National Park Service
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Natural Resource Stewardship and Science

Shoreline Change at Cumberland Island National Seashore

2018–2019 Data Summary

Natural Resource Data Series NPS/SECN/NRDS—2020/1258

ON THE COVER
Picture taken at Long Point on Cumberland Island. The picture displays the UTV and GPS antenna used to collect the shoreline monitoring data. The UTV is positioned on the high tide swash line. NPS Photo / SECN

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2018–2019 Data Summary

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Fort Collins, Colorado

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Acknowledgments

This report was completed with the assistance of Kelsey Mack (SECN Coastal Monitoring Intern) and previous work performed by Jason Gardner (previous Coastal Monitoring Technician). Thank you for your assistance and efforts that facilitated the creation this report.

Summary and Key Findings

In 2018 and 2019 the Southeast Coast Network collected shoreline data at Cumberland National Seashore as a part of the NPS Vital Signs Monitoring Program.

Monitoring was conducted following methods developed by the National Park Service Northeast Barrier Coast Network and consisted of mapping the high tide swash line using a global positioning system (GPS) unit in the spring of each year (Psuty et al. 2010). Shoreline change was calculated using the Digital Shoreline Analysis System developed by USGS (Theiler et al. 2008).

Key findings from this effort are as follows:

- A mean of 30.03 kilometers (18.66 miles [mi])of shoreline were mapped from 2018 to 2019 with a mean horizontal accuracy of 10.11 centimeters (3.98 inches [in]).
- The mean shoreline distance change from 2018 to 2019 was 1.82 meters (5.97 feet [ft]) with a standard deviation of 8.19 meters (26.87 ft). The shoreline change distance ranged from -23.62 meters to 75.65 meters (-77.49 to 248.20 ft).
- High erosion areas were present in the 2018 to 2019 shoreline survey analysis. 4.20 % of the transects were located in areas of erosion beyond the uncertainty range of the data (± 10 meters [32.8 ft]), which can be inferred that high erosion occurred along a cumulative 1.25 kilometers (0.78 mi) of the study area surveyed.
- High accretion areas were present in the 2018 to 2019 shoreline survey analysis. 11.01 % of the transects were located in areas of accretion beyond the uncertainty range of the data (± 10 meters [32.8 ft]), which can be inferred that accretion occurred along a cumulative 3.28 kilometers (2.04 mi) of the study area surveyed.

Introduction

The problem of land loss and gain and landscape alteration at the marine edge is fundamental to the many issues facing coastal park resource stewards. Shoreline change is a prime geoindicator of coastal environmental resource threats within parks. Change in shoreline position drives the alteration and replacement of established natural habitats, and shoreline retreat may destroy cultural resources, facilities, and other infrastructure. Geomorphologic change is a basic concern because it also influences change in other natural resource areas of interest within the National Park Service such as estuarine and subsurface water quality, species and habitats of concern, recreational visitor use, and even resource extraction. Spatial variability is inherent in shoreline change. Early identification of changes in past trends, along with an understanding of normal variability, is key to recognizing ecological problems in coastal parks. For managers, an understanding of the spatial and temporal patterns of geomorphologic change is important for optimal management of any coastal park because: (1) the interface of marine and land systems is very dynamic and is driven by multiple forcing mechanisms, (2) it results in alterations to resource patterns and dynamics at habitat and ecosystem level, and (3) it will eventually result in the loss of static resources. Developing an understanding of these effects will benefit from the establishment of local long-term monitoring programs.

To effectively monitor diverse and dynamic coastal resources, the Southeast Coast Network has implemented a monitoring approach which consists of mapping the high tide swash line along the oceanfront beaches using GPS equipment. The data collected is post-processed to attain higher accuracy data and analyzed using the Digital Shoreline Analysis System (DSAS) created by USGS (Theiler et al. 2008). This approach is modeled after the *Northeast Coastal Barrier Network Geomorphological Protocol: Part 1—Ocean Shoreline Position* (Psuty et al. 2010).

The monitoring objectives for which data are collected and analyzed as part of this effort are (Baron 2018a):

1. Determine inter-annual changes in mean high-water shoreline position (average and standard deviation of change in position at fixed transects, and cumulatively within management units).

2. Determine the magnitude, direction, and spatial distribution of observed shoreline change including the identification of areas of highly dynamic shorelines, and areas of accretion versus erosion.

This report provides a summary of shoreline monitoring data collected by the network to address these objectives at Cumberland Island National Seashore (CUIS) from 2018 through 2019 (Figure 1). Data used in this report are available at https://irma.nps.gov/DataStore/Reference/Profile/2267045.

Figure 1. Map showing the section of beach, highlighted in red (study area) where data is collected for the shoreline monitoring project. Data is collected from the south end of Cumberland Island National Seashore up to the north end of Long Point.

Study Area

Cumberland Island National Seashore is a barrier island off the coast of southeast Georgia. The seashore consists of 17.5 miles (28.2 kilometers) of shoreline. The island contains unique habitats such as extensive maritime forest and salt marsh as well as large fresh water ponds, tidal creeks, mud flats and wide ocean shoreline. Cumberland Island is part of the South Atlantic-Carolinian Biosphere Reserve and will be permanently protected in a primitive state. The northern half of the island has been designated a wilderness area (DeVivo et. al 2015). Many threated and endangered species use the island for nesting and overwintering, such as several species of sea turtle and a variety of shorebirds. Preferred nesting and overwintering areas vary seasonally and as shorelines change over time.

The island is rich in history with an abundance of historic sites and buildings. Many of these structures were built on land that has, in some cases, changed dramatically. Georgia's unique tidal ranges and currents create potential for dynamic shifts in shoreline makeup over time. Close monitoring of historic structures and wildlife habitats is critical along this section of the Georgia coast. Current mapping efforts are focused on the main stretch of shoreline from the St. Marys Inlet north to Long Point at the north end of the island ending at Christmas Creek.

The purpose of this report is to deliver the most recently-collected data from within the park as part of an ongoing long-term shoreline-change monitoring program.

Methods

Standard Operating Procedures

Table 1 lists the standard operating procedures (SOPs) utilized in the long-term shoreline monitoring data collection, processing, and reporting. These SOPs are critical to maintaining continuity between data sets across many surveys to ensure comparable results. The version numbers in the table apply to both 2018 and 2019 data sets.

The shoreline was mapped along the oceanfront sandy shoreline of Cumberland Island National Seashore following the methods developed by the National Park Service Northeast Coast Barrier Network (Psuty et al. 2010). The Digital Shoreline Analysis System (DSAS; Theiler et al. 2008) was used to analyze the shoreline change. Annual shoreline change distances were calculated by determining the distance between two shorelines. Shoreline surveys were collected in 2018 and 2019; therefore, the shoreline change that occurred between those two time periods is analyzed in this report (see Appendix A).

As stated in SOP 2.3.11 *Coastal Shoreline Monitoring Annual Change Analysis—Version 1.0* (Baron 2018b), the uncertainty of the individual shoreline survey is ± 5 meters (16.4 ft]). This value is derived from the: (1) GPS accuracy, (2) differential tide position, (3) meteorological effects–wave dimension and run-up, and (4) interpretation of the line (Psuty et al. 2010). The annual comparisons deduced using two individual shoreline surveys will have an uncertainty of ± 10 meters (32.8 ft; Psuty et al. 2010). Refer to Psuty et al. 2010 for additional information regarding shoreline survey uncertainty.

Shoreline Data Collection

Shoreline data is collected according to SOP 1.3.22 *Conducting the Shoreline Survey—Version 1.0* (Baron 2018c). The high tide swash line is mapped using a Trimble® GPS unit. The data collected is post-processed according to SOP 2.3.10 *Post survey GPS data processing—Version 1.0* (Baron 2018d) using Pathfinder Office software to obtain higher accuracy data. The corrected data is exported as an ESRI shapefile. The ESRI shapefile is then edited, formatted, and uploaded to a personal geodatabase to analyze using DSAS.

Shoreline Change Analysis

The two shorelines were analyzed using DSAS. The annual shoreline change was performed by analyzing the 2018 and 2019 shoreline data collected. The 2018 shoreline was collected on 7 April 2018 and the 2019 shoreline was collected on 15 April 2019. The two shorelines were analyzed by calculating the distance the high tide line has moved from 2018 to 2019, along cross-shore transects spaced 10 meters (32.8 ft) apart. This analysis is termed "net shoreline movement" in the Digital Shoreline Analysis System.

High erosion areas were determined as areas having negative shoreline change distance less than the uncertainty range of the data (± 10 meters [32.8 ft]). Accretion areas were determined as locations with positive shoreline change distances greater than the uncertainty range (± 10 meters [32.8 ft]).

Table 1. SOPs used for shoreline position data collection, processing, and reporting

SOP number	SOP title	SOP version
1.3.21	Survey timing and GPS mission planning	1.0
1.3.22	Conducting the GPS shoreline survey	1.0
2.3.10	Post survey GPS data processing	1.0
2.3.11	Coastal shoreline monitoring annual change analysis	1.0
2.3.09	Coastal shoreline monitoring annual reporting	1.0

Water Levels

Two shoreline surveys of the high tide swash line included in this report were conducted during neap tides. The survey window was chosen based on the predicted tides using the closest NOAA tide gage with predicted tides (Fernandina Beach, FL—Station ID: 8720030; National Ocean and Atmospheric Administration, 2013). The actual tide heights that occurred before the surveys included in this annual report are listed in Table 2. The two previous high tides prior to the shoreline surveys conducted have similar water levels. The 2018 high tide line height is 0.02 meters (0.07 ft) lower than the 2019 high tide line height. This tidal difference can influence the position of the high tide line along the beach, based on the topography of the beach.

Table 2. High tide levels surveyed for the spring Cumberland Island National Seashore shoreline monitoring (m—meters).

Season	Survey collection date	Previous high tide height* (m)	Previous high tide time
Spring 2018	4/7/2018	1.75	0200
Spring 2019	4/15/2019	1.77	0535

* Tide heights are relative to Mean Lower Low Water, Fernandina Beach, FL—Station ID 8720030

Results

Shoreline Data

Shoreline data was collected in 2018 and 2019. On average, 30.03 kilometers (18.66 mi) of shoreline were mapped during the time period analyzed with a mean horizontal error of 10.11 centimeters (3.98 in; Table 3).

Annual Shoreline Change

Appendix B contains maps of the spring shoreline change distances calculated for the 2018 and 2019 shoreline data collected. The annual shoreline change distance is displayed by the transects between the two shorelines, which are clipped to the extent of shoreline change envelope and colored according to the shoreline change rate. A negative shoreline change distance denotes erosion, shown in warmer colors (if present). Positive shoreline change distance is depicting accretion, and is shown in cooler colors (if present).

The shoreline change distance ranged from -23.62 meters (-77.49 ft) to 75.65 meters (248.20 ft; Appendix C). The mean shoreline distance change for the area mapped was 1.82 meters (5.97 ft) with a standard deviation of 8.19 meters (26.87 ft).

High erosion areas were present in the study area, represented as light orange, dark orange, and red transects in the maps in Appendix B. High erosion was identified for 4.20 % of the transects (125 of 2,979) in the analysis (Figure 2). Because the transects are located approximately every 10 meters (32.8 ft) along the baseline, it can be inferred that high erosions occurred along a cumulative 1.25 kilometers of the study area surveyed.

High accretion occurred within the study area, represented as green, teal, light blue, and dark blue transects in the maps in Appendix B. High accretion was identified for 11.01 % of the transects (328 of 2,979) in the analysis (Figure 2). Because the transects are located approximately every 10 meters (32.8 ft) along the baseline, it can be inferred that high accretion occurred along a cumulative 3.28 kilometers (2.04 mi) of the study area surveyed.

