



Monitoring Coastal Shoreline Change in Southeast Coast Network Parks

Protocol Implementation Plan

Natural Resource Report NPS/SECN/NRR—2018/1744



ON THE COVER

Cape Hatteras National Seashore shoreline.

Photograph courtesy of Lisa Cowart Baron (Southeast Coast Network).

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Lisa Cowart Baron

National Park Service
135 Phoenix Drive
Athens, GA 30605

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Abstract

The Southeast Coast Network is following the Northeast Coastal and Barrier Network Ocean Shoreline Position protocol (Psuty et al. 2010) to monitor shoreline change. The Southeast Coast Network monitoring objectives are to determine the spatial distribution of the magnitude and direction of observed shoreline change, determine cumulative and inter-annual changes in neap-tide high-tide shoreline position (average and standard deviation of change in position park-wide and within defined management units), and identify areas of highly dynamic shorelines and areas of accretion versus erosion. Some modifications have been made to the NCBN Ocean Shoreline Position protocol to accommodate park and network specific needs.

The shoreline monitoring protocol is implemented at the following parks: Cape Hatteras National Seashore, Cape Lookout National Seashore, Cumberland Island National Seashore, Canaveral National Seashore, Timucuan Ecological and Historic Preserve, and Fort Matanzas National Monument. To collect shoreline surveys, a Global Positioning Systems (GPS) or Global Navigation Satellite Systems (GNSS) is used to document the neap-tide high-tide shoreline position. The survey window for SECN data collection will be six to eight weeks during the spring. Fall shoreline surveys will be collected opportunistically as conditions permit. The modifications further detailed in the protocol implementation plan will allow SECN to maintain a long-term workload and meet our parks needs of documenting quantifiable shoreline change.

Section 1: Introduction

The problem of land loss/gain and landscape alteration at the marine edge is a fundamental issue facing coastal park resource stewards. Shoreline change is a prime geo-indicator 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. Geomorphological change, including shifting shoreline positions, can influence change in other natural resource areas of interest to the National Park Service: 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 the key to recognizing ecological problems in coastal parks. An understanding of the spatial and temporal patterns of geomorphological 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 operating at a variety of spatial and temporal scales;
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.

Local long-term monitoring programs will lead to an increased understanding of these effects.

This report outlines the methods for collecting, managing, and reporting data for the coastal shoreline vital sign as described in the approved Southeast Coast Inventory and Monitoring Network (SECN) Monitoring Plan (DeVivo et al. 2008). The methodology used for shoreline monitoring is based on Psuty et al. (2010). Implementation of this protocol, which was developed for the Northeast Coastal and Barrier Network (NCBN) parks, will occur with minor modifications that are described in Section 4: What's Being Measured and How. The monitoring methodology and its implementation at SECN parks is described in the standard operating procedures (SOPs) listed in Tables 8-10.

Section 2: Conceptual Framework for Monitoring

Understanding the effects of multiple concurrent stressors on parks—and mitigating and/or incorporating the impacts of those stressors at multiple spatial and temporal scales—is an ongoing challenge for SECN park managers (Table 1). To address the stressors on coastal parks, shoreline displacement and distribution of accretion and erosional zones will be monitored using mapping grade GPS/GNSS.

Table 1. Factors affecting coastal shorelines and topography within Southeast Coast Network Parks and potential measures for vital signs monitoring.

Category	Issue	Potential Measures
Coastal zone management	Construction of jetties and sea walls, filling and draining of marshes, and extensive dune stabilization and beach nourishment programs obstruct the natural fluctuations of sediment transport and barrier island formation.	Shoreline displacement ¹ Distribution of accretion and erosional zones ¹ Distribution of shore structures Sediment supply and transport
Sea-level rise	Projections of 21 st -century sea-level rise that may accelerate two to five fold compared to the global rate during the 1900s suggest an increasing vulnerability to coastal erosion.	Relative sea level ² Coastal topography Shoreline displacement ²
Extreme weather events	Vulnerability to shoreline erosion due to changes in the frequency, magnitude, and duration of storm events, as well as local variations in tidal ranges.	Tide magnitude/amplitude, sediment supply and transport, storm frequency, storm magnitude, shoreline displacement, coastal topography
Visitor use	Several parks allow vehicular access, which can potentially alter vegetation stability and increase soil erodability.	Visitor use patterns Soil disturbance ² Vegetation disturbance ²

¹ Selected for inclusion in the Southeast Coast Network coastal shoreline monitoring effort.

² Addressed through other monitoring initiatives by the National Park Service or partners.

Section 3: Measurable Objectives

To measure changes in shoreline position, the following objectives are applied to surveying locations in all study areas (Cape Hatteras, Cape Lookout, Cumberland Island and Canaveral National Seashores, Timucuan Ecological and Historic Preserve, and Fort Matanzas National Monument).

1. Determine the spatial distribution of the magnitude and direction of observed shoreline change.
2. Determine cumulative and inter-annual changes in neap-tide high-tide shoreline position (average and standard deviation of change in position park-wide and within defined management units).
3. Identify areas of highly dynamic shorelines and areas of accretion versus erosion.

The above stated objectives are analogous to those stated in Psuty et al. (2010); however, one deviation in SECN methodology is that seasonal shoreline change is not analyzed annually. Sampling will occur a minimum of once per year at each park in the spring (Northeast Coastal and Barrier Network samples in both spring and fall). The network will train local staff in monitoring methods to allow for fall sampling should local conditions present themselves, and these data will be included in analyses as warranted.

Section 4: What's being Measured and How

The Southeast Coast Network will monitor shoreline position with hand-held GPS units, and will analyze data with methods developed by USGS/NOAA called the Digital Shoreline Analysis System (DSAS; Tables 2 and 3; Thieler et al. 2008). The shoreline survey methods and utilization of DSAS for analysis of shoreline survey data were previously developed and approved for implementation in the Northeast Coastal and Barrier Network (NCBN) (Psuty et al. 2010).

Table 2. Monitoring objectives, sampling methods, and variables measured at SECN parks as a part of the protocol for monitoring coastal shorelines.

Objective	Sampling Method	Data Collected	Analysis Tool	Derived Data
Shoreline position	GPS Surveys (Differential-grade)	Latitude / Longitude	DSAS	Shoreline change distance
Accretion/Erosion	GPS Surveys (Differential-grade)	Latitude / Longitude	DSAS	Shoreline change distance

Table 3. Monitoring objectives, sampling frame, and scale of analyses at SECN parks as a part of the protocol for monitoring coastal shorelines.

