogenic and Lagoon shorelines all comprised 1% each of the coast (see Figures 3 and 4 for distribution and summary statistics). The description for each Coastal Class category in the survey area is given in Table 1. Photographic examples of the major Coastal Classes mapped in the Eastern Aleutian Islands survey area are found in Appendix A, Table A-1.

Table 1. Summary of Coastal Classes 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	9	52	<1	**22% 511 km**
	2	Rock Platform, wide	80	366	4	
	3	Rock Cliff	291	1,742	13	
	4	Rock Ramp, narrow	112	674	5	
	5	Rock Platform, narrow	10	122	1	
Rock & Sediment	6	Ramp w gravel beach, narrow	16	84	1	**33% 751 km**
	7	Platform w gravel beach, wide	91	380	4	
	8	Cliff with gravel beach	87	508	4	
	9	Ramp with gravel beach	171	1,016	8	
	10	Platform with gravel beach	19	113	1	
	11	Ramp w gravel & sand beach,	8	47	<1	
	12	Platform with G&S beach, wide	250	779	11	
	13	Cliff with gravel/sand beach	9	68	<1	
	14	Ramp with gravel/sand beach	60	353	3	
	15	Platform with gravel/sand beach	19	98	1	
	16	Ramp w sand beach, wide	1	12	<1	
	17	Platform w sand beach, wide	17.5	66	1	
	18	Cliff with sand beach	1	10	<1	
	19	Ramp w sand beach, narrow	1	8	<1	
	20	Platform w sand beach, narrow	1	2	<1	
Sediment	21	Gravel flat, wide	12	43	1	**43% 975 km**
	22	Gravel beach, narrow	356	1880	16	
	23	Gravel flat or fan	11	40	1	
	24	Sand & gravel flat or fan	90	254	4	
	25	Sand & gravel beach, narrow	336	1513	15	
	26	Sand & gravel flat or fan	37	138	2	
	27	Sand beach	20	38	1	
	28	Sand flat	73	144	3	
	29	Mudflat	<1	1	<1	
	30	Sand beach	50	127	2	
Organics	31	Organics/Estuarine	18	58	1	**1% 18 km**
Man-made	32	Man-made, permeable	15	76	1	**1% 17 km**
	33	Man-made, impermeable	2	8		
Lagoon	36	Lagoon	23	42	<1	**1% 23 km**
Totals:			***2,295***	***10,862***	***100***	***100%***

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

2.2 Environmental Sensitivity Index (ESI)

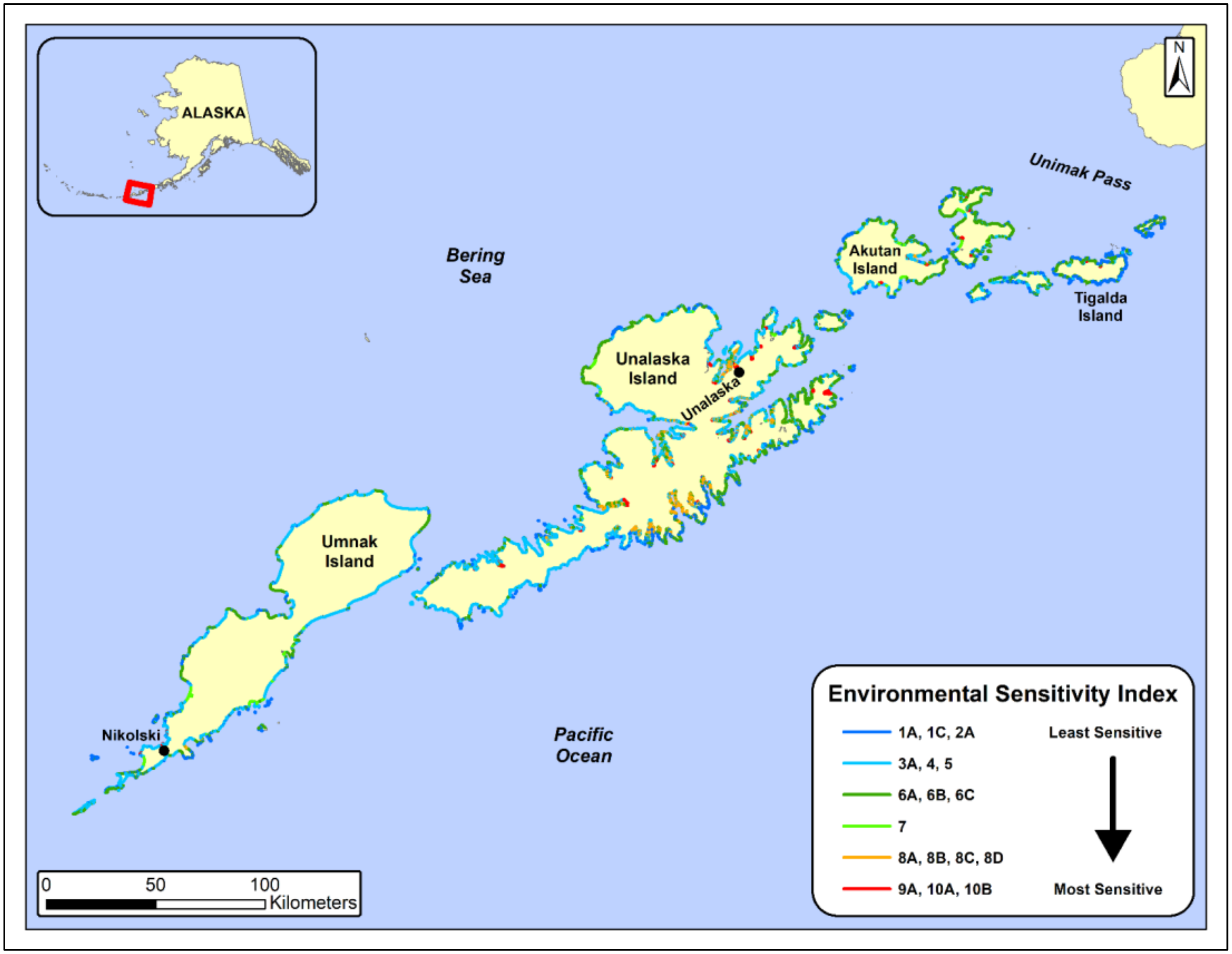

Figure 5. Distribution of the grouped ESI categories from least to most sensitive to oiling.

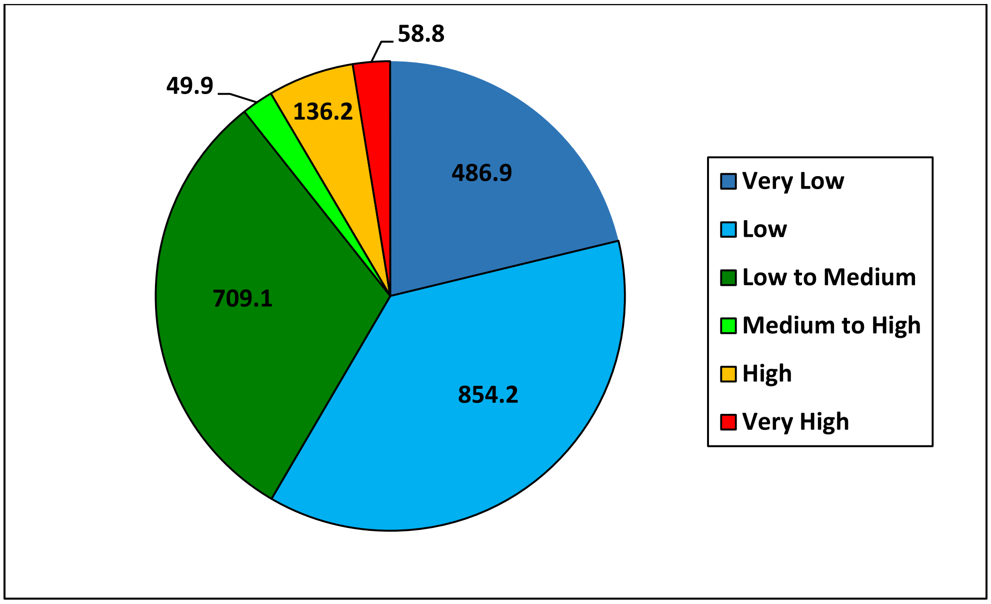

Figure 6. Grouped most sensitive ESI categories by shoreline length (km).

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 Low categories (89.3% of shoreline length). These sections of the shoreline have a potentially low sensitivity to oil. At the other end of the spectrum, only 10.7% of the shoreline was mapped with a potentially high sensitivity to oil (Figures 5 and 6). The summary of Shore Type by ESI class can be seen in Table 2.

Table 2. Summary of Coastal Classes 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	285	1,687	12
1C	Exposed rocky cliffs with boulder talus base	26	146	1
2A	Exposed wave-cut platforms in bedrock, mud, or clay	177	952	8
3A	Fine- to medium-grained sand beaches	63	177	3
4	Coarse-grained sand beaches	50	138	2
5	Mixed sand and gravel beaches	741	2,902	32
6A	Gravel beaches (granules and pebbles)	53	354	2
6B	Gravel beaches (cobbles and boulders)	654	3,384	29
6C	Rip rap	3	20	<1
7	Exposed tidal flats	50	116	2
8A	Sheltered scarps in bedrock, mud, or clay; sheltered rocky shores (impermeable)	85	545	4
8B	Sheltered, solid, man-made structures; sheltered rocky shores (permeable)	5	26	<1
8C	Sheltered Rip Rap	14	61	1
8D	Sheltered rocky rubble shores	33	185	1
9A	Sheltered tidal flats	24	74	1
10A	Salt- and brackish-water marshes	33	88	1
10B	Freshwater marshes	3	7	<1
	Totals:	***2,295***	***10,862***	***100***

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

2.3 Oil Residence Index (ORI)

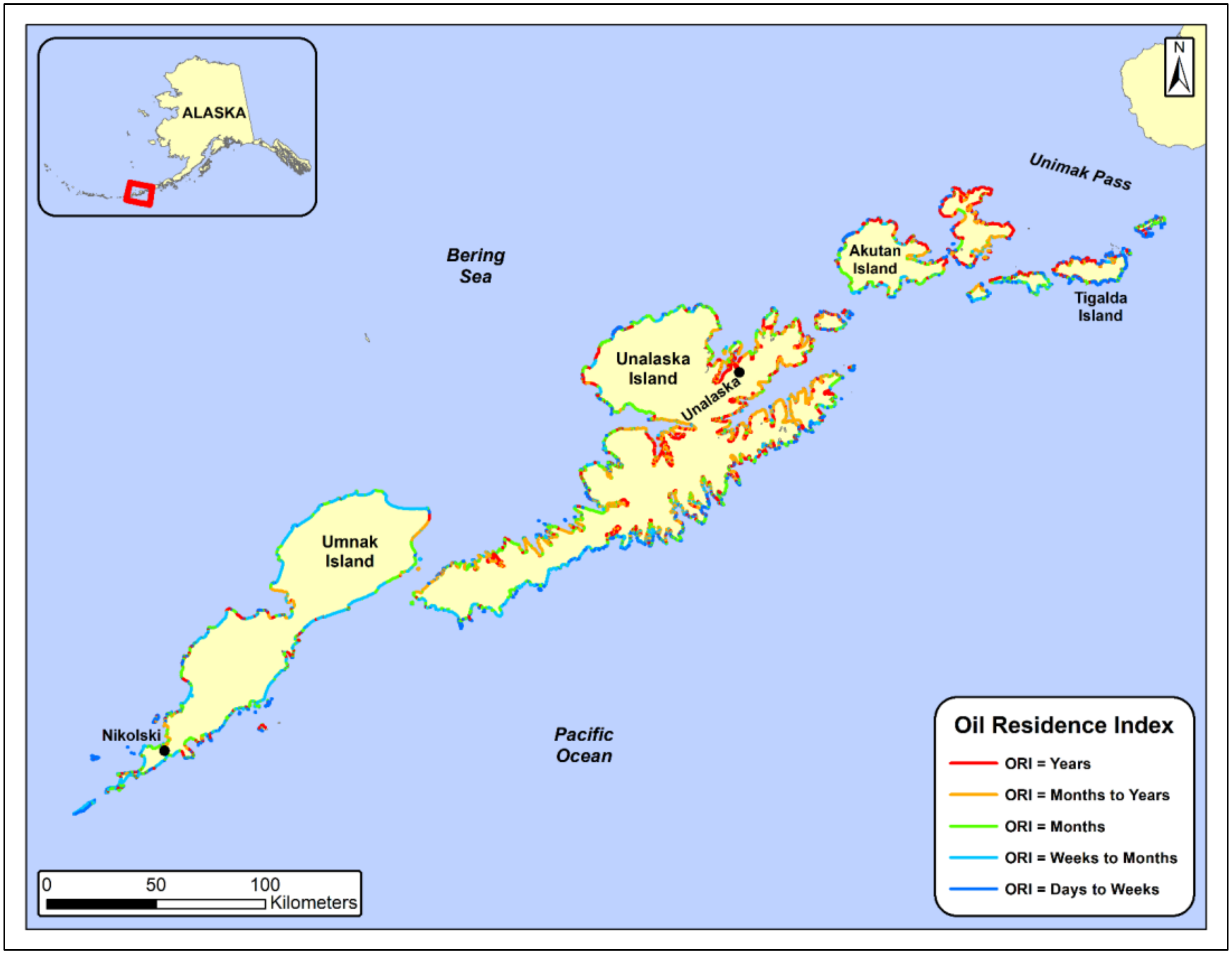

Figure 7. Distribution of the Oil Residence Index (ORI) categories.