Data used in this report are available at https://irma.nps.gov/DataStore/Reference/Profile/2267045.

Table 3. Table listing the length and positional error of the shorelines collected during 2018 and 2019 with the mean length and horizontal precision calculated by averaging across the entire shoreline feature [cm—centimeters; km—kilometers].

Collection Date	Mean Horizontal Accuracy (cm)	Length (km)
4/7/2018	10.21	29.97
4/15/2019	10.00	30.09

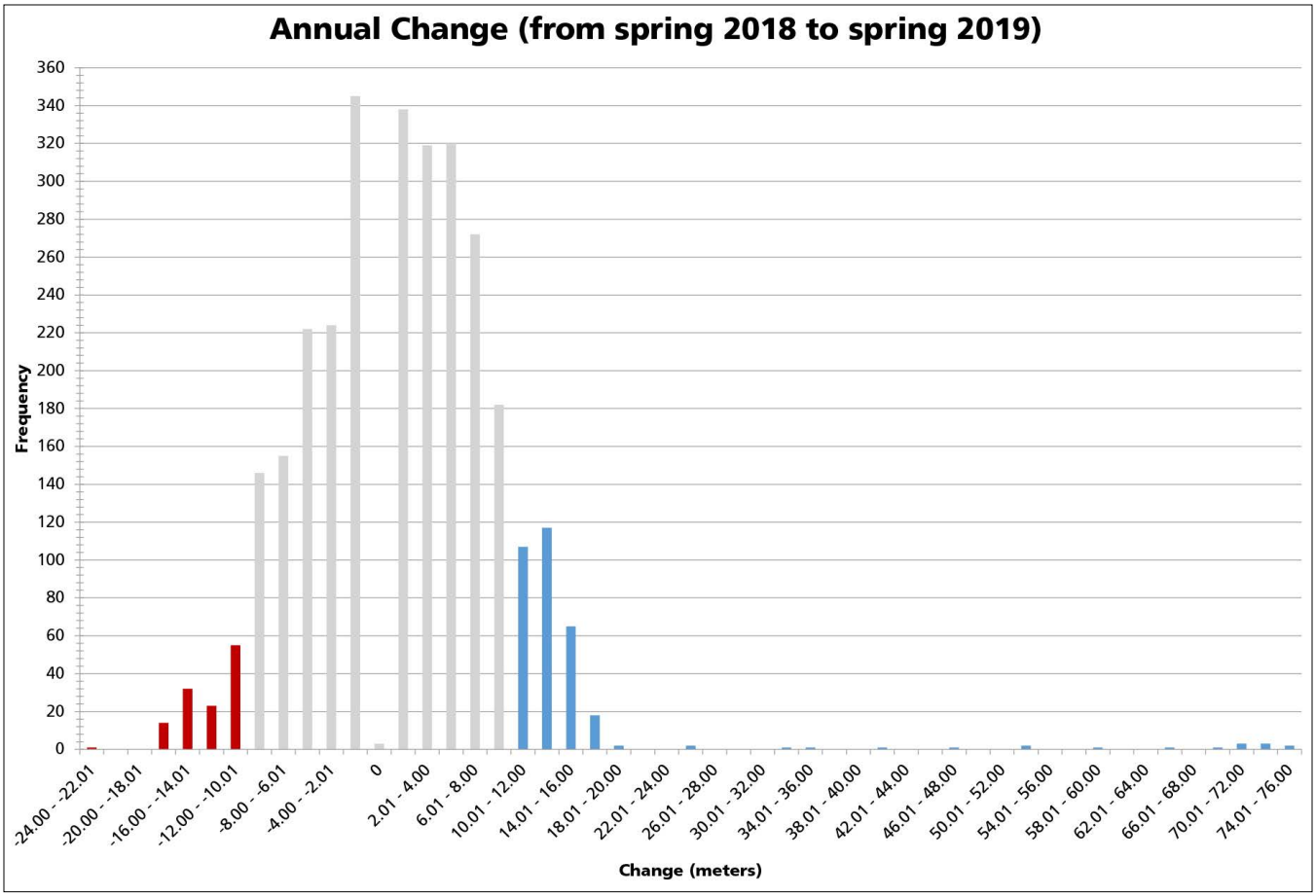

Figure 2. Histogram of transect shoreline change distances. The shoreline change distance is binned by 2-meter (6.56 ft) increments. The values along the x-axis represent the bin range. High erosion transects are presented as red (if present), transects that fall within the uncertainty range of the data (± 10 meters [32.8 ft]) are represented as grey, and the high accretion transects are represented as blue.

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Appendix A. Shoreline Data Collection Maps

Maps of the shoreline surveys collected from 2018 to 2019 at Canaveral National Seashore. The shoreline survey collected in 2018 is shown as a solid black line and the shoreline survey collected in 2019 is shown as a dotted black line.

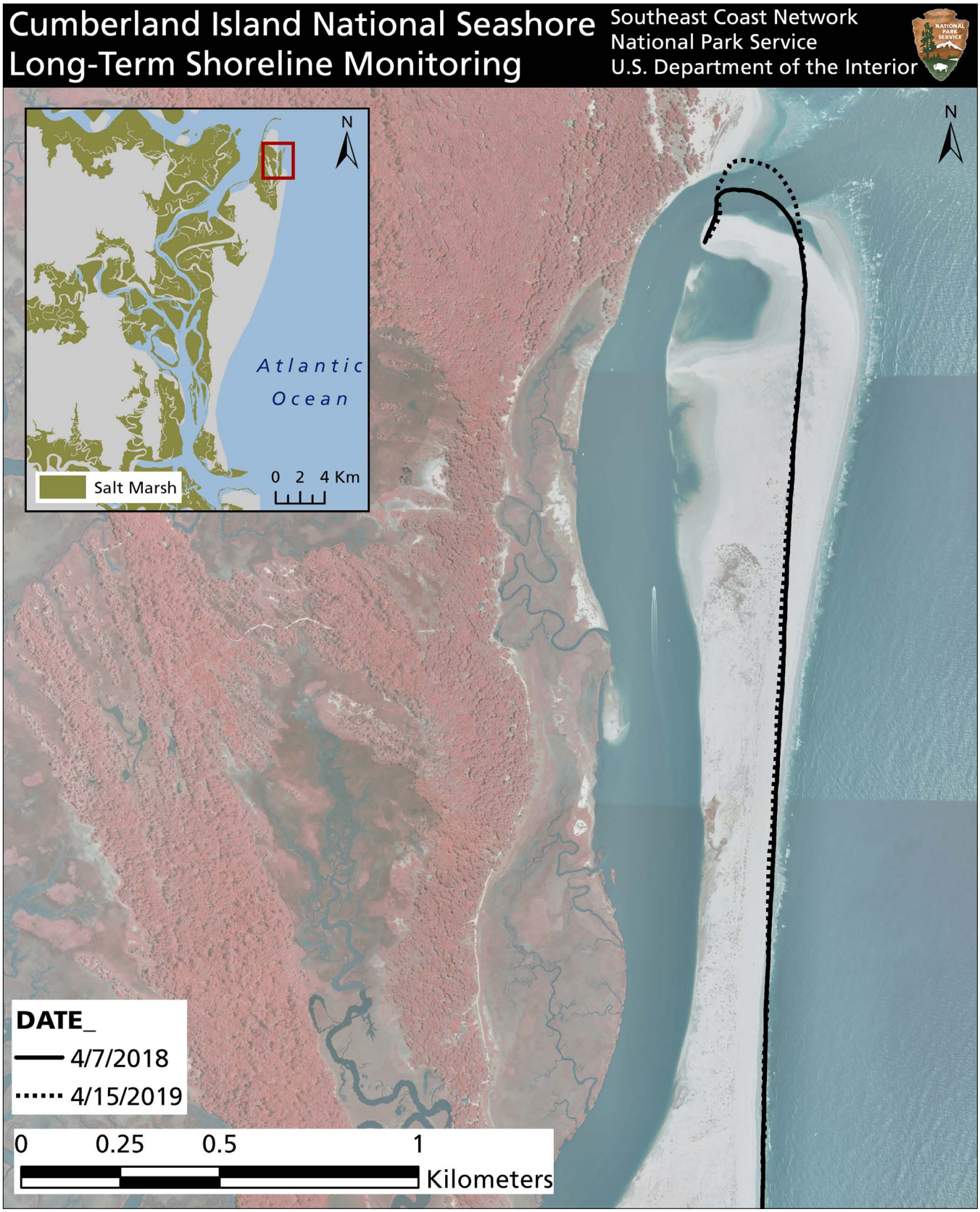


Figure A-1. Map 1 of 11 moving north to south.

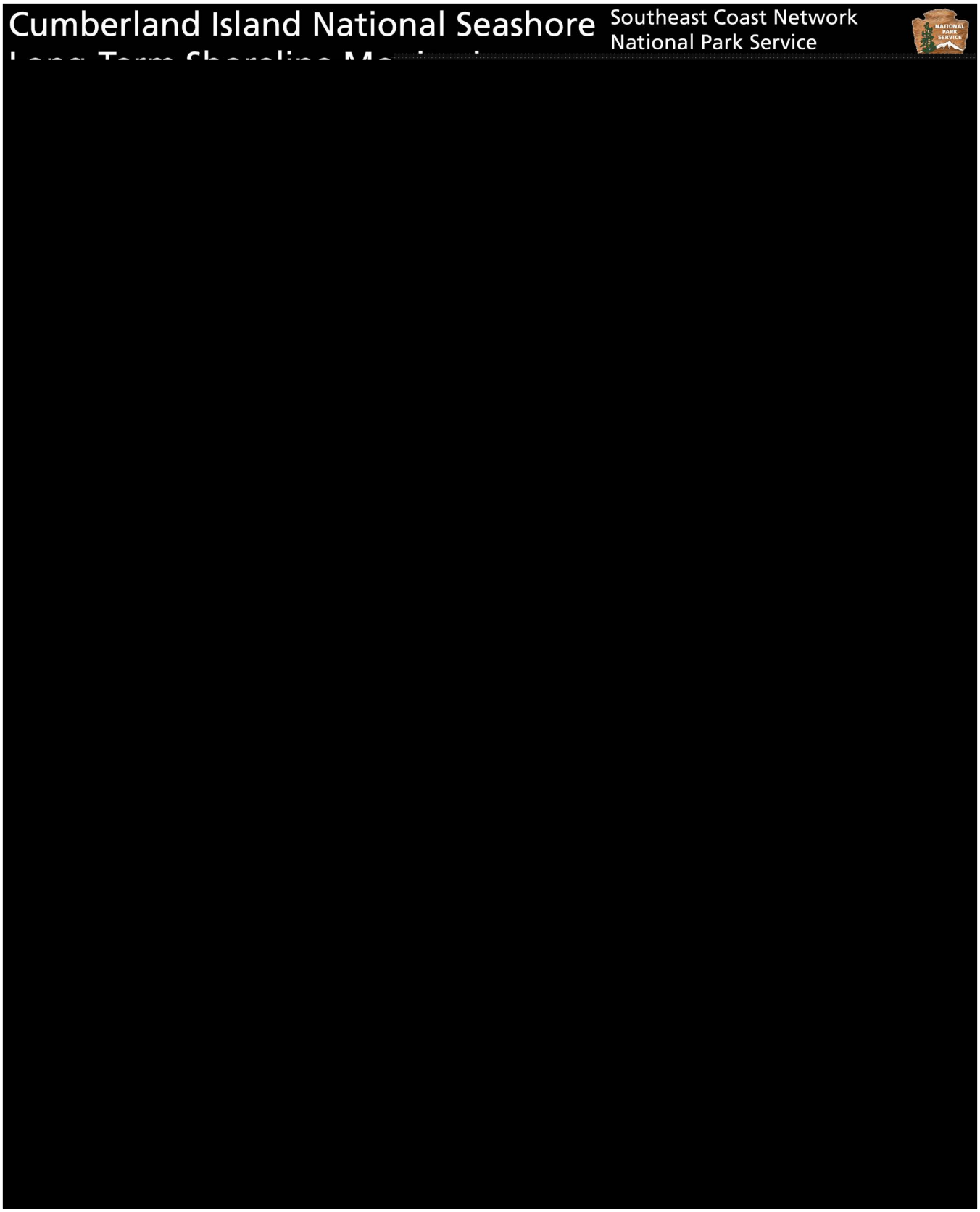


Figure A-2. Map 2 of 11 moving north to south.