Objective	Area Sampled	Spatial Design	Temporal Design	Scale of Analysis
Shoreline position	Neap-tide high-tide beaches	Full shoreline; interpolated from five-meter interval data	Annual spring index period	Park or management unit
Accretion/Erosion	Neap-tide high-tide beaches	Identified within full shoreline	Annual spring index period	Park, management unit, area of interest

Overview of Methods

Shoreline position will be mapped following Northeast Coastal and Barrier Network's approved shoreline position monitoring protocol (Psuty et al. 2010) and accompanying SOPs listed below:

- Equipment and Supplies
- Training for Field Data Collection
- Survey Timing and GPS Mission Planning
- Basic GPS Settings for Position Collection
- Conducting the GPS Shoreline Survey
- Initial Post-Survey Processing
- Change Calculation, Data Analysis, and Reporting
- Data Management

- Revising the Protocol

The differences between the SECN implementation and the above SOPs are as follows:

SOP 1: Equipment and Supplies

1. An all-terrain vehicle (ATV) or utility task vehicle (UTV) is required for conducting shoreline surveys. The network has one UTV purchased for vegetation mapping that has been repurposed for shoreline monitoring, and many parks have UTVs as well (which allows for multiple sampling/mapping teams).
2. At some locations, where surveys must be conducted on foot, the GPS unit will be held at a constant height.
3. The information in *Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part 1—Ocean Shoreline Position SOP 1-Equipment and Supplies* (Psuty et al. 2010) is included in SOP 1.3.22—*Conducting the GPS Shoreline Survey—Version 1.0* (Baron 2018a).

SOP 2: Training for Field Data Collection

1. Network staff will hold training sessions annually for any new SECN staff and park staff, prior to spring field season and as needed following the spring season.
2. Only two parks (CAHA and CALO) will be providing park staff to collect shoreline survey data. For these two parks training will be conducted as follows:
 - a. An initial in-person training session with park personnel.
 - b. Remote technical assistance following the initial training.
 - c. Refresher training or check-in meetings as needed or when SECN staff members are in the area for other field work.
 - d. The network will train park staff upon request. Parks that have the requisite GPS equipment will be able to implement the shoreline monitoring portion of the protocol at intervals above and beyond those included in the base protocol and with minimal additional training by SECN staff.
3. The information in *Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part 1—Ocean Shoreline Position SOP 2—Training for Field Data Collection* (Psuty et al. 2010) is included in SOP 1.3.20—*Training for Field Data Collection—Version 1.0* (Baron 2018b).

SOP 3: Survey Timing and Mission Planning

1. The survey window is expanded to include March and April. Efforts are made to collect shoreline surveys prior to bird nesting season, and March is the preferred month; however, due to weather and logistical constraints, a larger window is acceptable.
2. Although not a deviation, further clarification is needed in defining the shoreline mapping window, i.e. the time within the survey window when shoreline surveys can be collected. The network will map three days pre or post the neap-tide date and high tides no greater than 1

foot (0.3 m) above the neap-tide high-tide. There are two neap-tide high-tides in one month. Therefore, an 8 week survey window will allow for a maximum of four shoreline mapping windows.

3. The information in *Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part 1—Ocean Shoreline Position SOP 3—Survey Timing and Mission Planning* (Psuty et al. 2010) is included in *SOP 1.3.21—Survey Timing and GPS Mission Planning—Version 1.0* (Baron 2018c).

SOP 4: Basic GPS Settings for Position Collection

1. The information in NCBN SOP 4—*Basic GPS Settings for Position Collection* (Psuty et al. 2010) is included in *SOP 1.3.22—Conducting the GPS Shoreline Survey—Version 1.0* (Baron 2018a).
2. Step-by-step instructions are included in the SECN SOP.
3. An antenna is used during SECN shoreline surveys collected with a UTV. Shoreline surveys collected walking or with an ATV do not use an external antenna because the internal antenna alone is sufficient due to unobstructed views of the sky.

SOP 5: Conducting the GPS Shoreline Survey

1. Sampling will occur a minimum of once per year at each park in the spring (Northeast Coastal and Barrier Network samples in both spring and fall). Local staff will be trained in monitoring methods to allow for fall sampling should local conditions present themselves, and these data will be included in analyses as warranted.
2. When possible, spring sampling will be timed to ensure shoreline monitoring occurs before the onset of sea turtle nesting season and set-up of bird nesting closures.
3. The information in *Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part 1—Ocean Shoreline Position SOP 5—Conducting the GPS Shoreline Survey* (Psuty et al. 2010) is included in *SOP 1.3.22—Conducting the GPS Shoreline Survey—Version 1.0* (Baron 2018a).

SOP 6: Initial Post-Survey Processing

1. More detailed information, including step by step instructions on data download, post processing, editing, quality control (QC), and formatting to prepare the shoreline survey data for analysis are included in the *SOP 2.3.10 Post Survey GPS Data Processing—Version 1.0* (Baron, 2018d).
2. The information in *Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part 1—Ocean Shoreline Position SOP 6—Initial Post-Survey Processing* (Psuty et al. 2010) is included in *SOP 2.3.10—Post Survey GPS Data Processing—Version 1.0* (Baron 2018d).

SOP 7: Change Calculation, Data Analysis, and Reporting

1. The information in *Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part 1—Ocean Shoreline Position SOP 7—Change Calculation, Data Analysis, and Reporting* (Psuty et al. 2010) is included in SOP 2.3.11—*Costal Shoreline Monitoring Annual Change Analysis—Version 1.0* (Baron 2018e).
2. A separate SECN annual reporting SOP has been created, titled SOP 2.3.09 *Coastal Shoreline Change Annual Reporting—Version 1.0* (Baron 2018f).
3. A separate SECN trend reporting SOP will be completed by 2023.
4. SOP 2.3.11 includes step-by-step instructions that include parameters selected to process the shoreline change analysis in the Digital Shoreline Analysis System (DSAS).
5. If fall shoreline surveys are collected, seasonal shoreline change analysis will be performed in the annual report.
6. Yearly spring shoreline change will be calculated and presented in park annual reports. Shoreline change distance will be calculated at transect locations spaced every 10 meters (32.8 ft) along the shoreline.
7. The Shoreline Change Mapper software application used by the Northeast Coastal and Barrier Network will not be used initially since it is not currently fully functional. Once the application is fully functional, the network will use it to calculate and represent the shoreline change. In the meantime, clipped transects will be displayed on a map representing the amount of shoreline change that has occurred over the period.

SOP 8: Data Management

The Southeast Coast Network will use the access database as described in *Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol: Part 1—Ocean Shoreline Position SOP 8—Data Management* (Psuty et al. 2010).

SOP 9: Revising the Protocol

The Southeast Coast Network will use SOP 2.1.01—*Revision of Southeast Coast Network Protocols and Standard Operating Procedures* SOP (Wright and Curry 2016; see Table 8).

Section 5: Sampling Design and Monitoring Schedule

As stated in Psuty et al. (2010), the shoreline surveys are collected three days before or after the neap tide. Additionally, the high-tide surveyed must be within 1 foot (0.3 m) of the neap-tide high-tide. The spring shoreline-survey window identified in Psuty et al. (2010) spans six weeks from mid-March through April. However, for the six SECN parks where shoreline change is monitored, the field work window is expanded to an eight-week window, March through April, to accommodate for weather, bird nesting beach closures, and personnel. Table 4 lists the SECN parks where coastal shoreline monitoring is conducted and the length of shoreline surveyed (see Appendix B for park study area maps). Sampling during fall will occur opportunistically as conditions permit.

Table 4. Areas mapped for each park of the SECN coastal shoreline monitoring protocol. Each site will be sampled once in the spring, and opportunistically in the fall, as weather and personnel availability permit.