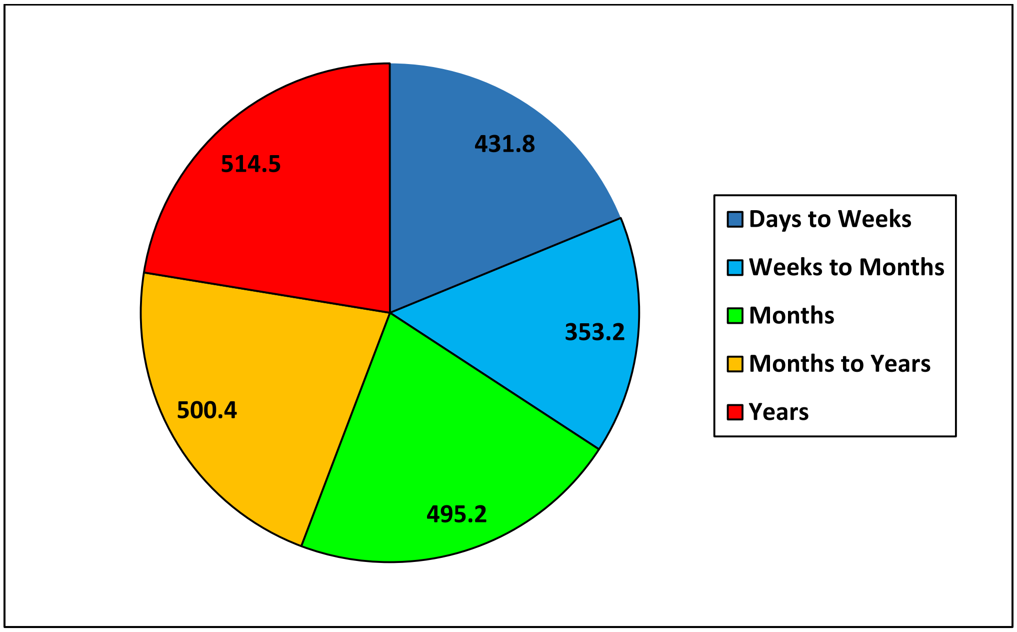

Figure 8. Oil Residence Index (ORI) categories by shoreline length (km).

The Oil Residence Index (ORI) is a rating between 1 and 5 with a value of 1 indicating a relatively short oil residence (days to weeks) while a value of 5 reflects potentially very long oil residence times (years). An ORI value is applied to each alongshore unit and to each across-shore component based on sediment texture and wave exposure (Cook *et al*. 2017). The ShoreZone ORI was developed by Dr. John Harper based on his many years of experience with cleaning up oiled shorelines, starting with the Exxon Valdez spill in Prince William Sound in Alaska. Higher wave exposures and consolidated sediments lead to lower ORI values for 55.8% of the shore segments in the Eastern Aleutian Island survey area, indicating oil residence times are on the order of weeks to months (see Figures 7 and 8 for distribution and summary statistics).

2.4 ShoreZone Coastal Vulnerability

2.4.1 Flood Zone Width

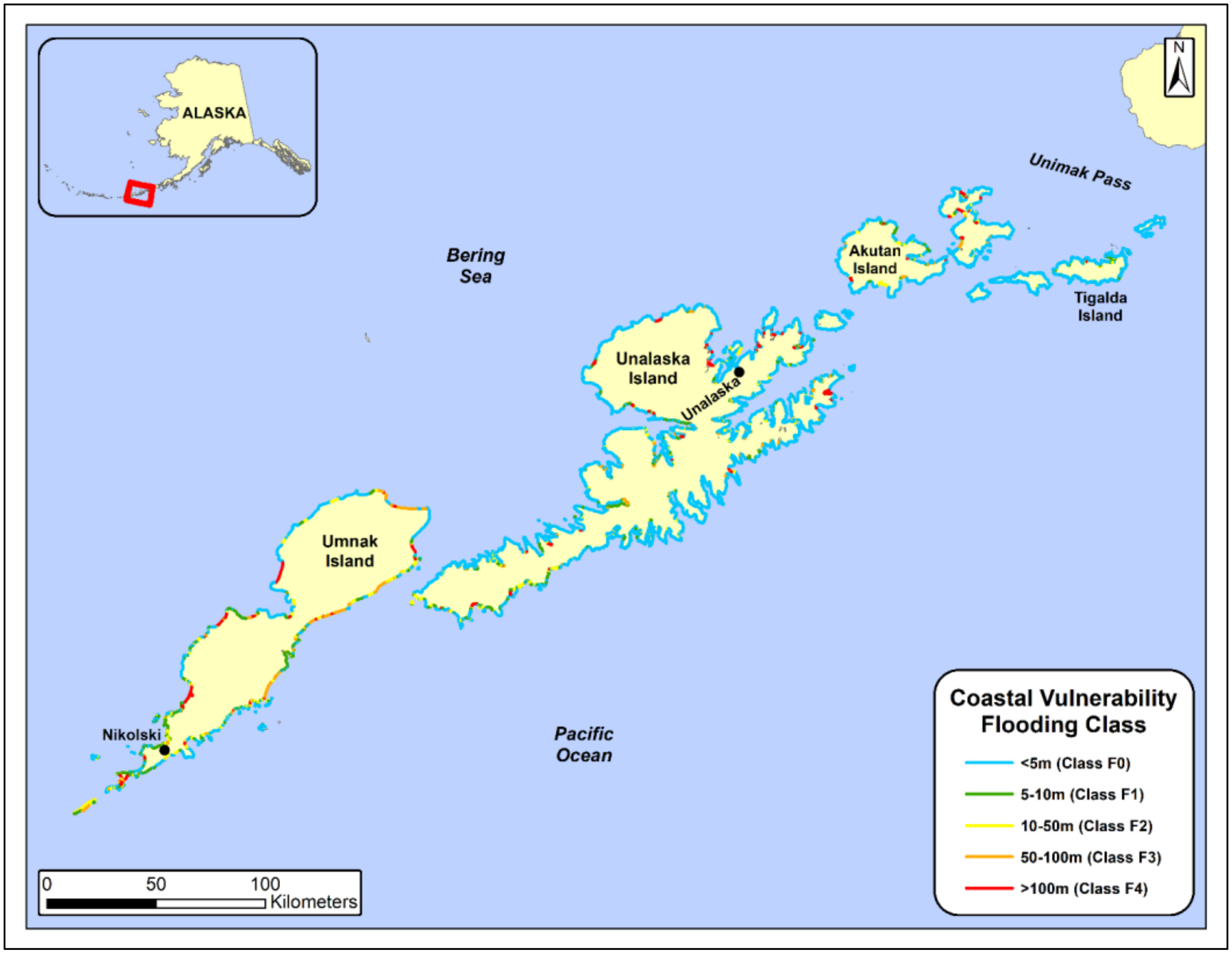

Figure 9. Distribution of the Coastal Vulnerability Flooding Class.

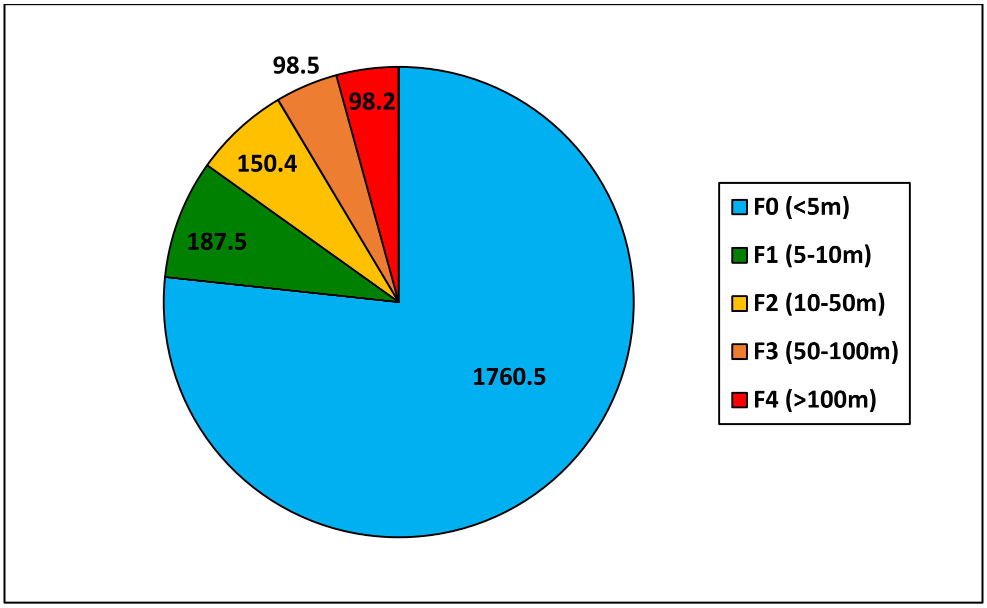

Figure 10. Flooding Class categories by shoreline length (km).

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 77% 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