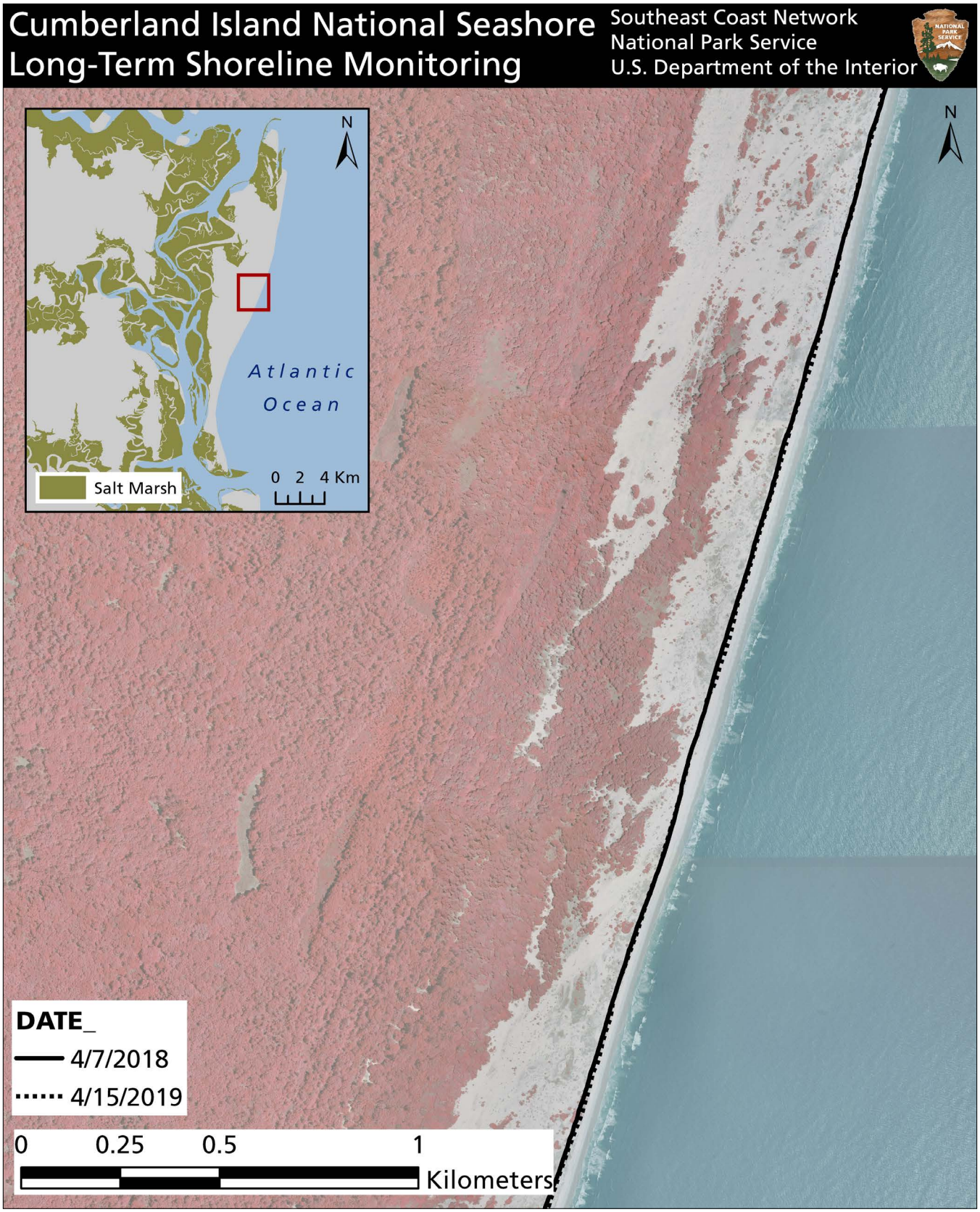


Figure A-5. Map 5 of 11 mvoing north to south.

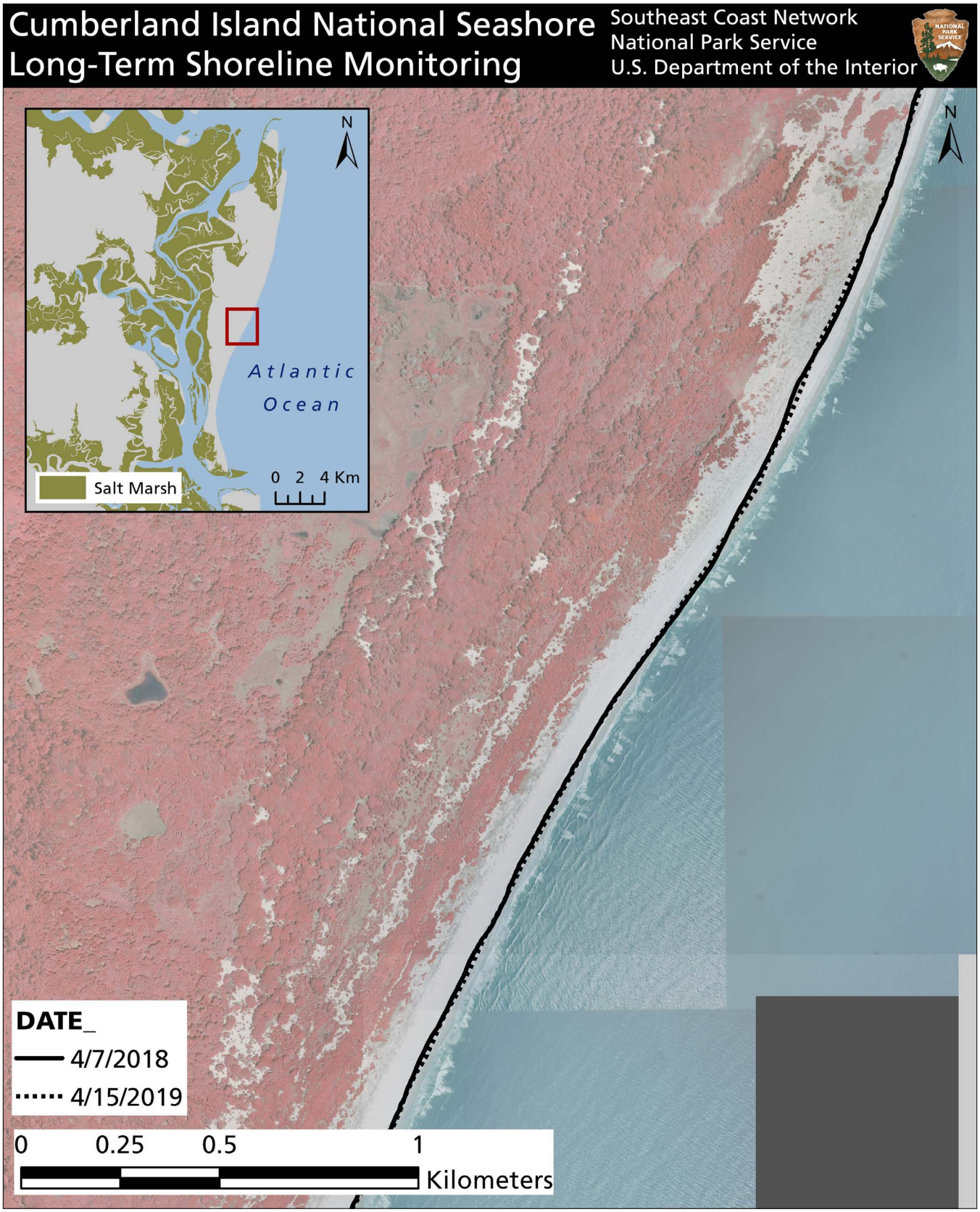
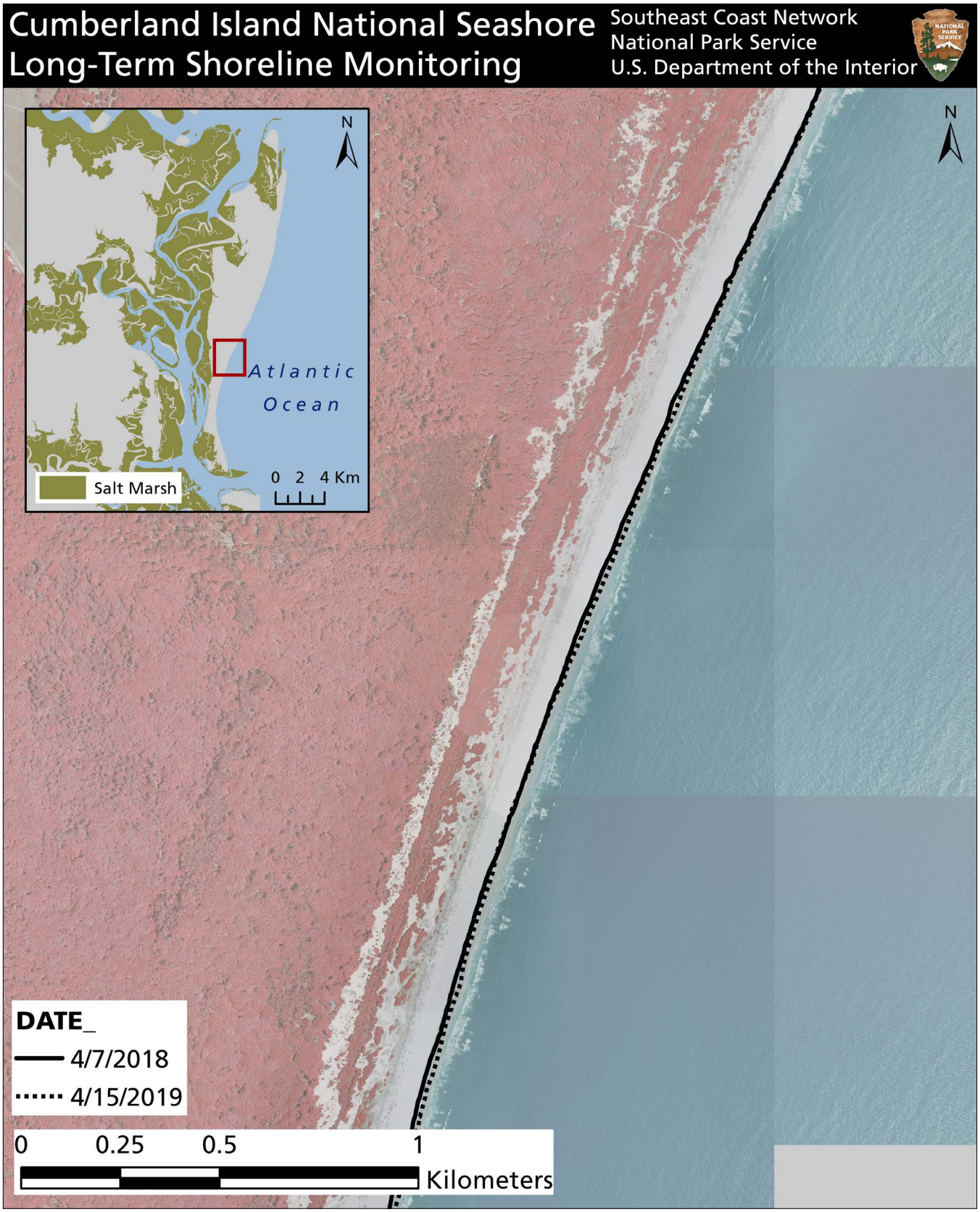


Figure A-6. Map 6 of 11 moving north to south.