Park	Area mapped	Approximate length (km)
CAHA	Bodie Island–Ramp 1 North to tip of spit	9
	Hatteras–Pea Island NWR park boundary to Hatteras Inlet	43
	Ocracoke–North end of island to Ocracoke Inlet	26
CALO	Shackleford Bank–Oceanfront side of island	15
	South Core Banks–Power squadron spit north to Ophelia Inlet	43
	North Core Banks–Ophelia Inlet north to Ocracoke Inlet	38
CUIS	North point south to the jetty and along the inlet to the creek near the south end ponds	28
TIMU	American Beach between two access ramps	<1
FOMA	Beach access ramp south under the A1A bridge, on the inland side to the access ramp	2
CANA	Park sign at Apollo Beach to south end of Playa Linda	39

Section 6: Data Management

The Southeast Coast Network is following the same processing and workflow approach presented in the NCBN protocol (Psuty et al. 2010). The Southeast Coast Network will use a Microsoft Access database developed by the Northeast Coastal and Barrier Network. The database is used to track the files created and analyzed in the shoreline monitoring reports. The section below describes the workflow steps included in the SECN coastal shoreline monitoring protocol.

Processing and Workflow

The shoreline monitoring processing workflow consists of the following steps: data collection, data download, data post-processing, data export, data QC, editing, analysis, and reporting (Figure 1).

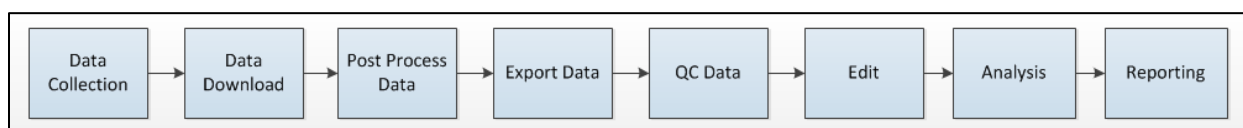


Figure 1. Workflow diagram of the steps involved in the SECN shoreline monitoring protocol. The steps include data collection, data download, post process data, export data, QC data, edit, analysis, and reporting.

A general breakdown of the workflow steps is listed below.

1. The surveyor(s) collects shoreline position data according to SOP-specific instructions (including quality assurance checks and photographs) and fills out the Field Data Form.
2. The surveyor downloads the raw GPS files and photographs, scans the field data form(s), and emails the data (GPS files, photographs, and scanned field data forms) to the Southeast Coast Network (if the data were not collected by SECN staff).
3. The raw GPS file (.ssf) is post processed, creating a corrected GPS file (.cor). The photographs are renamed and backed up. The field data forms are scanned (if not already).
4. The corrected GPS file (.cor) is exported in a GIS compatible format, generally a shapefile (.shp).
5. Quality control is performed on the shapefile using ArcGIS software.
 - a. The processor determines the distance from the position of the temporary benchmark data collected and compares it to the position displayed in the most recent aerial imagery available or benchmark or the surveyed position of the benchmark, if available.
 - b. If the distance between the temporary benchmark and the temporary benchmark position in the aerial photograph is within the allowable error range, then the shoreline survey data collected during the shoreline survey is also within allowable error.
6. The shapefile is edited using ArcGIS software.
 - a. This step addresses any discrepancies or erroneous data collection noted on the Field Data Form.
 - b. The shapefile is then formatted for analysis.

- c. The shapefile is loaded into the personal geodatabase used for analysis that contains previously collected shorelines, trendlines, and the baseline.
7. Analysis is performed on the shorelines selected in the personal geodatabase using the Digital Shoreline Analysis System (Thieler et al. 2008; Figure 2).



Figure 2. Example assessment at American Beach (TIMU) using mock shorelines. Neap-tide high-tide mock shorelines (orange and green) with DSAS analysis transects (black) and the baseline (yellow) are shown.

8. The results of the analysis are summarized and detailed in a report for the park.

Data Files

Based on the workflow stated above, the data sets in Table 5 are generated for the coastal shoreline monitoring project. The Protocol Implementation Plan (PIP; this document), along with related SOPs and appendix items will be managed locally as long-term records and also posted to the NPS Integrated Resource Management Application (IRMA). Other ancillary documents and datasets associated with the PIP such as those downloaded for trip planning, e.g., tide predictions and weather data, will be managed locally as long-term records.

Table 5. Table listing the datasets, process step, product description, and product type for each step in the shoreline monitoring workflow.

Data Type	Process Step	Product Description	Product Type
Raw data	Data Download	Trimble GPS/GNSS field data (shoreline(s), discontinuity, benchmarks).	.ssf files
Raw data	Data Download	Field data form.	Paper field sheets
Raw data	Data Download	Digital photos.	.jpg files
Provisional data	Post Process Data	GNSS differential corrections performed in Trimble Pathfinder Office.	.cor files
Accepted data	Post Process Data	Differential correction accuracy information.	.txt
Accepted data	Post Process Data	Photos renamed.	.png
Provisional data	Post Process Data	Field form data are verified and entered into database.	.mdb file
Accepted data	Post Process Data	100% cross-check performed with field data forms.	.mdb file
Accepted data	Post Process Data	Verified field forms are scanned.	.pdf
Provisional data	Export Data	Differentially corrected files exported as ESRI shapefile.	.shp files
Provisional data	QC Data	Corrected GPS data (Shapefiles) verified in GIS and error/outliers are identified.	.shp files
Provisional data	Edit	Error/outliers reconciled with field data forms and features formatted for analysis.	.shp files
Accepted data	Analysis	Edited shoreline loaded into personal geodatabase.	.mdb
Provisional data	Analysis	Analysis using DSAS creates intersect and rates tables stored within personal geodatabase.	.mdb
Accepted data	Analysis	Distance tables exported from personal geodatabase and saved in an excel spreadsheet.	.xls
Accepted data	Reporting	Scanned field data forms, raw GPS data, and provisional datasets archived locally.	.zip

Table 5 (continued). Table listing the datasets, process step, product description, and product type for each step in the shoreline monitoring workflow.

Data Type	Process Step	Product Description	Product Type
Accepted data	Reporting	Paper field data forms managed as long-term records.	Paper field sheets
Accepted data	Reporting	Accepted data and reports are published to IRMA, which include: DSAS personal geodatabase, distance table, and pictures included in report.	.zip
Accepted data	Reporting	Annual and trend reports published to IRMA	.pdf

Reporting and Analysis Schedule

The Southeast Coast Network will collect shoreline surveys in the spring annually and analyze shoreline surveys in the fall of the same year. Annual reports will be drafted the same year or prior to the next spring shoreline survey collected. Consistent with Psuty et al. (2010), long-term trend reports will be created in consultation with subject matter experts after five spring sampling events.

Section 7: Budget

The startup cost and estimated annual cost for the SECN shoreline monitoring protocol are presented in Tables 6 and 7. The network will initially perform park staff training at Cape Hatteras and Cape Lookout National Seashores. After initial training, refresher trainings will be scheduled as needed and full training will be scheduled for new staff. Meetings will be scheduled with supporting park staff when coastal project field work is being conducted in or near the park. Additionally, technical support will be provided remotely, as needed.

