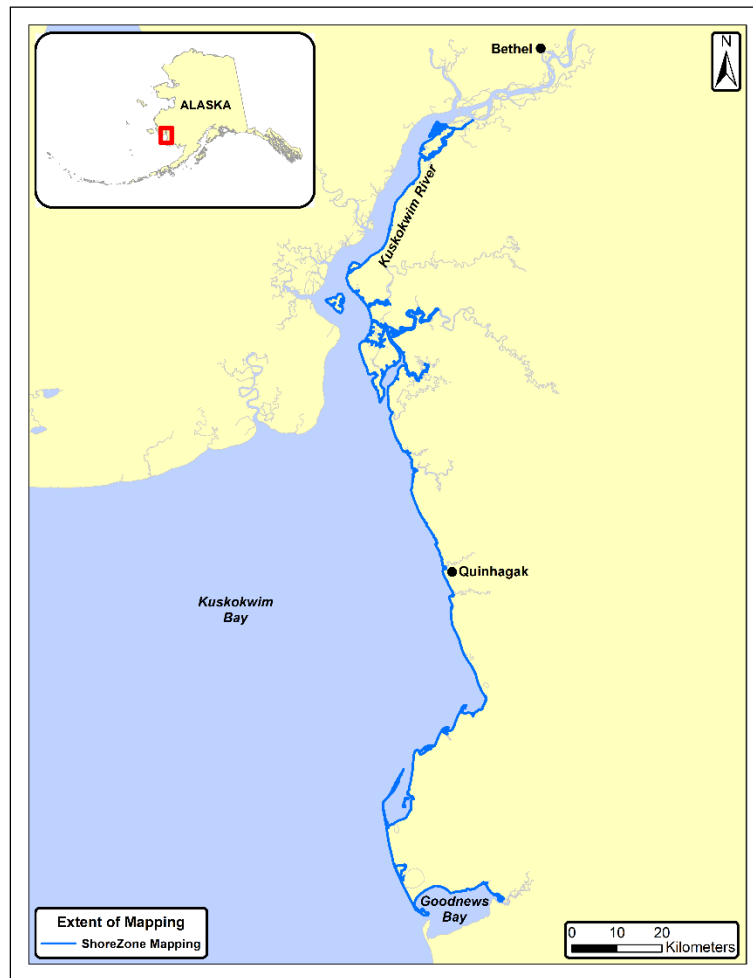


ShoreZone Mapping Summary

Kuskokwim Bay, YK Delta



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Resources, Fairbanks, Alaska, 52 p.



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 Schoch *et al.* (in prep).

This report summarizes the data collected on geomorphological and biological features from the Kuskokwim Bay portion of the 2014 coastal imaging survey of the Yukon-Kuskokwim (YK) Delta. Please refer to the previous summary report for the portion of the YK Delta mapping done to the north available here: <http://www.shorezone.org> (Coastal and Ocean Resources, 2015).

Several changes to the physical mapping protocols were implemented in 2016 including: addition of the Coastal Vulnerability Index that evaluates the effects of storm waves on coastal flooding and erosion, the redefinition of the Stability and Flooding Indices in the Coastal Vulnerability Module, and new guidelines for delineating alongshore units that will help describe the coastline in greater detail. 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. These revised protocols were applied over the portion of the YK Delta survey area included in this report.

Kuskokwim Bay Area Quick Facts

678 km of shoreline mapped.

2,178 shoreline units created.

Units averaged **311 m** in length, with the shortest being 9 m and the longest being 1291 m.

61% of the shoreline is in the **most sensitive ESI** category.

The new **Coastal Vulnerability Index** ranked **56%** of the shoreline at **High or Very High** risk of inundation.

87% of the intertidal area classified was considered some form of **tidal flat**.

11 biobands were classified with the **Wetland Vegetation (WEVE)** bioband being the most common.

The survey is part of the **Bering Sea Biogeographic Region**, which is an attribute newly added for the current protocol.



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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 70,700 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 Kuskokwim Bay portion of the Yukon-Kuskokwim (YK) Delta survey area. This is the section of shoreline covered by this summary report.

The field survey conducted around the Yukon-Kuskokwim Delta in July and August of 2014 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 Schoch *et al.* (in prep). The purpose of this report is to provide a summary of the physical and biological data imaged and classified in the Kuskokwim Bay area (Figure 2).

The length of shoreline mapped is 678 kilometers in 2,178 along-shore segments (units), averaging 311 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 Alaska_63,360 shapefile; the secondary source was the Continuously Updated Shoreline Product (CUSP) shapefile available from NOAA (May 2015), and the tertiary was the National Hydrography Dataset (NHD). The minimum mapping unit for this project was set at 50 meters meaning it was determined that resolving units smaller than 50 meters on the best available digital shoreline for this section of coastline was not possible. There were several places along the digital shoreline where smaller resolution was possible so 132 units were mapped with lengths smaller than 50m. A number of these are river mouths that were wider than 10m and were therefore mapped as linear units rather than points.



Figure 1. Extent of ShoreZone imagery in Alaska, British Columbia, Washington State and Oregon as of September 2016.

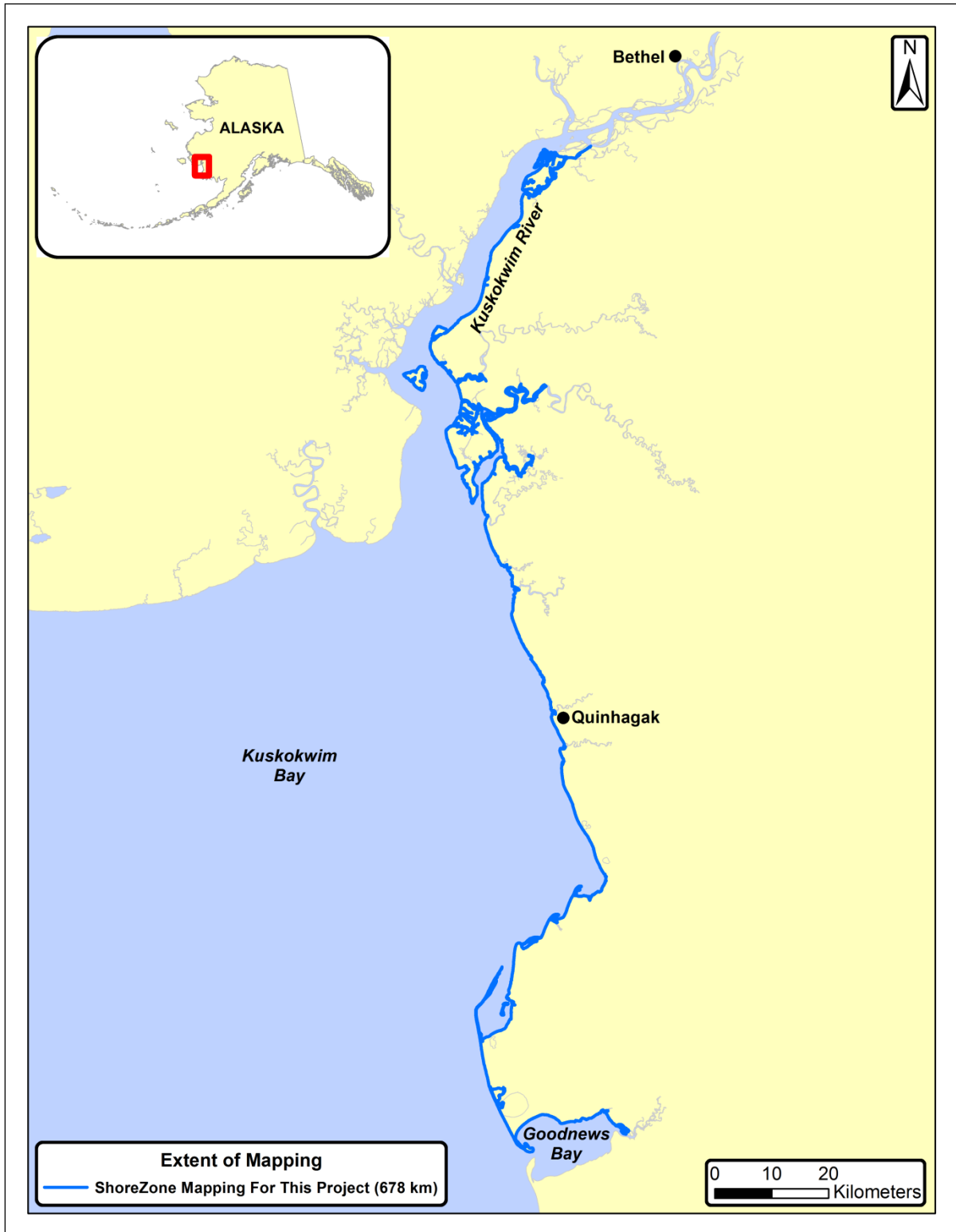


Figure 2. Map of the Kuskokwim Bay portion of the YK Delta imaging survey (2014) represented by this report. The portion north of this section was mapped in 2015. The imagery south of Goodnews Bay to Cape Newenham taken during the 2014 survey will be mapped in 2016.

2 PHYSICAL ATTRIBUTE DATA SUMMARY

2.1 Shore Type Classification

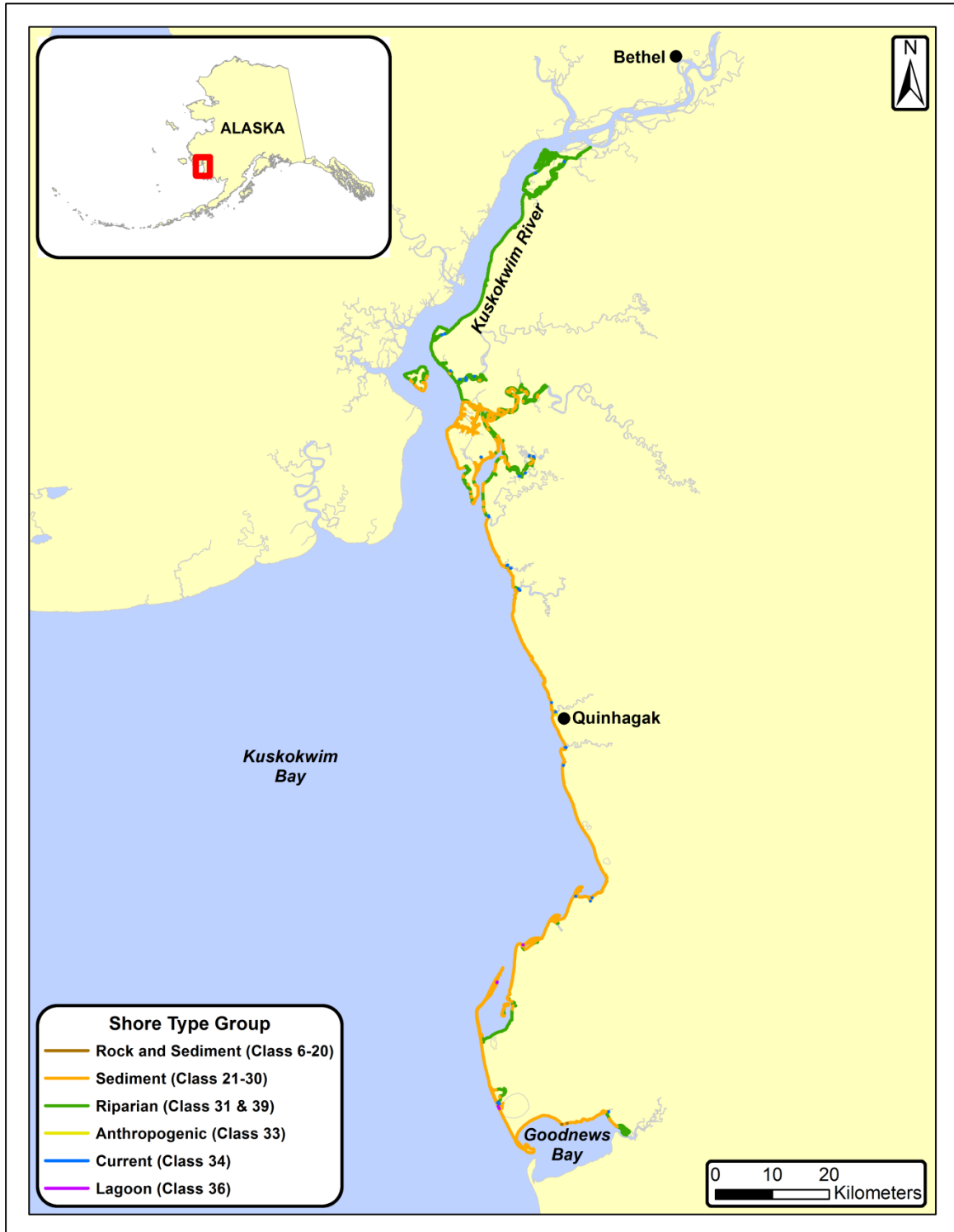


Figure 3. Map of the Shore Type groups in the Kuskokwim Bay area.

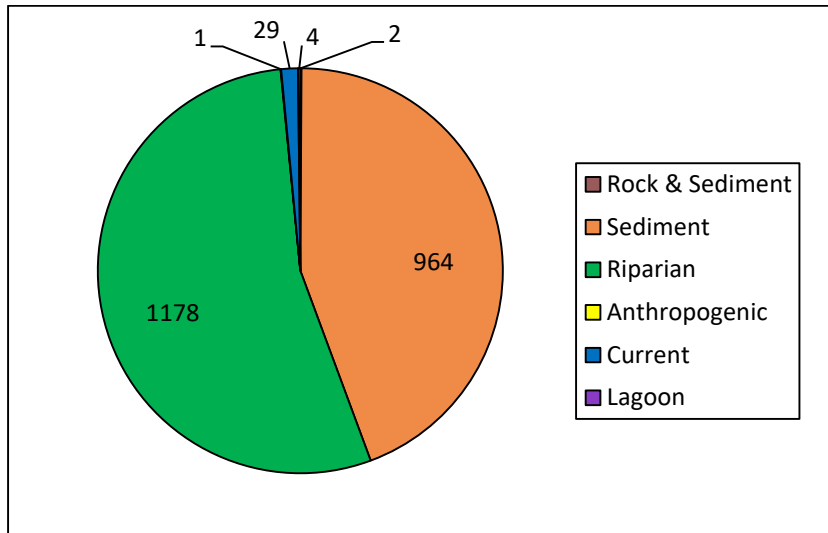


Figure 4. Shore Type group by number of units.

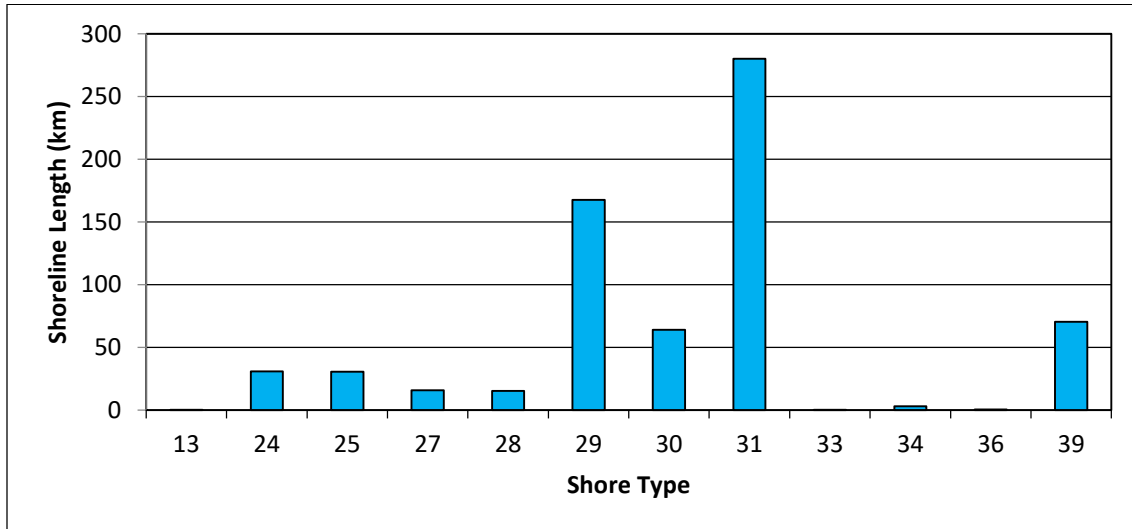


Figure 5. Shoreline length of each Shore Type category.

The principal characteristics of each along-shore unit are used to assign one of 39 overall unit classifications called “Shore Type”. Sediment shorelines (48%) and Riparian shorelines (52%) dominated the Kuskokwim Bay area. The rest of the shoreline is comprised of Rock & Sediment, Anthropogenic, Current and Lagoon Shore Types (see Figures 3 and 4 for distribution and summary statistics). The total shoreline length for each Shore Type category mapped in Kuskokwim Bay is shown in Figure 5. The definitions for each of these Shore Types is given in Table 1 and are applicable to all Shore Type figures in this report. Photographic examples of the Shore Types mapped in the Kuskokwim Bay area are in Appendix A.

**Table 1.** Definitions of Shore Types classified in Kuskokwim Bay. Please see Schoch *et al.* (in prep.) for a list of all Shore Types for ShoreZone.