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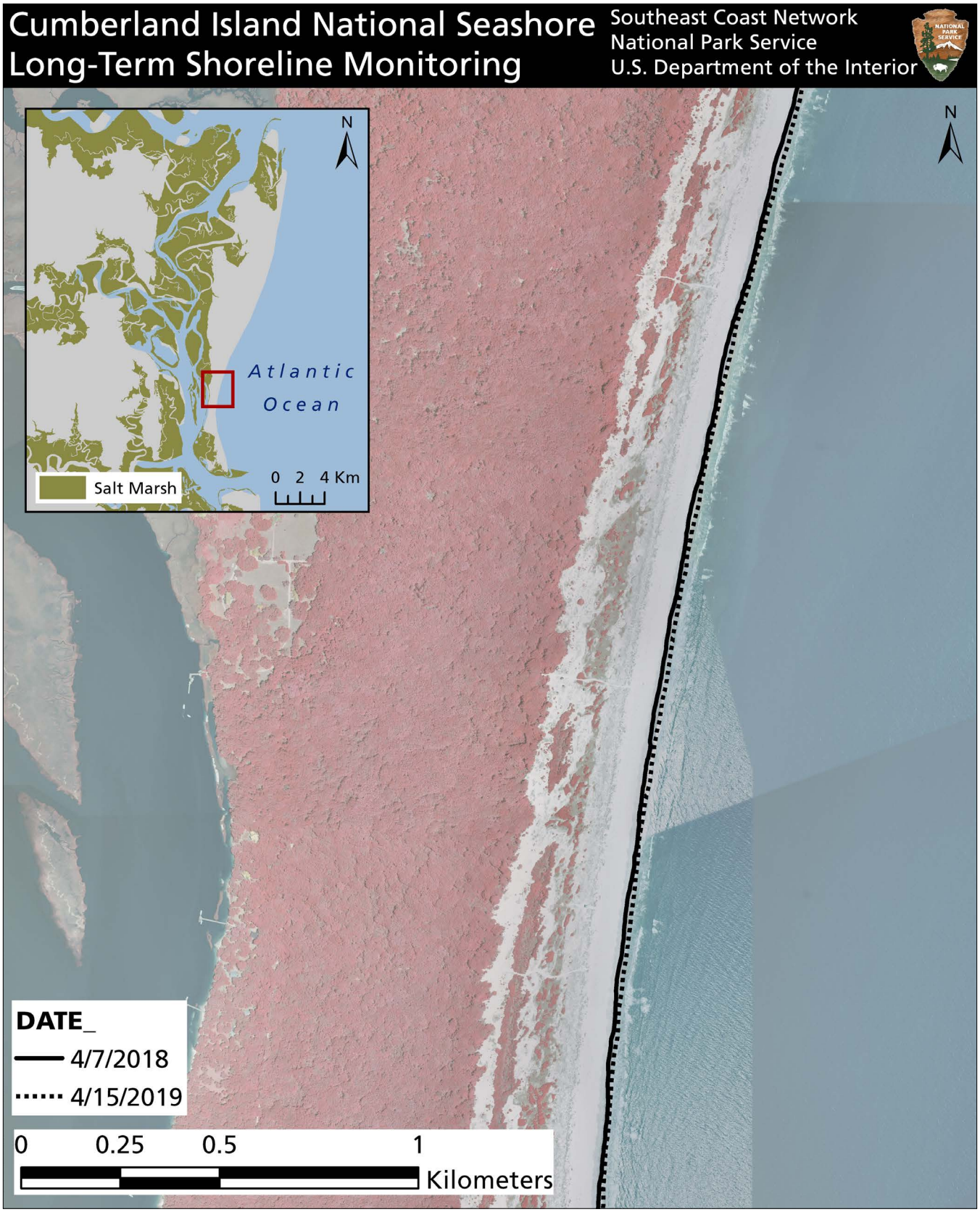
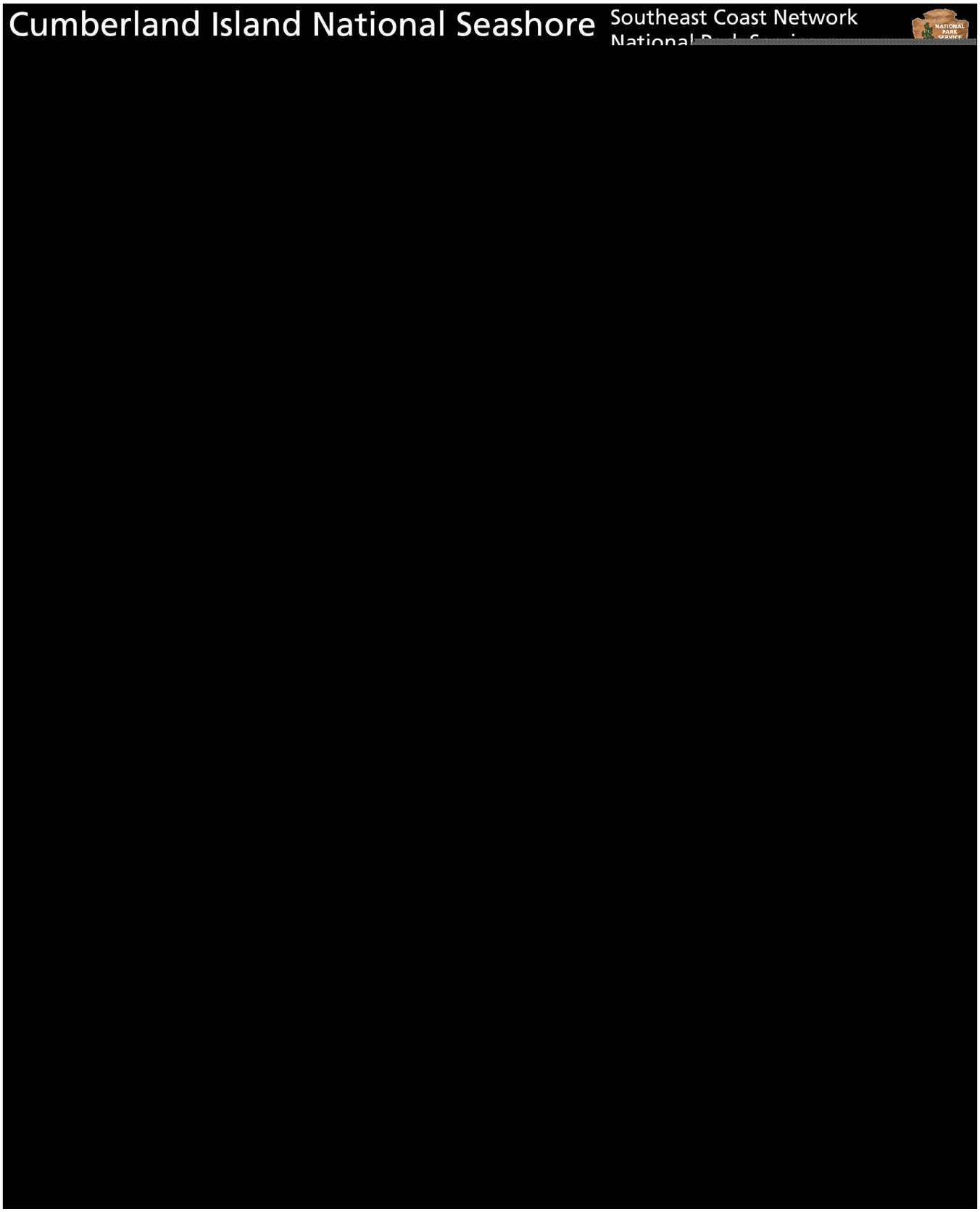


Figure A-8. Map 8 of 11 moving north to south.



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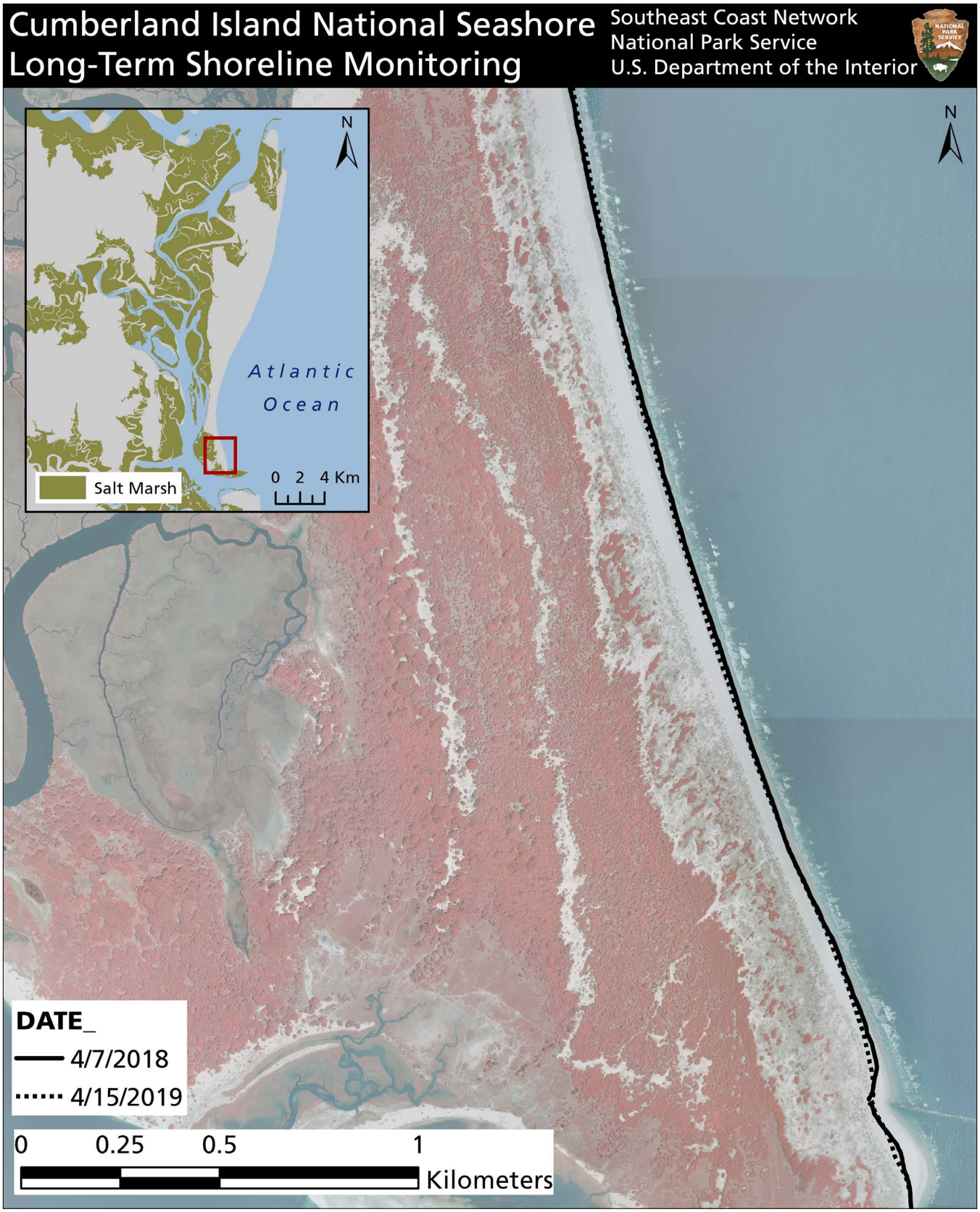