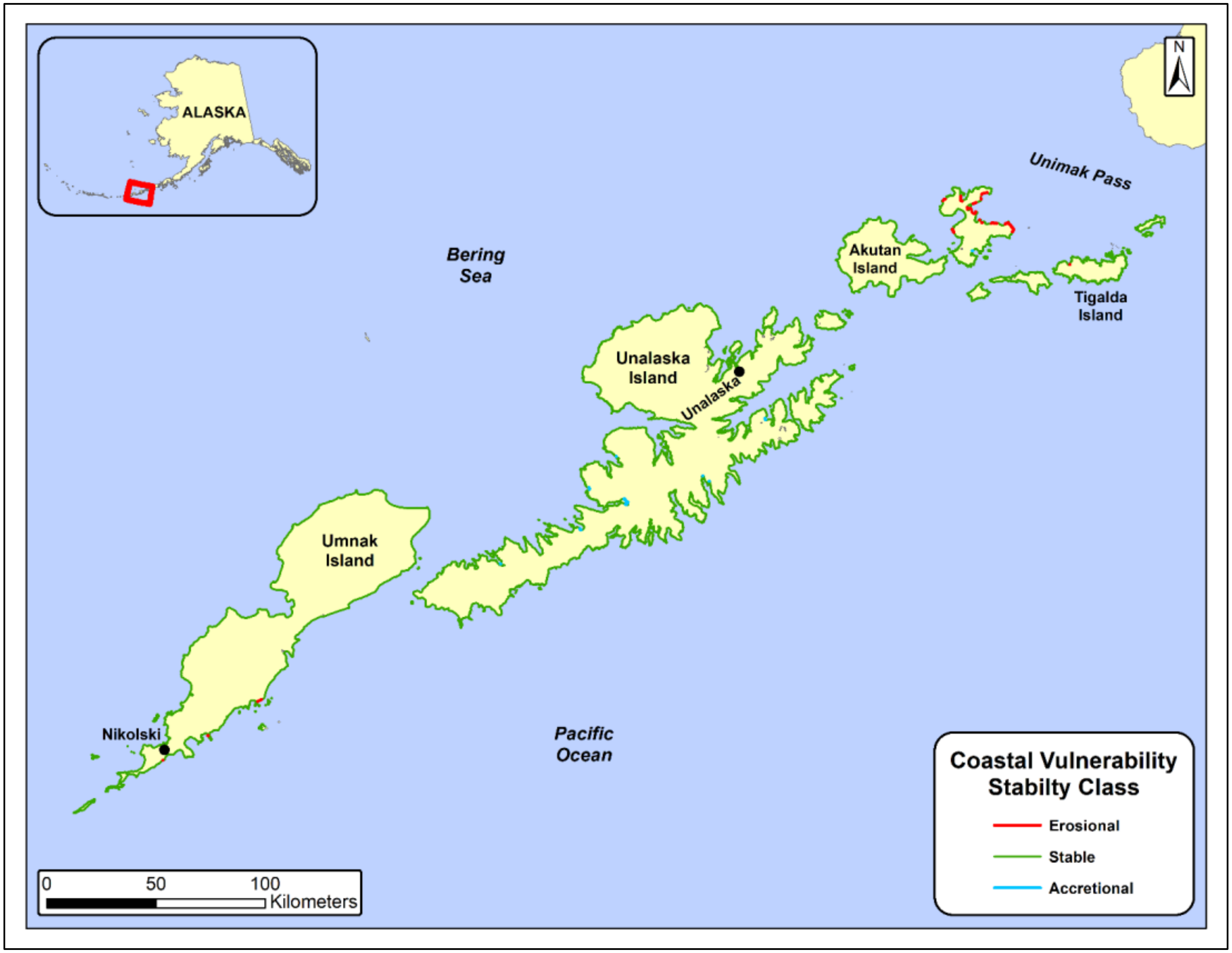

Figure 11. Distribution of the Coastal Vulnerability Shoreline Stability Index

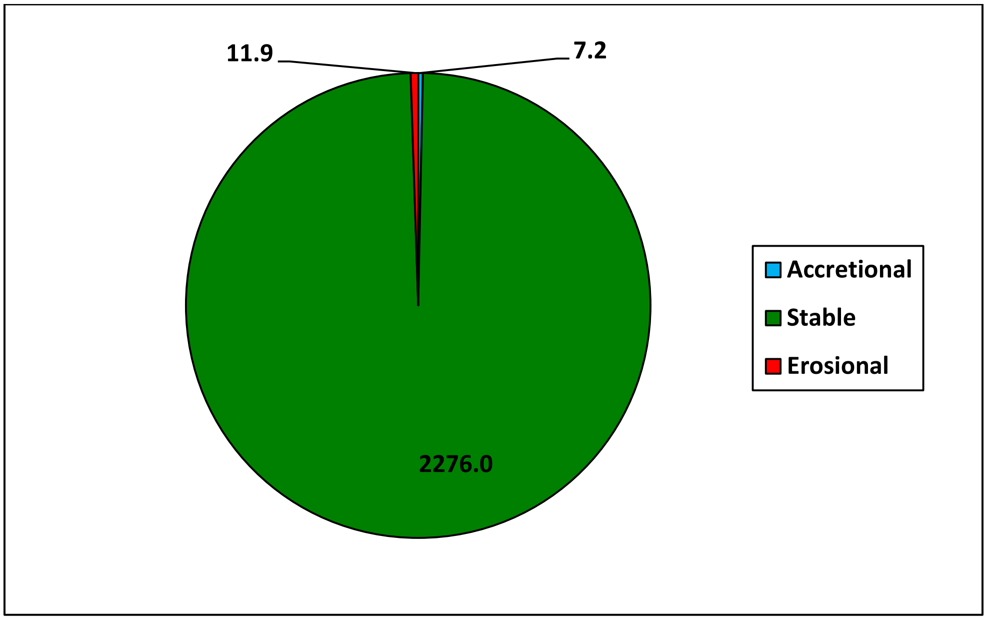

Figure 12. Shoreline Stability Index categories by shoreline length (km).

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

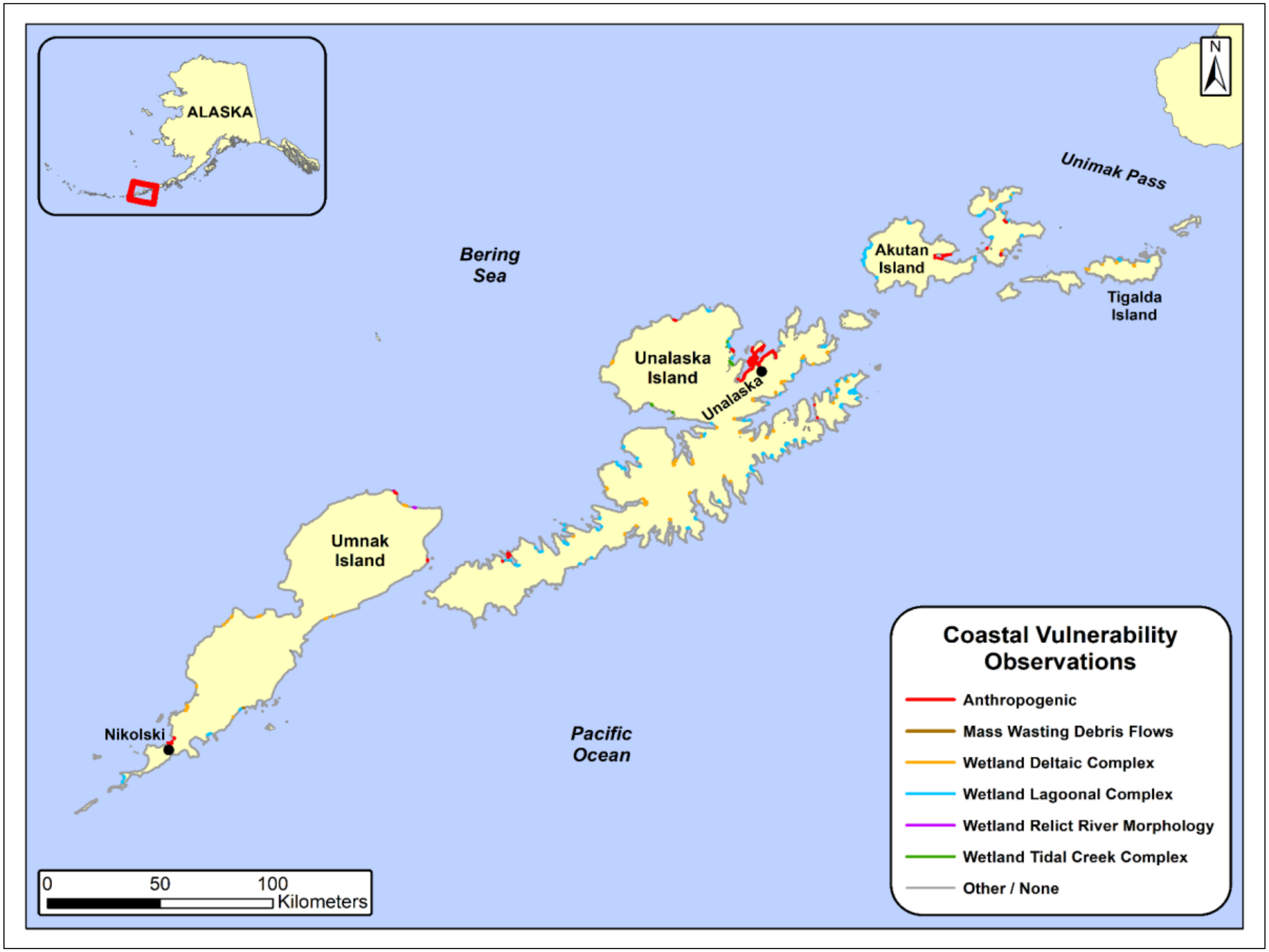

Figure 13. Distribution of the Coastal Vulnerability Observations categories.

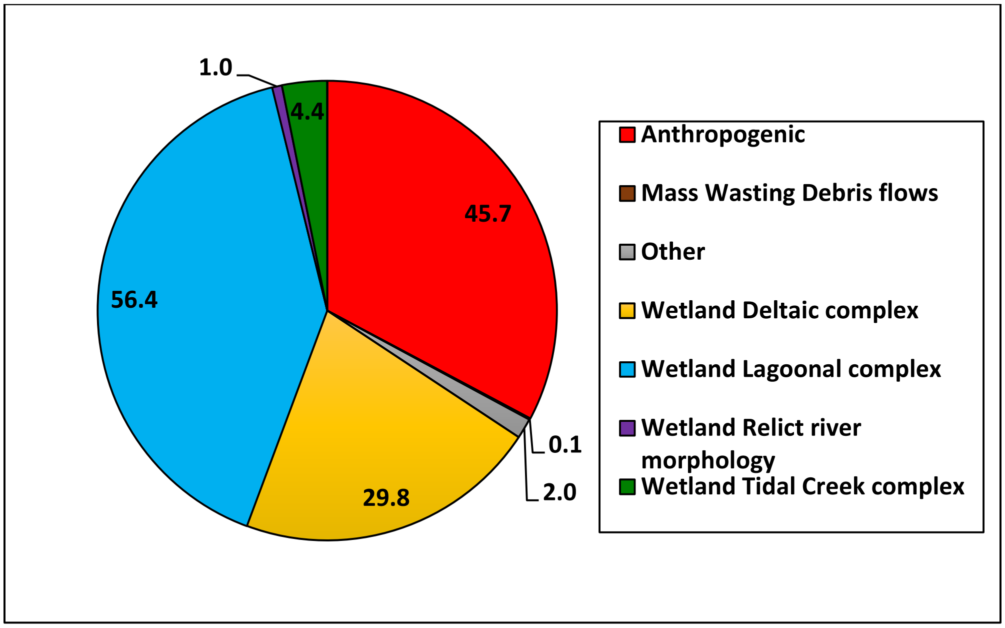

Figure 14. Coastal Vulnerability Observations categories by shoreline length (km). Category 'None' not shown.

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 Wetland Lagoonal complex category with 56.4 km and the Anthropogenic category with 45.7 km (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). When we first attempted to calculate the CVI for the portion of the shoreline funded in the Eastern Aleutians by OSRI, it did not match the observations of the mappers as it appeared to rank too much of the rocky, steep shoreline as High or Very High in terms of vulnerability to sea level rise. After analysis of the data, we determined this was due to using a relative ranking system where the values from the study area were only compared to each other to determine the CVI rank. To resolve this issue we calculated an absolute value for each CVI rank which is described in the latest version of the protocol (Cook *et al*., 2017). The proportion of CVI rank by shoreline length is shown in Figure 15 and the distribution of ranks in the survey area is shown in Figure 16. Under the new absolute ranking system, only 7% of the shoreline of the Eastern Aleutians is ranked as High vulnerability to sea level rise, while no shoreline was ranked as Very High. This is a more consistent result with mapper observations during review of the imagery.

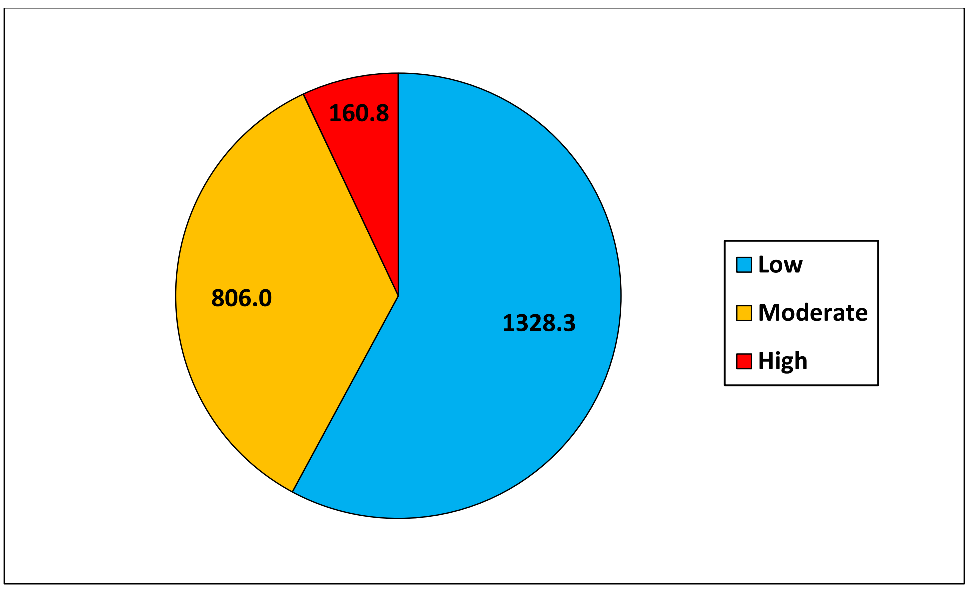

Figure 15. Coastal Vulnerability Index ranks by shoreline length (km).