Table 6. Startup costs for operating for the SECN shoreline monitoring protocol.

Category	Sub-Category	Cost	Notes
Equipment and Supplies	UTV	\$12,000	—
	UTV trailer	\$4,000	—
	GPS units (2)	\$15,700	—
	GPS related software	\$5,400	—
Total	Total Startup Protocol Costs	\$37,100	—

Table 7. Estimated annual operating costs for the SECN shoreline monitoring protocol. Budget does not include park support provided. All estimates are based on fiscal year 2016 quotes.

Category	Sub-Category	Cost	Notes
Personnel	SECN Coastal Ecologist	\$28,700	0.40 FTE GS-11 ^a
	SECN Coastal Technician	\$21,100	0.40 FTE GS-5 ^a
	SECN Data Manager	\$11,600	0.10 FTE GS-12 ^a
	SECN Data Management Assistant	\$10,100	0.10 Agreement Cost
	Trained park staff	\$4,000	40 hours of work
	Total Personnel Costs	\$75,500	—
Equipment and Supplies	UTV Maintenance	\$560	—
	GPS unit maintenance warranty	\$1,100	—
	GPS unit replacement ^b	\$3,200	—
	Total Equipment Costs	\$4,860	—

^a Salaries were calculated using the step 5 of each position in FY 2017 rounded to the closest \$100 plus 35% for benefits.

^b GPS units will be replaced on a five-year schedule and are estimated at \$16,000 for two units.

^c The training is a one-day training by two SECN personnel that is performed with park staff during salt marsh field work trips, therefore limiting extra travel. This estimate is based on FY16 costs.

Table 7 (continued). Estimated annual operating costs for the SECN shoreline monitoring protocol. Budget does not include park support provided. All estimates are based on fiscal year 2016 quotes.

Category	Sub-Category	Cost	Notes
Travel	Spring CANA, FOMA, TIMU, and TIMU	\$8,000	Park housing provided by CUIS.
	Fall CANA, FOMA, TIMU, and TIMU	\$8,000	Park housing provided by CUIS.
	Training ^c	\$1,500	—
	Total Travel Costs	\$17,500	—
Total	Total Annual Protocol Costs	\$97,860	—

^a Salaries were calculated using the step 5 of each position in FY 2017 rounded to the closest \$100 plus 35% for benefits.

^b GPS units will be replaced on a five-year schedule and are estimated at \$16,000 for two units.

^c The training is a one-day training by two SECN personnel that is performed with park staff during salt marsh field work trips, therefore limiting extra travel. This estimate is based on FY16 costs.

Section 8: Safety

Implementation of this protocol has multiple complex risks. Staff will continuously evaluate all risks at the programmatic, personnel, and site level. Programmatic-level safety information is presented here, while procedures to mitigate risks associated with activities included in the protocol (such as safe operations of UTVs, vehicle use and operation, injury reporting, and accident reporting) are addressed in separate standard operating procedures listed below.

A Job hazard analysis (JHA) was completed for portions of the protocol in which risks and risk abatement strategies (including training needs) were identified (Appendix A).

Specific safety concerns include:

- Crew members will spend many hours (and miles) driving to, between, and from sampling locations to conduct the requisite sampling.
- Crew members will often work in park areas outside of communications range (either by park radio or by cell phone).

Injury or loss of life while in transit to and from field sites (via road vehicles or watercraft) are the most significant risks encountered when conducting shoreline monitoring.

Based on the JHA, it was determined that this protocol can be safely implemented provided that Southeast Coast Network and partner staff implement it in accordance with the referenced SOPs and recommended risk abatement strategies. In addition to SOPs that have been developed to safely implement this protocol, specific training needs for all staff have been identified, including certification in basic first aid. To increase the overall level of safety and awareness, obtaining additional levels of training beyond basic certifications will be encouraged.

Safety procedures are routinely reviewed with network staff and partners before field operations as prescribed in SOPs. The protocol JHA is reviewed and revised annually as a part of the performance review cycle. Safety SOPs are reviewed at least annually, and updated as necessary, to ensure that they adequately mitigate risks to personnel, property, and the public.

In addition to protocol-specific safety procedures and guidelines, SECN staff will follow the general guidelines set forth in the NPS Occupational Safety and Health Program (NPS 2008). These procedures are generally outlined below.

1. Adhere to established occupational safety and health procedures, including those contained within Reference Manual 50B (NPS 2008).
2. Work collaboratively with supervisors to develop and use JHAs or equivalent for all routine tasks and help develop and use site-specific safety plans for non-routine, complex, multi-phase jobs.
3. Properly use and maintain required clothing and/or personal protective equipment.
4. Maintain a level of personal wellness and fitness as needed for assigned work tasks.
5. Identify and correct unsafe conditions and work practices.

6. Report unsafe/unhealthful conditions and operations to an immediate supervisor or the appropriate chain of command.
7. Report mishaps, including minor accidents and "near-hits," to a supervisor as soon as possible, but in no case later than the end of the work shift.
8. Contribute to a safe work culture by practicing safe work procedures, even while working alone.

Section 9: Standard Operating Procedures

To ensure consistent implementation of this protocol over time, the following standard operating procedures (SOPs) have been identified or developed (Tables 8–10). To the greatest extent possible, SOPs are adapted from procedures approved and implemented programmatically through other monitoring efforts. Current and previous versions of operational SOPs are available for download at the NPS [Integrated Resource Management Applications portal](#).

Table 8. List of source documents, deviations, and SECN SOPs used in SECN shoreline monitoring.

Topic	Source Protocol or SOP	Explanation of Differences	SECN Updated SOP	Link
Training	Psuty, N. P., M. Duffy, J .F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service, Fort Collins, Colorado.	Modified from NCBN protocol SOP #2 to document SECN-specific methods.	Baron, L. C. 2018. Training for field data collection—Version 1.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.3.20. Southeast Coast Network, Athens, Georgia.	2253890
Planning	Psuty, N. P., M. Duffy, J .F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service, Fort Collins, Colorado.	Same methods and approach are used, but the NCBN protocol SOP #3 was modified to include SECN-specific information and more detailed instructions.	Baron, L. C. 2018. Survey timing and GPS mission planning—Version 1.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.3.21. Southeast Coast Network, Athens, Georgia.	2253892
GPS Settings and Data Collection	Psuty, N. P., M. Duffy, J .F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: Part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service, Fort Collins, Colorado.	NCBN SOP #4 and #5 were combined for the SECN SOP. Method, approach, and content are the same; the SECN SOP includes additional instruction to ensure reproducibility of data collection.	Baron, L. C. 2018. Conducting the GPS shoreline survey—Version 1.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.3.22. Southeast Coast Network, Athens, Georgia.	2253893
Post Survey Processing	Psuty, N. P., M. Duffy, J .F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service, Fort Collins, Colorado.	Same methods and approach are used, but the NCBN protocol SOP #6 was modified to include SECN-specific information and more detailed instructions.	Baron, L. C. 2018. Post survey GPS data processing—Version 1.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.3.10. Southeast Coast Network, Athens, Georgia.	2253896

Table 8 (continued). List of source documents, deviations, and SECN SOPs used in SECN shoreline monitoring.