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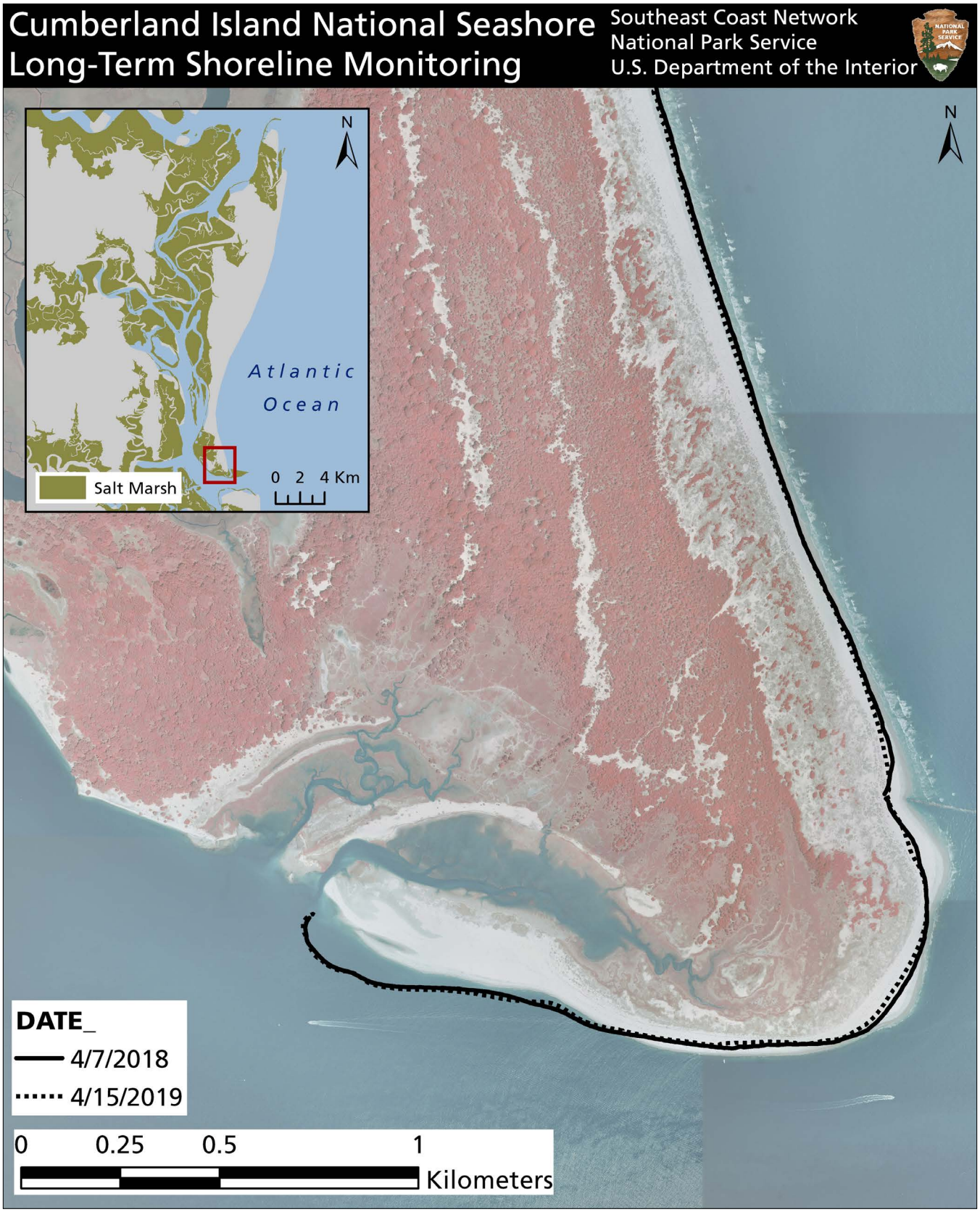


Figure A-11. Map 11 of 11 moving to north to south.

Appendix B. Shoreline Change Distance Maps

Maps of shoreline change distance (meters) for the 2018 and 2019 surveys collected. The more negative shoreline change denotes more erosion and is shown in warmer colors (if present). The less negative shoreline change denotes less erosion and in some cases can represent accretion (when positive), and is displayed as cooler colors (green, light blue, and dark blue). The grey transects denote shoreline change distance within the error range of the data (±10 meters [32.8 ft]).

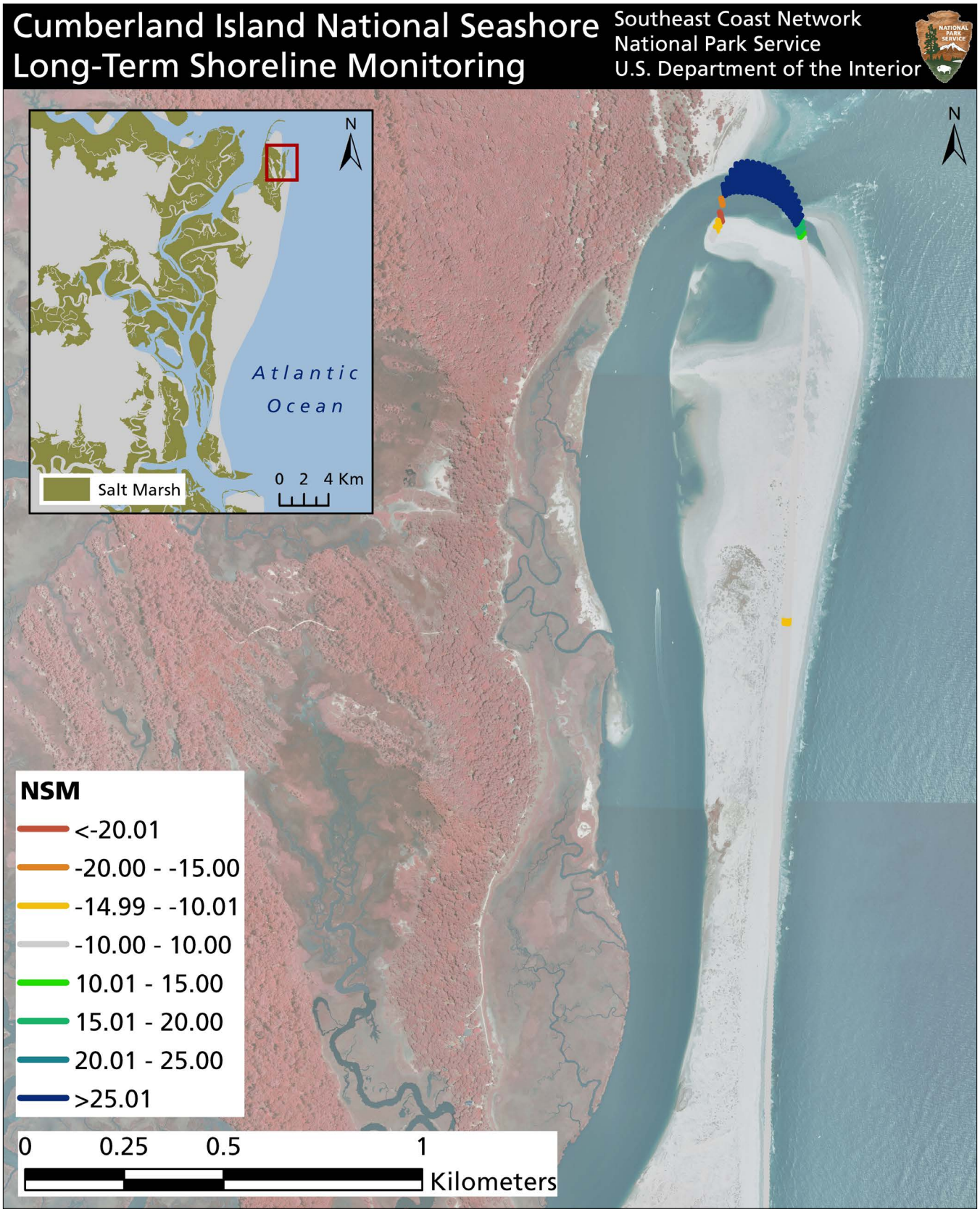
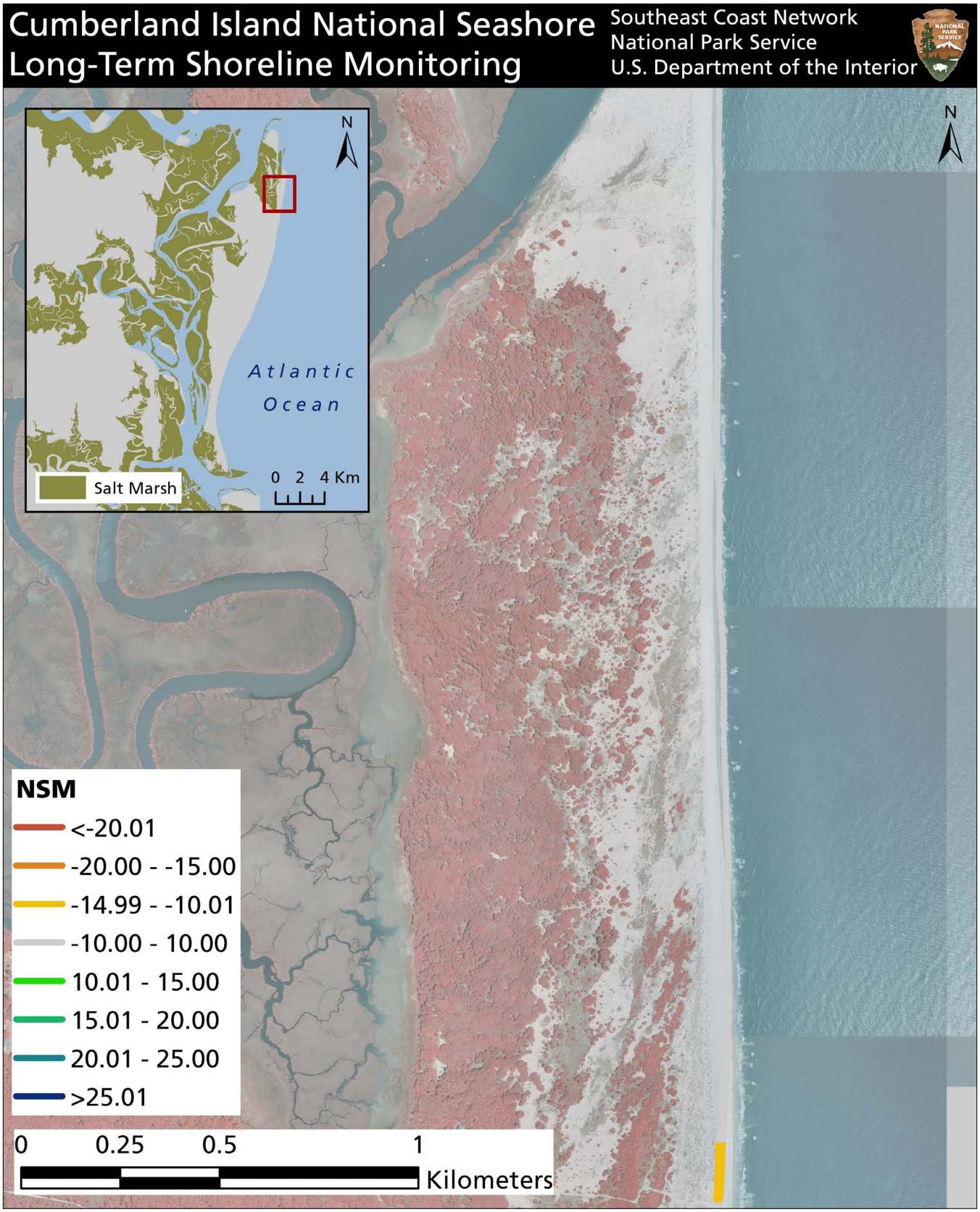


Figure B-1. Map 1 of 11 moving north to south.