Shore Type Number	Dominant Structuring Process	Substrate	Description
13	Waves	Rock & Sediment	Narrow (<30m), steep (>45°) cliff with sand and gravel beach
24	Waves	Sediment	Wide (>30m), flat (<5°) sand and gravel flat or fan
25	Waves	Sediment	Narrow (<30m), inclined (5-45°) sand and gravel beach
27	Waves	Sediment	Wide (>30m), inclined (5-45°) sand beach
28	Waves	Sediment	Wide (>30m), flat (<5°) sand flat
29	Waves	Sediment	Wide (>30m), flat (<5°) mud flat
30	Waves	Sediment	Narrow (<30m), inclined (5-45°) sand beach
31	Riparian	Sediment/ Vegetation	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 shore type may also be applied if a significant amount of marsh (25% or more) infringes on the intertidal zone.
33	Anthropogenic	Varies	Impermeable man-made structures such as concrete seawalls and steel sheet pile.
34	Current	Varies	Current-dominated shore types occur in elongate channels with restricted fetches and where currents (tidal or otherwise) are the dominant structuring process.
36	Lagoon	Varies	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 narrow and restricted in elevation. Saltwater influxes may be only episodic.
39	Riparian	Peat/ Vegetation	Low vegetated peat are areas of low-lying peat banks; usually vegetated in the supratidal zone, but not always vegetated in the intertidal zone. Minimal mineral sediment is present.

2.2 Environmental Sensitivity Index (ESI)

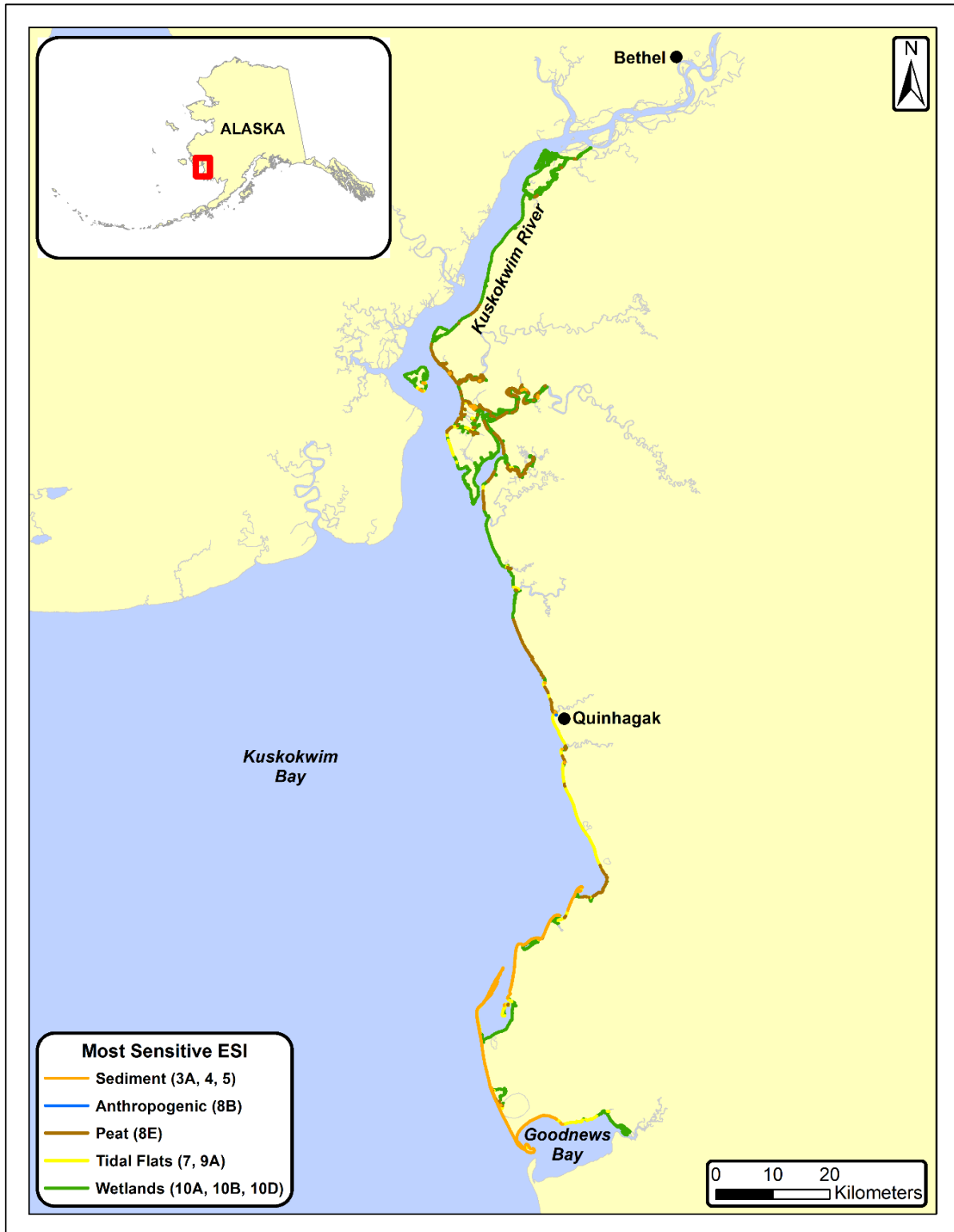


Figure 6. Distribution of the most sensitive grouped ESI categories.

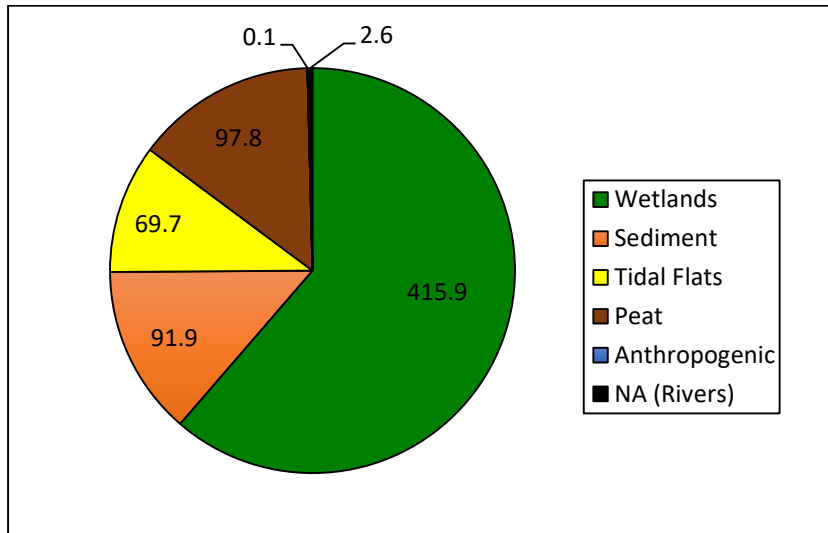


Figure 7. Grouped most sensitive ESI categories by shoreline length (km).

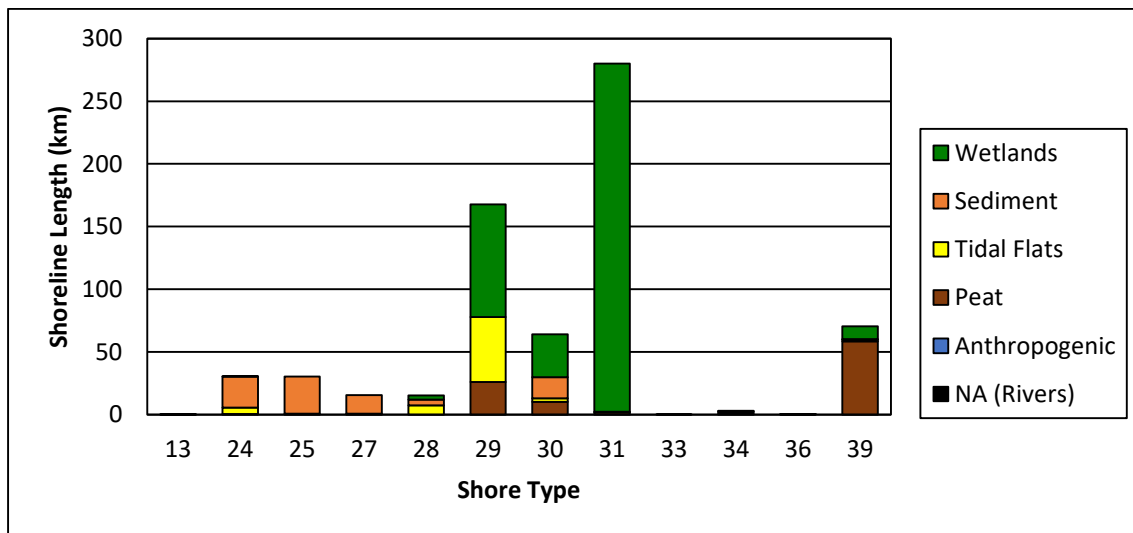


Figure 8. Grouped most sensitive ESI categories by length of Shore Type.

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 Kuskokwim Bay area is dominated by the Wetland category (61% of shoreline length). These were mostly estuarine and riverine wetlands. The type of wetland was determined by using the National Wetlands Inventory (NWI) online mapping atlas (<http://www.fws.gov/wetlands/data/mapper.HTML>) to classify areas as either part of a marine/estuarine or riverine and lacustrine system.

2.3 Oil Residence Index (ORI)

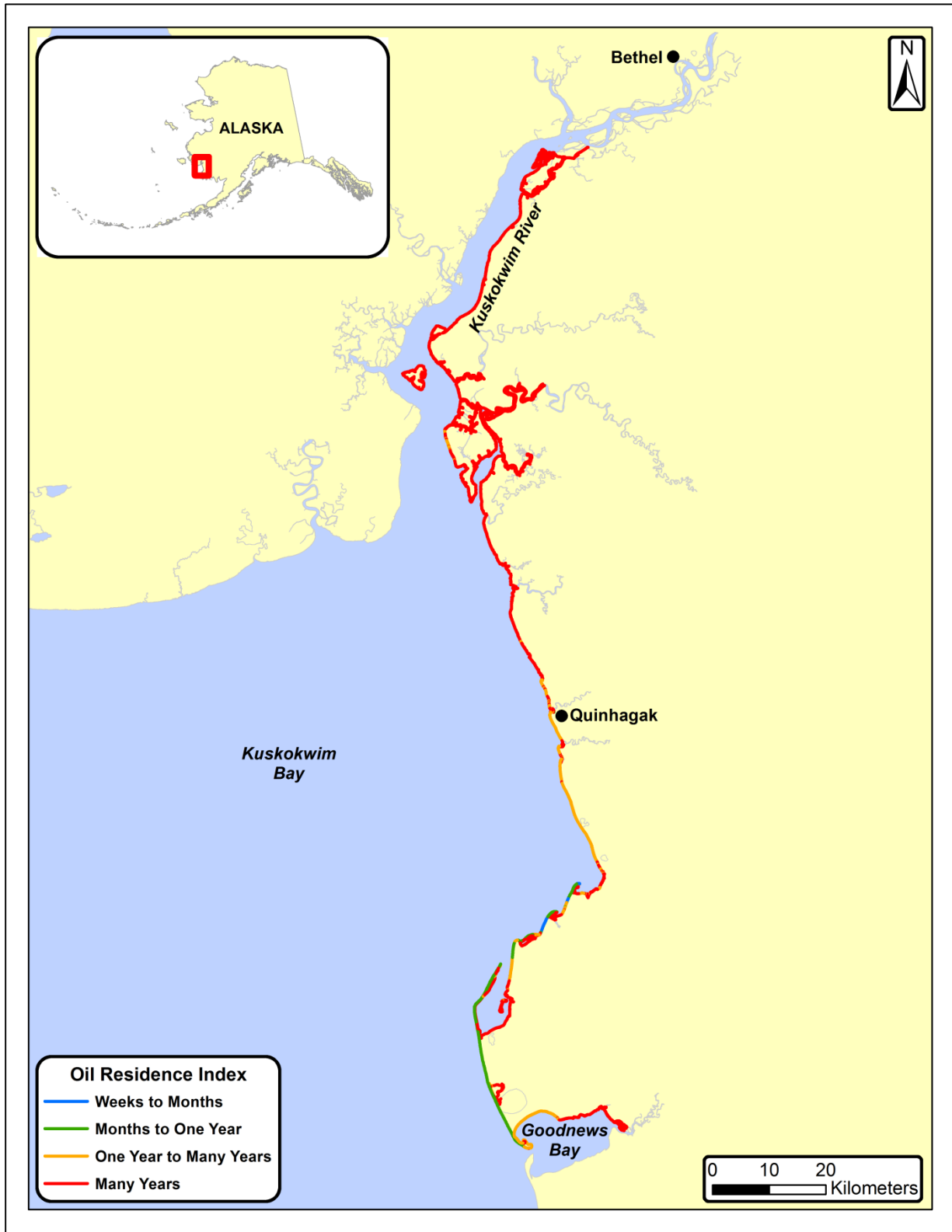


Figure 9. Distribution of the Oil Residence Index (ORI) categories.

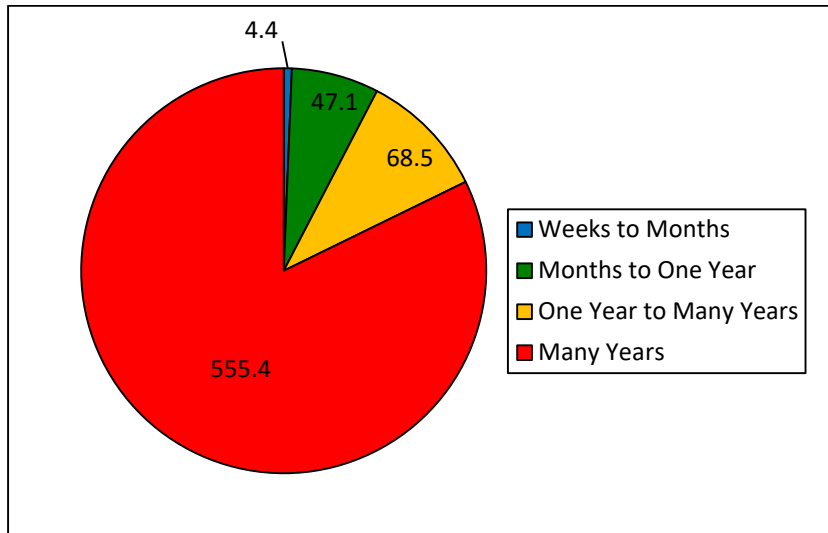


Figure 10. Oil Residence Index (ORI) categories by shoreline length (km).

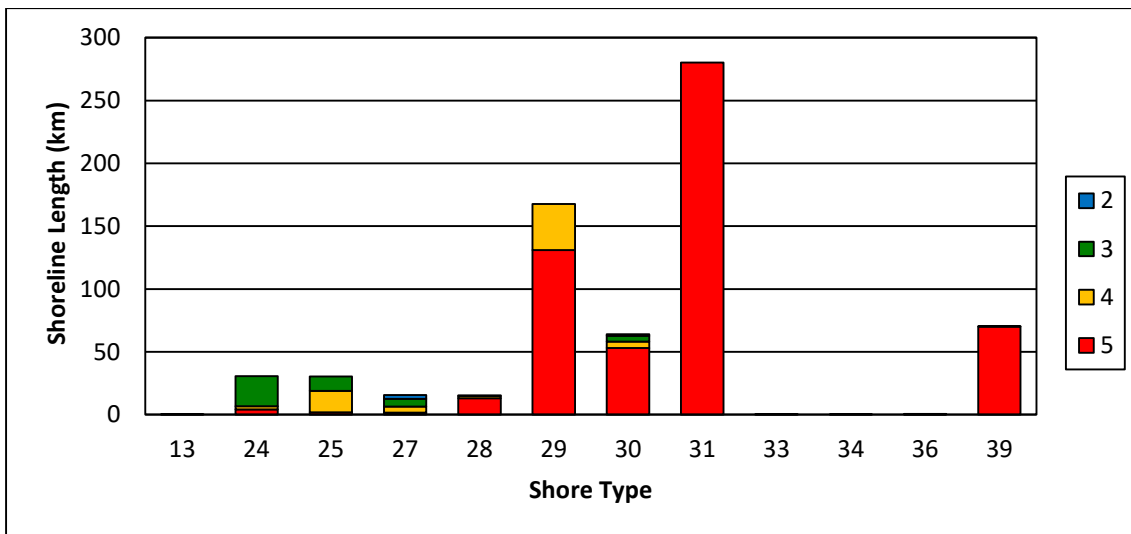


Figure 11. Oil Residence Index (ORI) categories by length of Shore Type.

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. The dominance of lower wave exposures and sand-gravel sediment textures results in high ORI values for 92% of the shore segments in the Kuskokwim Bay area, indicating oil residence times are on the order of months to years (see Figures 9 to 11 for distribution and summary statistics).