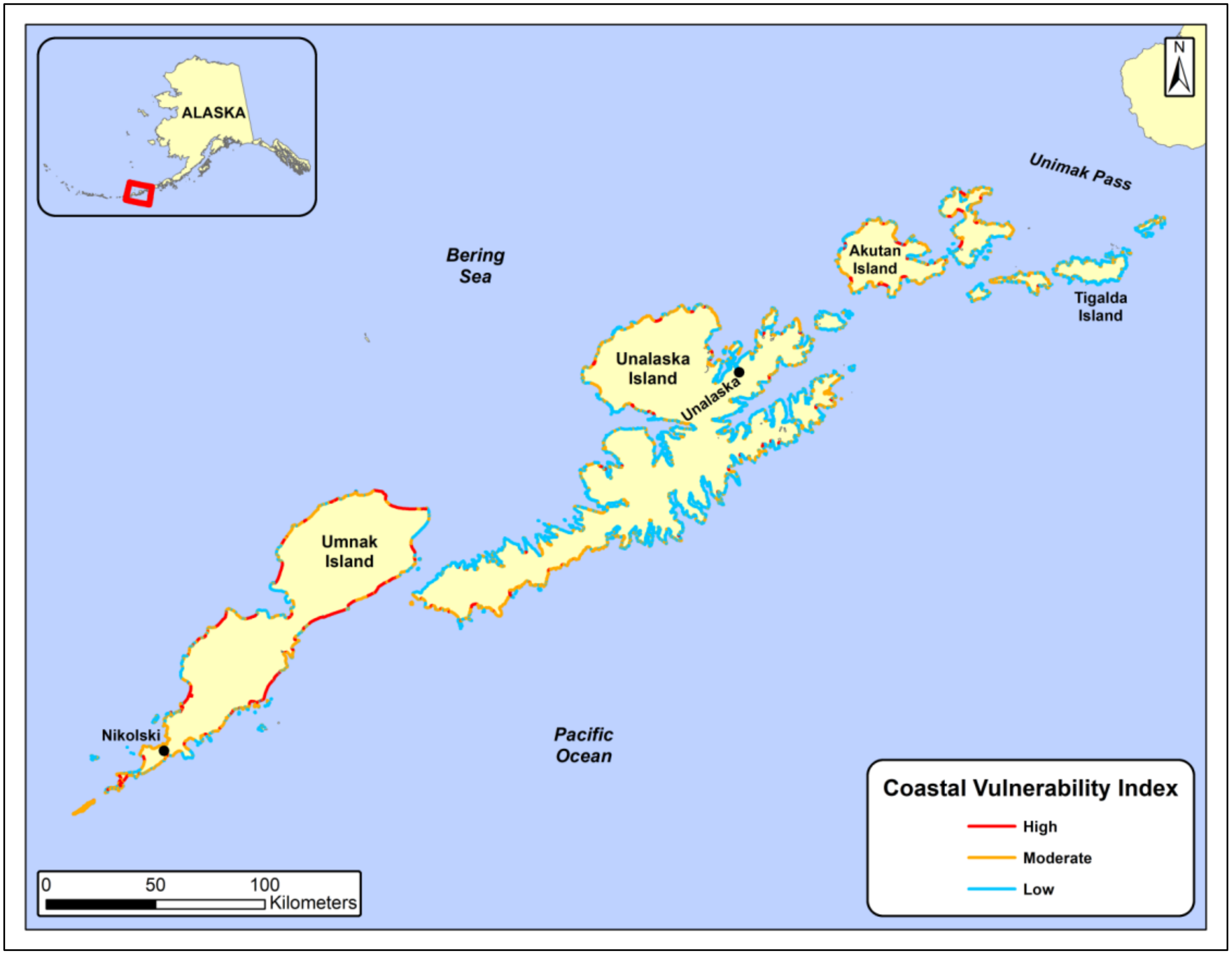

Figure 16. Distribution of Coastal Vulnerability index ranks in the Eastern Aleutians survey area.

2.5 Anthropogenic Shore Modifications

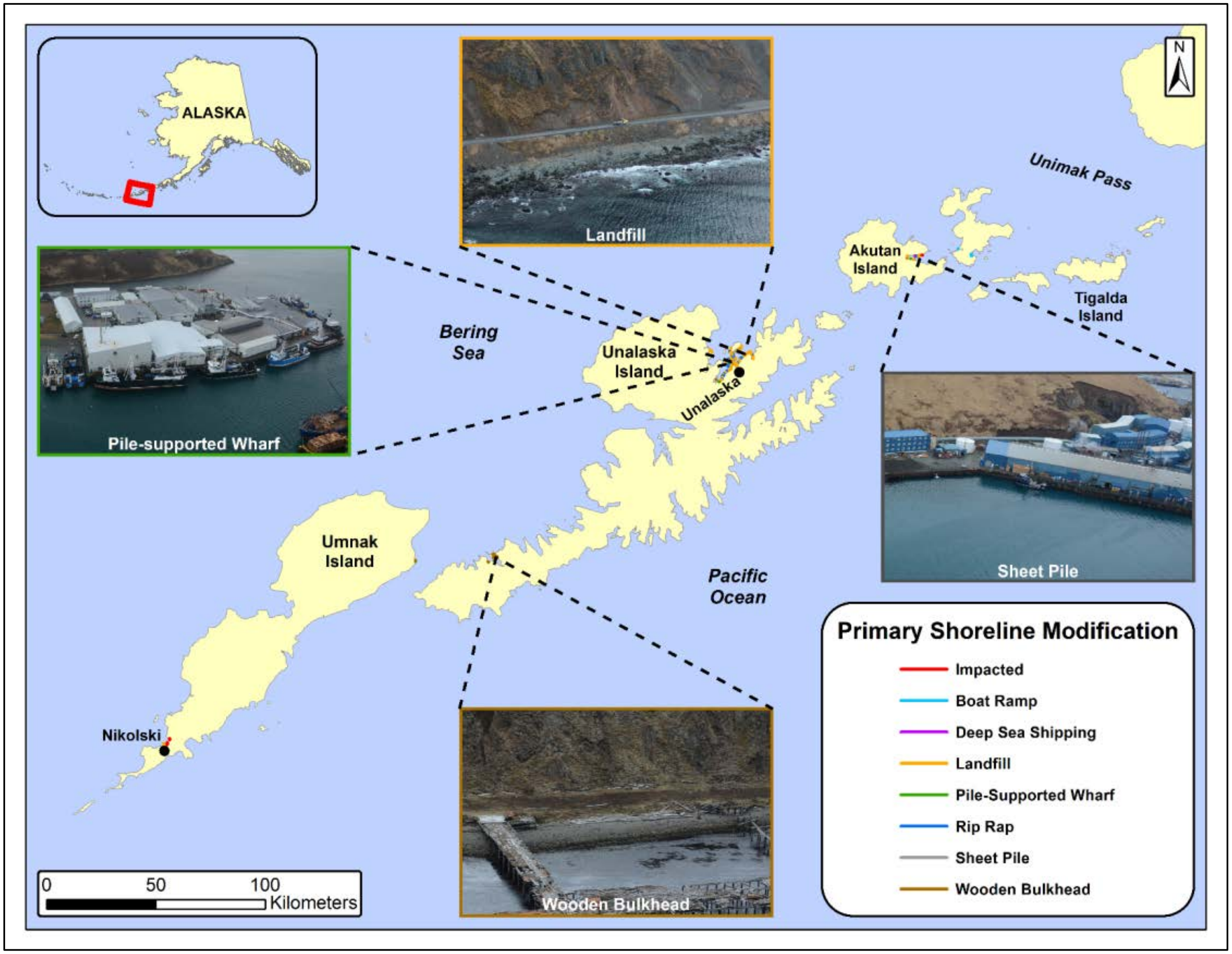

Figure 17. Distribution of types of the primary Shore Modifications. There may be other shore modifications in any given unit. That data would be found in the Shore Modifications table in the geodatabase.

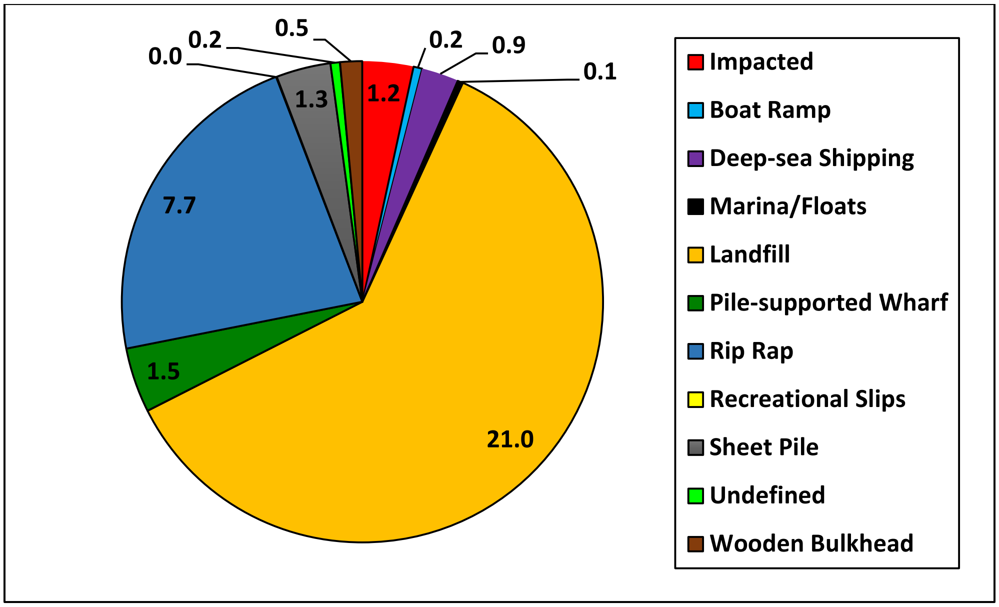

Figure 18. Shore Modifications by estimated shoreline length (km) of each modification type.

The Shoreline Modification attribute provides a thorough catalogue of the specific types of anthropogenic modification in each unit (Cook *et al*., 2017). This includes many modifications within a given unit. For example, if both riprap and a pile-supported wharf occur, both are catalogued in the appropriate zone of that unit with an estimate of the alongshore length of the unit that modification covers. A total of 1.5% of the shoreline (taking the estimated length of that modification within the unit into account) exhibits shore modifications in the Eastern Aleutian Islands study area (Figure 18). Landfill was the most commonly recorded observation (60.7%) with Rip Rap (22.3%) and Sheet Pile (3.7%). The associated map (Figure 17) shows the distribution of primary shore modifications though it should be noted that any given modification is necessarily along the entire length of the indicated shore unit. The Geodatabase delivered with this report displays each shore modification with a specific length category (meters) along the shoreline pertaining to each unit as well as the specific zone (supratidal or intertidal) the modification occurs in.

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 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 the Eastern Aleutians survey area are summarized in Tables 3 and 4. The most commonly occurring intertidal biobands in the survey areas were Barnacles and Filamentous and Foliose Red Algae with both being found in over half the units with Winter Laver and Brown Bladed Kelps being the next most common in just under half the units. The most common Splash Zone bioband was Black Lichen, occurring in 67% of the units while the Dune Grass bioband was found in 44% of units. The most common subtidal biobands found were Brown Bladed Kelps (44%), Dark Brown Kelps (23%), Dragon Kelp (25%) and Bull Kelp (31%). All the most common biobands were typically associated with semi-exposed to exposed rock or rock and sediment 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		
Salt Marsh	SAMA	Upper to Mid-Intertidal (B)	1	20	1	1	4	0	0	27	<1
Wetland Vegetation	WEVE		0	13	4	1	13	0	0	31	<1
Winter Laver	WILA		50	3967	471	16	1	1	4	4510	42
Barnacle	BARN		131	6408	452	43	3	2	7	7046	65
Rockweed	ROCK		69	2002	130	4	0	1	1	2207	20
Blue Mussels	BLMU		19	127	5	1	0	0	0	152	1
Green Algae	GRAL		163	3909	218	8	1	0	1	4300	40
Filamentous and Foliose Red Algae	FFRA		77	5737	575	24	3	2	1	6419	59
Brown Bladed Algae	BRBA	Lower Intertidal (B)	66	4613	301	27	5	4	26	5042	46
Soft Brown Kelps	SOBK		19	185	38	3	0	0	0	245	2
Dark Brown Kelps	DABK		64	2127	600	55	5	2	4	2857	26
Eelgrass	EELG		0	8	2	0	0	0	0	10	<1
Anemones	ANEM		8	1	0	0	0	0	0	9	<1
Sponges	SPON		3	0	0	0	0	0	0	3	<1
Coralline Red Algae	CORA		118	2673	132	5	0	1	5	2934	27

*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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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)	59	631	442	0	1132	10
Black Lichen	BLLI		1399	3690	2153	0	7242	67
Yellow Lichen	YELI		138	527	272	0	937	9
White Lichen	WHLI		93	144	17	0	254	2
			<10 m	10-30 m	>30 m	Bioband Present, Width Category Not Assessed		
Dune Grass	DUGR	Supratidal (A)	4011	516	279	17	4823	44
Grasses	GRAS		105	19	10	0	134	1
Salt Marsh	SAMA		42	3	0	0	45	<1
Wetland Vegetation	WEVE		57	3	17	0	77	<1
Eelgrass	EELG	Subtidal (C)	2	8	1	7	18	<1
Brown Bladed Algae	BRBA		603	125	43	4028	4799	44
Soft Brown Kelps	SOBK		31	6	1	195	233	2
Dark Brown Kelps	DABK		59	35	14	2389	2497	23
Urchin Barren	URBA		31	60	107	52	250	2
Brown Canopy Kelp	BRCA		56	144	146	158	504	5
Dragon Kelp	DRKE		1109	885	485	199	2678	25
Bull Kelp	BUKE		446	863	1429	619	3357	31

*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 4% of units (see Figures 19 and 20 for graph of proportion and distribution map). It is likely the occurrence 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 Dune Grass and Grasses biobands are shown together in the distribution map in Figure 20. 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 or a terrestrial grass. Dune Grass 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 (<10m wide) was most common in the Eastern Aleutians survey area, often growing at the base of cliffs and talus slopes on the more exposed coastline. 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 20.