Topic	Source Protocol or SOP	Explanation of Differences	SECN Updated SOP	Link
Analysis	Psuty, N. P., M. Duffy, J .F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service, Fort Collins, Colorado.	Same methods and approach are used, but the NCBN protocol SOP #7 was modified to include SECN-specific information and more detailed instructions to ensure reproducibility.	Baron, L. C. 2018. Coastal shoreline monitoring annual change analysis—Version 1.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.3.11. Southeast Coast Network, Athens, Georgia.	2253897
Reporting	Psuty, N. P., M. Duffy, J .F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service, Fort Collins, Colorado.	SECN created a separate annual report SOP that was modified from the NCBN protocol SOP #7 to include SECN-specific information and more specific instructions to ensure reproducibility.	Baron, L. C. 2018. Coastal shoreline monitoring annual reporting—Version 1.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.3.09. Southeast Coast Network, Athens, Georgia.	2253895
Protocol Revision	Wright, W. and S. E. Curry. 2016. Revision of Southeast Coast Network protocols and standard operating procedures—Version 2.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.1.01. Southeast Coast Network, Athens, Georgia.	SECN has a network-wide protocol revision SOP in place.	N/A	2237739
Reporting Guidelines	Wright, W., and S. E. Curry. 2016. Southeast Coast Network reporting guidelines—Version 2.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.1.02. Southeast Coast Network, Athens, Georgia.	SECN has a network-wide reporting guidelines SOP in place.	N/A	2237905

Table 9. List of source protocols, deviations, and SECN protocols addressing the shoreline monitoring database standard operating procedures included in SECN shoreline monitoring.

Topic	Source Protocol or SOP	Explanation of Differences	SECN Updated SOP	Link
Photo Management	Southeast Coast Network. 2017. Digital image management—Version 3.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.1.07. Southeast Coast Network, Athens, Georgia.	SECN has a network-wide photo management SOP in place.	N/A	2243092
Metadata	Psuty, N. P., M. Duffy, J .F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service, Fort Collins, Colorado.	Southeast Coast Network will use the already published SECN SOP with network-specific differences which has similar content as the NCBN protocol SOP #6.	Southeast Coast Network. 2016. Dataset and Metadata Publication—Version 2.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—2.1.08. Southeast Coast Network, Athens, Georgia.	2238047
Database	Psuty, N. P., M. Duffy, J .F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service, Fort Collins, Colorado.	N/A	N/A	664308

Table 10. List of source protocols, deviations, and SECN protocols addressing the shoreline monitoring safety standard operating procedures included in SECN shoreline monitoring.

Topic	Source Protocol or SOP	Explanation of Differences	SECN Updated SOP	Link
Injury	Corbett, S. L., B. D. Smrekar, M. Moore, and J. Pressnell. 2016. Identification, treatment, and reporting of on-duty injury and illness—Version 3.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.01. Southeast Coast Network, Athens, Georgia.	SECN has a network-wide injury SOP in place.	Same as source, standardized SECN SOP	2237691
Park Communication	DeVivo, J. C., and S. L. Corbett. 2016. Communicating field operations with SECN parks—Version 3.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.07. Southeast Coast Network, Athens, Georgia.	SECN has a network-wide park communication SOP in place.	Same as source, standardized SECN SOP	2238044
Vehicle Use	Southeast Coast Network. 2016. Vehicle Use and Operation—Version 2.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.03. Southeast Coast Network, Athens, Georgia.	SECN has a network-wide vehicle use SOP in place.	Same as source, standardized SECN SOP	2237830
Off Road Vehicle Use	Southeast Coast Network. 2016. Safe operations of off-highway vehicles—Version 2.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.08. National Park Service, Athens, Georgia.	SECN has a network-wide off road vehicle use SOP.	Same as source, standardized SECN SOP	2237833
Vehicle Accident	Corbett, S. L., and B. Smrekar. 2016. Motor vehicle accident reporting procedures—Version 2.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—3.1.04. National Park Service, Athens, Georgia.	SECN has a network-wide vehicle accident SOP in place.	Same as source, standardized SECN SOP	2237832

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Appendix A. Job Hazards Analysis

Table A-1. Potential hazards and recommended safety procedures for the operation of utility task vehicles (UTV) or all-terrain vehicles (ATV) at Canaveral, Cape Hatteras, Cumberland Island, and Cape Lookout National Seashores while conducting shoreline monitoring.

Basic Job Steps	Potential Accidents or Hazards	Recommended Safety Procedures
Confirm operator qualifications	No documentation of basic operator training, i.e. valid state driver's license	Cease operations until an operator is located with valid basic operator training, i.e. valid state driver's license.
Confirm operator training qualifications	UTV or ATV training not completed	Have operator review and sign the SECN Off Highway Vehicle SOP (3.1.08; SECN 2016) or complete ATV certification course.
Review SECN Off Highway Vehicle SOP (3.1.08; SECN 2016) and Shoreline Monitoring JHA	Lack of understanding what UTV or ATV Safety SOP actually states	Conduct training on equipment used for shoreline monitoring survey collections using the UTV or ATV Safety SOP, Shoreline Monitoring SOPs, and this JHA.
	Lack of knowledge and experience of equipment may lead to an incident	Provide supervised road time to ensure employee(s) can operate equipment safely before using equipment unsupervised.
Conduct pre-operations check of UTV or ATV to ensure safe operations.	Equipment failure (brakes, overheating, spills)	Inspect all equipment for serviceability using checklist.
Load UTV or ATV and equipment on trailer.	UTV or ATV becomes damaged	Load UTV or ATV onto trailer. Secure UTV to trailer by using tie downs. Apply emergency brake and leave UTV in gear.
Drive to shoreline monitoring site	–	Review SECN On Road/Highway Driving JHA and Vehicle Use SOP 3.1.03 (SECN 2016)
Unload UTV or ATV from trailer.	UTV or ATV becomes damaged	Ensure the UTV or ATV is aligned with ramp when off-loading. Remove all tie downs.
Check area as you are surveying	Soft sand	Do not drive the UTV or ATV in soft sand if the UTV or ATV feels like it is getting bogged down. Walk the stretch of soft sand and drive the UTV or ATV to the next drivable stretch of shoreline.
	Ditches, sinkholes, rocks	Identify obstructions and drive around obstructions. Walk the survey in this area if need be.
	Slopes	Identify slopes in advance and use the right equipment when cutting on slopes. If the slope is too steep, walk the stretch of shoreline and drive the UTV or ATV to the next drivable stretch of shoreline.

Table A-1 (continued). Potential hazards and recommended safety procedures for the operation of utility task vehicles (UTV) or all-terrain vehicles (ATV) at Canaveral, Cape Hatteras, Cumberland Island, and Cape Lookout National Seashores while conducting shoreline monitoring.