2.4 ShoreZone Coastal Vulnerability Module

2.4.1 Coastal Vulnerability Flooding Class

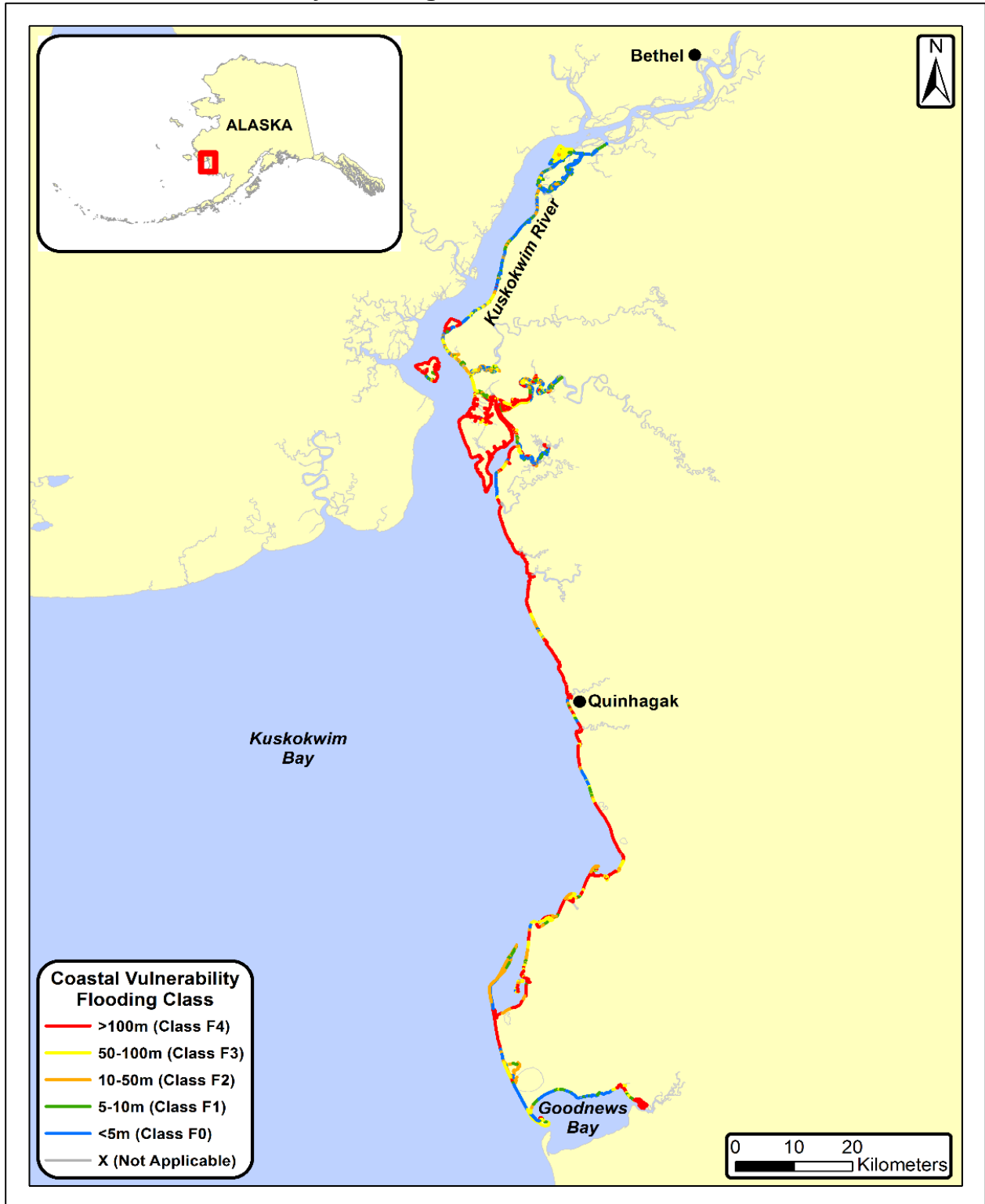


Figure 12. Distribution of the Coastal Vulnerability Flooding Class.

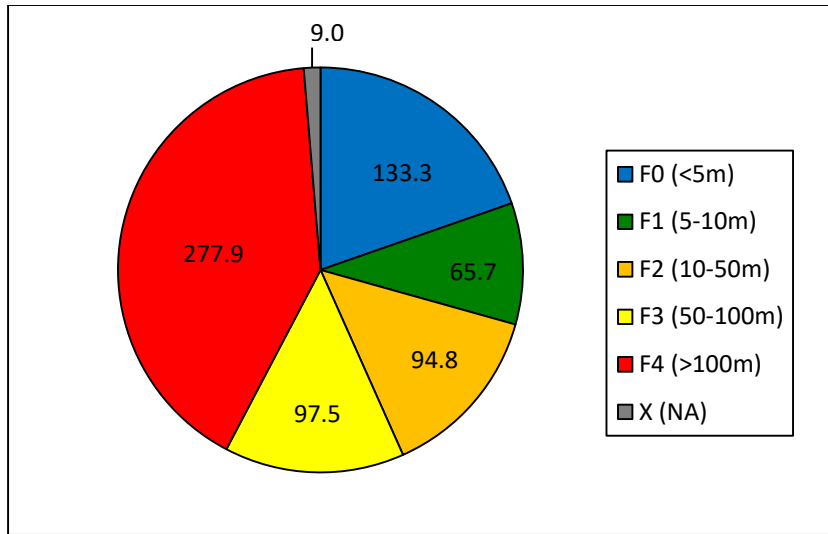


Figure 13. Flooding Class categories by shoreline length (km).

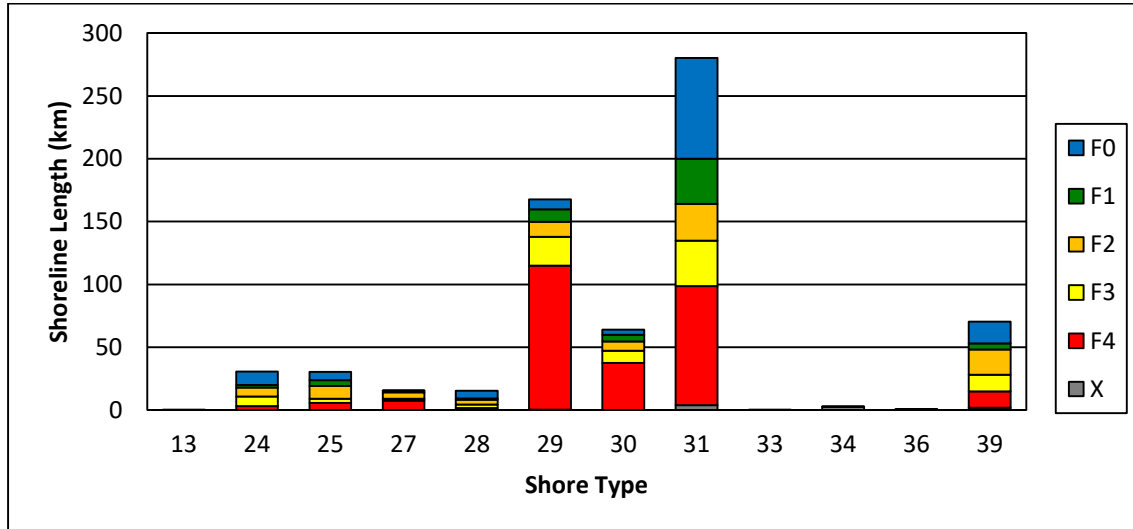


Figure 14. Flooding Class categories by length of Shore Type.

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 high in the study area, with 55% of the shoreline at risk of flooding >100m from MHW (see Figures 12 to 14 for distribution and summary statistics). The flooding class is a parameter of the Coastal Vulnerability Index (see Page 17).

2.4.2 Coastal Vulnerability Stability Class

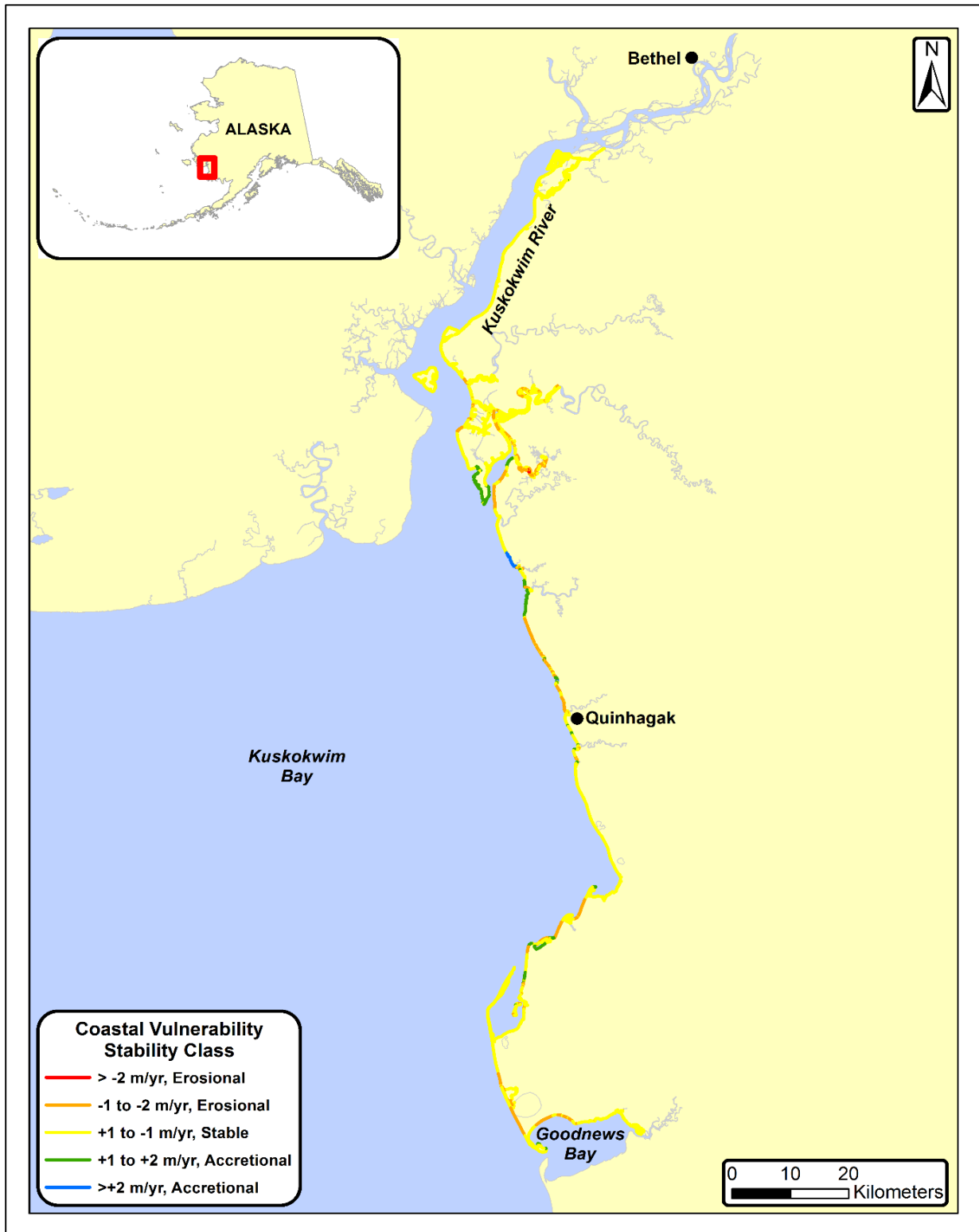


Figure 15. Distribution of the Coastal Vulnerability Stability Class.

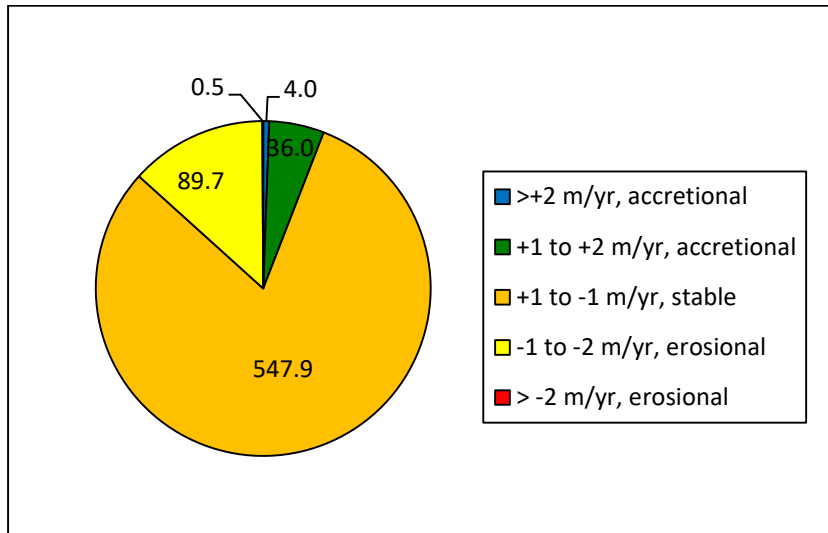


Figure 16. Stability Class categories by shoreline length (km).

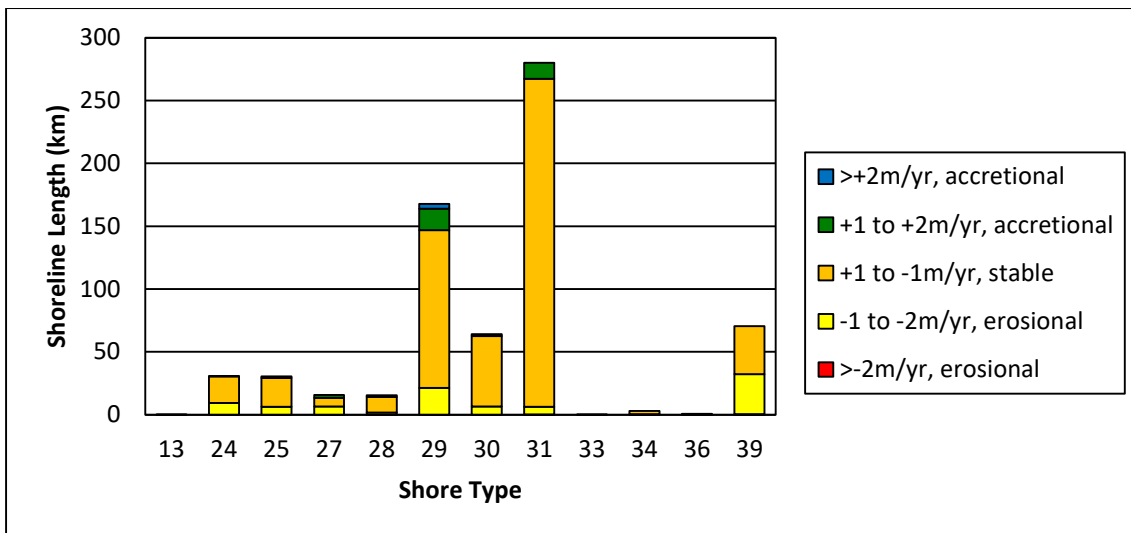


Figure 17. Stability Class categories by length of Shore Type.

The CVM Stability Class is a ranking of the vulnerability of shoreline units to erosion. This is based on erosional or accretional forms within the unit. In the Kuskokwim Bay area, most of the shoreline units (81% shoreline length) were mapped as stable (see Figures 15 to 17 for distribution and summary statistics). The stability class is a parameter of the Coastal Vulnerability Index (see Page 17).

2.4.3 Coastal Vulnerability Observations

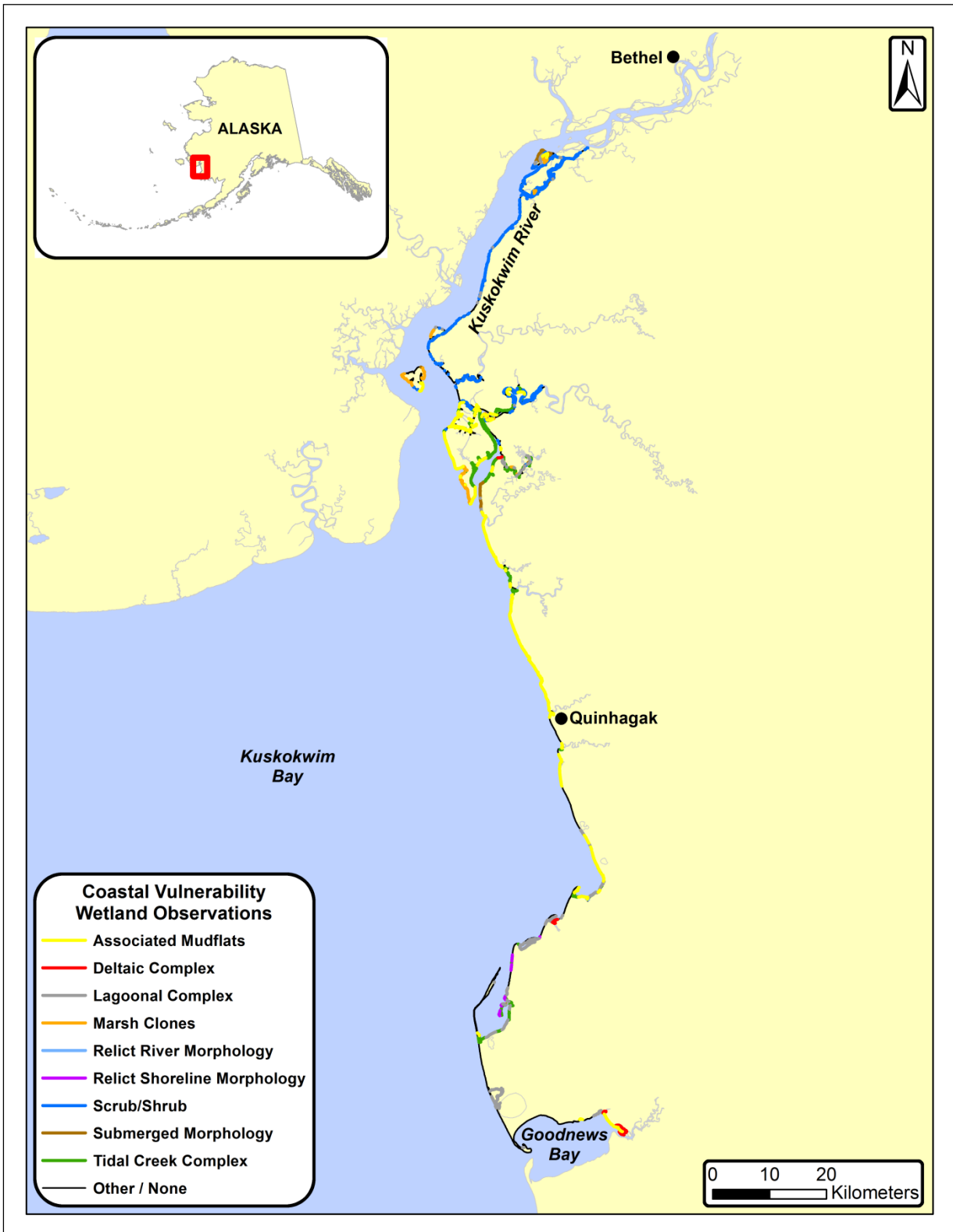


Figure 18. Distribution of the Coastal Vulnerability Observations wetland categories.