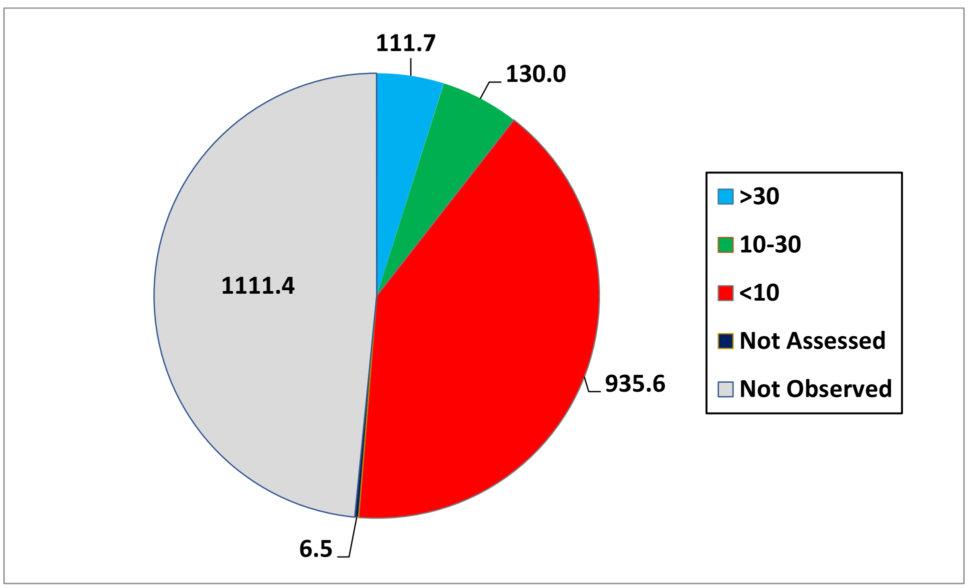

Figure 19. Proportion of shoreline length of the supratidal Dune Grass (DUGR) bioband by width category.

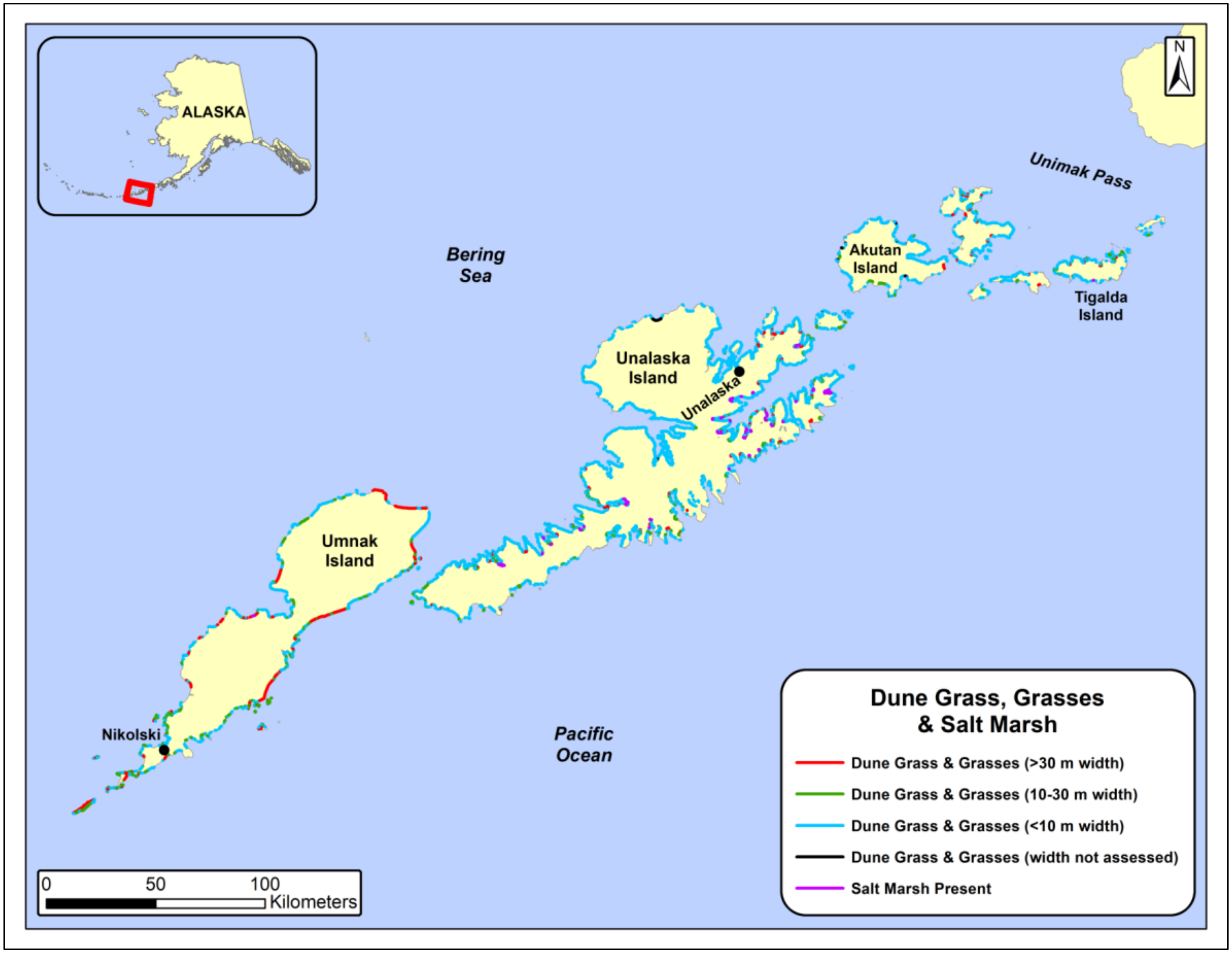

Figure 20. Distribution of the Dune Grass (DUGR) and Grasses (GRAS) biobands by width category and the presence of Salt Marsh (SAMA) in the supratidal (A zone).

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 for the graph of distribution (Figure 21) and the distribution map (Figure 22) as the difference between these three bands 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 any kelp bioband 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 22. 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.

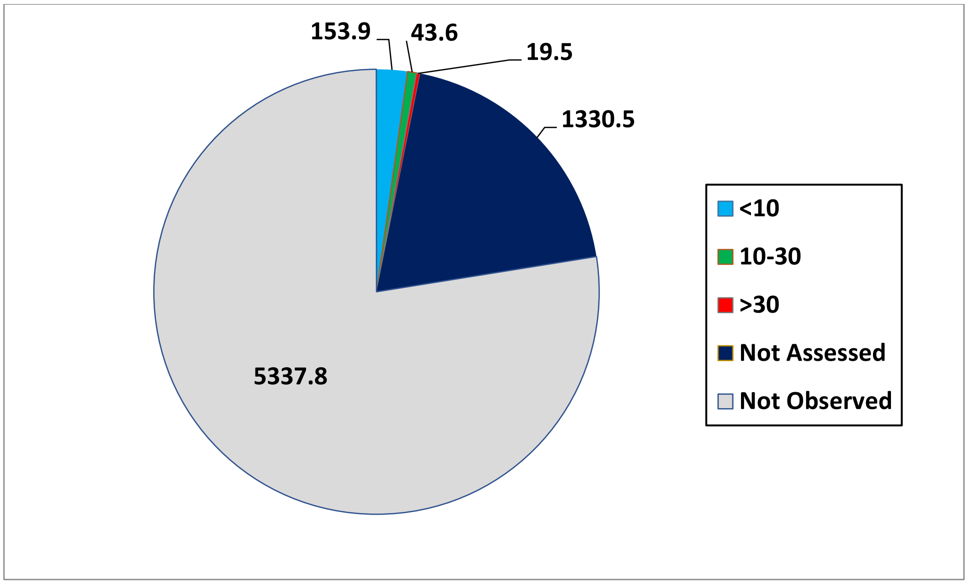

Figure 21. Distribution of the subtidal Bladed Kelps biobands (combination of BRBA, SOBK and DABK) by width category and shoreline length (km).

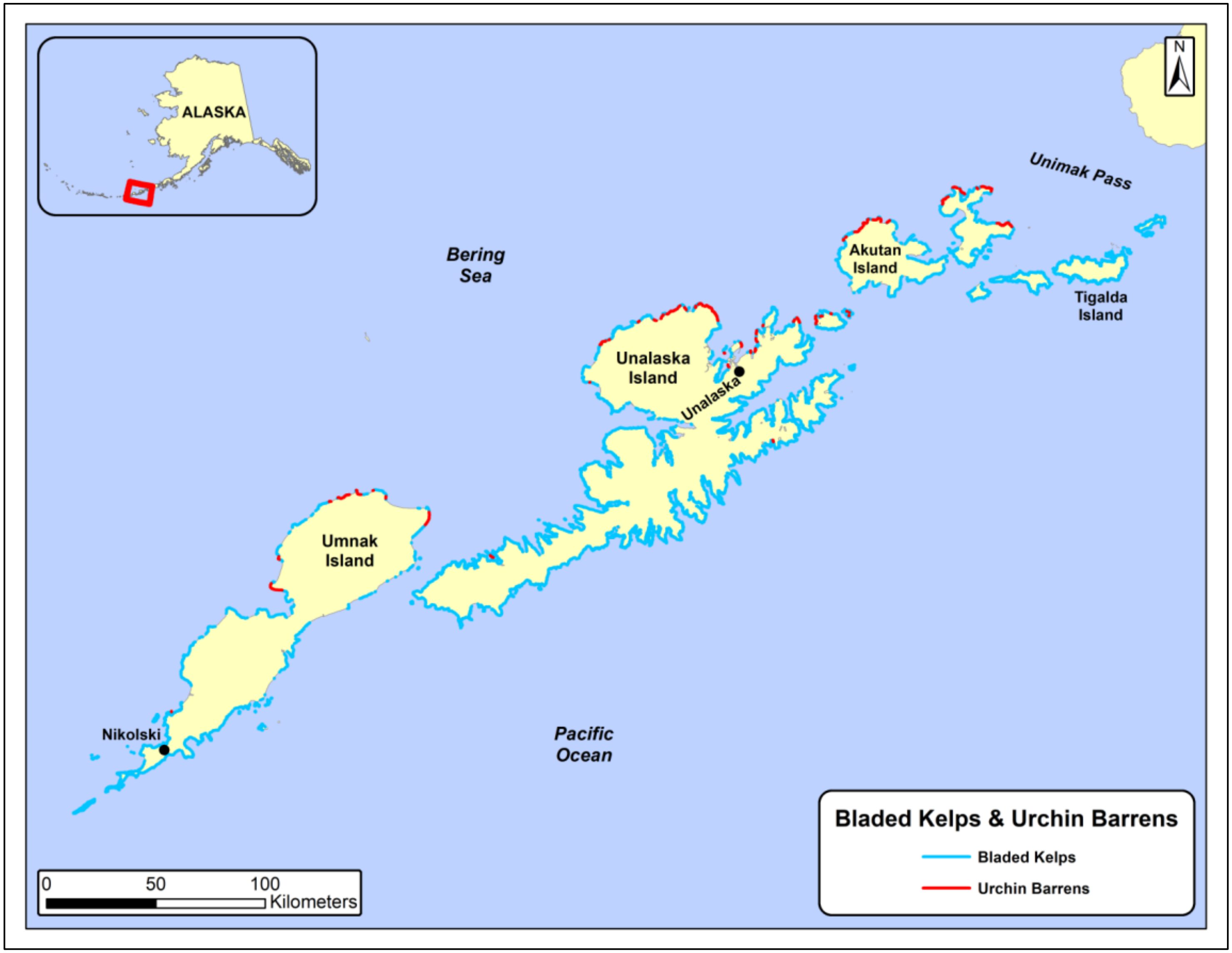

Figure 22. Distribution of the Bladed Brown Kelps (BRBA), Dark Brown Kelp (DABK) and Soft Brown Kelp (SOBK) Biobands (referred to as Bladed Kelps on the map) in the intertidal or subtidal (B or C zones) and the Urchin Barren (URBA) bioband. Please note that Bladed Kelps generally co-occur with Urchin Barrens.

The Coralline Red Algae (CORA) bioband was found in 27% of the units in the survey area (see Figure 23 for distribution statistics of percent cover and Figure 24 for map of the distribution of percent length of unit). 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 23), although it tended to be found along a greater percent length of the unit, as seen in Figure 24.

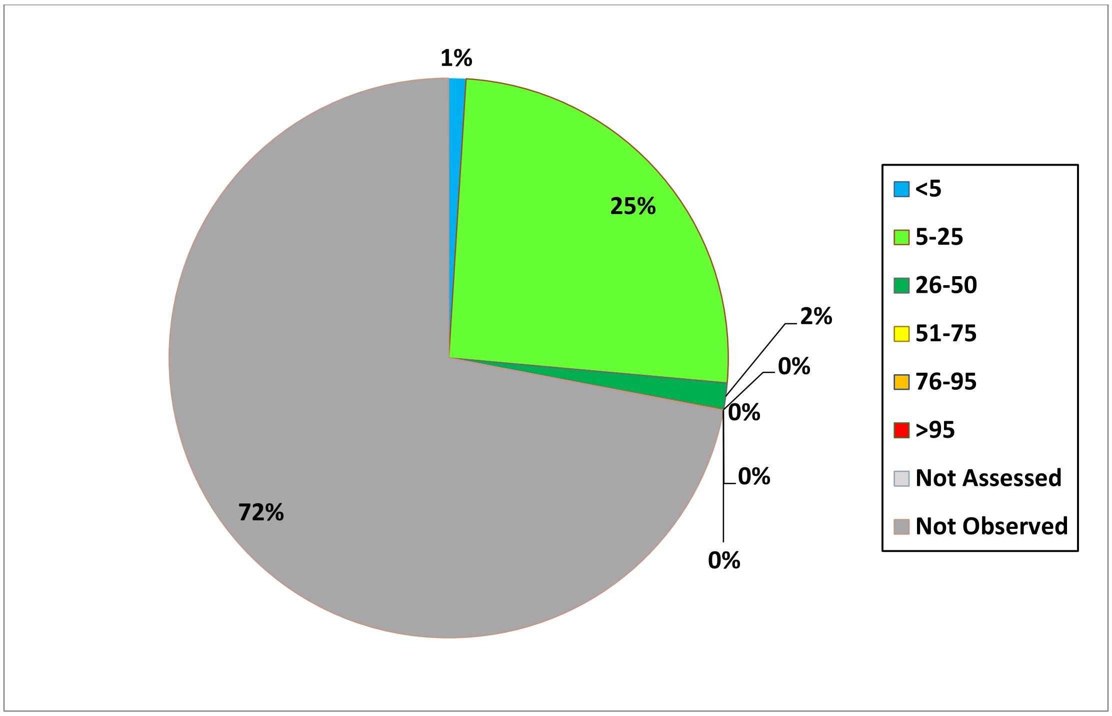

Figure 23. Distribution of the intertidal Coralline Red Algae (CORA) bioband by percent cover category and shoreline length (km).