Basic Job Steps	Potential Accidents or Hazards	Recommended Safety Procedures
UTV or ATV Malfunctions	Vehicle Fires	All UTVs and ATVs must be equipped with a working fire extinguisher (the extinguisher should be the appropriate class type, in date and fully charged.). Never park a vehicle with a warm engine in tall grass. Be alert for hazardous fire conditions. Do not enter uncontrolled burning areas with a vehicle. Minimize flammables in and near vehicle and work area. If a vehicle is on fire, and the fire cannot be suppressed with an extinguisher, MOVE 75 ft AWAY FROM THE VEHICLE. Under no circumstances should you re-enter the vehicle to remove belongings or equipment when a vehicle is burning. Call 911 immediately or the proper emergency response number by your location.
Load UTV or ATV and equipment on trailer.	UTV or ATV becomes damaged	Load UTV or ATV onto trailer. Secure UTV or ATV to trailer by using tie downs. Apply emergency brake and leave UTV or ATV in gear.
Drive to UTV or ATV storage site	–	Review SECN On Road/Highway Driving JHA and Vehicle Use SOP (3.1.03; SECN 2016)
Conduct post-op check of equipment.	Equipment requiring repair	Identify repairs that are detrimental to safety and the environment. Ensure all employees are aware that equipment is not to be used until repaired. Schedule to drop UTV or ATV off at certified UTV or ATV repair shop.
Perform field maintenance of equipment (as needed).	Breakdown of equipment due to regular service not performed	Perform yearly maintenance of UTV or ATV at certified UTV or ATV location.

The recommended safety procedures for conducting shoreline monitoring are outlined below. The required personal protective equipment and corresponding hazards are detailed in Table A-2.

- Vehicle operators will review SECN Off Highway Vehicle SOP 3.1.08 (SECN 2016).
- Personal Protection Equipment required: DOT approved helmet, helmet face shield or impact/shatter-resistant eyewear, gloves, and sturdy footwear (close-toed, above ankle, leather work boots).
- The supervisor and safety officer approve additional PPE. The employee is responsible for wearing proper PPE.

- The supervisor will not authorize employees to operate UTVs or ATVs without safe field attire.
- The supervisor is responsible for verifying that the employees are wearing proper PPE as a condition for authorized use of UTV or ATV.
- Wear sunscreen when exposure to sun is likely to result in sunburn.
- Employee should be carrying at least one communication device in order to stay in contact with fellow employees.
- Wear ear protection when driving UTV long distances.

Table A-2. Personal protective equipment required while conducting shoreline monitoring at Canaveral, Cape Hatteras, Cumberland Island, and Cape Lookout National Seashores, Fort Matanzas National Monument, and Timucuan Ecological and Historic Preserve.

PPE Required	Potential Accidents or Hazards
Helmet (required for UTV and ATV use)	Head injury
Safety Eyewear	Blowing sand in eyes
Gloves	Hand injury
Close-toed shoes	Foot injury
Sunscreen	Sunburn
Communication Device	No means of communication

Table A-3. Environmental & General Hazards encountered doing general fieldwork while conducting shoreline monitoring at Canaveral, Cape Hatteras, Cumberland Island, and Cape Lookout National Seashores, Fort Matanzas National Monument, and Timucuan Ecological and Historic Preserve.

Potential Accidents or Hazards	Recommended Safety Procedures
Treatment of general injuries	All NPS staff and contractors are required to have current (American Red Cross) or biannual (American Heart Association) First Aid and CPR training course. Always carry standard PPE, which includes a first aid kit, compass, safety whistle, hydration bladder/water bottles.
Tick Bites (Lyme Disease, Rocky Mountain Spotted Fever)	Spray clothing with insect repellent (e.g., Permethrin) as a barrier. Wear light colored clothing that fits tightly at the wrists, ankles, and waist. Each outer garment should overlap the one above it.

Table A-3 (continued). Environmental & General Hazards encountered doing general fieldwork while conducting shoreline monitoring at Canaveral, Cape Hatteras, Cumberland Island, and Cape Lookout National Seashores, Fort Matanzas National Monument, and Timucuan Ecological and Historic Preserve.

Potential Accidents or Hazards	Recommended Safety Procedures
Tick Bites (Lyme Disease, Rocky Mountain Spotted Fever) (continued)	Cover trouser legs with high socks, boots, or nylon gaiters OR duct tape pant legs to shoes. Tuck in shirt tails. Search the body on a regular basis, especially hair and clothing; ticks generally do not attach for a couple of hours. Run your fingers across your skull feeling for any atypical bumps. If a tick becomes attached, use tweezers to grasp the tick as close as possible to the point of attachment, turn counter clockwise for one/two turns, wait for 2-3 seconds and pull straight out with gentle pressure. If tweezers are not available, use a tick twister (preferred) tool. Wash skin with soap and water, then cleanse with rubbing alcohol Place the tick in an empty container for later identification if the victim should have a reaction. Record dates of exposure and removal. Do not try to remove the tick by burning with a match or covering it with chemical agents. If you cannot remove the tick, or the head detaches, seek prompt medical help If you are bitten by a tick, first document it on tick log, then watch for warning signs of illness: a large red spot on the bite area; fever, chills, headache, joint and muscle ache, significant fatigue, and facial paralysis are reactions that may appear within two weeks of the bite. Symptoms specific to Lyme disease include: confusion, short-term memory loss, and disorientation. Review the CDC documents relating to tick-borne diseases at the CDC tick-borne disease website.
Tetanus	Insure tetanus booster is up-to-date. Wear all-leather-upper protective footwear
Allergic Reactions, Insect Stings	If a bite/sting victim develops hives, asthmatic breathing, tissue swelling, or a drop in blood pressure, seek medical help immediately. If you or anyone you are working with is known to have allergic reactions to bee, wasp, hornet, yellow jacket, or other insect stings, tell the rest of the crew and your supervisor. Make sure the person that is allergic carries emergency medication (EpiPen, etc.) with you at all times AND that the team knows how to administer that medication.

Table A-3 (continued). Environmental & General Hazards encountered doing general fieldwork while conducting shoreline monitoring at Canaveral, Cape Hatteras, Cumberland Island, and Cape Lookout National Seashores, Fort Matanzas National Monument, and Timucuan Ecological and Historic Preserve.