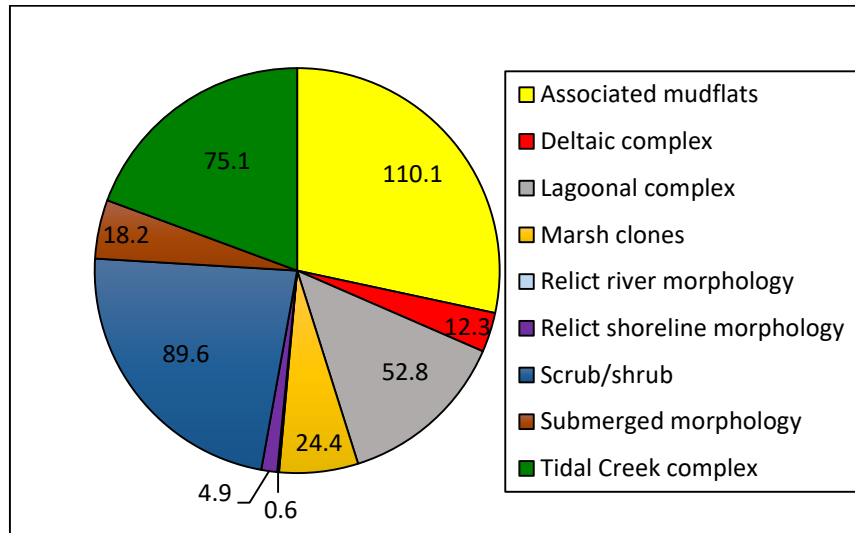


Figure 19. Coastal Vulnerability Observations wetland categories by shoreline length (km).

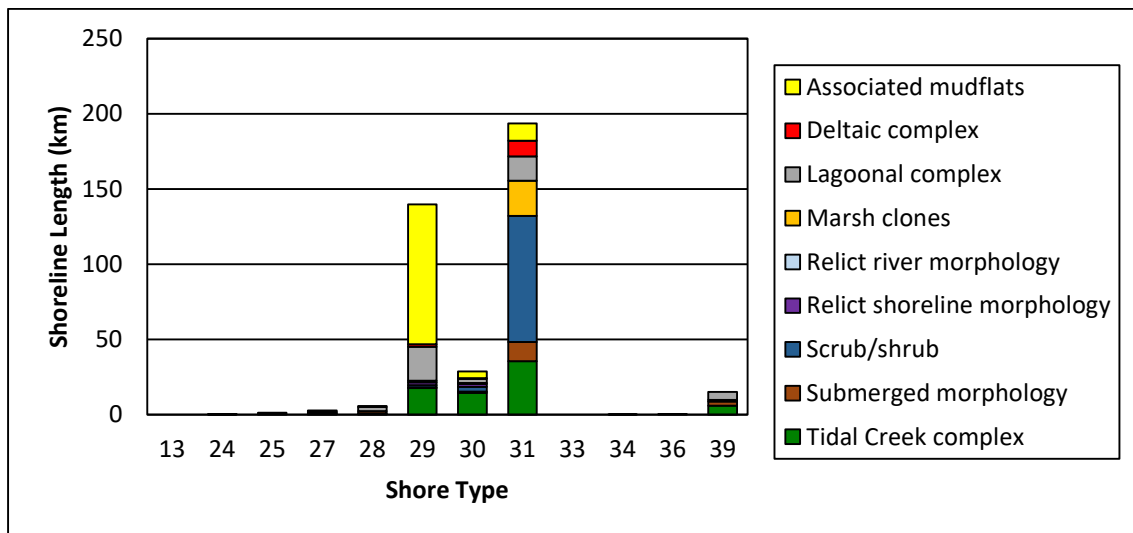


Figure 20. Coastal Vulnerability Observations wetland categories by length of Shore Type.

The CVM Observations are features important for estimating the frequency and extent of coastal inundation. In the Kuskokwim Bay area the majority of observations were from the wetlands observation category (see Figures 18 to 20 for distribution and summary statistics). The Wetland Scrub/Shrub category was dominant in the Riparian Shore Type (31) and wetlands associated with mudflats were dominant in the Mudflat Shore Type (29).

2.4.4 Coastal Vulnerability Index

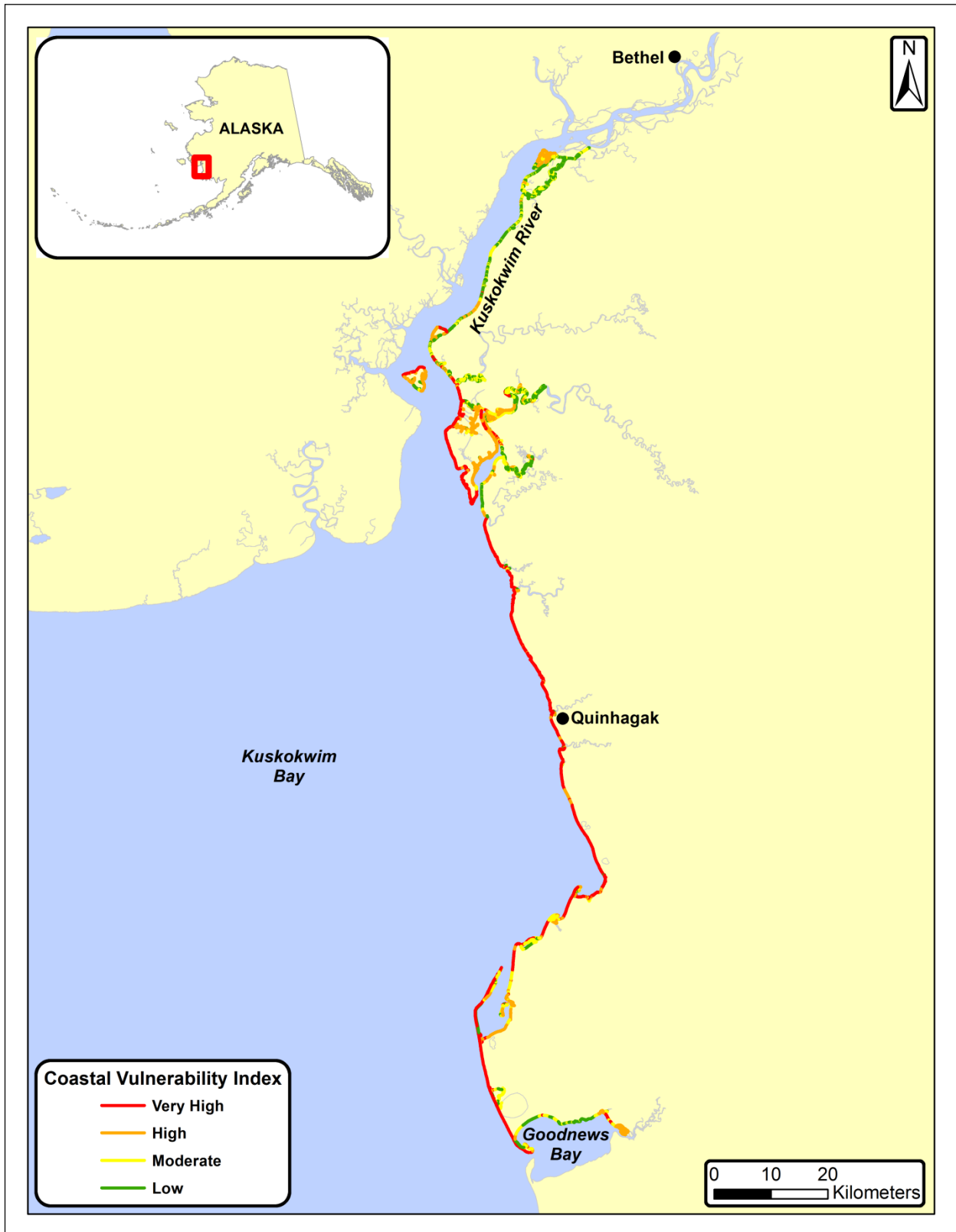


Figure 21. Distribution of the Coastal Vulnerability Index categories.

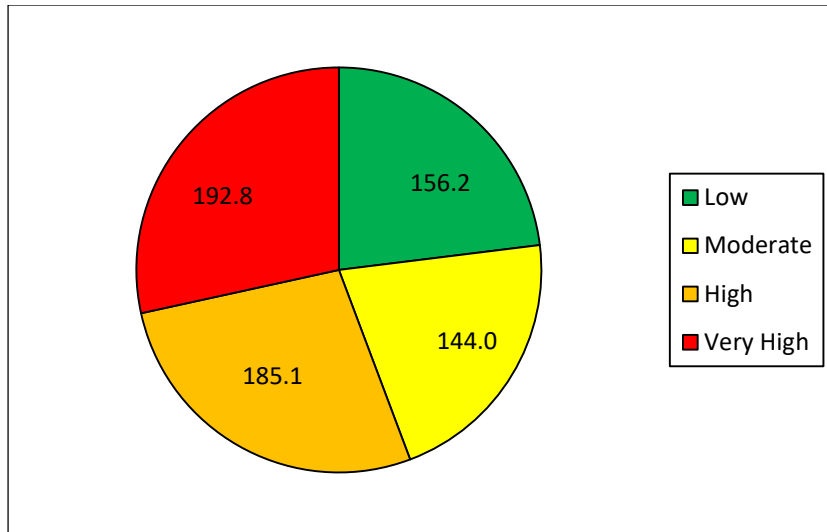


Figure 22. Coastal Vulnerability Index categories by shoreline length (km).

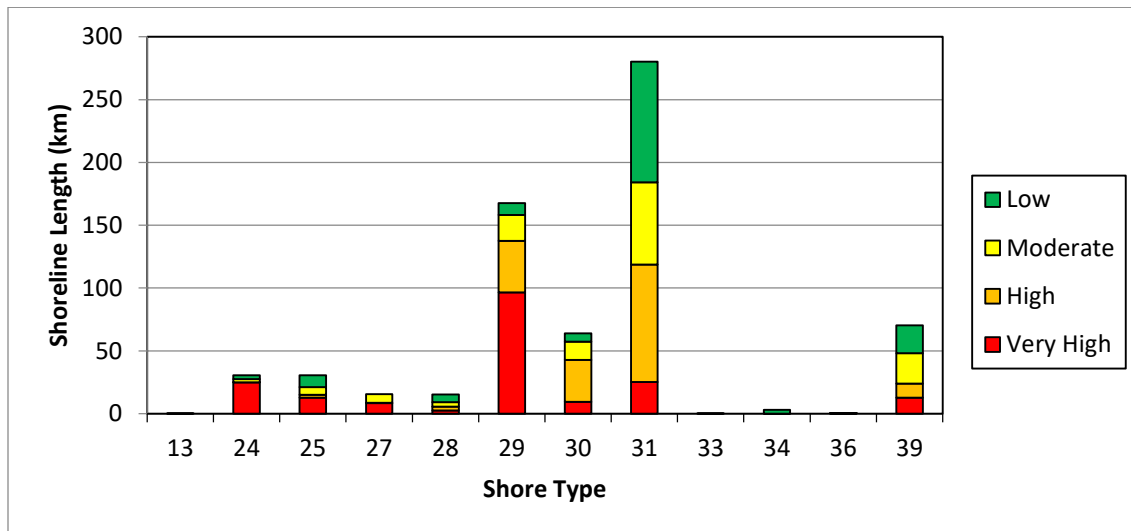


Figure 23. Coastal Vulnerability Index categories by length of Shore Type.

The methods of Thieler and Hammer-Klose (2000) (<http://woodshole.er.usgs.gov/project-pages/cvi/>) are used to calculate the Coastal Vulnerability Index (CVI) using five ShoreZone attributes: Shore Type, Max Tide Range, Stability Class, Flooding Class, and Significant Wave Height. These attributes are ranked for each unit and used to calculate a CVI value. A histogram of these values are divided into quartiles which are used to rank the CVI values in four categories from Low to Very High. 56% of the shoreline length in Kuskokwim Bay is in the High and Very High CVI categories, indicating that much of this shoreline is vulnerable to coastal inundation (see Figures 21 to 23 for distribution and summary statistics). Most of the YK Delta region is very low-lying marshlands, large tidal flats, and mobile substrate beaches that tend to be more prone to flooding. The outer coasts also have high CVI classes because of potentially high significant wave heights and storm surges. The geomorphology of this coastline, consisting mainly of large tidal flats and mobile substrate beaches, also makes it more vulnerable to inundation.

2.5 Maximum Fetch

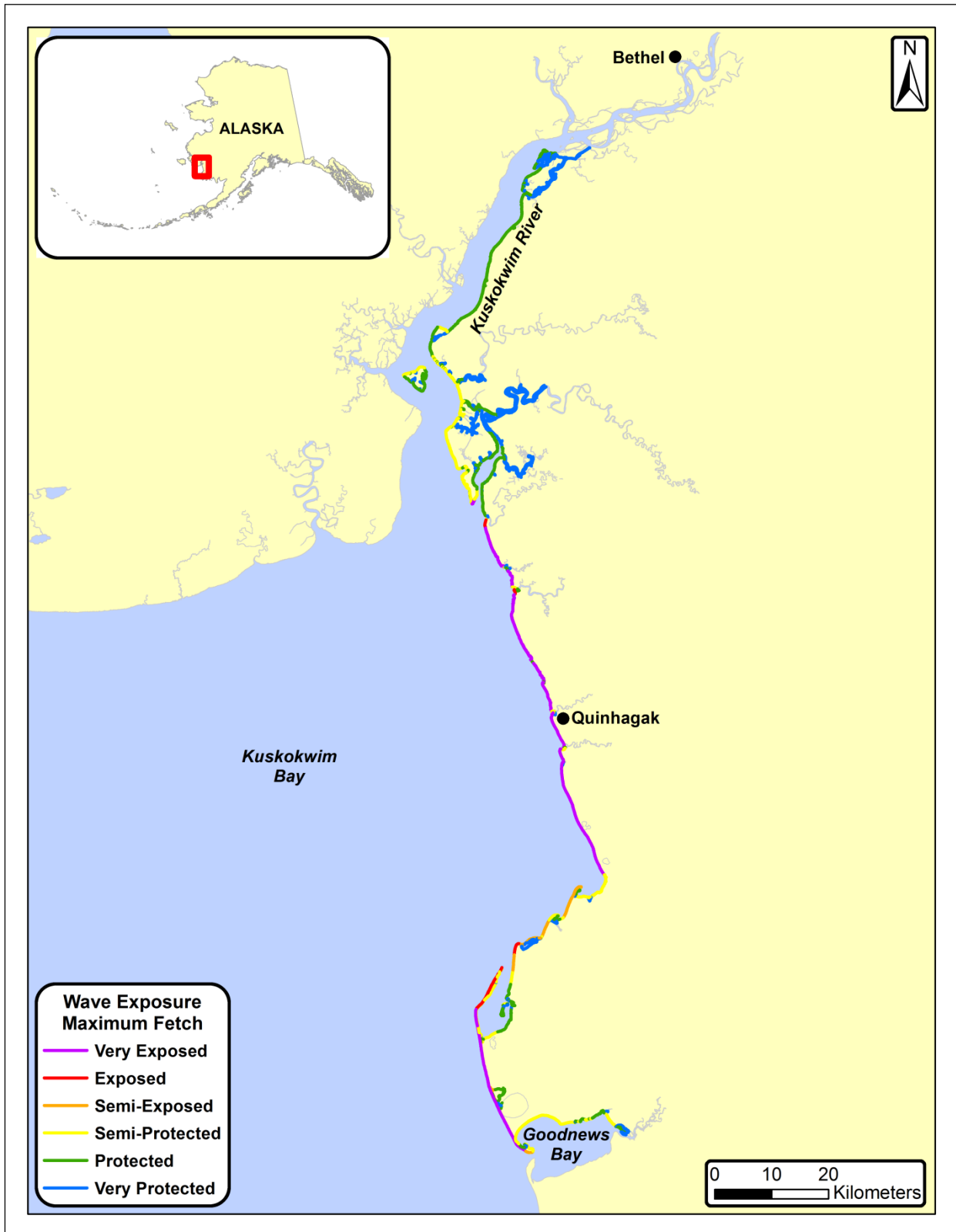


Figure 24. Distribution of the Maximum Fetch categories.

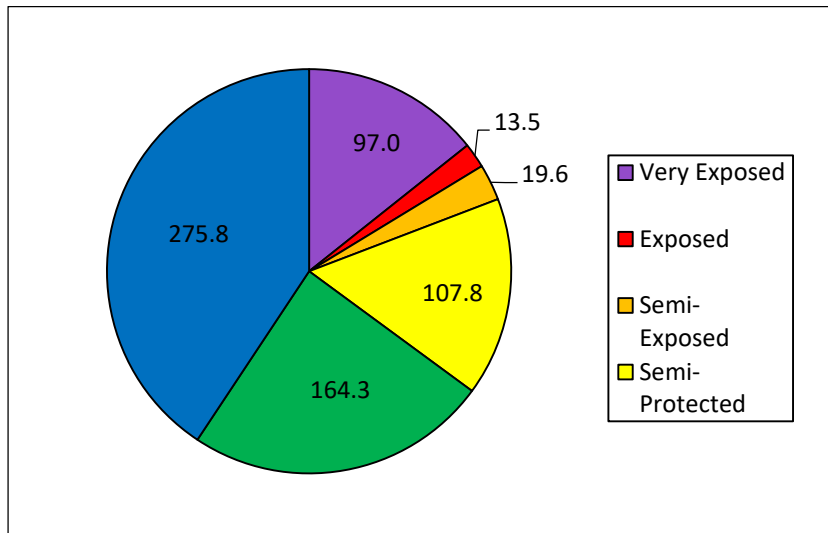


Figure 25. Maximum fetch categories by shoreline length (km).