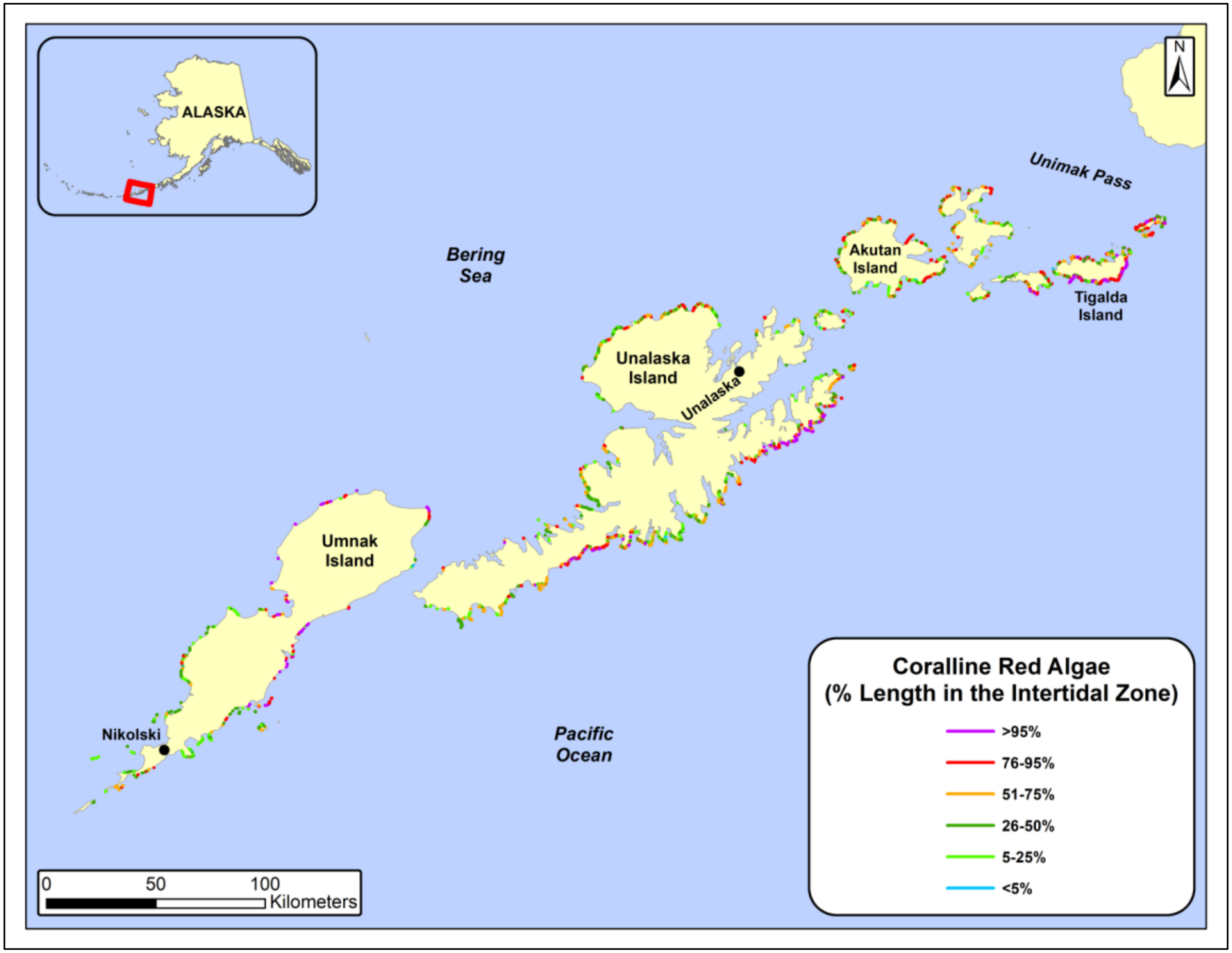

Figure 24. Distribution of the Coralline Red Algae (CORA) bioband by percent alongshore length of the unit in the intertidal (B zone).

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 25 to 27 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.

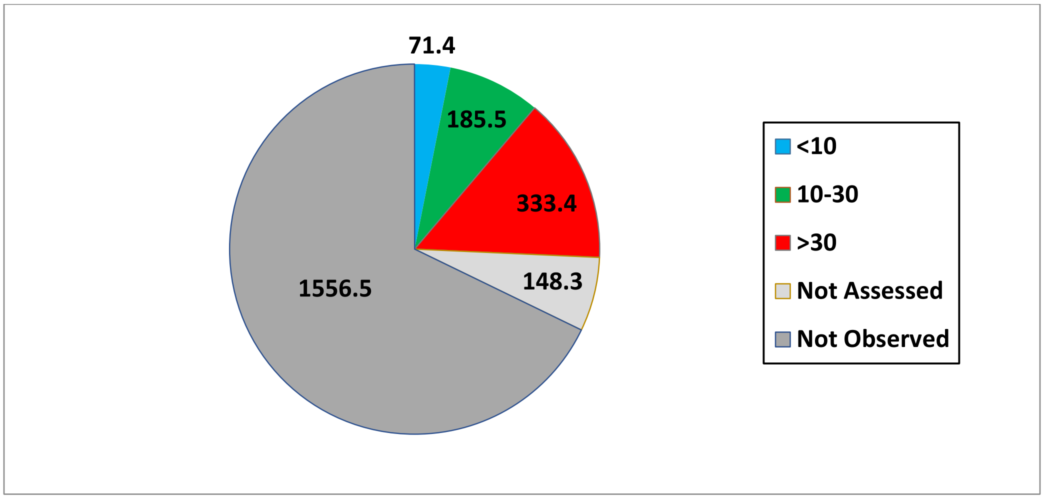

Figure 25. Distribution of the subtidal Bull Kelp (BUKE) bioband by width category and shoreline length (km).

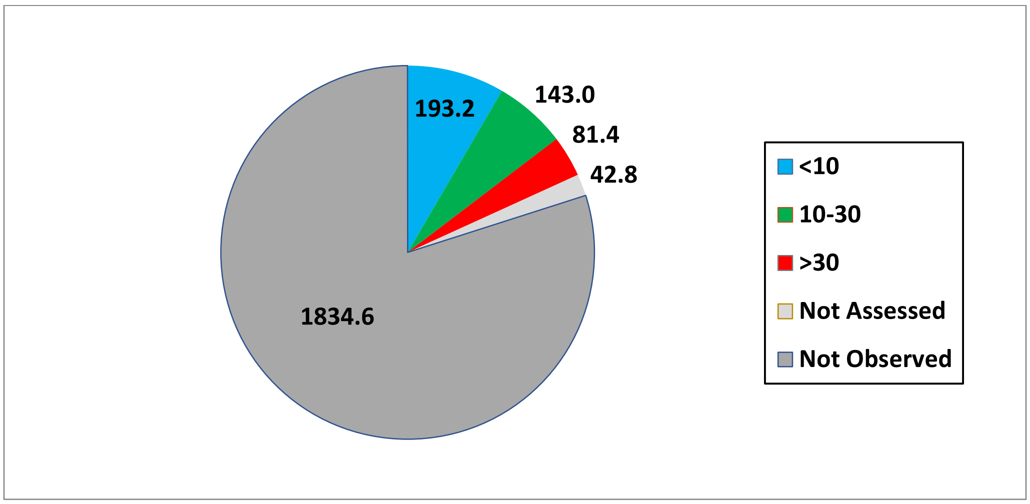

Figure 26. Distribution of the subtidal Dragon Kelp (DRKE) bioband by width category and shoreline length (km).

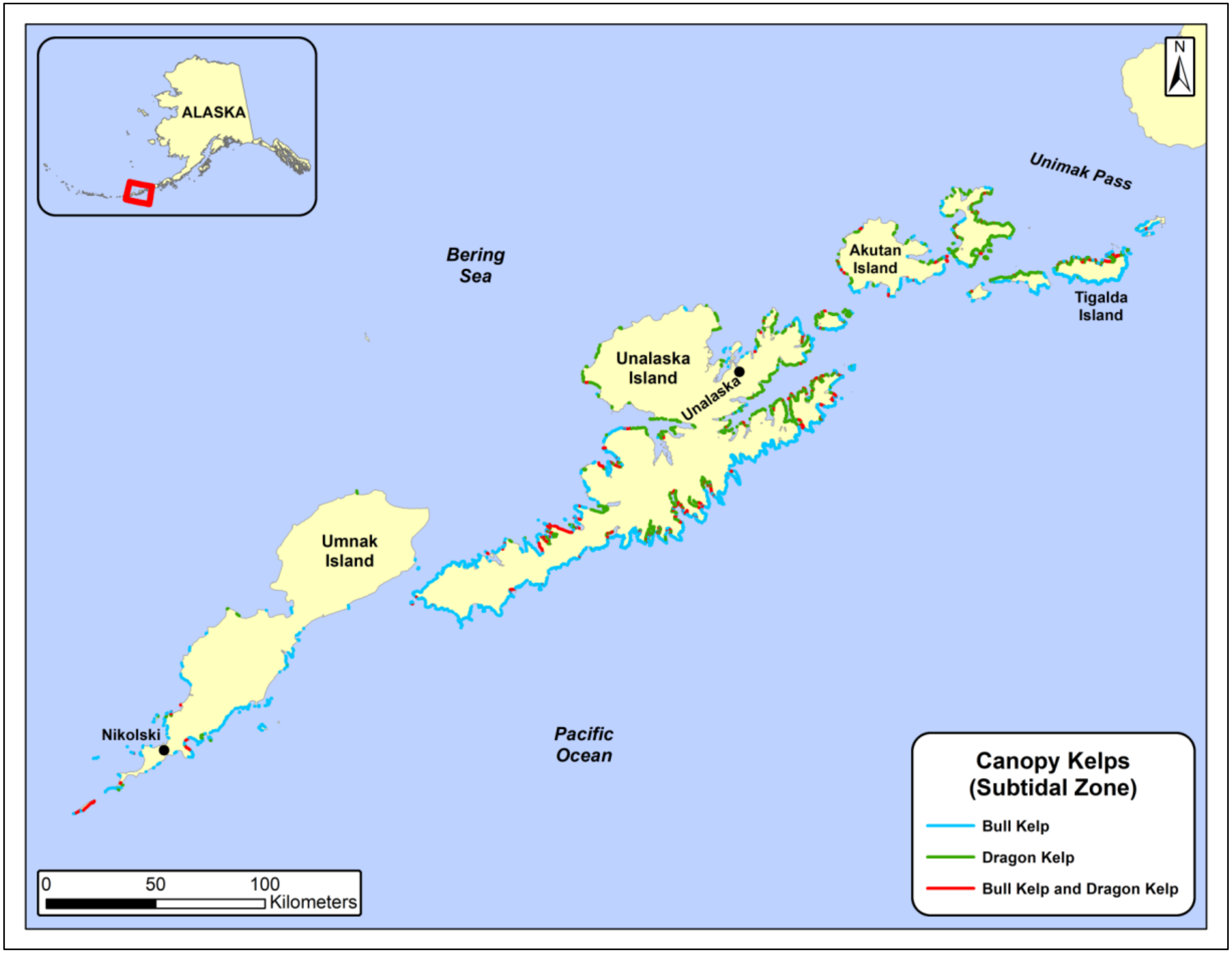

Figure 27. Distribution of the canopy kelp biobands, Bull Kelp (BUKE) and Dragon Kelp (DRKE) in the survey area.

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 28 and a distribution map of the categories is shown in Figure 29. Most of the coastline was in the higher exposure categories of Semi-Exposed or Exposed (62%) 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.