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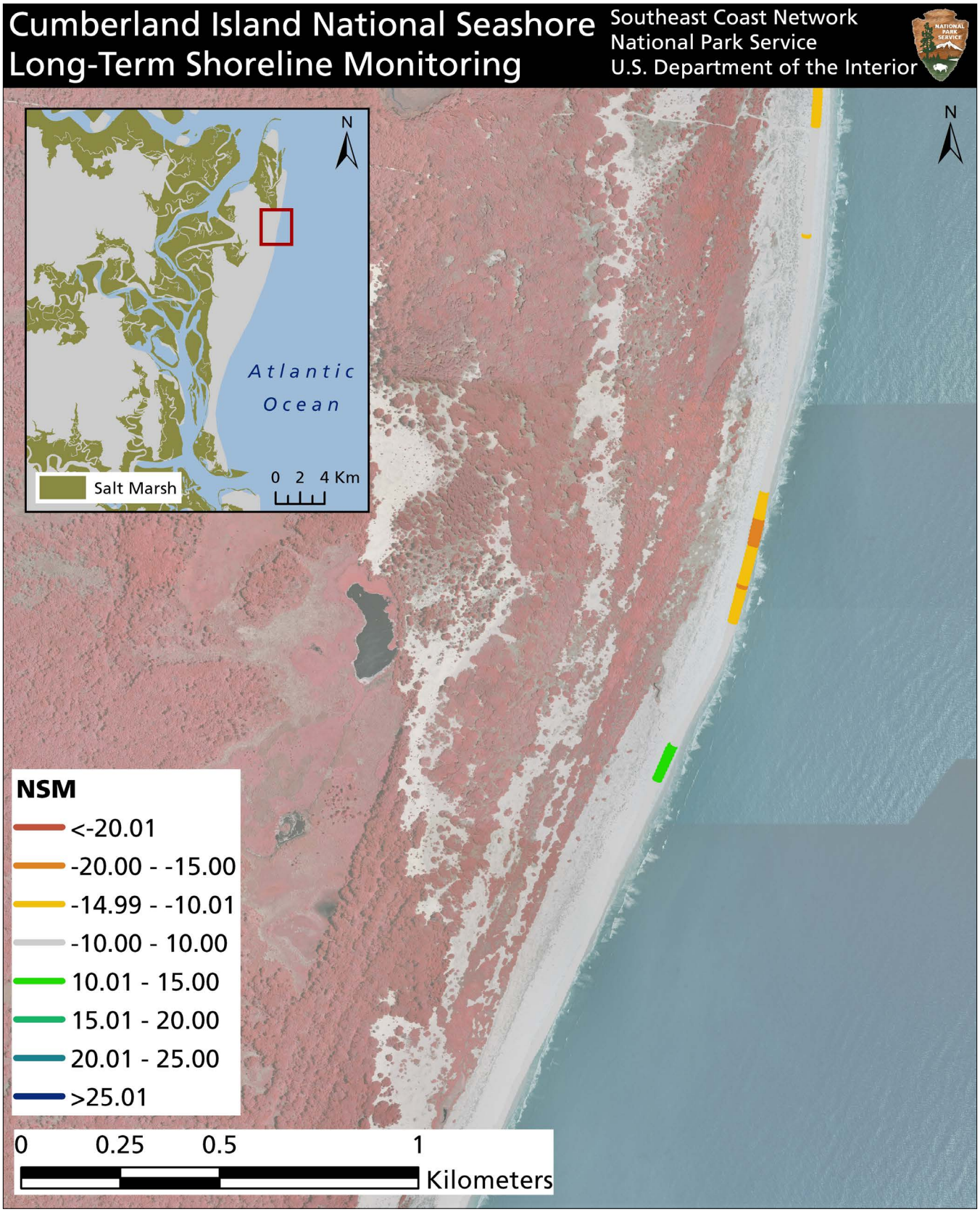

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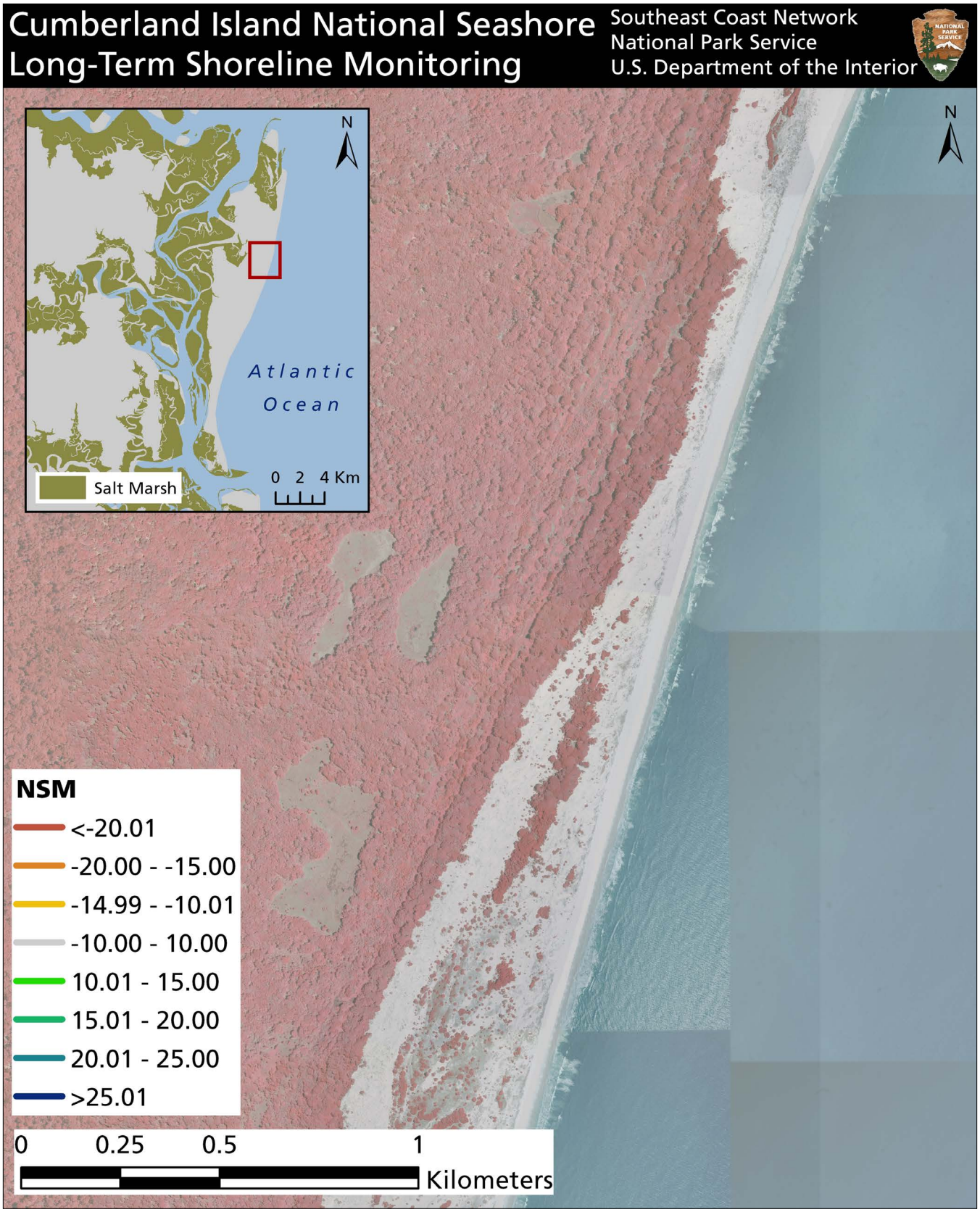

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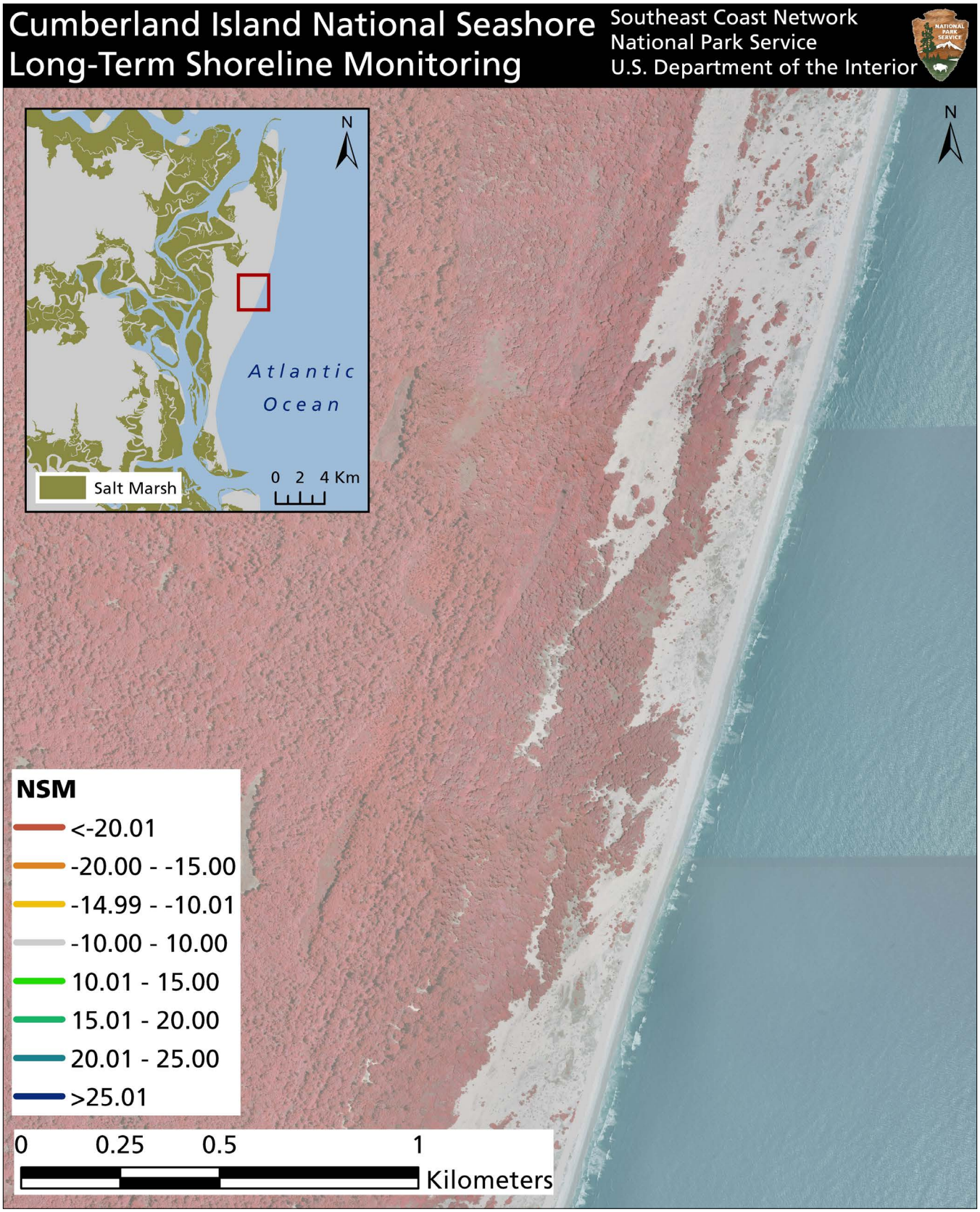