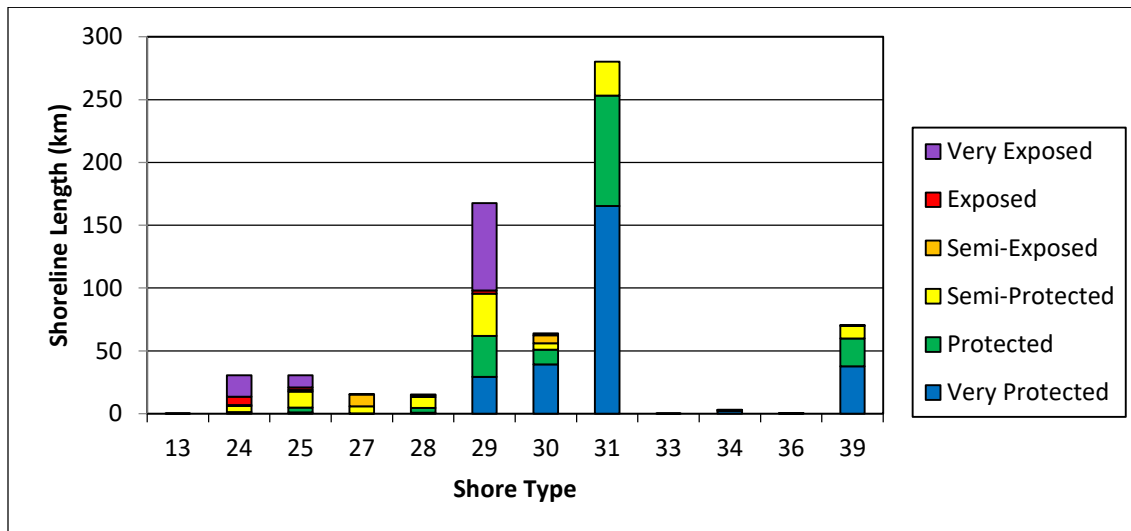


Figure 26. Maximum Fetch categories by length of Shore Type.

Maximum Fetch categories range from Very Exposed (VE) to Very Protected (VP) based on the potential wind fetch that could create waves for that portion of shoreline and is measured from satellite imagery for each unit. The distribution of the Maximum Fetch categories mapped in the Kuskokwim Bay area is summarized in Figure 24 with summary statistics in Figures 25 and 26. Most of the coastline river channels or bays are in the lower categories of Protected or Very Protected (65% shoreline length) with the outer coast being Exposed or Very Exposed (16% shoreline length). It should be noted that many of the beaches classed as Exposed or Very Exposed do not receive high wave energy during the winter months when the nearshore ice pack has formed. Ice movement can be a greater structuring force during that time. This may change as the number of ice-free months increases as has been the trend in recent years.

2.6 Wave Energy Dissipation

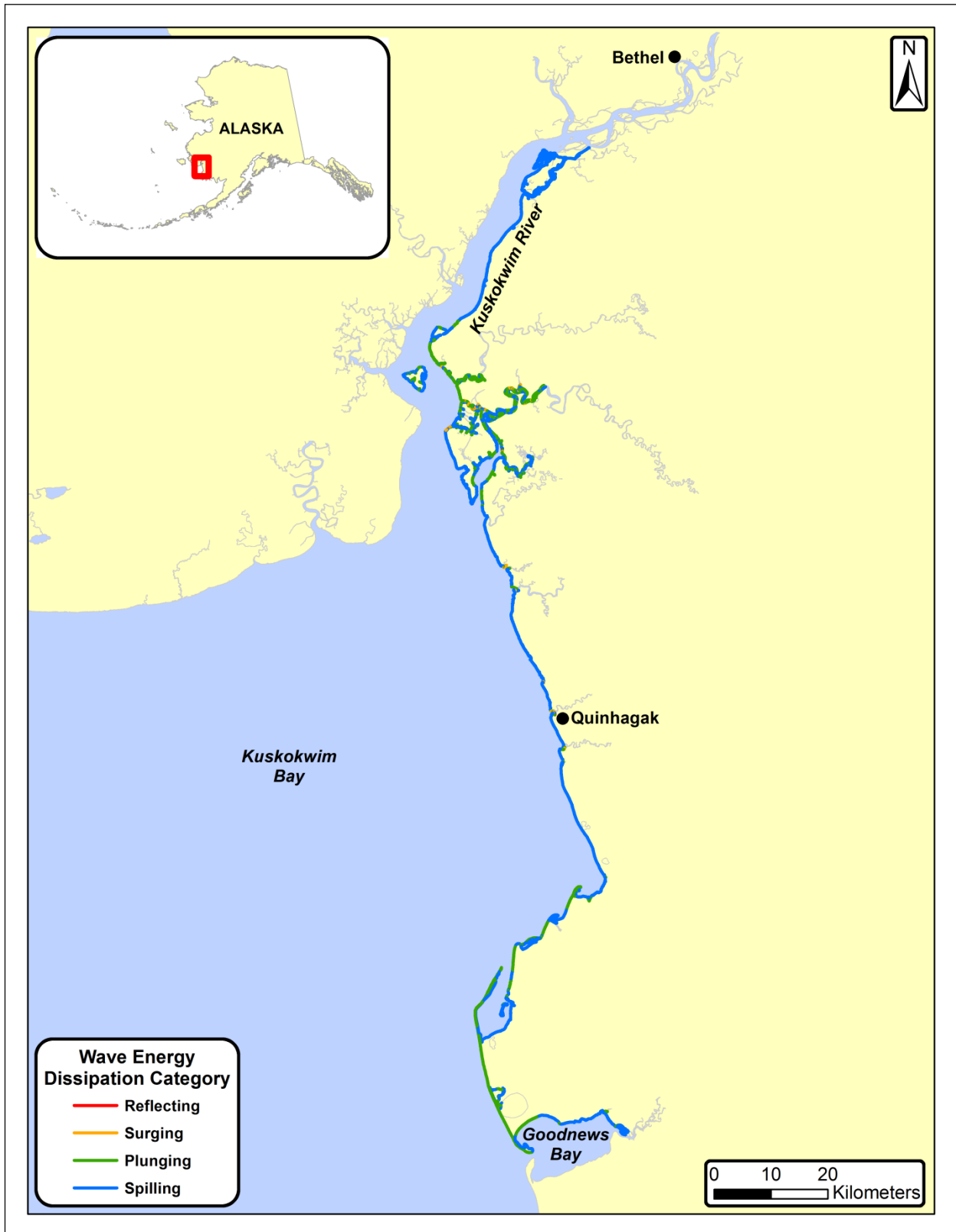


Figure 27. Distribution of Wave Energy Dissipation categories.

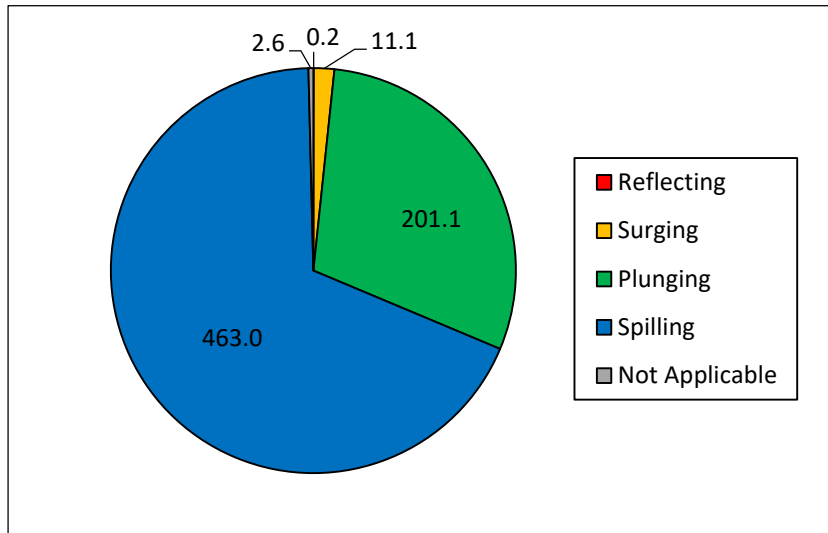


Figure 28. Wave Energy Dissipation categories by shoreline length (km).

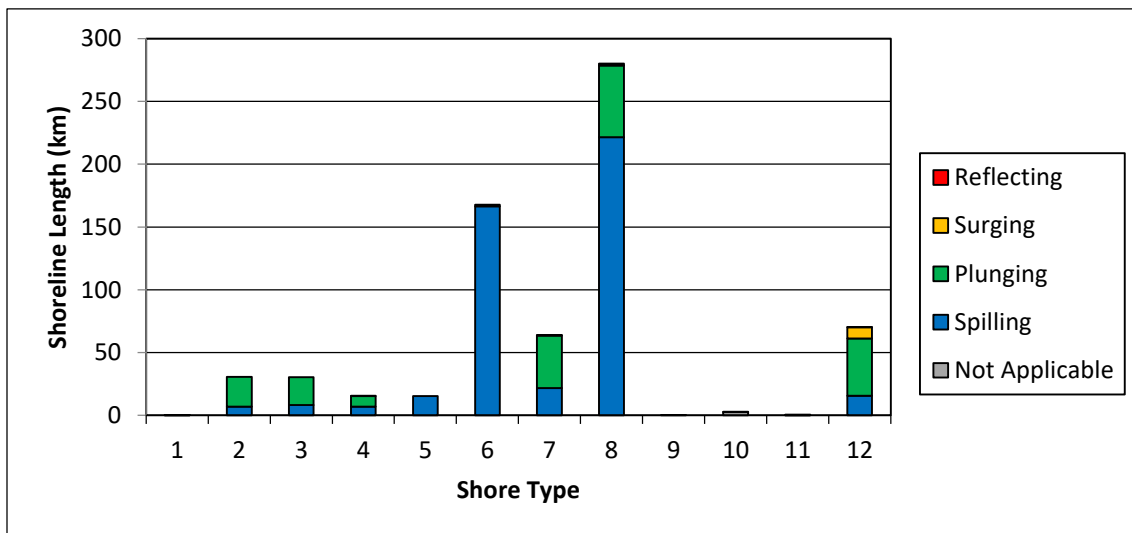


Figure 29. Wave Energy Dissipation categories by length of Shore Type.

The Iribarren class is a fluid dynamics concept that uses slope, wave height and wave period to model the effects of surface gravity waves on a beach. There are four classes: Spilling, Plunging, Surging, and Reflecting. This attribute was only Not Applicable for large river mouths. In the Kuskokwim Bay area, the Spilling class was most common (68% of the mapped shoreline) where most wave energy is dissipated. Plunging waves that break directly on the beach face can cause the most damage from shoreline erosion, and these accounted for 30% of the shoreline length. The Surging and Reflecting class was mostly found on peat shorelines where short intertidal width and high slope angles were common (see Figures 27 to 29 for distribution and summary statistics).

2.7 Geomorphology

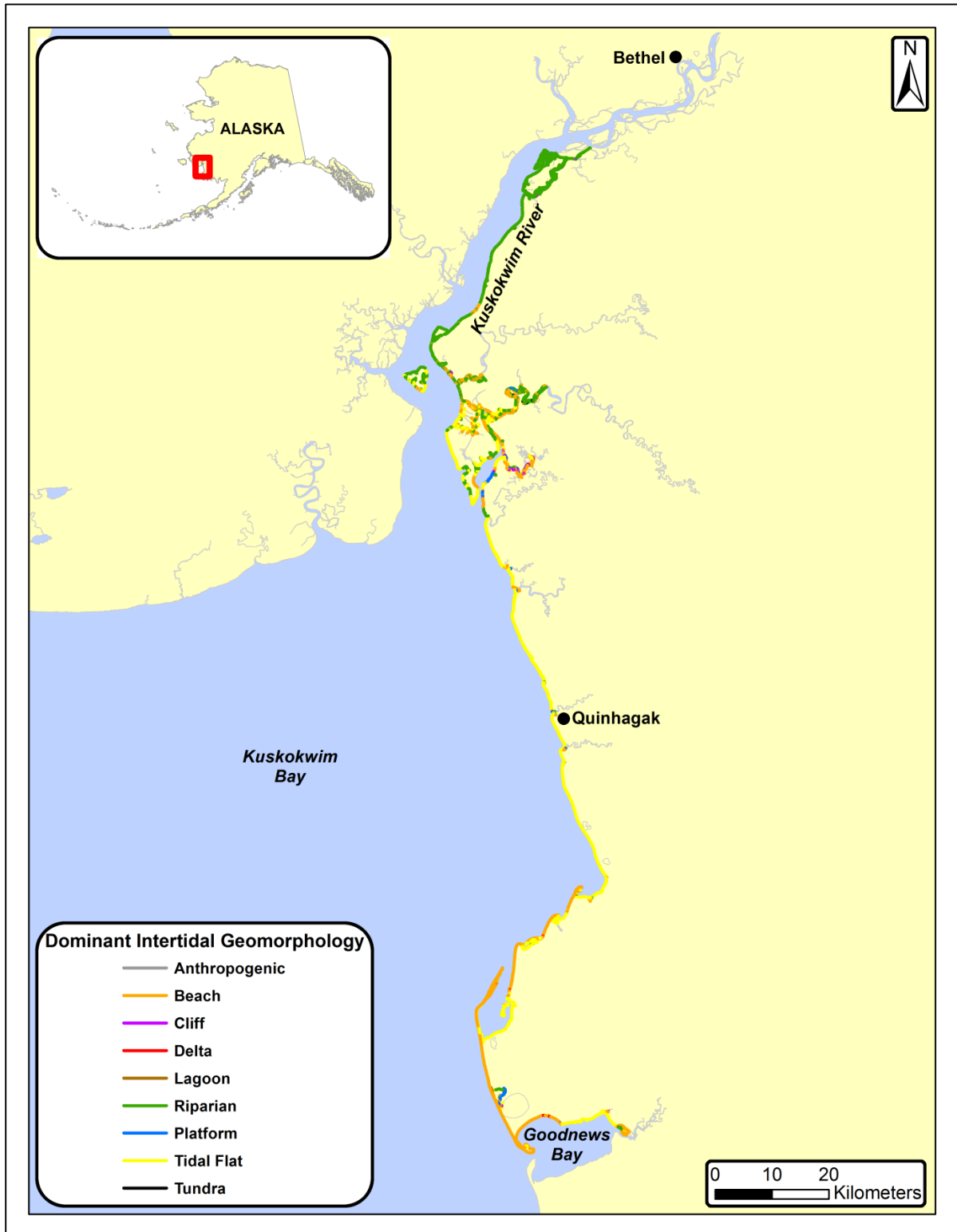


Figure 30. Distribution of the Dominant Intertidal Geomorphological forms.

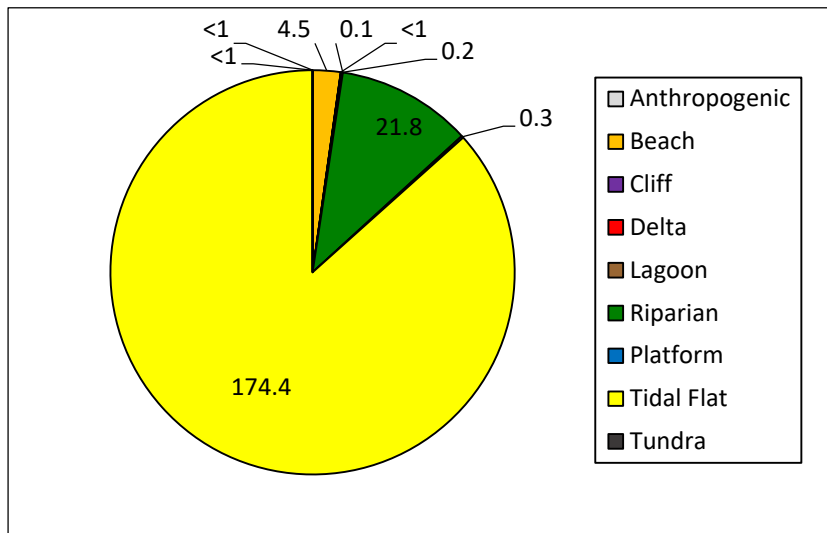


Figure 31. Primary intertidal Geomorphology by intertidal area (km²).

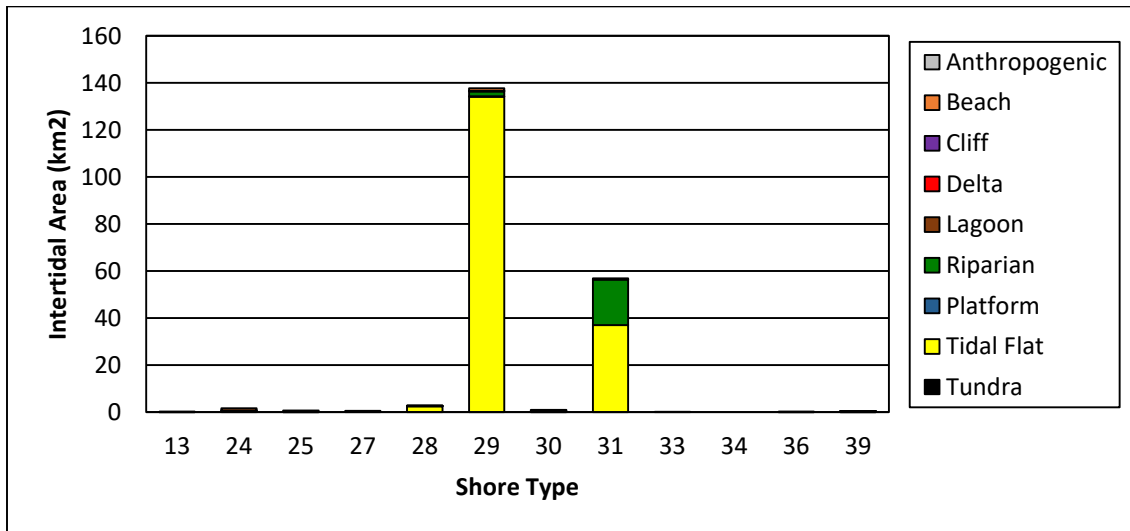


Figure 32. Primary Intertidal Geomorphology forms by area of Shore Type.