Potential Accidents or Hazards	Recommended Safety Procedures
Allergic Reactions, Insect Stings (continued)	Wear long sleeve shirts and trousers; tuck in shirt. Bright colors and metal objects may attract bees. If you are stung, cold compresses may bring relief. Also, it is advisable to take Benadryl immediately if multiple stings are received. Minimize exposure to plants that cause contact dermatitis (poison ivy, Brazilian peppertree, poison sumac, etc.), EVEN if you don't typically react to them (immunity breaks down with continued exposure). If you are known to have severe reactions, wear ivy block before exposure, and use neutralizing soaps (e.g., Technu) if exposure occurs. Wear long sleeves, long pants, and gloves if working in dense areas with dermatitis-inducing plant species.
Mosquito Bites—Skin Irritation, Encephalitis	Wear long sleeves and trousers. Avoid heavy scents, such as strong soap, lotion, or perfume. Use insect repellents. If using Permethrin, do not apply directly to skin; apply to clothing only. Carry after-bite medication to reduce skin irritation.
Dehydration	Drink at least a half a quart of water every hour. Limit caffeine intake, as caffeine dehydrates you. Carry sufficient amounts of water. Avoid prolonged exposure to sun. Wear hat with wide brim for shade. Use electrolyte supplements or drink sports drinks (e.g., Gatorade).
Uneven Terrain/Tripping	Wear all-leather-upper, lace up, 6" minimum high boots with nonskid rubber soles. Test and use secure footing. Walk, never run, down slopes. Maintain a safe walking distance between people.
Uneven Terrain/Tripping (Continued)	In heavy undergrowth, lift knees high to clear obstacles. Know how to fall. Try to land in the least obstructed spot. Protect your head and back. Roll with the fall. Do not stick out your arms to break a fall. Use the entire sole of your boots to increase traction and also reduce the fatigue associated with walking on the toes

Table A-3 (continued). Environmental & General Hazards encountered doing general fieldwork while conducting shoreline monitoring at Canaveral, Cape Hatteras, Cumberland Island, and Cape Lookout National Seashores, Fort Matanzas National Monument, and Timucuan Ecological and Historic Preserve.

Potential Accidents or Hazards	Recommended Safety Procedures
Solar Ultraviolet Radiation	Keep exposed skin covered by wearing a hat, a bandanna, and a long sleeved shirt. Use protective sunscreen lotion.
Fatigue	Know the limits of your own body (e.g., tolerance to heat and cold, allergies, strength, endurance, etc.), pursue physical conditioning prior to the field season if necessary, and do not overexert yourself.
Working in Isolated Areas	Use the buddy system and carry a cellular phone or NPS park radio. Always be alert. Follow network procedures for checking in and out with park staff. Never work alone or leave partner alone. Exceptions may apply to the coastal ecology program when an individual may be required to work alone, but will always have access to communications (cell phone, satellite device, etc.). When possible, it is strongly advised to work in pairs.
Heat Stress	Take appropriate breaks. Maintain proper hydration and electrolyte consumption. Slow pace or reduce field hours if heat index is high (over 95° Fahrenheit, or 35° Celsius).
Cold Stress/Hypothermia	Wear layered clothing, gloves, hard hat with winter liner, etc. During cold weather, layer clothing and wear wind impervious outerwear; during warm months, wear a long sleeve cotton shirt.
Weather	Know the weather forecast prior to going into the field. Enable weather alerts on GPS units, portable radio, or cell phone. If a tornado approaches and you are caught in the field, take shelter in low area, lie flat on belly, and cover head. There is no safe place outdoors in a lightning storm, but if lightning approaches and you are caught in the field, avoid: standing water if possible, isolated trees, picnic tables, pavilions, flagpoles, metal objects, and fences. Seek shelter under a large grove of trees (preferably shorter than those around it), squat close to ground, keep feet together, tuck head down, close eyes and cover ears, stay 50 feet apart from other people, and remove metal objects from your person. If caught in a storm away from an enclosed vehicle, try to find some form of enclosed building or shelter. DO NOT seek shelter in the UTV, under large trees, or in open areas. Seek shelter in low lying areas such as a ditch.

Table A-3 (continued). Environmental & General Hazards encountered doing general fieldwork while conducting shoreline monitoring at Canaveral, Cape Hatteras, Cumberland Island, and Cape Lookout National Seashores, Fort Matanzas National Monument, and Timucuan Ecological and Historic Preserve.

Potential Accidents or Hazards	Recommended Safety Procedures
Flash Floods	DO NOT TRY TO WALK, DRIVE, OR OTHERWISE CROSS FLOODWATERS. Keep in mind that floodwaters are swift moving, even if they don't appear to be on the surface. It is possible to drown in just a few inches of water if swept away by floodwaters. Especially important when working in stream and river areas, workers should be aware of the possibility of flash floods. When working in stream and river environments, at least one team member should watch nightly weather reports or monitor weather band radio to assess if weather conditions for flash floods may exist. If caught in a flash flood while in a boat, point the boat downstream and continue with the flow until it is safe to pull to the bank. If caught in a flash flood while in an automobile, abandon the vehicle immediately and move to higher ground. If the vehicle is submerged, don't panic, allow the vehicle to fill with water, and open the doors when the vehicle is full (doors won't open until the water pressure is equal outside and in). Opening windows will expedite the process. Hold your breath and swim for the surface and toward the bank if possible. If caught in a flash flood while on foot, immediately move to higher ground.
Weather conditions	Changes in climatic conditions require adjusting to different weather situations. Turn on headlights when using windshield wipers during rain. Do not drive in adverse weather conditions if the trip can be delayed. Avoid being rushed; you will need more time to prepare the vehicle and get to your destination. Remove all frost and snow prior to starting your trip. Make sure vents are clear of snow to provide adequate airflow for defrosting.
Hand Tool Use	Always use hand tools for the purpose for which they are intended (use the "right tool for the job"). Wear protective eyewear and clothing while using hand tools if there is any chance of flying debris.

Appendix A. Literature Cited

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Appendix B. Maps of Shoreline Monitoring Area of Each Park

Cape Hatteras National Seashore



Figure B-1. Map of shoreline survey area (red polygon) at Cape Hatteras National Seashore.

Cape Lookout National Seashore



Figure B-2. Map of shoreline survey area monitored (red polygon) at Cape Lookout National Seashore.

**Cumberland Island National Seashore
Shoreline Study Area**

Southeast Coast Network
National Park Service
U.S. Department of the Interior

Map showing the Cumberland Island National Seashore Shoreline Study Area. The study area is highlighted in red along the coastline. Key features include the Satilla River, Cumberland River, and various creeks. The map also shows the surrounding water bodies, including St. Andrew Sound and the Atlantic Ocean. A scale bar and north arrow are included.

Scale: 0 to 4 Miles / 0 to 6 Kilometers

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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Timucuan Ecological and Historic Preserve



Figure B-4. Map of shoreline study area (red polygon) at Timucuan Ecological and Historic Preserve.