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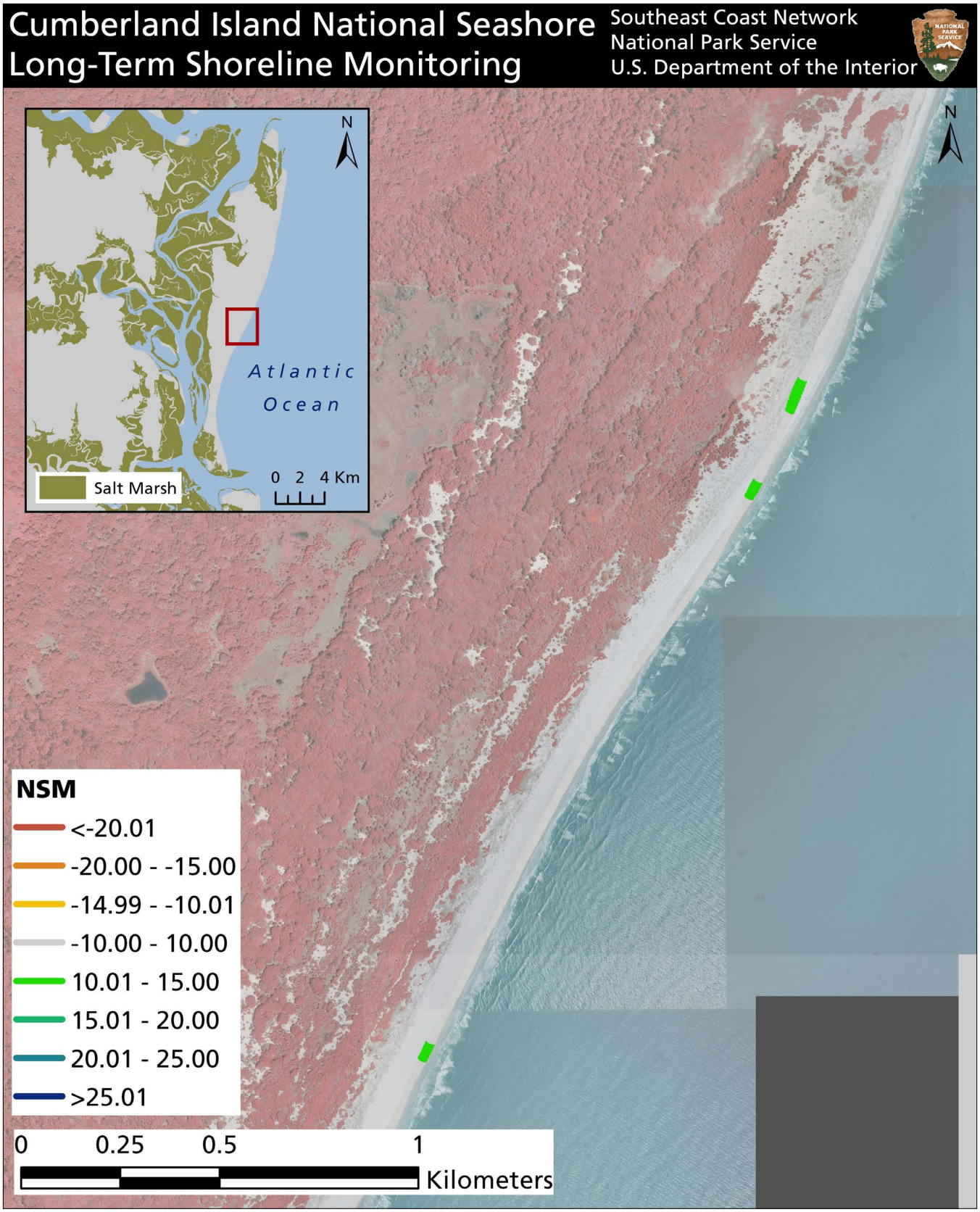

Figure B-6. Map 6 of 11 moving north to south.

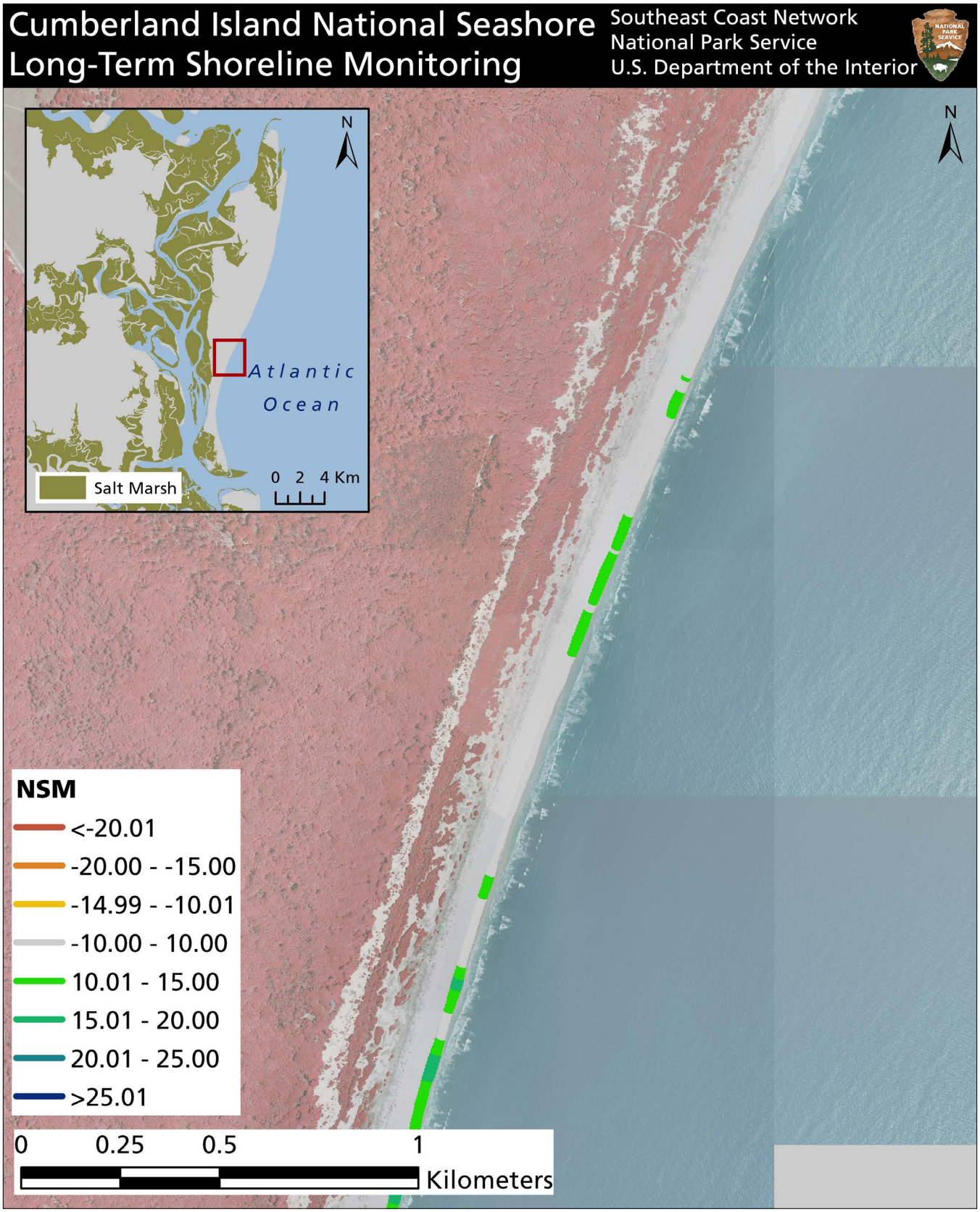

Figure B-7. Map 7 of 11 moving north to south.

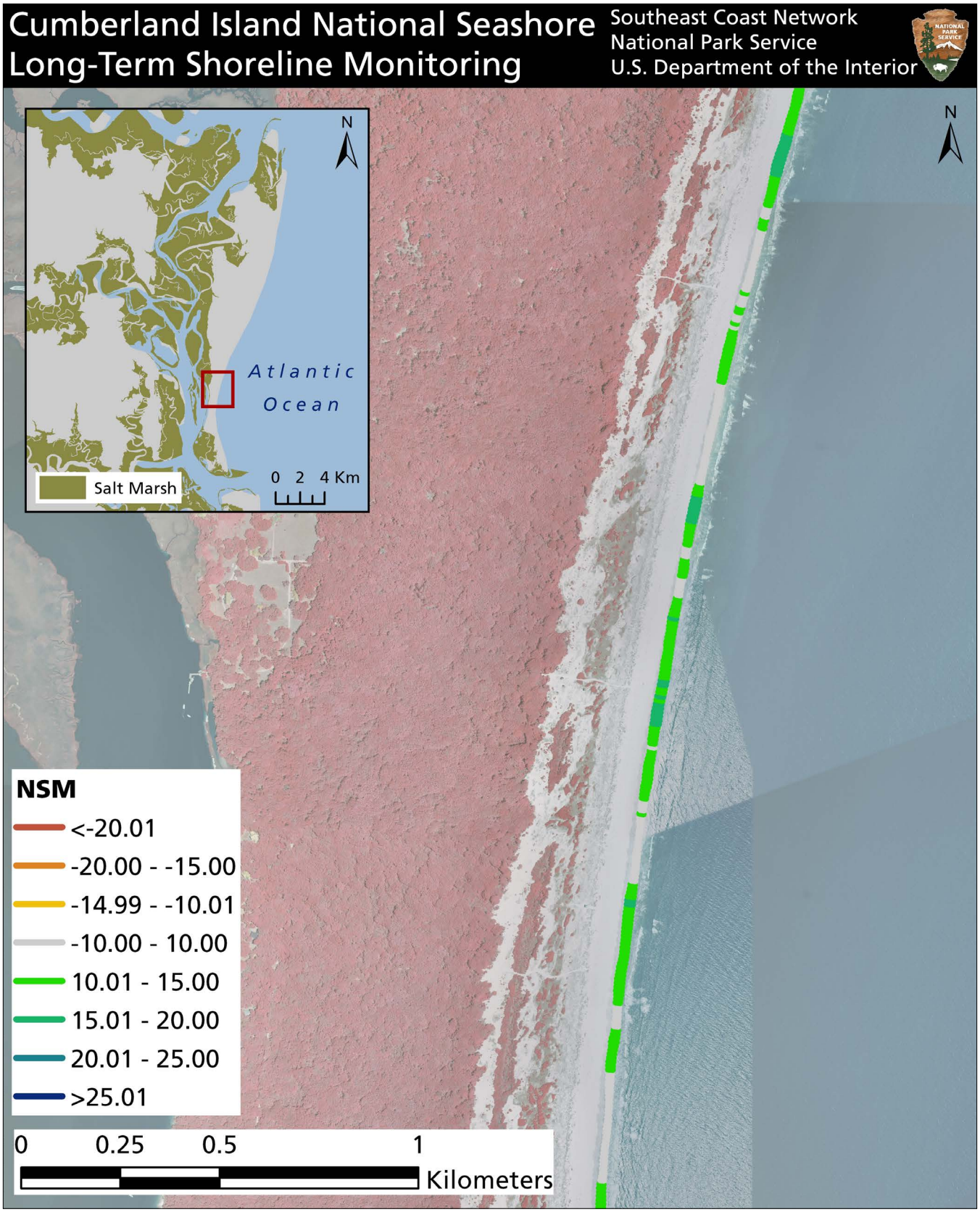

Figure B-8. Map 8 of 11 moving north to south.