ShoreZone classifies the geomorphology of Forms which can be separated into 13 different structuring groups. Within these structuring groups there are many sub-forms which represent a geomorphic attribute on the shoreline, such as a beach face (mapped Bf). With new ShoreZone mapping methods, it is now possible to determine the area of one particular form in each component. Figure 30 shows the distribution of intertidal primary forms mapped in Kuskokwim Bay. Figure 31 shows the percent of each primary form, based on intertidal area (km²). Wide tidal flats make up most of the intertidal area, as Shore Type 29 (Figure 32) boasts the largest area based on intertidal geomorphology.



2.8 Anthropogenic Shore Modifications

Anthropogenic features such as seawalls, rip rap breakwaters, docks, dikes and wharves are included in the ShoreZone classification. Only one shoreline unit near the town of Quinhagak (0.01%) has been modified with Sheet Pile. A photo example for Shore Type 33 (impermeable man-made structures) including Sheet Pile can be found in Appendix A of this report.

3.1 Biobands

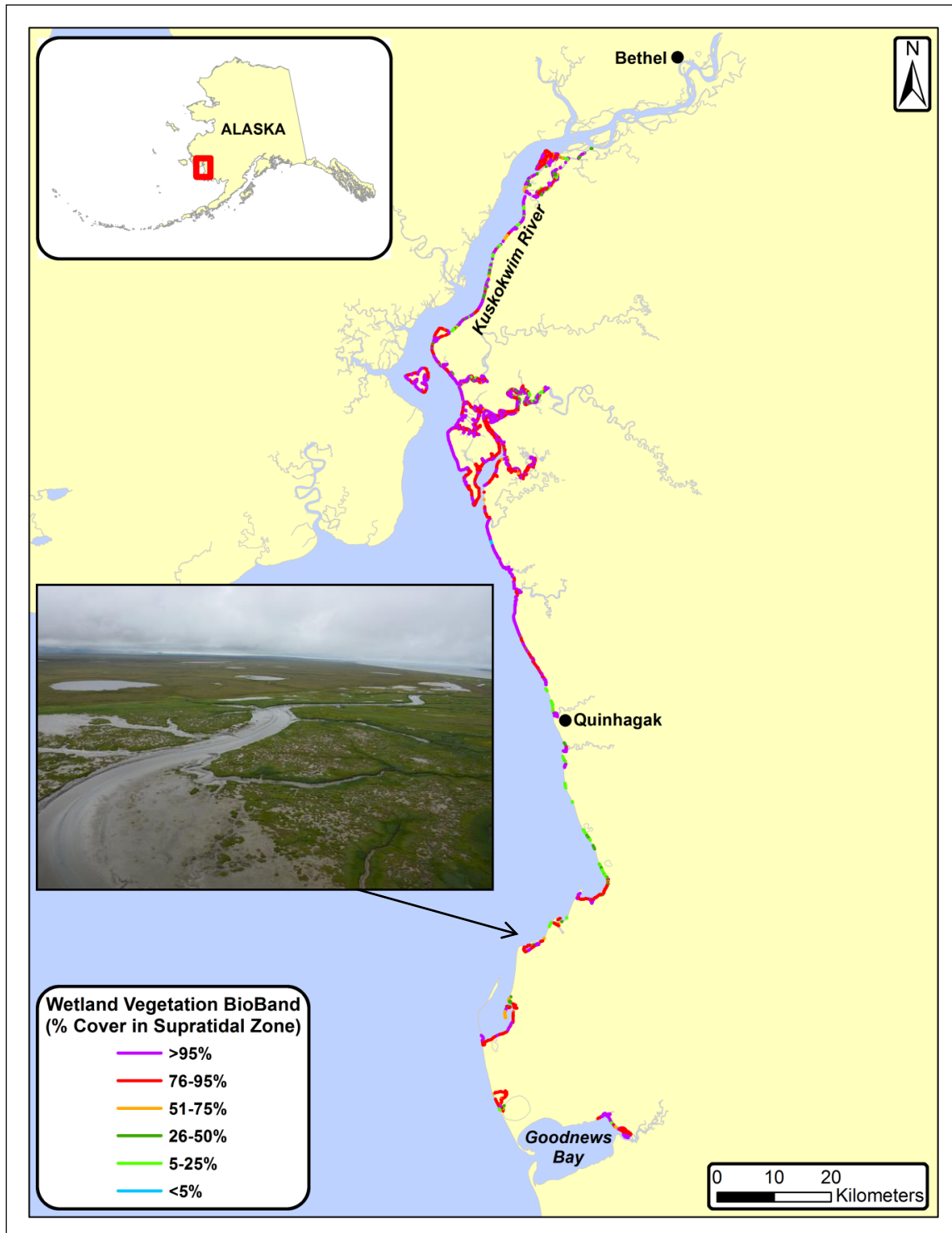


Figure 33. Distribution of the Wetland Vegetation bioband (WEVE) bioband in the supratidal (A zone) with a photographic example from near Takiketak. See Appendix A for more photographic examples of biobands.

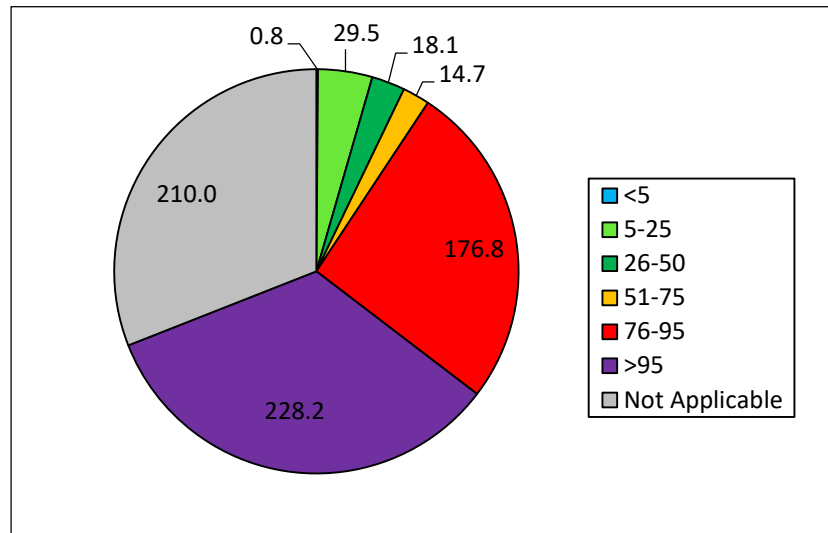


Figure 34. Distribution of the supratidal Wetland Vegetation (WEVE) bioband by percent cover and shoreline length (km).

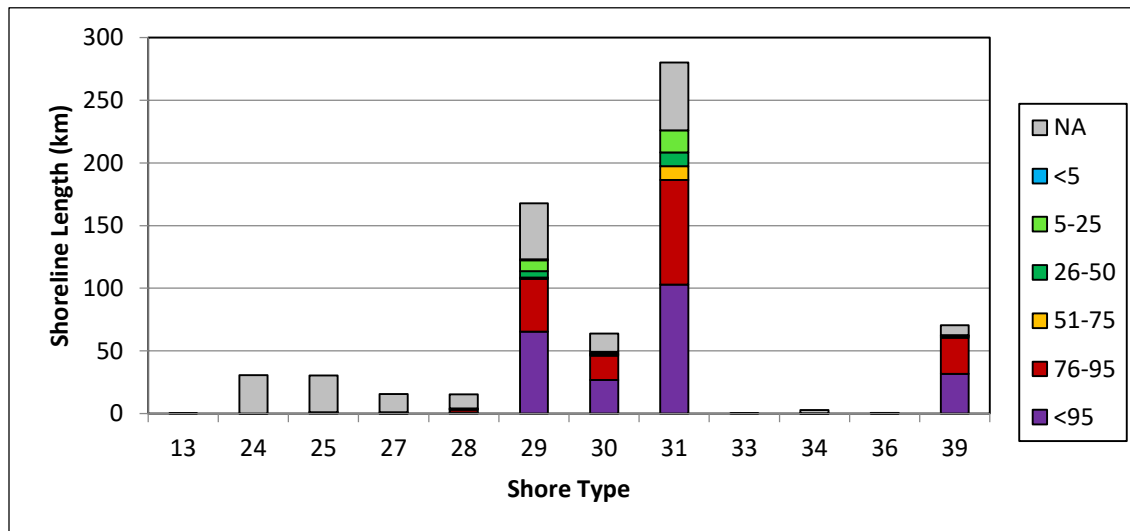


Figure 35. Supratidal Wetland Vegetation (WEVE) bioband by percent cover and length of Shore Type.

Wetland Vegetation (WEVE) was the most commonly occurring bioband and was found in 70% of the units totaling 69% of the shoreline length. This bioband was mostly found in the supratidal zone (distribution and summary statistics shown in Figures 33 to 35) with a fringe sometimes found in the upper intertidal zone. This bioband indicates the presence of wetland plants such as sedges and other marsh grasses and is associated with sources of fresh water which are abundant in Kuskokwim Bay where the Kuskokwim River and other large rivers flow into the ocean. This can be seen in the maps of the area created by the National Wetlands Inventory (<http://www.fws.gov/wetlands/data/mapper.HTML>) which shows the coastal vegetation falling mostly under the Freshwater Emergent Wetland category.

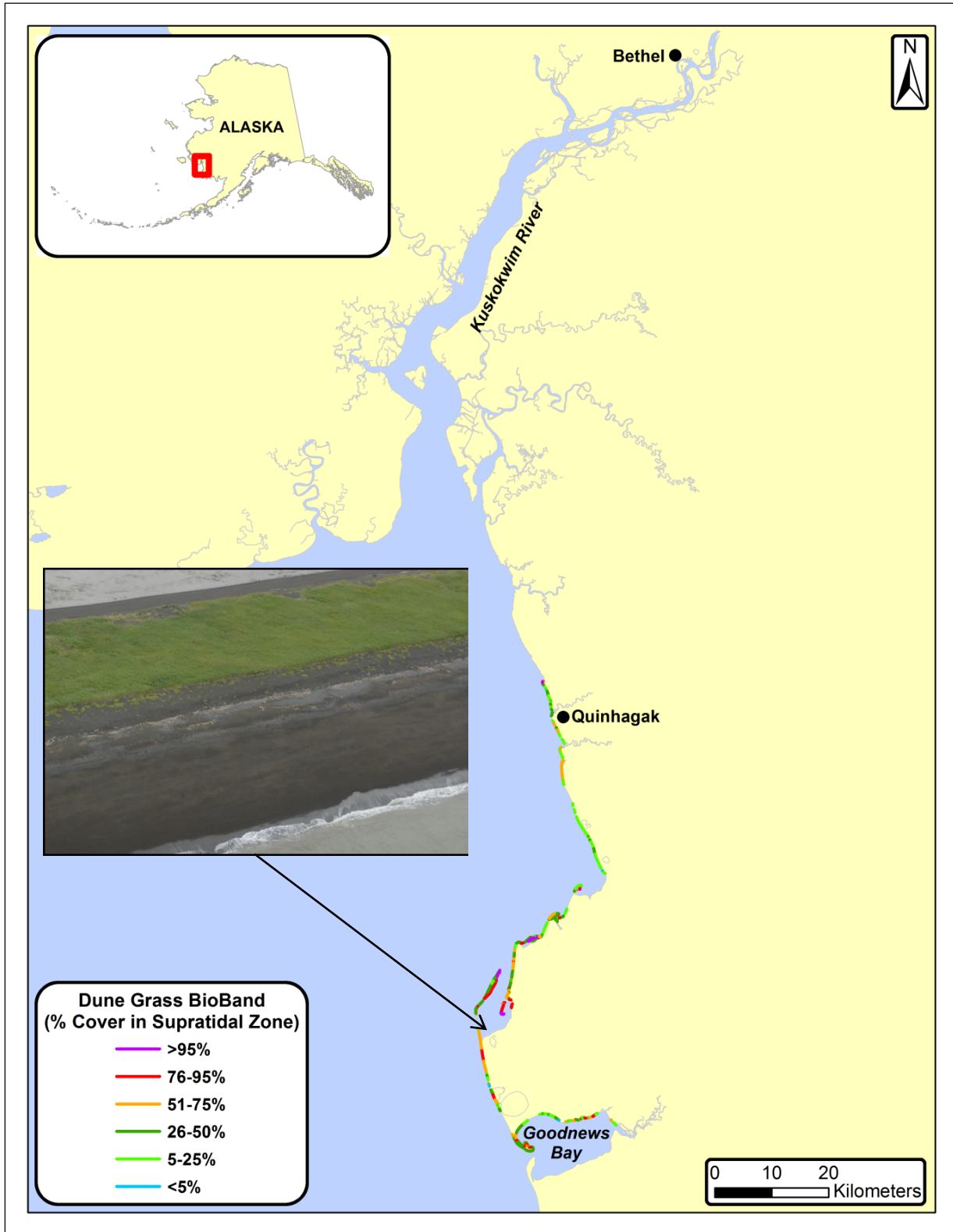


Figure 36. Distribution of the Dune Grass (DUGR) bioband by percent cover and shoreline length in the supratidal (A zone) with a photographic example from the outside of the spit protecting Carter Bay. See Appendix A for more photographic examples of biobands.

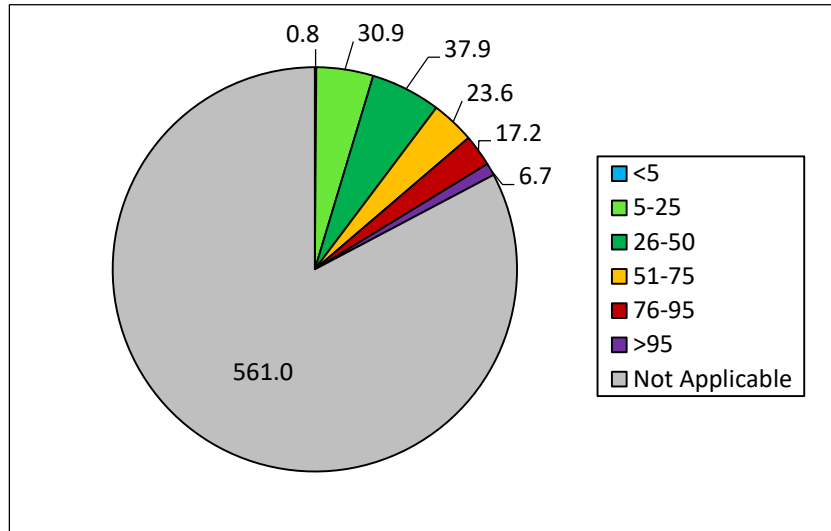


Figure 37. Distribution of the supratidal Dunegrass (DUGR) bioband by percent cover and shoreline length (km).

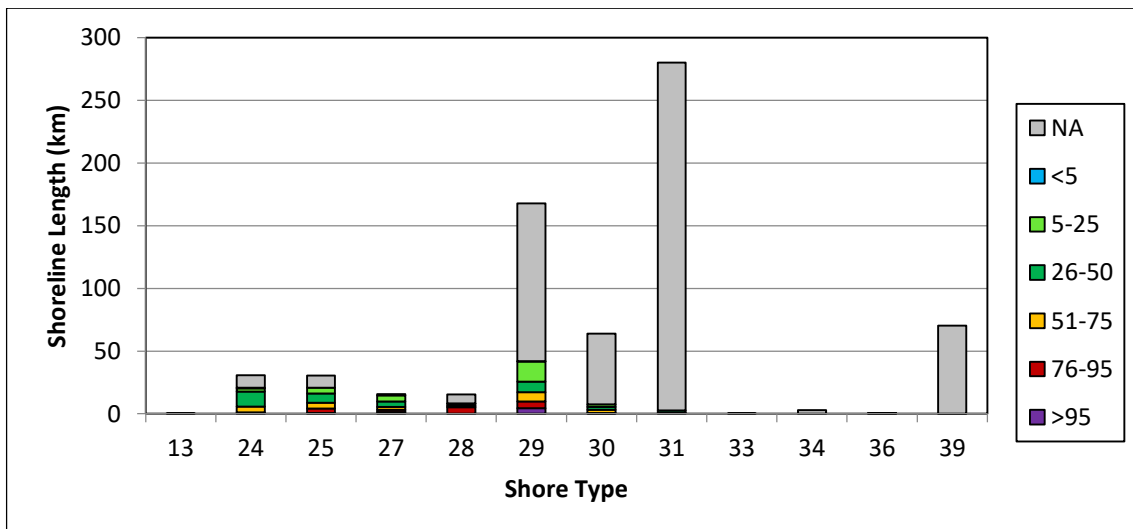


Figure 38. The supratidal Dunegrass (DUGR) bioband by percent cover and length of Shore Type.

Dune Grass (DUGR) occurred in 14% of the units totaling 17% of the shoreline length (see Figures 36 to 38 for distribution and summary statistics). 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 Kuskokwim Bay area, often with fringing Salt Marsh (SAMA) bioband lower in the supratidal and Wetland Vegetation (WEVE) behind. The sandy beaches favored by Dunegrass tended to occur in the Semi-Exposed and Exposed areas south of the Kuskokwim River mouth in this area.