Fort Matanzas National Monument

Fort Matanzas National Monument Shoreline Study Area

Southeast Coast Network
National Park Service
U.S. Department of the Interior

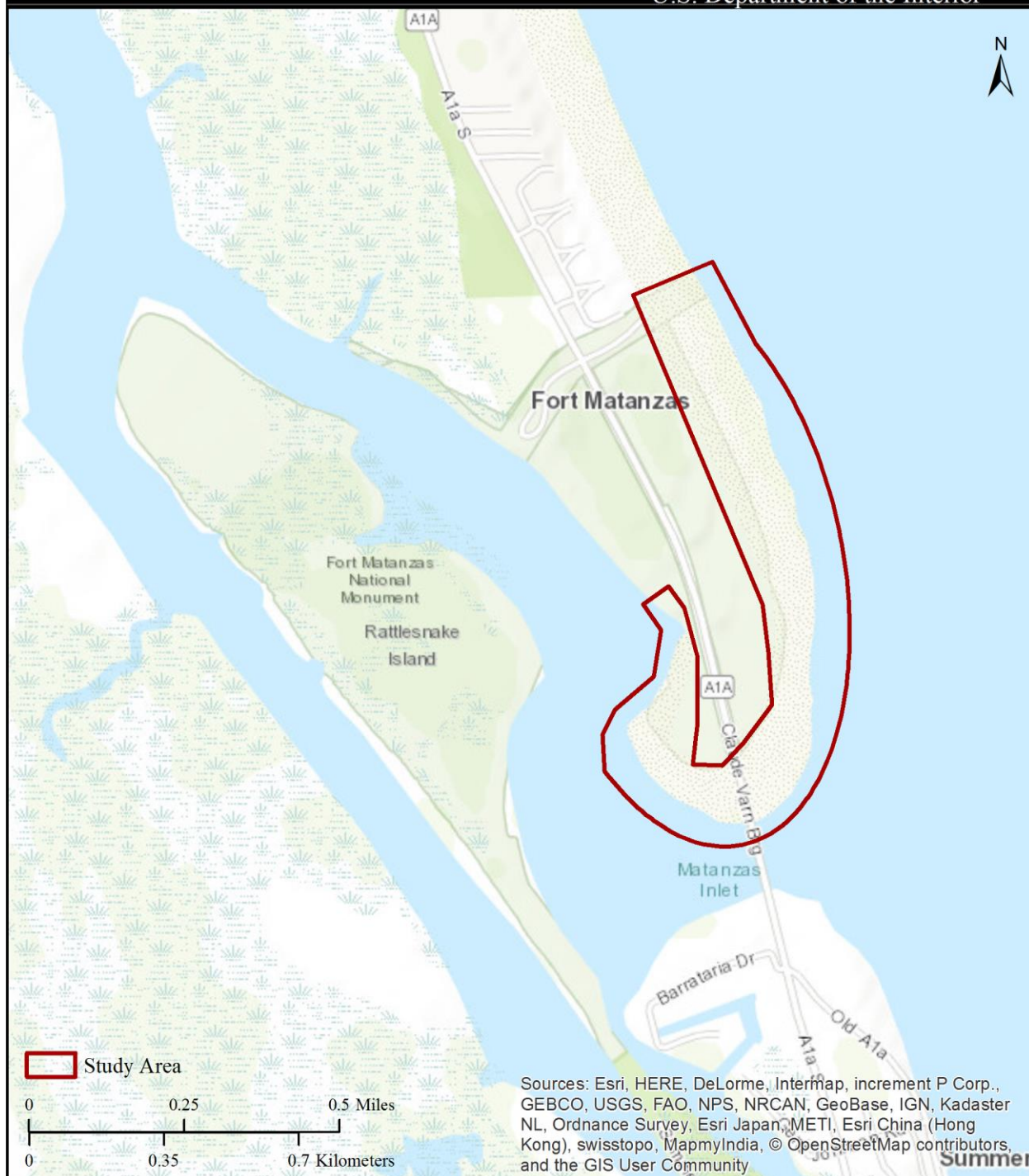


Figure B-5. Map of shoreline survey study area (red polygon) at Fort Matanzas National Monument.

Canaveral National Seashore

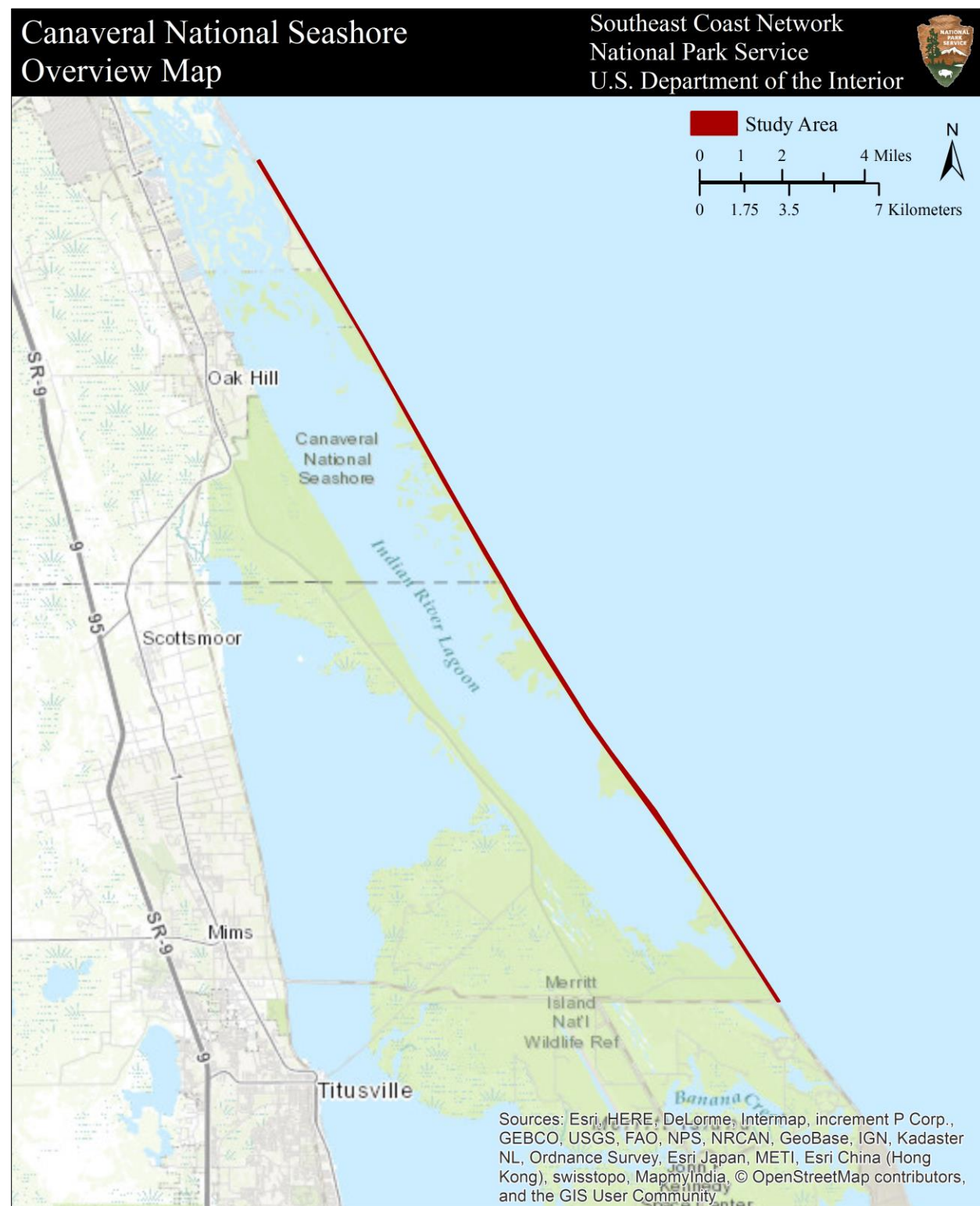


Figure B-6. Map of the shoreline study area (red polygon) at Canaveral National Seashore.

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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1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525