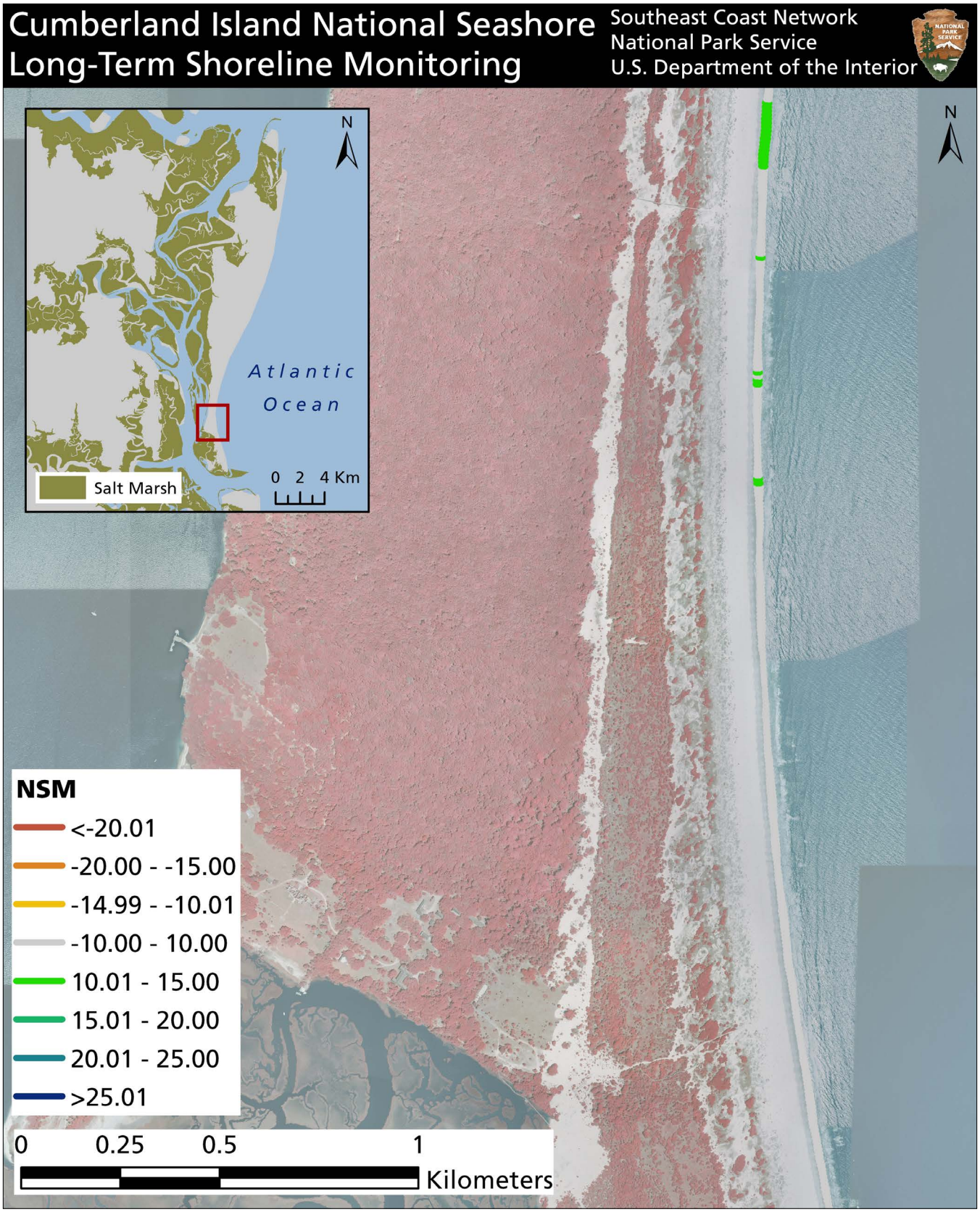

Figure B-9. Map 9 of 11 moving north to south.

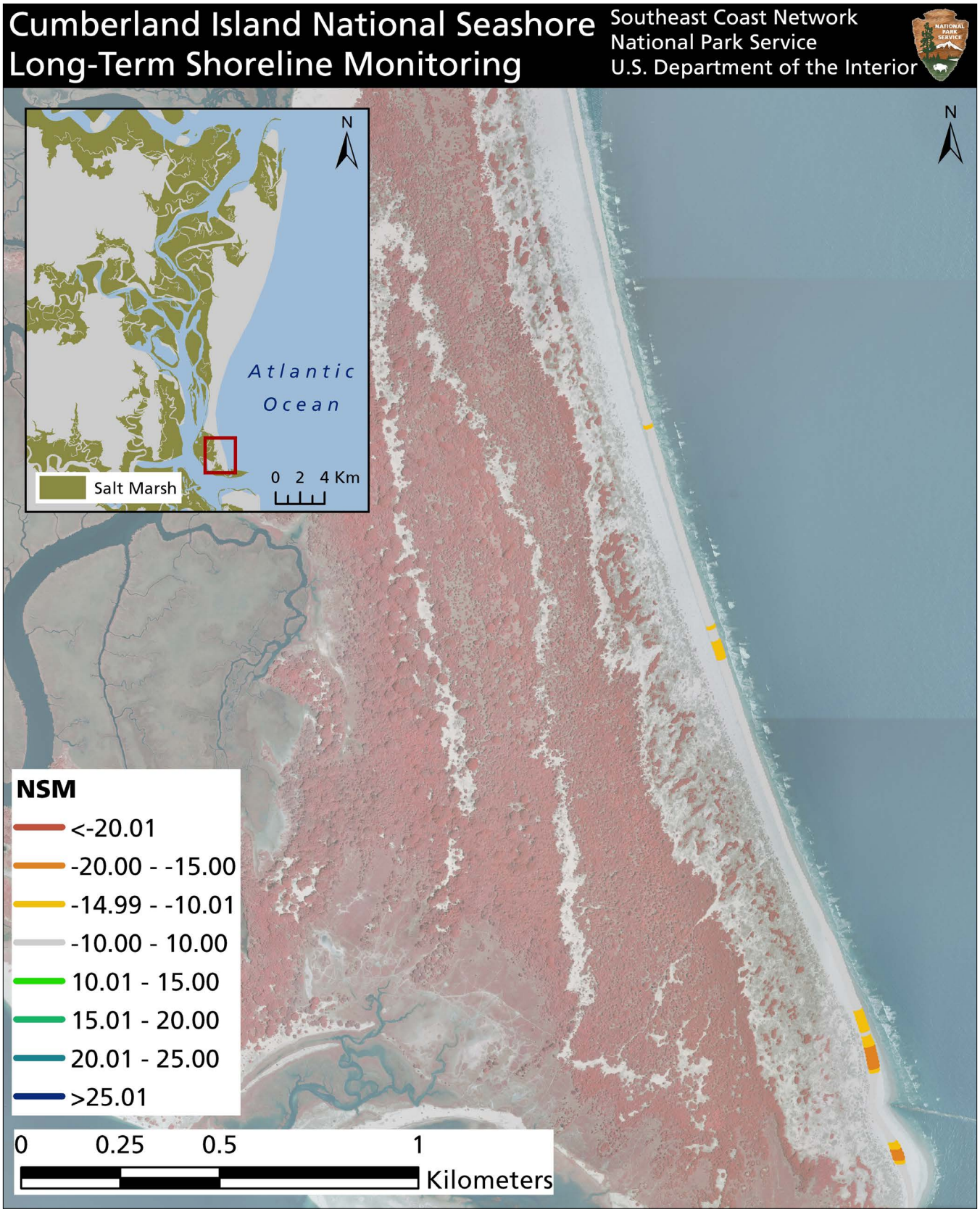

Figure B-10. Map 10 of 11 moving north to south.

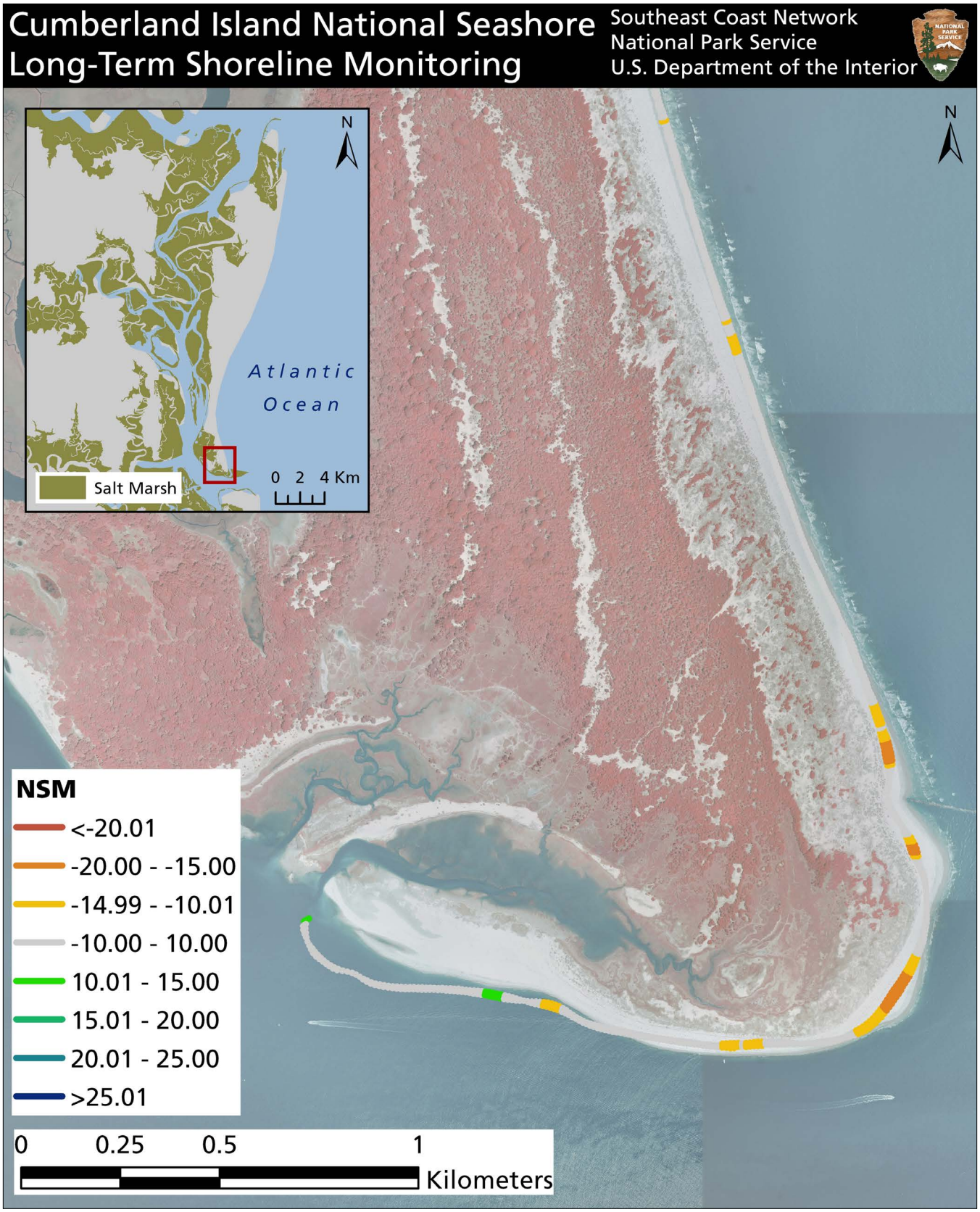

Figure B-11. Map 11 of 11 moving north to south.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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