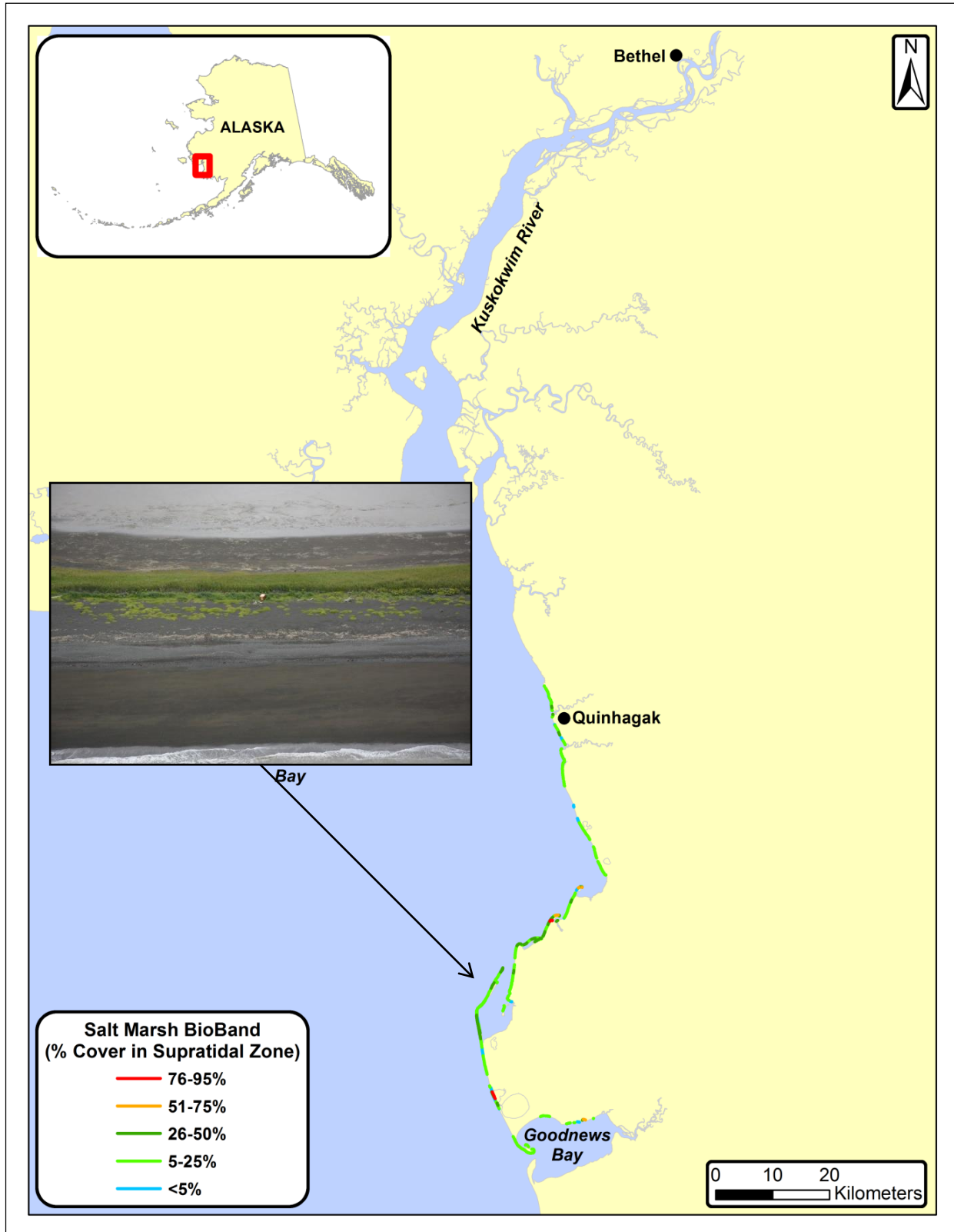


Figure 39. Distribution of the Salt Marsh (SAMA) bioband in the supratidal (A zone) with a photographic example from the exposed spit outside Carter Bay. See Appendix A for more photographic examples of biobands.

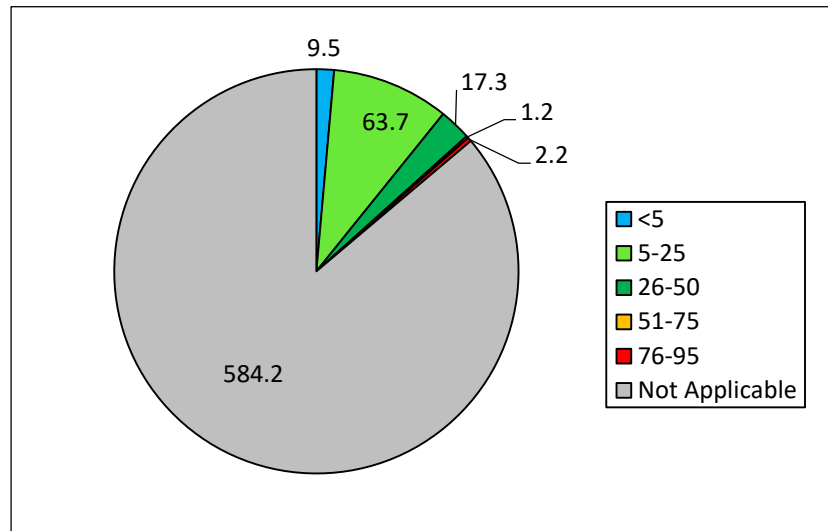


Figure 40. Distribution of the supratidal Salt Marsh (SAMA) bioband by percent cover and shoreline length (km).

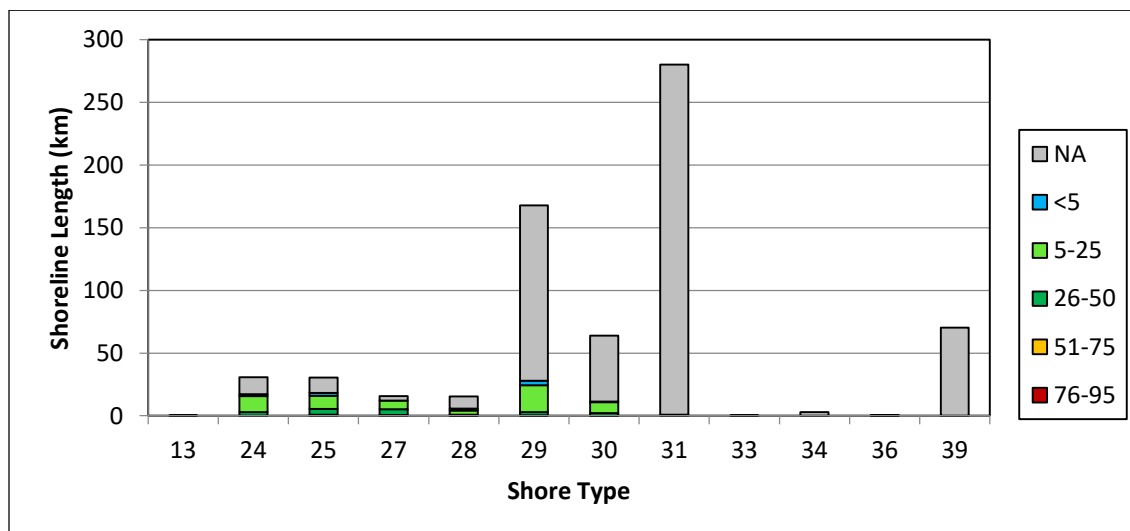


Figure 41. The supratidal Salt Marsh (SAMA) bioband by percent cover and length of Shore Type.

The Salt Marsh (SAMA) bioband was found in 10% of the units totaling 14% of the shoreline length (see Figures 39 to 41 for distribution and summary statistics). This is considerably less than may be expected for an area that consists mostly of a large estuary, which is the typical habitat for coastal salt marshes; however, this area is structured by the presence of large amounts of freshwater dominating the backshore. This can be seen in the maps of the area created by the National Wetlands Inventory (<http://www.fws.gov/wetlands/data/mapper.HTML>) with the Freshwater Emergent Wetland category dominating this portion of the coastline. The Salt Marsh bioband in this part of Kuskokwim Bay was exclusively fringing salt marsh (usually occurring with Dunegrass (DUGR)) that does not show up on NWI maps.

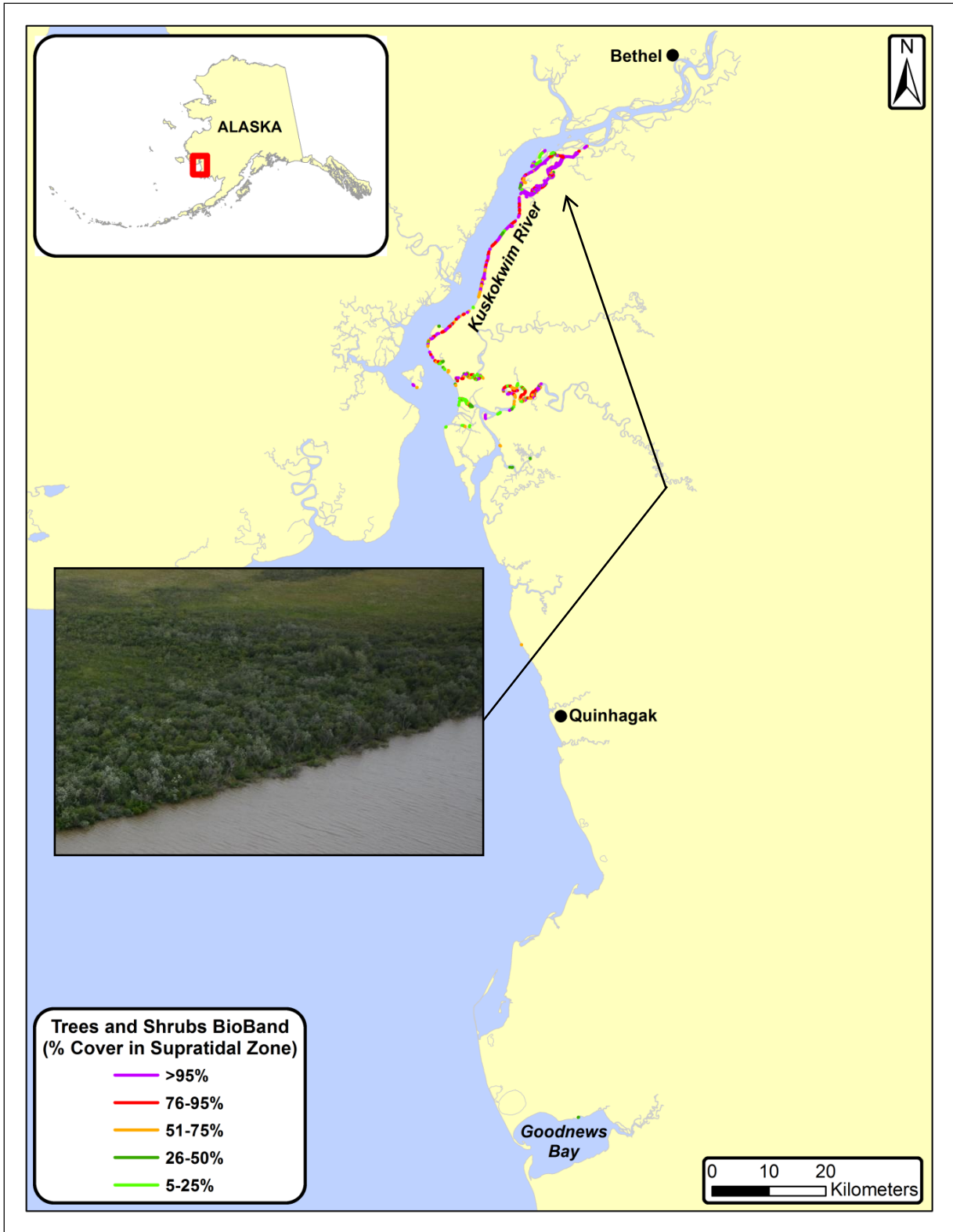


Figure 42. Distribution of the Trees and Shrubs (TRSH) bioband in the supratidal (A zone) with a photographic example from the Kuskokwim River. See Appendix A for more photographic examples of biobands.

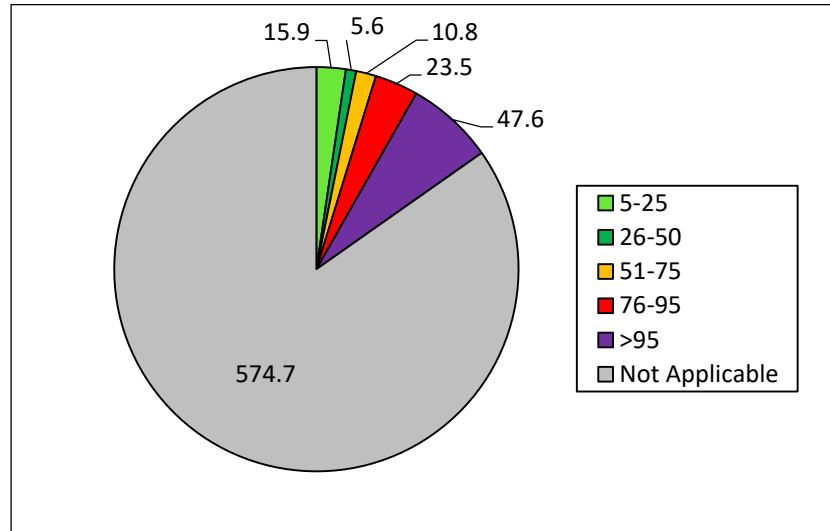


Figure 43. Distribution of the supratidal Trees and Shrubs (TRSH) bioband by percent cover and shoreline length (km).

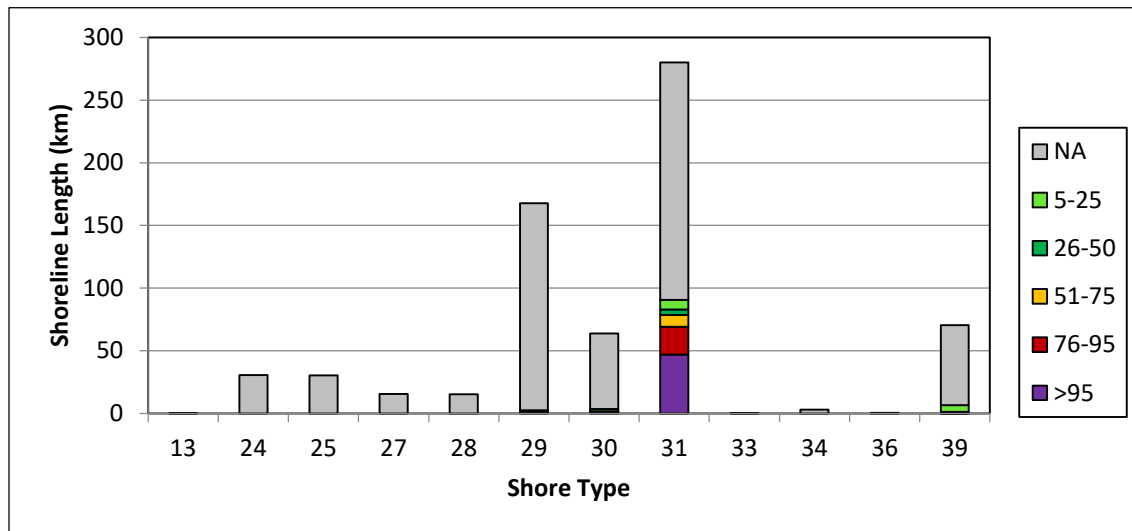


Figure 44. The supratidal Trees and Shrubs (TRSH) bioband by percent cover and length of Shore Type.

The Trees and Shrubs (TRSH) were mapped in 20% of units totaling 16% of the shoreline length (see Figures 42 to 44 for distribution and summary statistics). This bioband is generally considered to be terrestrial so would be unusual along the coast; however, this bioband was only mapped up the Kuskokwim River in Kuskokwim Bay and was generally associated with undercuts and eroding bank where terrestrial vegetation was falling into the water. This was also observed in previous ShoreZone mapping in the YK Delta estuary (Coastal and Ocean Resources, 2015).

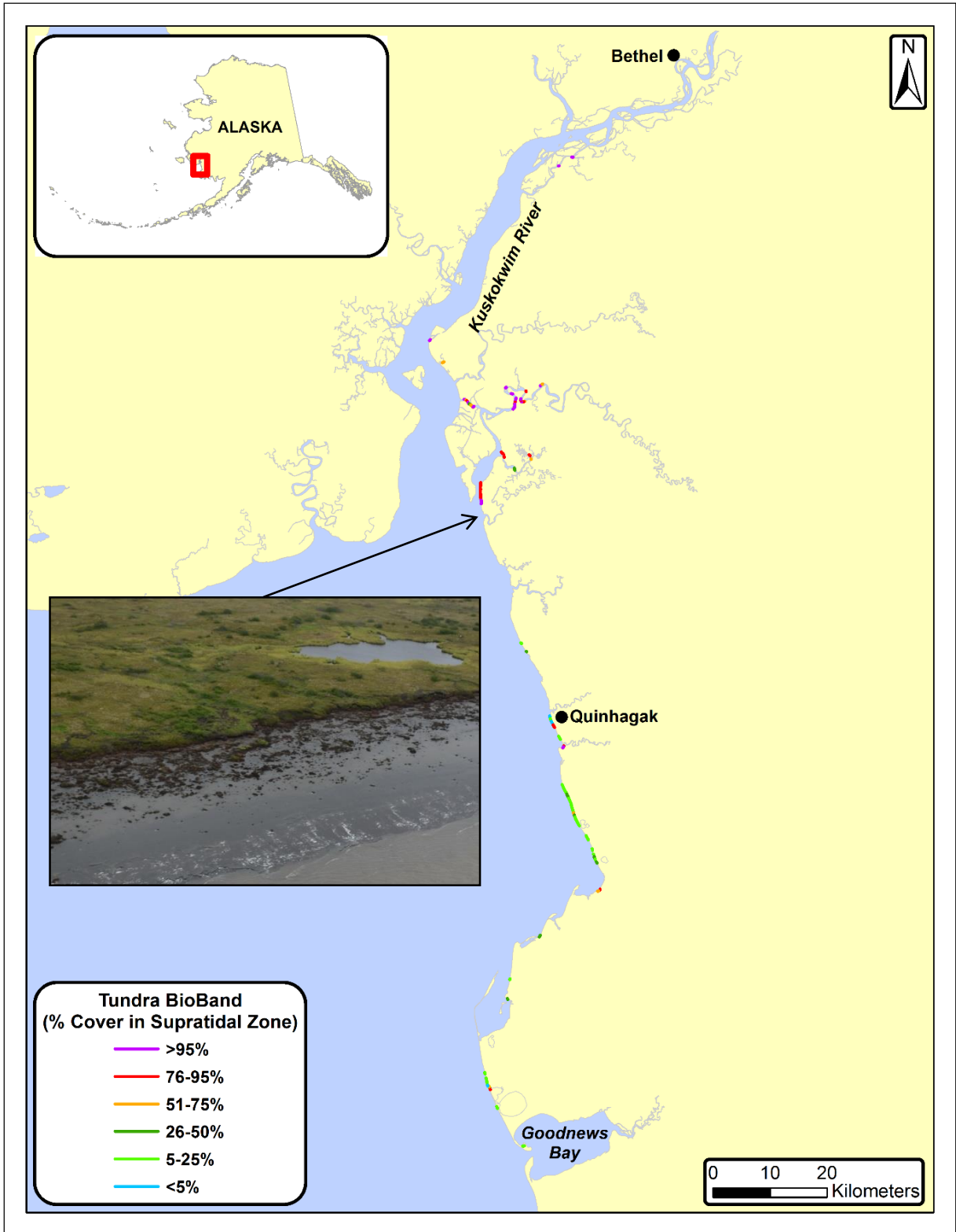


Figure 45. Distribution of the Tundra (TUND) bioband in the supratidal (A zone) with a photographic example from the Kuskokwim River near the Eek River mouth. See Appendix A for more photographic examples of biobands.