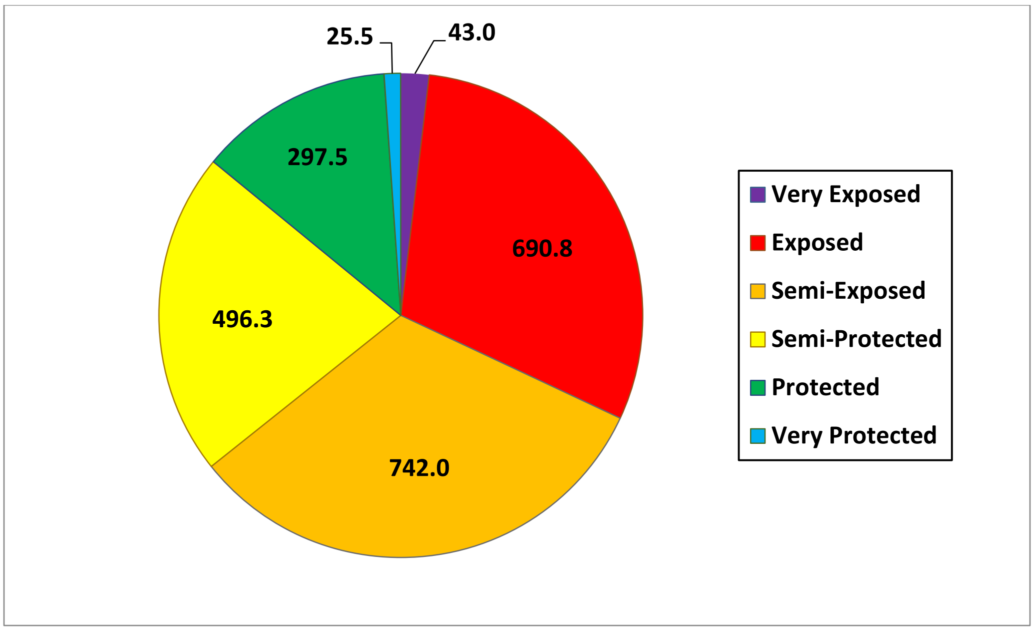

Figure 28. Distribution of biological wave exposures mapped in the Eastern Aleutians survey area by shoreline length (km).

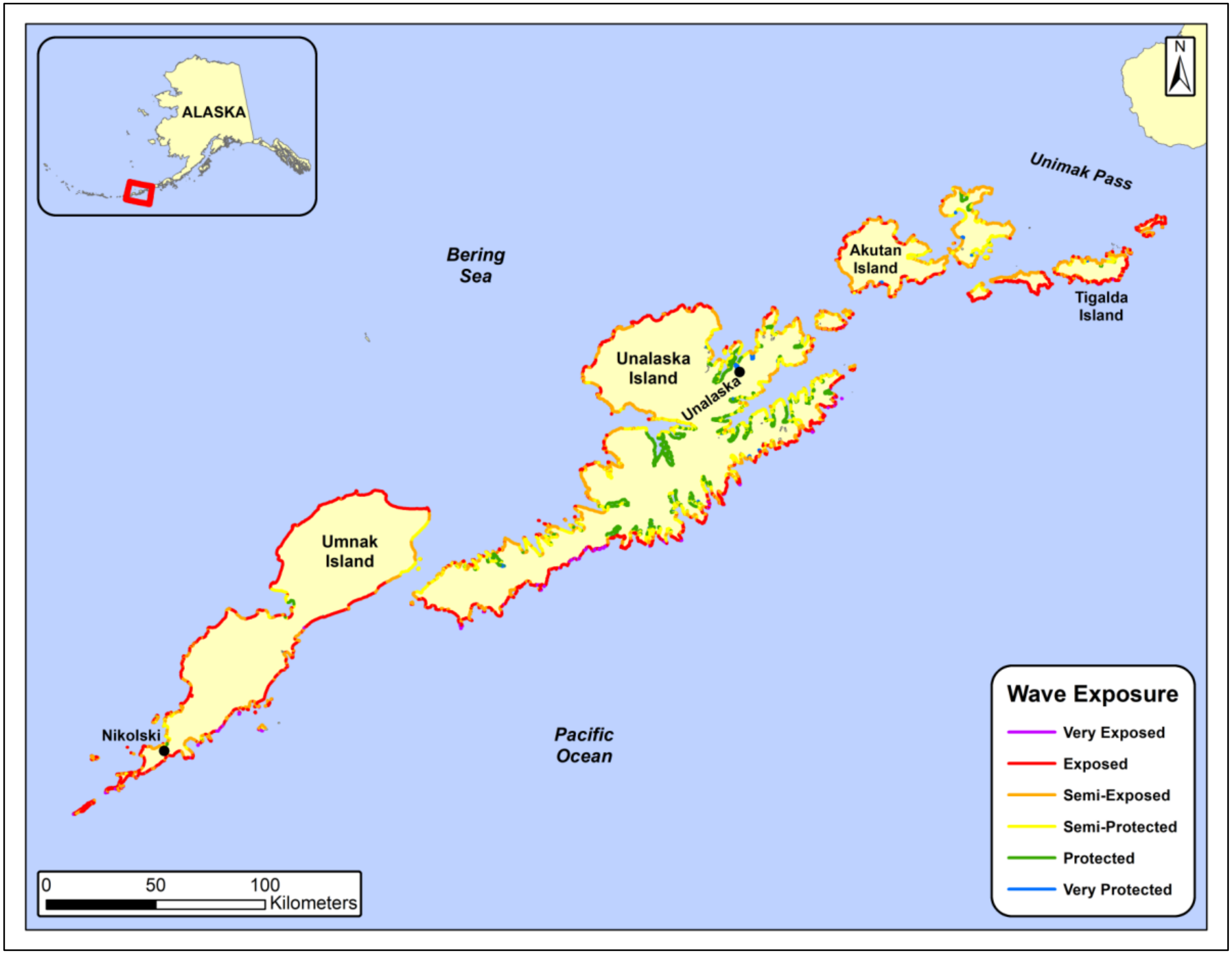

Figure 29. Distribution of the Biological Wave Exposure in the Eastern Aleutians survey area.

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 30 and 31. Partially mobile substrate is the dominant shoreline type (58%). Estuaries are not very common in this area with only 1% 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 is rare. The Lagoon and Anthropogenic habitat classes each occurred in approximately 1% of units as well. This is also to be expected in the Aleutians where there are few villages or settlements.

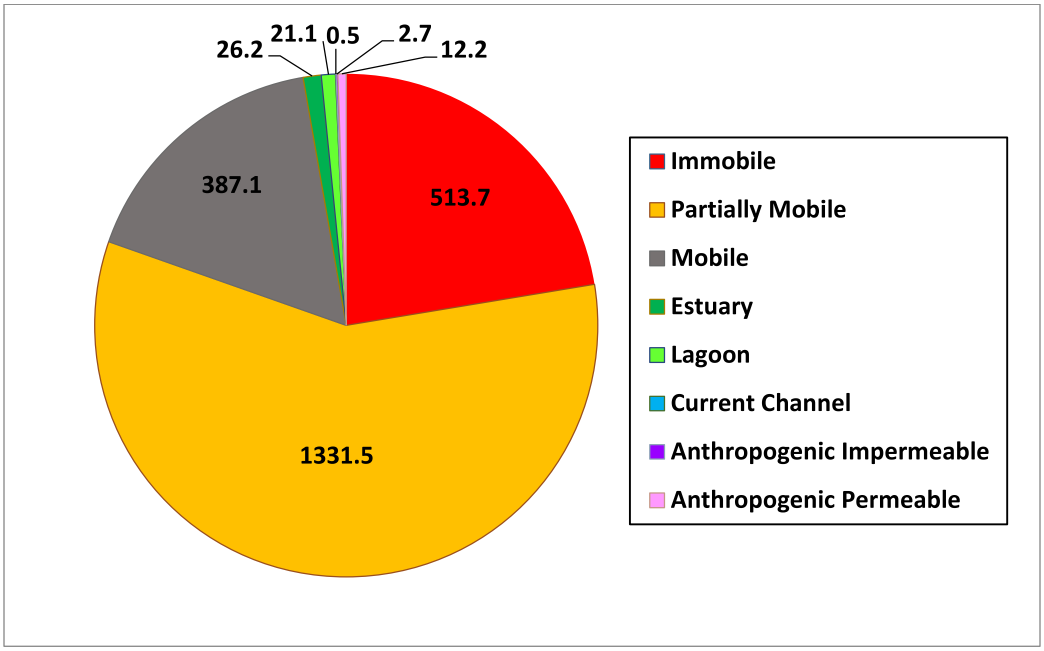

Figure 30. Distribution of Habitat Class categories in the Eastern Aleutians survey area by shoreline length (km).

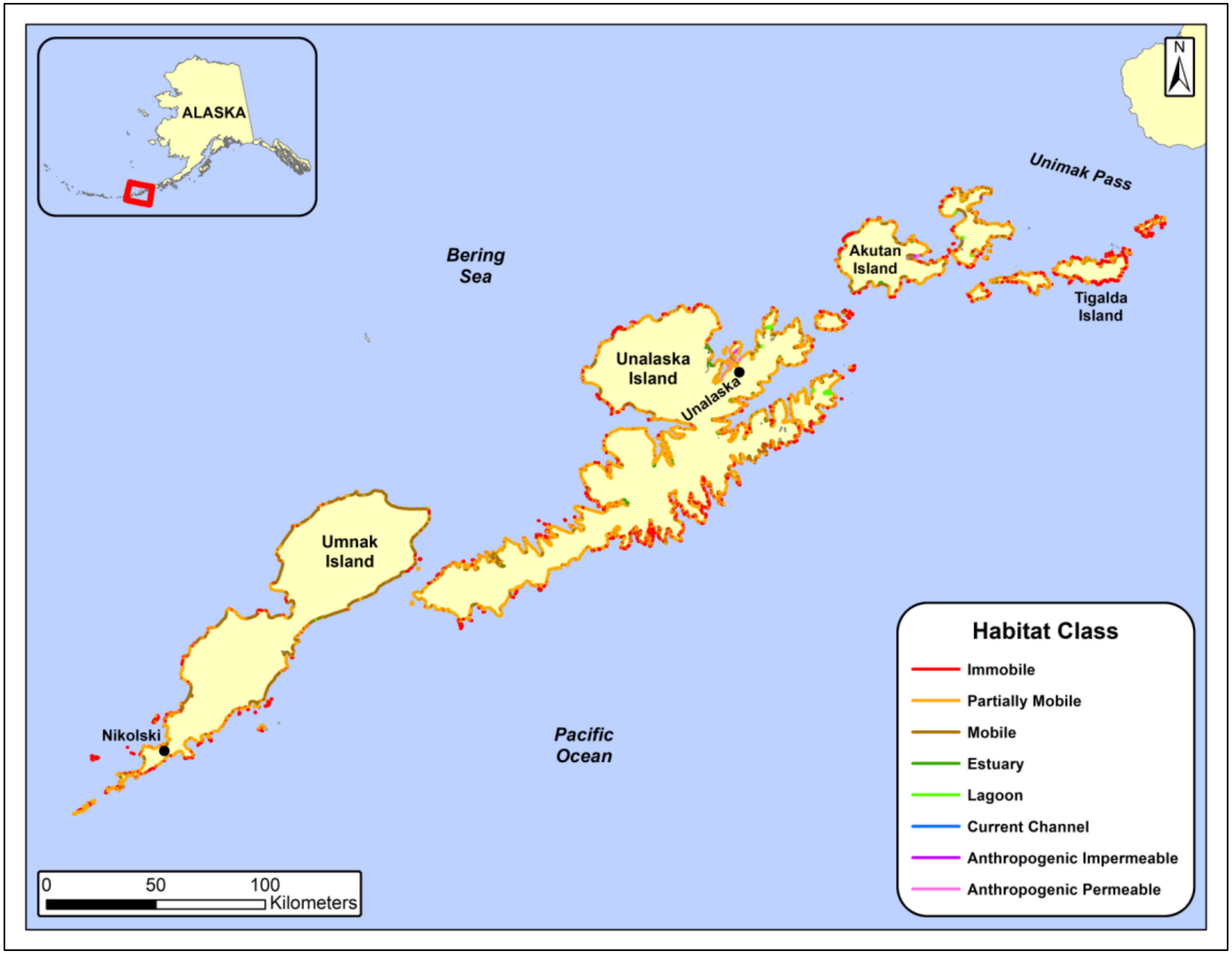

Figure 31. Distribution of Habitat Class categories in the Eastern Aleutians survey area.

4 REFERENCES

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

Cook, S., S. Daley, K. Morrow and S. Ward. 2017. ShoreZone Coastal Imaging and Habitat Mapping Protocol. Coastal and Ocean Resources, Victoria, BC. 78p.

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

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

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

Rao, A. 2015. 2015 Summary Report Burrard Inlet-Indian Arm Eelgrass Mapping. Prepared by SeaChnage Marine Conservation Society and Tsleil-Waututh Nation. 26p. Accessed at http://seagrassconservation.org/wp-content/uploads/2016/05/Burrard-Inlet-Indian-Arm-site-report.pdf on April 03, 2018.

Thieler, E.R. and E.S. Hammar-Klose, 2000. National Assessment of Coastal Vulnerability to Sea-Level Rise: Preliminary Results for the U.S. Pacific Coast. U.S. Geological Survey. Accessed at http://pubs.usgs.gov/dds/dds68/reports/westrep.pdf on September 19th, 2016.