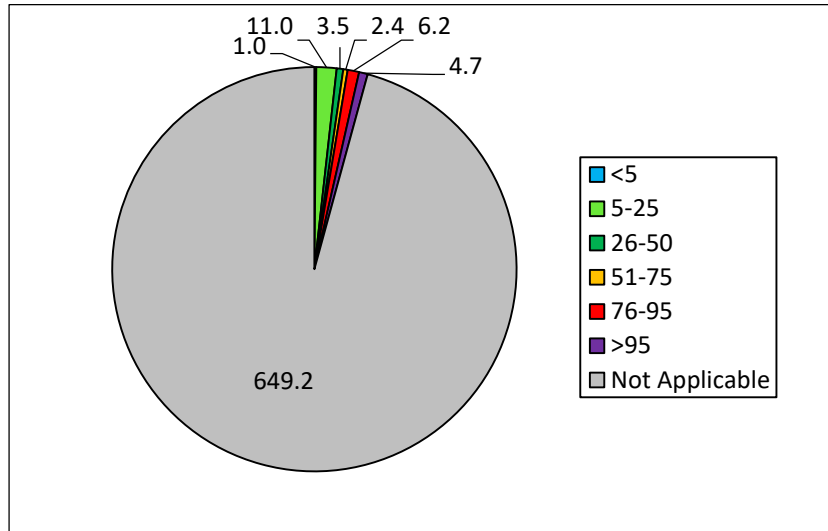


Figure 46. Distribution of the supratidal Tundra (TUND) bioband by percent cover and shoreline length (km).

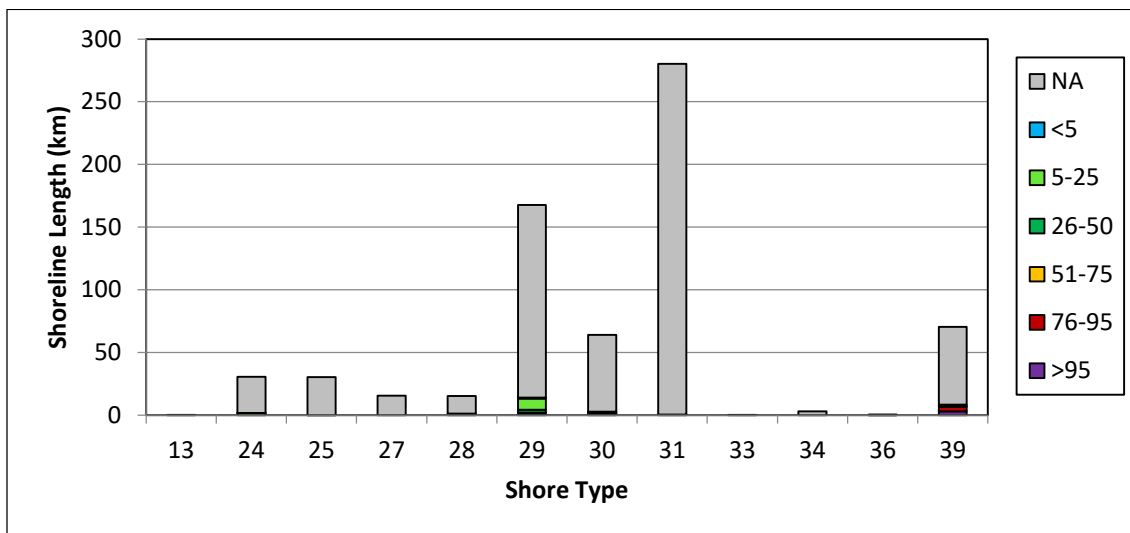


Figure 47. The supratidal Tundra (TUND) bioband by percent cover and length of Shore Type.

The Tundra bioband (TUND) was mapped in only 4% of units totaling 4% of the shoreline length (see Figures 40 to 42 for distribution and summary statistics). This bioband is also generally considered to be terrestrial so would not normally be mapped in a coastal zone; however, like the Trees and Shrubs (TRSH) bioband, this was only found up the Kuskokwim or Eek Rivers and was generally associated with undercuts and eroding bank. These areas were unlike any other surveyed by ShoreZone in Alaska, being more riverine or palustrine in nature than marine. This was also observed in previous ShoreZone mapping in the YK Delta estuary (Coastal and Ocean Resources, 2015).

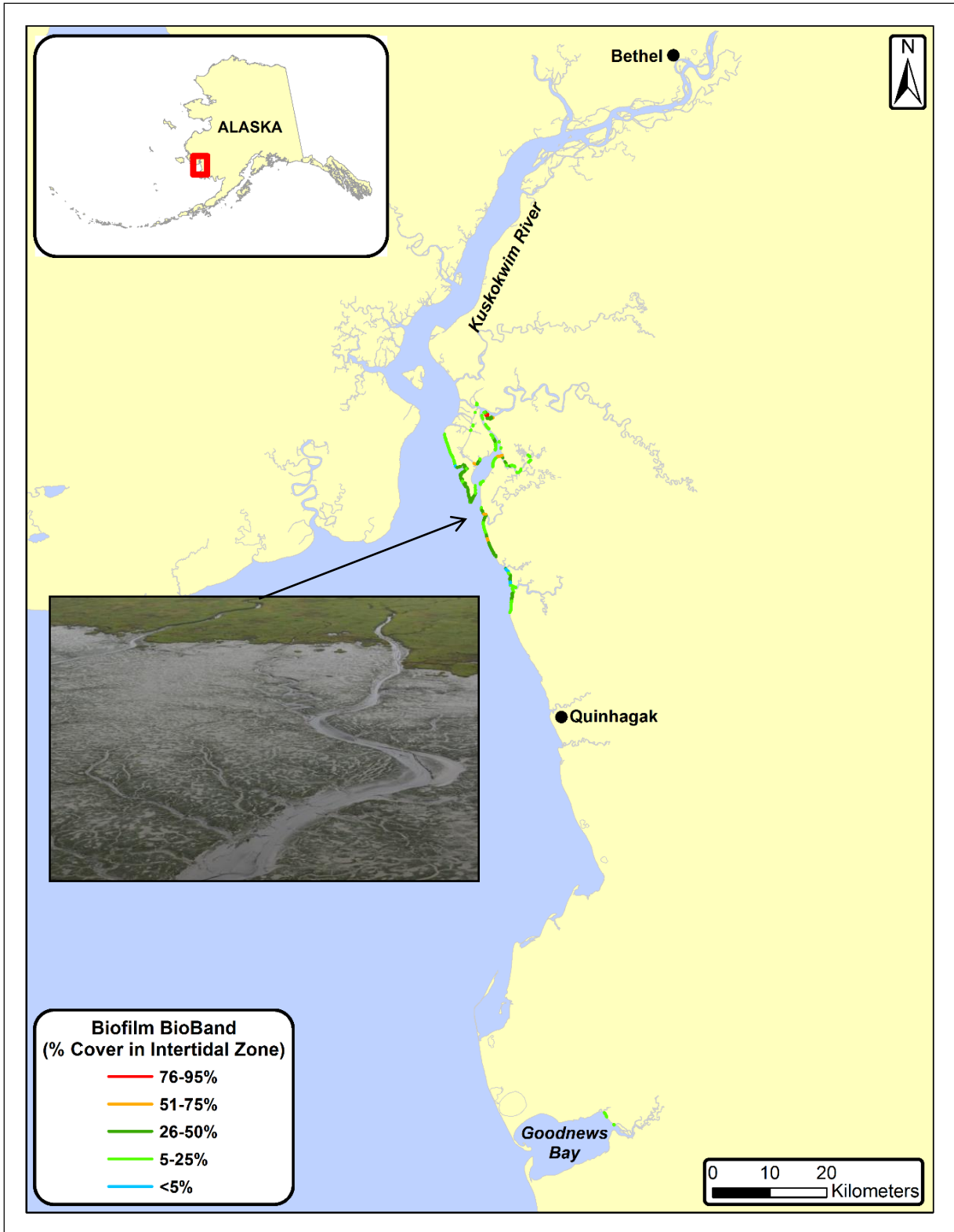


Figure 48. Distribution of the Biofilm (BIOF) bioband in the intertidal (B zone) with a photographic example from the tip of Eek Island at the mouth of the Kuskokwim River. See Appendix A for more photographic examples of biobands.

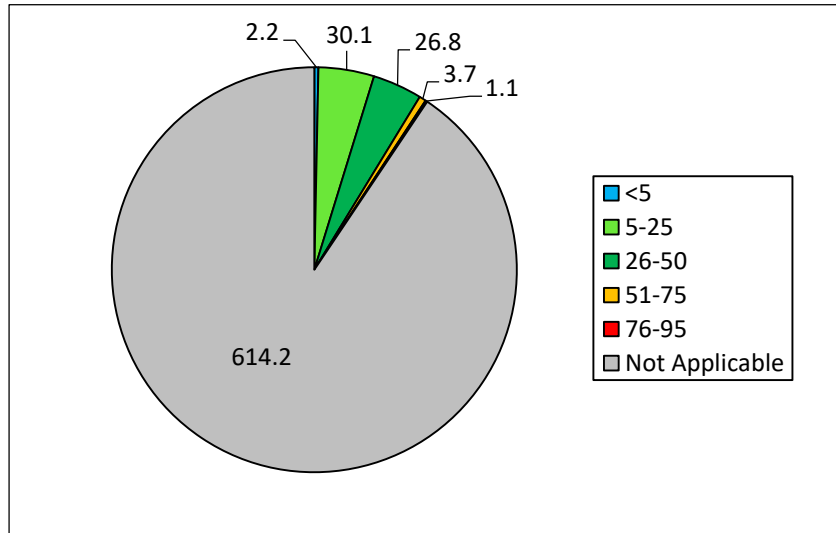


Figure 49. Distribution of the intertidal Biofilm (BIOF) bioband by percent cover and shoreline length (km).

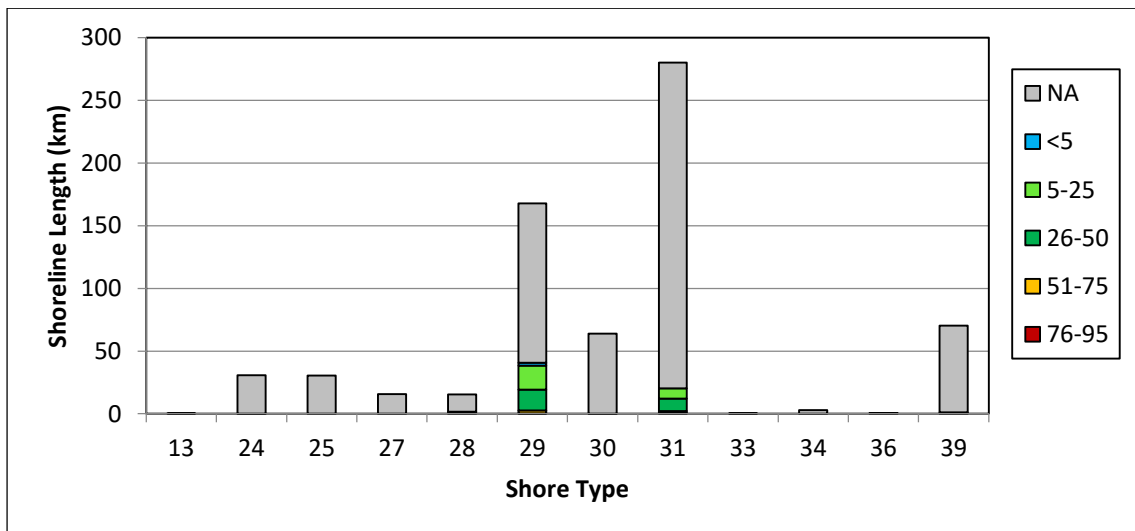


Figure 50. The intertidal Biofilm (BIOF) bioband by percent cover and length of Shore Type.

Supratidal vegetation dominated this survey area with 97% of units (totaling 98% of the shoreline length) having at least one supratidal vegetation bioband (not including splash zone bands which only occurred in 0.9% of units). 70% of units had intertidal vegetation, although BIOF was the only exclusively intertidal bioband (in 6% of units totaling 9% of shoreline length) (see Figures 48 to 50 for distribution and summary statistics) with all other intertidal biobands being high intertidal/supratidal bands like Wetland Vegetation (WEVE). Only 0.2% units had subtidal biobands, all of which were the Eelgrass (EELG) bioband in Goodnews Bay. This lack of intertidal and subtidal biobands is likely due to the low nearshore salinity, high suspended sediments in the nearshore waters and the dominance of mobile sand and mud beaches in Kuskokwim Bay area.

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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, 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 or Dr. G. Carl Schoch at Coastal and Ocean Resources: Carl@coastalandoceans.com.

APPENDIX A

Photographic Examples of Shore Types and Biobands

Table A-1. Examples of the Shore Types in the Kuskokwim Bay area (Page 41).
Table A-2. Examples of the Biobands in the Kuskokwim Bay area (Page 47).

Table A-1. Examples of the Shore Types in the Kuskokwim Bay area.



Photo bs14_bt_11503: Example of Shore Type 13; Cliff with gravel/sand beach.
Goodnews Bay.



Photo bs14_bt_11490: Example of Shore Type 24; Sand & gravel flat or fan.
Goodnews Bay.



Photo bs14_bt_11446: Example of Shore Type 25; Sand & gravel beach, narrow.
Goodnews Bay.



Photo bs14_bt_10541: Example of Shore Type 27; Sand beach, wide.
South of Jacksmith Bay.



Photo bs14_bt_15294: Example of Shore Type 28; Sand flat.
Apokak Slough.



Photo bs14_bt_15547: Example of Shore Type 29; Mudflat.
Eek Island.



Photo bs14_bt_13479: Example of Shore Type 30; Sand beach.
Eenayarak River.



Photo bs14_bt_14906: Example of Shore Type 31; Organics/fines.
Eek River.



Photo bs14_bt_13888: Example of Shore Type 33; Impermeable man-made structures. Kanektok River.



Photo bs14_bs_12988: Example of Shore Type 34; Current-dominated. Nanvakfak Lake.



Photo bs14_bt_10955: Example of Shore Type 36; Lagoon.
Carter Bay.



Photo bs14_bt_13523: Example of Shore Type 39; Low vegetated peat.
Eenayarak River.



Table A-2. Examples of the Biobands in the Kuskokwim Bay area.



Photo bs14_bt_11532: Good example of the Black Lichen (BLLI) bioband which is a black band in the supratidal zone, usually cause by the lichen *Verrucaria* sp. Goodnews Bay.



Photo bs14_bt_11523: Good example of the Yellow Lichen (YELI) bioband which is defined as a yellow band in the supratidal splash zone caused by yellow/orange lichens. Goodnews Bay.



Photo bs14_bt_11448: Good example of the Grasses (GRAS) bioband. This protected beach shows the grasses on the eroding cliff in the A Zone that cannot fit into any other bioband. Goodnews Bay.



Photo bs14_bt_15496: Good example of the Tundra (TUND) bioband in the A zone. Kuskokwim River near Eek River mouth.



Photo bs14_yk_01674: Good example of the Trees and Shrubs (TRSH) bioband. Kuskokwim River near Bethel.



Photo bs14_bt_10616: Good example of the Wetland Vegetation (WEVE) bioband in an estuary. Near Takiketak.



Photo bs14_bt_10445: Example of the Dunegrass (DUGR) bioband with Salt Marsh (SAMA) below. Outside Jacksmith Bay.



Photo bs14_bt_11049: Good example of a fringing Salt Marsh (SAMA) bioband below fringing Dunegrass (DUGR). Outside Carter Bay.



Photo bs14_bt_14284: Good example of the Biofilm (BIOF) bioband on the tidal flat. This dark green is typical of the YK Delta area. Tip of Eek Island.



Photo bs14_bt_11373: Example of the Green Algae (GRAL) bioband. This photo was cropped to illustrate the bioband at the waterline. Goodnews Bay.



Photo bs14_bt_11395: Example of the dark green Eelgrass (EELG) bioband. This bioband was rare in the Kuskokwim Bay area Goodnews Bay..