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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, General manager of Coastal and Ocean Resources 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 Coastal Classes and Biobands

Table A-1. Examples of the Coastal Classes around the Aleutian Islands.

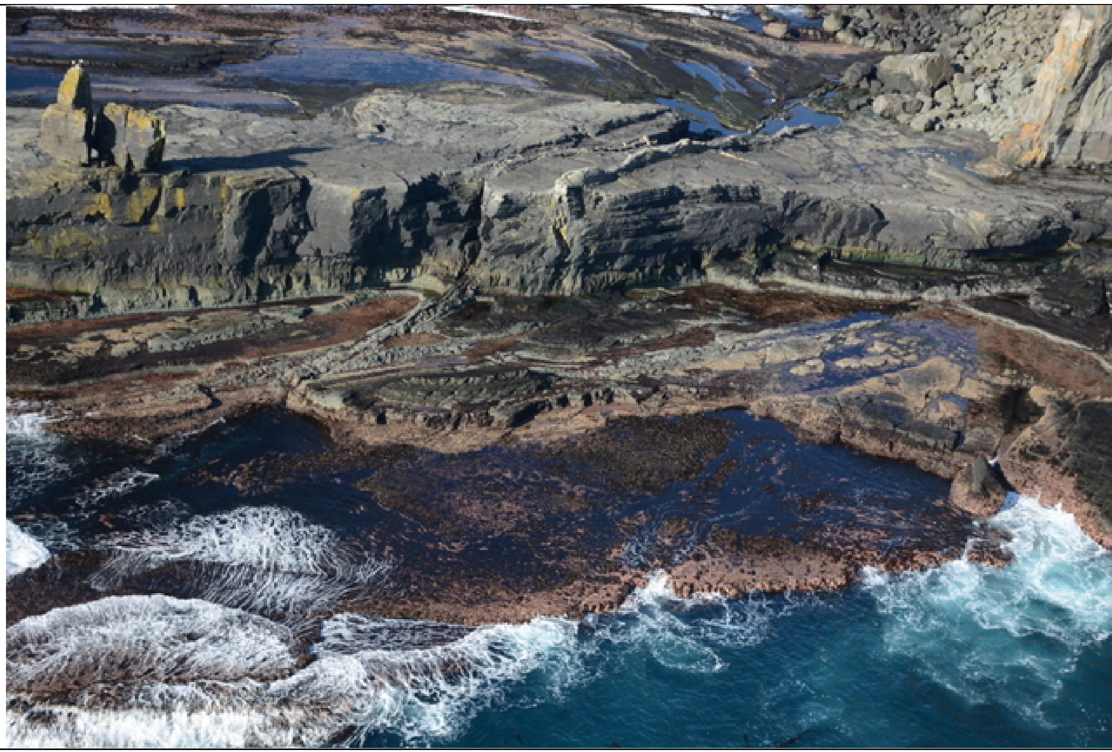

Photo ai16_ua_08364: Example of Coastal Class 2; Rock Platform, wide.
Sedanka Island.

Photo ai16_ua_05433: Example of Coastal Class 3; Rock Cliff.
Tigalda Island.

Photo ai16_ua_04722: Example of Coastal Class 8; Cliff with gravel beach.
Akun Island.

Photo ai16_ua_17611: Example of Coastal Class 12; Platform with gravel and sand beach, wide.
Unalaska Island.

Photo ai16_ua_16501: Example of Coastal Class 14; Ramp with gravel/sand beach, narrow. Peter Island, Anderson Bay.

Photo ai16_ua_04694: Example of Coastal Class 16; Ramp with sand beach, wide. Easy Cove.

Photo ai16_ua_16467: Example of Coastal Class 25; Sand and gravel beach, narrow.
Anderson Bay, Unalaska Island.

Photo ai16_ua_16861: Example of Coastal Class 24; Sand and gravel flat or fan.
Niginak Cove, Unalaska Island.

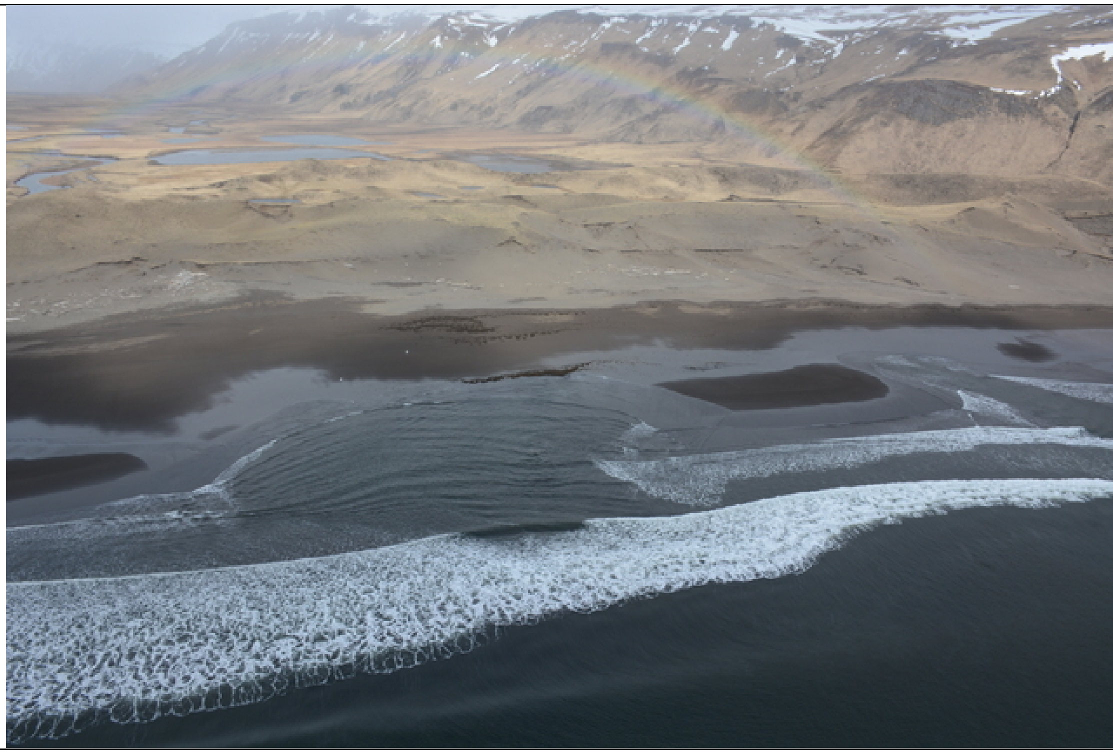

Photo ai16_ua_10967: Example of Coastal Class 28; Sand flat.
South Umnak Island.

Photo ai16_ua_03348: Example of Coastal Class 32; Permeable man-made structures.
Captains Bay, Unalaska Island.

Table A-2. Examples of the most common Biobands in the Eastern Aleutians 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.

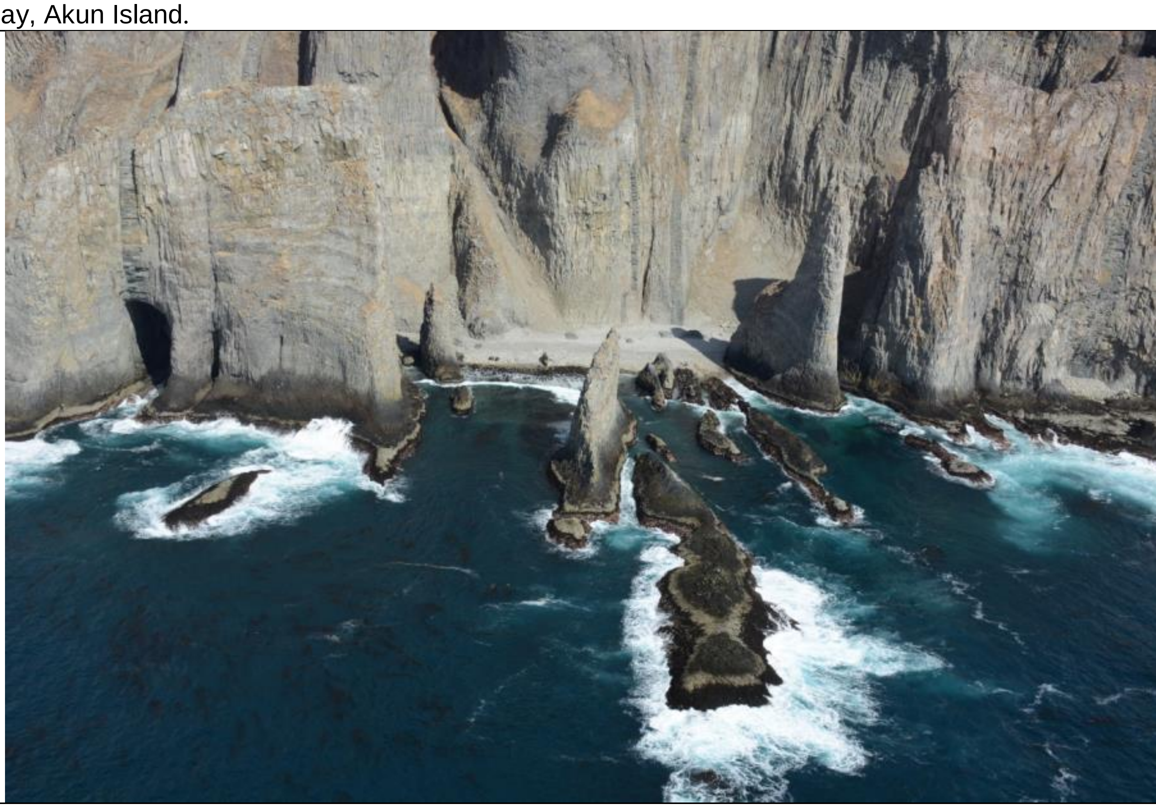

Photo ai16_ua_15105: Good example of the Dark Brown Kelps (DABK) bioband in the lower intertidal zone. South side of Unalaska Island.

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

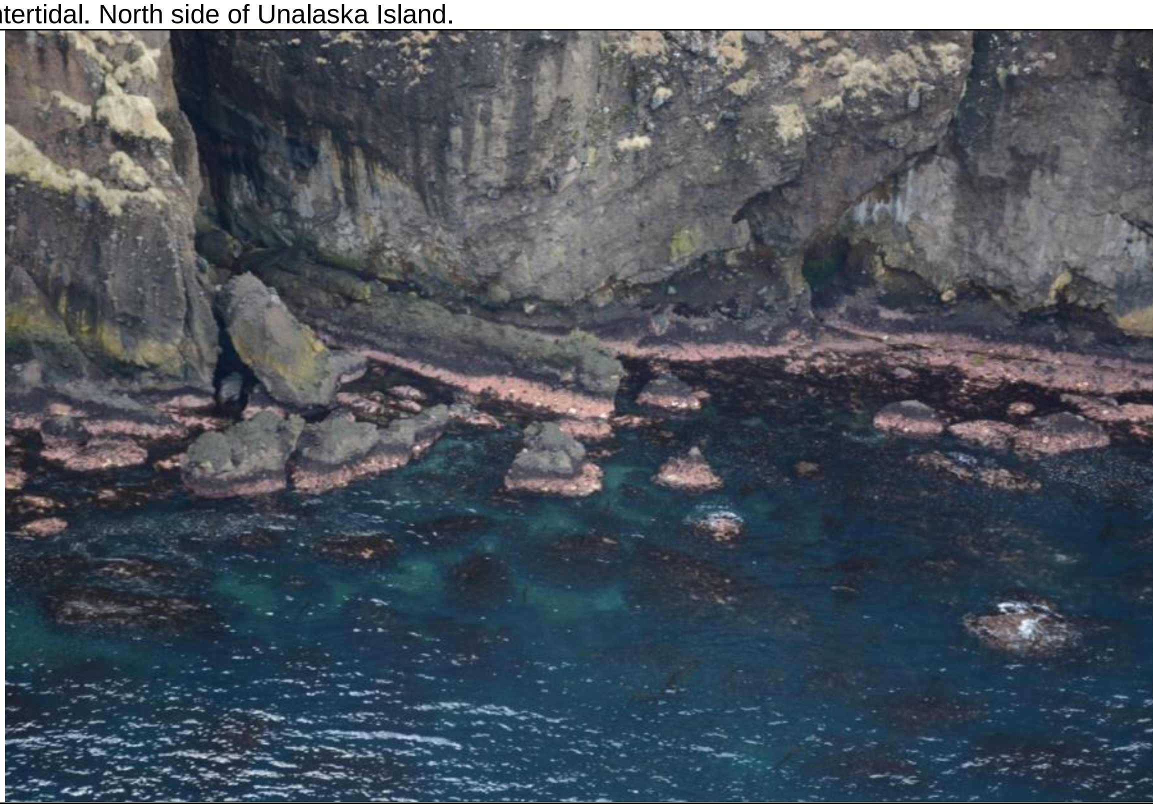

Photo ai16_ua_11080: Good example of the bright pink Coralline Red Algae (CORA) bioband. Akutan Island.

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.